SCIENCE

Level

F	1	2	3	4	5	6	B6

Society's ideas have changed

Strands
Science and Society, Earth and Beyond, and Life and Living

Key concepts
Decisions about the ways that science is applied have short- and long-term implications for the environment, communities and individuals.

Living things use the resources of the Earth, solar system and universe to meet their needs.

Environments are dynamic and have living and non-living components which interact.

Purpose

Activities in this module are designed to help students understand that applications of science have been influenced by social attitudes. These attitudes include those related to the Earth being a resource that may be used for different purposes and the consequences of that use.

Students will have opportunities to:

- investigate various aspects of water catchment areas;
- interpret data and draw conclusions about the health of a catchment area;
- communicate decisions based on scientific evaluations within a social context.

Overview of activities

The following table shows the activities in this module and the way in which these are organised in **introductory**, **developmental** and **culminating** phases.

Introductory ►	Developmental ►	Culminating
The story of a river	Good versus poor catchment management	The story of a river revisited
In which catchment area do I live?	Trees and watertables	Planning a model catchment basin
	Monitoring water quality	
	Role-play: Clearing the hills	

Queensland School Curriculum Council
Queensland Government Department of Natural Resources

Core learning outcomes

This module focuses on the following core learning outcomes from the Years 1 to 10 Science Syllabus:

Science and Society

4.3 Students present analyses of the short- and long-term effects of some of the ways in which science is used.

5.3 Students analyse the relationship between social attitudes and decisions about the applications of science.

6.3 Students use scientific concepts to evaluate the costs and benefits of applications of science (including agricultural and industrial practices).

Earth and Beyond

4.3 Students summarise information to compare ways in which different communities use resources from the Earth and beyond.

5.3 Students prepare scenarios about the use of renewable and non-renewable resources of the Earth and beyond.

6.3 Students argue a position regarding stewardship of the Earth and beyond, and consider the implications of using renewable and non-renewable resources.

Activities in this module provide opportunities for students to engage with understandings relevant to the following core learning outcome from the Life and Living strand.

Life and Living

5.3 Students evaluate the consequences of interactions between the living and non-living parts of environments.

Core content

This module incorporates the following core content from the syllabus:

Science and Society

Applications of science

- community, environment, agriculture

Short-term effects (costs and benefits) for:

- environment — pollution of water

Long-term effects (costs and benefits) for:

- the environment — degradation, habitat loss, agricultural practices, sustainability, biodiversity
- the home and community — use and supply of chemicals (water)

Futures

- sustainability
- planning

Earth and Beyond

Using the Earth's environment

- to obtain needs — water
- for human recreation — aesthetics, waterways

Caring for the environment

- managing human impact on land and water

Information as a resource

- for making predictions
- for utilising and conserving resources
- for considering ideas of futures and sustainability

Life and Living

Types of environments — aquatic

Human influence

- changes in biodiversity — conservation
- modification of habitat — agricultural practices (grazing, irrigation, soil degradation), urbanisation

Assessment strategy

Suggestions for gathering information about student learning are provided in each of the activities in this module. Once sufficient information has been collected, judgments can be made about students' demonstrations of outcomes. Typical demonstrations of this module's intended outcomes are provided here to indicate the pattern of behaviour to look for when making judgments.

Science and Society

4.3 Students present analyses of the short- and long-term effects of some of the ways in which science is used.

Students may:

- describe the effects of various human impacts on waterways — for example, soil erosion, nutrient loading;
- interpret data and draw conclusions about the health of a waterway;
- relate tree clearing to the problems caused by rising watertables.

Science and Society

5.3 Students analyse the relationship between social attitudes and decisions about the applications of science.

Students may:

- evaluate scenarios that represent various approaches to catchment management;
- describe the community decision-making processes implicit in an integrated catchment management approach.

Science and Society

6.3 Students use scientific concepts to evaluate the costs and benefits of applications of science (including agricultural and industrial practices).

Students may:

- evaluate the costs and benefits of various catchment management approaches for a range of stakeholders within a catchment area.

Earth and Beyond

4.3 Students summarise information to compare ways in which different communities use resources from the Earth and beyond.

Students may:

- list different land uses that occur in catchment areas;
- discuss ways that various groups of people use particular environments;
- gather information about the effects on an environment of a variety of land-use activities.

5.3 Students prepare scenarios about the use of renewable and non-renewable resources of the Earth and beyond.

Students may:

- make and judge observations about the effects of various land-use practices on an environment;
- explore and elaborate ideas about different approaches to management of renewable and non-renewable aspects of an environment;
- compare different approaches to management recognising the needs and interests of different groups of society.

6.3 Students argue a position regarding stewardship of the Earth and beyond, and consider the implications of using renewable and non-renewable resources.

Students may:

- explain the short- and long-term effects on renewable and non-renewable resources of some management practices;
- summarise and report on the use different groups in society make of an environment;
- suggest management practices that can accommodate the needs of different groups of society in a sustainable way.

Life and Living

5.3 Students evaluate the consequences of interactions between the living and non-living parts of environments.

Students may:

- explain the relationship between the clearing of trees high in a catchment area and possible salting effects in lower areas.

Background information

Current scientific conceptions

Catchment areas

A catchment area or basin is land that is bounded by natural features, such as hills or mountains, and from which all run-off water flows to a low point. Catchment areas vary in size and make-up. Large catchment areas, such as those drained by the Fitzroy River (central Queensland) and Burdekin River (northern Queensland), are bordered by mountain ranges and include major drainage networks of creeks and rivers. Large catchment areas are made up of hundreds of smaller 'sub-catchment areas'. These may be bordered by low hills and ridges and drained by only a small creek or gully.

A range of natural resources and land uses will be found in a catchment area from the headwaters to the mouth of a river or lake, but these may vary greatly. Some of the following may be found:

cities and towns
crops and pastures
dams
domestic animals
farms
forestry areas
gardens
homes
industry
irrigation systems
national parks
natural vegetation
recreation facilities
refuse
sewerage system
transport routes
water
wildlife
windmills and pumps

Events in one part of a catchment area are likely to affect other parts of the catchment area. For example:

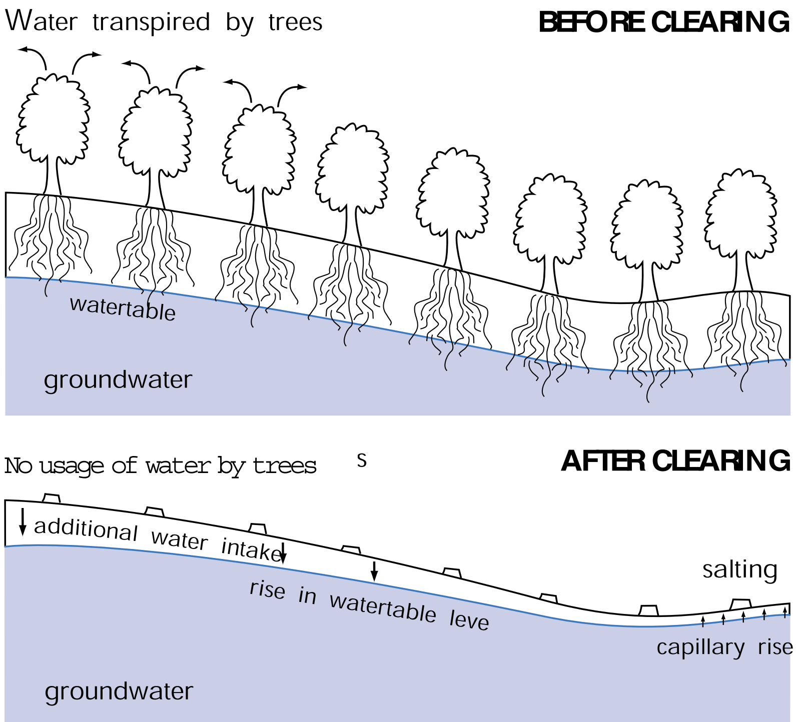
- soil erosion on a farm in the upper parts of a catchment area may lead to erosion or siltation lower in the catchment area, affecting water quality;
- tree clearing in one part of the catchment area may cause soil salinity problems or erosion in other areas or contribute to declining biodiversity in the catchment area;
- inappropriate use of agricultural chemicals in one part of the catchment area may affect water quality in streams, rivers, lakes and the ocean.

A lack of understanding of the Australian continent has resulted in some land-management practices that have caused serious environmental problems. These problems include rising watertables, soil erosion, water pollution and the loss of biodiversity. Agricultural and environmental scientists monitor these problems and conduct research into strategies for remediation.

Watertables and salinity

Groundwater is any water that is stored below the plant root zone. It is more commonly thought of as water that occupies openings, cavities and spaces in layers of rocks and other geological materials well beneath the surface of the Earth. The source of most groundwater is rainfall and surface water that percolates below the surface. The term 'watertable' is used to describe the upper surface of groundwater. Normally, the watertable is located well below the surface of the ground and does not affect plants.

Salts contained in the soils are dissolved in the water percolating through them. In areas where the watertable is close to the surface, capillary action draws salty water to the soil surface. Also, evaporation of water from the surface concentrates salts. Many crops are intolerant of these conditions.



Saline soils occur naturally in parts of coastal, south-west and northern Queensland. Salinity may also be induced by particular land-management practices. The large quantities of water transpired by trees contribute to a lower watertable. Tree clearing may result in a rise in groundwater levels with salts being concentrated at the soil surface by evaporation. Irrigation may lead to salinity when water with high salt levels is used or when the excessive use of water results in a rise in the watertable.

Riparian vegetation

The riparian zone is the zone directly adjoining a waterway. It includes bank vegetation, which covers the bank, and verge vegetation, the strip of land up to at least 30 metres from the waterway channel. The land beyond this is considered to be the surrounding land-use area.

Integrated catchment management

There are now well-developed techniques for dealing with rising watertables, degradation of waterways and for reducing soil erosion from agricultural land. To be effective, these techniques need to be implemented by farmers and graziers. Technologies are also available for improved sewage treatment. While these new technologies have been developed using scientific knowledge and practices, they need to be implemented in a social context. The debates about which technologies and practices might be implemented, and the extent, influence public policy.

Integrated catchment management is an approach to managing natural resources that seeks to balance the various uses of land, water and other natural resources in river catchment areas in ways that ensure the future preservation of the environment while maintaining sustainable production. The Queensland Government adopted this strategy in 1991. It seeks to bring together a range of people who are involved in land-use decisions within a catchment area. The people involved could include farmers, graziers, conservationists, state and local government representatives, industrialists and other community members. Together they comprise a catchment coordinating committee that produces catchment management strategies.

Students' prior understandings

Some students may think that:

- the phrase 'catchment area' means a dam or water storage facility;
- the word 'pollution' is associated only with industrial chemical pollution;
- excessive amounts of nitrates and phosphates in waterways do not constitute pollution problems because the chemicals have a natural origin;
- turbid water is polluted water.

Teachers can provide students with opportunities to broaden their understanding by supporting students as they:

- collect information about environments and ways they are used as a resource by humans and other living things;
- explore the impact that activities, especially human activities, have on the environment;
- identify ways that environments are managed and compare the effects of different management practices.

Terminology

Terms associated with catchment management that are essential to the activities in this module include:

aeration	erosion	nitrogen	storage
aquatic	estuary	nutrient	sulfate
biodiversity	feedlot	percolate	toxin
catchment area	groundwater	phosphorus	watertable
ecosystem	integrated catchment management (ICM)	riparian	wetlands
effluent			

Students may already be familiar with some of these terms and understand their meanings and use in scientific contexts. If so, the activities in this module will provide opportunities for them to evaluate current usage. If not, these activities will provide opportunities for students to develop their understandings.

Strategies for role-play

Role-play is used in this module to encourage students to consider ideas from the points of view of groups of society other than the ones to which they belong. Some strategies have been included here to inform teachers who may not be familiar with this technique.

At the beginning of the role-play there needs to be an agreement that the students will go into role and 'pretend' to be people other than themselves. This could be as simple as a statement such as: 'I would like us to undertake a role-play of (names of role-play). Are you all prepared to do this?'

Some rules or parameters may need to be set. For example:

- We will listen to each other.
- We agree not to be silly or disruptive.
- We agree to go along with the fiction.

Students will need to be reminded that:

- students adopt the roles of different people involved in the situation;
- students adopt the points of view of the role;
- students do not present their own views.

Students should have a clear outline of a scenario for the role and a clear understanding of the attitude of the character to the situation in the role-play.

- Students who do not have specific roles form the audience and may ask questions. Being in the audience is also adopting a role — a group role.
- Any argument that develops in the role-play is between the roles and not between the individual students.
- Students may use props to help them get into the role.

There need to be signals for 'in' and 'out' of role. For example, badges could be worn (possibly with the names of the characters on them). When the badge is being worn, the person is in role. Taking the badge off indicates that they are out of role and are being themselves.

The most important part of a role-play is the debriefing, both with respect to identifying and clarifying what was learnt (not just reinforcing previous stereotyped positions) and dealing with any strong emotions.

School authority policies

Teachers need to be aware of and observe school authority policies that may be relevant to this module.

Safety policies are of particular relevance to the activities that follow. It is essential that demonstrations and student activities are conducted according to procedures developed through appropriate risk assessments at the school.

In this module, teachers need to consider safety issues relating to:

- handling biological material including live animals and plants;
- conducting excursions to field study sites.

Support materials and references

Print resources

Brisbane City Council 1998, *Best Practice Guidelines for the Control of Stormwater Pollution from Building Sites*.

Foster, D., Queensland Department of Primary Industries, Brisbane:
1994, *Waterwatch Queensland Technical Manual*
1995, *Waterwatch Action by School Communities*

Foster, D., Rob, J. & Yorkston, T. 1995, *Waterwatch and Your Catchment*, Queensland Department of Primary Industries, Brisbane.

Hauenschild, P. 1999, *Forest Management Education Activity Series — Forest Waterways, Years 7–9*, Queensland Department of Natural Resources, Brisbane.

Hobson, M. & Carey, B. 1994, *State of the Land: An Overview of Land Management Issues in Queensland*, Queensland Department of Primary Industries, Brisbane.

Hobson, M. & Hunt, K. 1994, *Saltwatch: Information Book*, Queensland Department of Primary Industries, Brisbane.

Hunter, H. M., Eyles, A. G. & Rayment, G. E. 1995, *Downstream Effects of Land Use*, Queensland Department of Natural Resources, Brisbane.

Kelly, K. 1992, *Catchment Care Education Kit*, Queensland Department of Primary Industries, Brisbane.

Landcare Queensland 1997, *Case-study Oxley Creek Environment Group*, Queensland Department of Natural Resources, Brisbane.

Queensland Department of Education 1993, *P–12 Environmental Education Curriculum Guide*, Brisbane.

Queensland Department of Natural Resources, *Landcare and ICM News*, Brisbane.

Smith, M. 1998, *Natural Resource Monitoring Guide*, Department of Natural Resources, Brisbane.

CD-ROMs

Queensland Department of Primary Industries 2000, *Prime Notes*, version 9. (This CD-ROM is updated regularly and currently contains over 3900 fact sheets on a wide range of issues related to primary production. Environmental topics include landcare, erosion, salinity, soil acidification, weed and pest control, and use of chemicals.)

University of Wollongong & NSW Department of Land and Water Conservation 1996, *Exploring the Nardoo: An Imaginary Inland River to Investigate, Maintain and Improve*.

Websites

Additional resource material and activities related to this module are available from the Queensland Department of Natural Resources website: http://www.dnr.qld.gov.au/education (accessed November 2000).

The following websites may also be useful:

Alice Ferguson Foundation, Hard Bargain Farm Environmental Center. Available URL: http://www.fergusonfoundation.org/ (accessed November 2000).

Australian Association of Natural Resource Management. Available URL: http://www.soil-water.org.au (accessed November 2000).

Environmental Education in Australia. Available URL: http://ee.environment.gov.au/pd/tsw/intros/index.html (accessed November 2000).

Landcare Australia. Available URL: http://www.landcareaustralia.com.au (accessed November 2000).

Queensland Department of Primary Industries. Available URL: http://www.dpi.qld.gov.au (accessed November 2000).

Queensland Environmental Protection Agency. Available URL: http://www.env.qld.gov.au (accessed November 2000).

Waterwatch Victoria. [Follow links from 'For the teacher' to 'Waterwatch Manual'.] Available URL: http://www.vic.waterwatch.org.au/ (accessed November 2000).

ACTIVITY

The story of a river

Introductory

Focus

This activity provides opportunities for students to identify the short- and long-term effects of water within a catchment area. It also introduces students to some of the decision-making processes involved in managing catchment areas.

Materials

For the class:

- one clear container (4–5 L) filled with water (e.g. punchbowl or small fishbowl)
- 16 film canisters (available from some photographic laboratories)
- substances listed in Resource Sheet 1 — to be placed in canisters
- 16 labels — to be attached to the film canisters (see Resource Sheet 1)

For the teacher:

- Resource Sheet 1, 'The story of a river — information'

For each student:

- Resource Sheet 2, 'The story of a river'

Teaching considerations

Some students with vision impairment may need assistance for this activity. Seek advice from their support teacher.

Resource Sheets 1, 2

The preparation necessary for this activity is described in Resource Sheet 1.

Role allocation

In this activity, students see the accumulated effects of various land uses on a river. As the story (Resource Sheet 2) is read to the class, students pour the contents of film canisters into a clear container filled with water. There are 16 land uses identified in the activity. This number can be adapted to suit the number of students in the class. For example, each land use could be assigned to two students, some land uses could be omitted or more than one could be allocated to a student. Some land uses could be omitted if they are not relevant to a particular catchment area.

Introduction

Introduce the activity by discussing that Australia is the driest inhabited continent; water is very precious; and many ecosystems are under threat of pollution from human actions. Everyone lives in a catchment area and contributes directly or indirectly, significantly or not so significantly, to the degradation of waterways. Often people do not realise the impacts they have.

The title of the river in the story has been left open so that the name of a local river that runs through the local catchment area may be included. The story can be adapted to include issues relevant to the local catchment area.

Monitoring changes

To reinforce the changes that are occurring, some simple water testing could be done as the story unfolds. For instance, salinity or turbidity measurements could be taken. Alternatively, students can record their observations, describing events that happened and changes that resulted.

Simulations

Discuss with students how models or simulations can be used to explain complex ideas. Discuss also the limitations of the particular simulation being used and the features of the simulation that may not correspond to the real situation. It is important that strategies used to explain or clarify one concept do not create misconceptions about others.

Working scientifically

Time: 30 minutes

Exploring phenomena
Making and judging observations
Constructing meaning
Formulating and elaborating ideas
Making links
Describing
Responding

Resource Sheet 2

▶ Students sit around the container filled with clear water and listen to the teacher read the 'The story of a river' (Resource Sheet 2). On cue, students pour the contents of their canisters into the container.

▶ Students discuss their initial responses to the story. Stimuli for discussion could include the following:

- What did each of the materials added to the water represent?
- Suggest how some people would react to the changes in the colour and look of the river.
- Why would they react in this way?
- How would you react if you had to drink or swim in this water?
- Why was the water so different in appearance at the end of the story?
- Do you think this is like a real situation?
- Is this how pollution might occur in our river?

▶ Students discuss their understanding of the terms 'water quality' and 'water pollution'.

▶ Students individually read a copy of the story and identify the issues that relate to the way in which the catchment area is managed. These issues could include:

- heat pollution;
- nutrient loading;
- salinity;
- soil erosion;
- litter;
- industrial and pesticide pollution.

Students share their lists with a partner and then form groups of four by joining two pairs to negotiate a group list. Students report their ideas to the class.

▶ In groups, students suggest ways that pollution in a catchment area could affect them personally. They discuss how accumulated pollution could affect a lake into which a river flows and then the coast and ocean. Students discuss how these effects would in turn affect communities and individuals.

▶ Students rank items in their lists of effects from highest to lowest in terms of the impact on the environment. They suggest:

- reasons the activities leading to water pollution continue to occur;
- measures that could be used to prevent or reduce water pollution;
- where the measures could be used to raise people's awareness of water pollution.

► Students prepare a response to the story and the subsequent discussions. They group their responses under the following headings:

- nature of the catchment area;
- activities that can cause water pollution in the catchment area;
- local actions to improve the quality of its creeks, lakes and rivers.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' lists of catchment area issues;
- students' written responses to the activity.

ACTIVITY

In which catchment area do I live?

Introductory

Focus

This activity provides opportunities for students to identify and investigate the local catchment area.

Materials

For each group of students:

- a laminated contour map of the local catchment area
- overhead transparency of the catchment map
- water-based overhead projector pens

Teaching considerations

To identify a catchment area, follow each stream back to its origin. On maps with contour lines, the highest areas between one river/creek and the next denotes the catchment boundary.

Catchment maps

Maps are available from the Department of Natural Resources Services Centre (telephone [07] 3896 3216). It is necessary to specify the catchment area required. For advice on the extent of your catchment, contact your local Catchment or Waterwatch Coordinator or the local council. A list of Waterwatch coordinators is included in the Natural Resource Management Catalogue, a free resource sent to each school. Contact the Department of Natural Resources for extra copies.

Students with vision impairment

Some students with vision impairment may need assistance for this activity. Seek advice from their support teacher.

Working scientifically

Time: 60 minutes

Engaging with problems
Identifying
Drawing conclusions
Interpreting data
Discussing thinking

▶ Working in groups of three or four, students examine the local catchment map provided and mark the boundary of the catchment area.

▶ Students discuss the impact of human activity on this catchment area by identifying and listing:

- types of land use — for example, grazing, crop farming, recreational, residential, industrial;
- types of natural vegetation or natural features in the area — for example, open forest, mangrove, wetland, beaches;
- features that humans have created or altered — for example, dams on rivers or creeks; barrages; fish ladders; sewage and effluent treatment plants and discharge areas.

▶ Students discuss the possible impacts that these uses and features have on the natural vegetation and waterways of the catchment area. They could record the main points of their discussion in a table such as the one on the next page.

Impact on waterways

Land use or feature	Possible impact
Grazing	• Trees are removed, possibly leading to erosion. • Wastes from cattle add to the nutrient load in local creeks. • Pasture is improved and grass cover is increased. • Dams are created, reducing run-off.

▶ Groups share information in a whole-class discussion. An overhead transparency of the catchment map could be used to locate various features during the discussion. Students then compile a list of the environmental issues in the catchment area.

Gathering information about student learning

Sources of information could include:

- group maps and human impacts table;
- students' contributions to discussions.

Source: This activity is adapted from Kelly, K. 1992, *Catchment Care Education Kit*, Queensland Department of Primary Industries, Brisbane.

ACTIVITY

Good versus poor catchment management

Developmental

Focus

This activity provides opportunities for students to analyse decisions made about land management and the underlying scientific knowledge used to justify management strategies.

Students evaluate scenarios that represent various catchment management issues.

Materials

For each student:

- Resource Sheet 3, 'Good versus poor catchment management'

For each group:

- Resource Sheets 4–8, 'Fact sheets'
- butcher's paper (or overhead transparency sheets) and pens

Teaching considerations

Information on five catchment management issues has been included in Resource Sheets 4–8. Select issues that relate to the local area. The number of issues studied will depend on the size of the class. Adjust the number of students in the groups to match the number of issues that are examined.

Sources of information to support this activity include fact sheets available from the following:

- Queensland Department of Natural Resources: http://www.dnr.qld.gov.au
- Queensland Department of Primary Industries: http://www.dpi.qld.gov.au
- Queensland Department of Primary Industries, *Prime Notes* CD-ROM (see 'Support materials and references', p. 9).

Working scientifically

Engaging with problems
Exploring phenomena
Constructing meaning
Dealing in an orderly manner with the parts of a complex whole
Examining and evaluating
Making links
Preparing scenarios
Synthesising
Creating presentations
Discussing thinking
Supporting decisions

Resource Sheets 3–8

Time: 60 minutes

▶ Students individually read the scenarios on Resource Sheet 3. Each student decides whether the scenarios represent good or poor catchment management. They record their decision about each scenario and include notes explaining the reasoning they used. Students share their ideas with a partner; then they contribute ideas to a whole-class discussion.

▶ Working in home groups of five (or the number of issues used), students match each of the topics in the fact sheets (Resource Sheets 4–8) with a scenario on Resource Sheet 3. They use the scenario numbers to complete the table at the end of Resource Sheet 3. Each student in the group chooses a different topic to research and uses the relevant fact sheet to answer these questions:

- What is the issue?
- What are some of the causes or contributing factors?
- Which catchment management strategies could be used? Why?

▶ Each student becomes the 'group specialist' for one particular issue. Students in the class working on the same fact sheet could work together in one or two groups to extract the relevant information.

▶ The 'group specialists' report back to their home groups. Students then synthesise the information on all topics and create a presentation based on one management scenario for the class.

▶ The presentation should include answers to the following questions:

- What attitudes might the person or people in the scenario hold which result in a choice of particular practices?
- How do the views these people hold compare with those of the scientific community?
- How might the attitudes of people such as these affect the ways in which new scientific knowledge about natural resource management practices is applied? If you identify problems, suggest some solutions.

▶ Possible formats for the presentation include:

- an illustration, story or cartoon;
- a television advertisement that dramatises important aspects of the topic;
- a mock interview that could be staged by the group or in which the rest of the class could interview the group.

▶ As a follow-up, students choose one of the scenarios that reflects poor management and rewrite it to include strategies that demonstrate good management.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' presentations;
- students' rewritten statements.

Source: This activity is adapted from Kelly, K. 1992, *Catchment Care Education Kit*, Queensland Department of Primary Industries, Brisbane.

ACTIVITY

Trees and watertables

Developmental

Focus

This activity provides opportunities for students to analyse past land-clearing practices, the long-term effects of those practices, and how science can contribute to community understanding of land-management practices and associated issues.

Students investigate the effects of a rising watertable on the soil and plants in an area.

Materials

For each group:

- Resource Sheet 9, 'Trees and watertables'
- materials listed on Resource Sheet 9

Teaching considerations

Watertables

This activity starts with some simple activities that simulate two aspects of watertable management. The first activity shows how trees can lower the level of watertables by transpiration. The second activity shows how salt below the earth can be brought to the surface by a rising watertable. Both activities encourage students to consider the consequences of management strategies. Teacher guidance will enable students to make links between the activity and its implications for watertables (see 'Background information' pp. 5–6.)

Simulations

Discuss with students how models or simulations can be used to explain complex ideas. Discuss also the limitations of the particular simulation being used and the features of the simulation that may not correspond to the real situation. It is important that strategies used to explain or clarify one concept do not create misconceptions about others.

Plants

A number of different plants would be suitable for this activity. It is important, however, that the seedlings are healthy, well grown and all about the same size. Care must be taken to preserve as many roots as possible when removing the soil from around the plants.

Open-ended investigations

Strategies for approaching experimental designs are discussed in the sourcebook guidelines (pp. 34–36). A planning session is required to allow students to choose a problem, to design an initial experiment and to list the equipment required. If time allows, it is helpful for students to evaluate their initial experiments and to improve on their original designs.

Sensitive issues

Be sensitive to students' experiences and circumstances — for example:

- the families of some students may be employing land-use practices being discussed in the activity.

Working scientifically

Time: 30 minutes in one lesson; 30 minutes in a follow-up lesson; more detailed investigations may need up to five lessons

Exploring phenomena
Looking for patterns and meanings
Making and judging observations
Predicting
Interpreting data
Making links
Synthesising
Describing
Discussing thinking
Collecting information
Handling materials

Resource Sheet 9

▶ Students discuss their understanding of the term 'watertable'. They use information from dictionaries and other resource materials to clarify their understanding.

▶ Students compare trees and grass in terms of:

- the extent of their root spread;
- the part of the soil from which they obtain water;
- the relative amount of water each would require.

▶ Students suggest reasons why trees were cleared in the past and still are today. They discuss the potential effect on a watertable of trees being cleared and woodland or forest being replaced by grassland.

▶ Students carry out experiments described on Resource Sheet 9 to assist them develop a better understanding of the causes of soil salinity and its relationship to tree clearing.

▶ Students use information collected from the two experiments as they discuss the following questions:

- Soils and underground water can have high levels of different salts, such as sodium chloride, magnesium and calcium sulfates and bicarbonates. What do you think would happen to the salts, both in the short term and long term, if the watertable were to rise through the soil?
- High salinity in the root zone adversely affects the total growth of many species. This often causes the leaf area of plants to be reduced. Some plant species are more salt tolerant than others. What could be some of the short- and long-term consequences of clearing large trees in the valley of a catchment?
- How can scientific research contribute to community understanding of issues related to tree clearing and other land-management practices?

▶ Students describe the principles supporting good land-management practices designed to control salinity.

Additional learning

▶ Groups of students design experiments to test the effects of salt water on plants. Ideas for experiments could include:

- comparing the effect of salinity on a range of seedlings to identify those plants that may be more salt tolerant;
- testing the effect of different salt concentrations on the same type of seedlings.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' responses to questions.

ACTIVITY

Monitoring water quality

Developmental

Focus

This activity provides opportunities for students to monitor the water quality in their local area using a range of tests and to draw conclusions about human impacts on the quality of water in their catchment area.

Materials

- water quality monitoring equipment:
  - thermometer (temperature)
  - turbidity tube (turbidity)
  - electrical conductivity meter (salinity)
  - test strips or aquarium pH test kit (pH)
  - stopwatch and an orange (flow rate)
- camera
- collection jars
- map of the catchment area (see introductory activity, 'In which catchment area do I live?')

Teaching considerations

Completing a riparian vegetation assessment and a water-bug survey in conjunction with the water sampling would provide a more complete picture of the ecology of the waterway. Approaches to conducting an assessment of riparian vegetation and a survey of the water bugs in a waterway are included in Resource Sheet 3 of the module 'Consequences of interactions in the environment'.

Sampling

Two approaches to sampling can be taken, depending on the accessibility of a suitable local waterway to the school:

1. *Single-site sampling*

Students can sample from the same location at the same time every week for an extended period of time. Students sample once to gain an appreciation of the site and then analyse subsequent weekly samples in the laboratory. Sampling over a number of weeks aids students' understanding of the significance of the tests.

2. *Multi-site sampling and catchment crawls*

Alternatively, students can sample three or four different sites along a waterway on a single day. The sites should be a couple of kilometres apart and have a variety of landforms and vegetation. For instance, sites could be well shaded, in full sun or below a stormwater outlet. If access is difficult, samples could be collected and taken to the classroom for analysis. However, if students have not visited a site, they will be unable to visualise the associated landforms and vegetation. Studying a range of sites in lower, middle and upper parts of a catchment is referred to as a 'catchment crawl'. At each stop students investigate similar characteristics or parameters so that a comparative overview can be taken of the catchment. This can be achieved by:

- taking photographs or making sketches at different sites;
- conducting water quality tests;
- conducting habitat and riparian vegetation assessments;
- land-use surveys.

After the excursion, students draw conclusions about the relative health of the waterway at the various sites and the possible human impacts that may affect the waterway. The booklet *Waterwatch and Your Catchment* provides ideas about how to plan a catchment crawl and provides activities to use on the field trip. It can be obtained from the Department of Natural Resources by telephoning (07) 3896 9332. A local Catchment Coordinating Committee or Waterwatch group may assist in planning a catchment crawl.

Other tests

Other parameters can be tested, depending on the availability of equipment, the skill level of the students and the risk assessments of the tests. These could include dissolved oxygen, phosphates, nitrates and faecal coliforms.

Background information on the individual tests are included in the *Waterwatch Queensland Technical Manual* and can be photocopied onto coloured card and laminated. At least two sets of the cards will be required for a class. The *Waterwatch Queensland Technical Manual* is available from the Department of Natural Resources (see above).

Some local councils or Department of Natural Resources offices will lend water quality test kits to interested groups. Contact the local Waterwatch Coordinator (listed in the Natural Resource Management Catalogue from the Department of Natural Resources) or the State Waterwatch Coordinator, email: waterwatch@dnr.qld.gov.au.

Information about testing procedures is also available on the Waterwatch Victoria website at http://www.vic.waterwatch.org.au/manual.

Working scientifically

Time: 30 minutes for information retrieval; 30 minutes for monitoring (or a one-day excursion plus a 40-minute lesson for collation and interpretation of data)

Collecting information
Handling materials
Measuring
Analysing
Applying ideas and concepts
Inferring from data
Interpreting data
Making comparisons
Making links
Discussing thinking
Summarising and reporting

▶ Students discuss the meaning of the term 'water quality'. They list factors that could influence water quality in waterways in their local area.

▶ Students discuss where they would be able to conduct an investigation of water quality. They study a map of the area they have selected and collect information about land use or other factors in the catchment area that could influence water quality. (Information gathered by students in the activity 'In which catchment area do I live?' could be used here.)

▶ Students discuss how they will investigate water quality. They formulate questions to which they will need answers before they begin their investigation — for example:

- Where is there safe access to the water?
- Where is material added to the water that could influence its quality?
- How can data be collected for specific elements or characteristics?
- Which indicators of water quality can be tested for using the resources available?
- How will data be recorded?

▶ Students formulate questions that could be answered by the investigation — for example:

- How does input from ____ *(for example, stormwater or industrial outfall)* affect water quality?
- Do different crops have different effects on water quality?

▶ Working in groups, students collect their water samples from the sites concerned. The group will also need to take notes describing the human impacts that are visible adjacent to the sampling site. Students analyse their samples and record data in a table. If sampling is to occur over a number of weeks, groups could take turns to perform a particular test. Data from the whole class could then be collated.

▶ Students discuss the significance of their test results and draw conclusions about the effects that human impacts may have on the water quality at their sites. (Ideas from the introductory activity 'In which catchment area do I live?' could also be a focus.)

▶ Individually, students present a short report tabulating their data, graphing their results and explaining their conclusions. Their reports should also offer suggestions for actions that could be taken to minimise the impact of human activity in the area on water quality.

▶ Students discuss how:

- the suggested actions could be implemented;
- people affected by the proposed changes could be informed;
- these people might react to the proposed changes;
- these reactions might affect the proposed changes.

▶ Students indicate whether they think attitudes of society in general would support the solutions that they have proposed to improve water quality.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' plans for the investigation;
- students' records of data collected;
- students' reports.

Source: This activity is adapted from Foster, D. 1995, *Waterwatch Action by School Communities*, Queensland Department of Primary Industries, Brisbane.

ACTIVITY

Role-play: Clearing the hills

Developmental

Focus

This activity provides opportunities for students to explore the impact of social factors on the applications of science.

Materials

- Resource Sheet 10, 'Role-play: Clearing the hills'

Teaching considerations

Students not familiar with role-play will need some guidelines to follow (see p. 8).

Prepare role cards, each with a description of one of the twelve characters in the role-play. The thirteenth character is the chairperson of the meeting. The teacher may take this role or allocate it to a student.

The classroom should be set up to simulate a community meeting.

Working scientifically

Engaging with problems
Apply ideas and concepts
Formulating and elaborating ideas
Preparing scenarios
Recognising and analysing options
Synthesising
Arguing a position
Exploring and elaborating ideas
Expressing points of view
Improvising and performing
Listening and questioning
Supporting decisions

Resource Sheet 10

Time: 60 minutes

▶ The teacher introduces the role-play scenario to students (Resource Sheet 10). Twelve students are selected to play particular roles and the role cards are distributed. Working with a partner, students develop their roles and decide on names for their characters.

▶ The Chair begins the meeting. The rest of the students act as observers and do not contribute at this stage. The Chair ensures that all characters have an opportunity to present their cases. The meeting should run for about 20 to 30 minutes.

▶ The class discusses the options available to grazier Lee Cannon. The options are posted on the board. Students then choose the option they consider the best for Lee and write one or two paragraphs explaining the reasons for their choice.

▶ As a conclusion to the activity, students discuss the following questions:

- Which characters have the most information to support their points of view? Why?
- What conflicts were identified?
- What did you learn about the interrelated effects of changes in the catchment area?
- Do you think scientific arguments or solutions can change society's attitudes?

Gathering information about student learning

Sources of information could include:

- students' preparations for the role-play;
- students' written responses explaining which option is preferred and why;
- students' contributions to discussions.

ACTIVITY

The story of a river revisited

Culminating

Focus

This activity provides opportunities for students to apply ideas and concepts to the development of a scenario that demonstrates effective catchment management.

Materials

- Resource Sheet 2, 'The story of a river', used in the introductory activity

Teaching considerations

Using ideas and concepts developed in this module, students revisit the introductory activity, 'The story of a river', and rewrite the story to reflect good catchment management practices.

Working scientifically

Time: 60 minutes

Accessing resources
Collecting information
Designing and performing investigations
Forecasting and backcasting
Formulating questions
Making plans
Analysing
Applying ideas and concepts
Formulating and elaborating ideas
Looking for alternatives
Recognising and analysing options
Creating presentations
Envisioning alternative futures

▶ Students re-read 'The story of a river'. Working in groups of four or five they discuss what they know about:

- the human activities that led to the river's pollution;
- knowledge of society and attitudes that might have contributed to the situation;
- ways that applications of science in the past contributed to the situation;
- why change is needed;
- current attitudes of society that might support change;
- ways that scientific ideas could be used to improve catchment management.

▶ Students identify aspects of these topics about which they need more information and formulate questions to guide their research. They discuss possible sources of the information they require.

▶ Students conduct their research and create a presentation in which they:

- reflect on information they collected;
- envision alternative future management strategies for the river and its catchment area.

Resource Sheet 2

▶ The presentation could be in the form of a PowerPoint presentation; an illustrated story suitable for Year 3 or Year 4 students; a feature article for a newspaper; a poster; or a video dramatisation of the story.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' contributions to the group project;
- students' presentations.

ACTIVITY

Planning a model catchment basin

Culminating

Focus

This activity provides opportunities for students to integrate their knowledge about the applications of science in relation to the needs and views of society.

Materials

For each group of students:

- Resource Sheet 11, 'Everyone lives in a catchment area'
- Resource Sheet 12, 'Information on poor management practices'
- Resource Sheet 13, 'Suggestions'
- Resource Sheet 14, 'Information on good management practices'
- Resource Sheet 15, 'Catchment management — do it yourself'

Teaching consideration

Although the picture (Resource Sheet 11) targets particular catchment issues, the task is open-ended, and students may suggest issues and management strategies that have not been included — for example, providing sediment control.

Working scientifically

Time: 60 minutes

Engaging with problems
Making plans
Applying ideas and concepts
Dealing in an orderly manner with the parts of a complex whole
Formulating and elaborating ideas
Making comparisons
Preparing scenarios
Suggesting
Using ideas, theories and principles
Clarifying ideas and concepts
Creating diagrams
Discussing thinking
Summarising and reporting

Resource Sheets 11–15

▶ Working in groups, students discuss the picture of the catchment area (Resource Sheet 11) and identify features that could influence sustainability of the land and water quality of the river. They write a sentence stating the effect of each feature.

▶ Students read the information about poor catchment management on Resource Sheet 12 and add to their list any features or issues that they may have missed. They expand on the others.

▶ Students use the outline drawing of the catchment (Resource Sheet 15) to redraw the area including features that would indicate good management strategies. They can then discuss their ideas with the class and compare their ideas with those presented in Resource Sheets 13 and 14.

▶ In groups, students identify applications of science represented by the activities shown in the pictures. They discuss:

- ways in which community attitudes might influence decisions that are made about the applications of science;
- the attitudes or knowledge in the community that might have led to the decisions leading to poor management of the catchment area;
- the attitudes or knowledge in the community that could lead to improved management strategies.

▶ Students list people in the community who could be involved in creating a catchment area that reflects good catchment management.

▶ Students suggest ways that these community members could coordinate catchment management strategies. They describe how this process might influence community knowledge and attitudes, and future decision making about the applications of science.

▶ Students present a report that outlines ways of involving stakeholders in a coordinated management strategy for the catchment area.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' drawings of a well-managed catchment area;
- students' reports.

The story of a river — information

Resource Sheet 1

Labels for canisters

power station	grazing land	waterskiing	gardens
herd of cattle	coalmine	park	roads
farming country	hobby farms	tourism	industry
piggery	fishing	subdivision	tannery

Substances

Land use	Substance	Quantity/description
power station	vinegar (acid rain)	$^1/_2$ canister
herd of cattle	thick muddy water	$^1/_2$ canister
farming country	baking powder (fertiliser)	$^1/_2$ teaspoon
piggery	thick muddy water	$^1/_2$ canister
grazing land	salty water	$^1/_2$ teaspoon salt in full canister of water
coalmine	vinegar (acid run-off)	$^1/_2$ canister
hobby farms	yellow food colouring in water, toilet paper	full canister water, small pieces of paper
fishing	nylon fishing line	tangle of line
waterskiing	vegetable oil	$^1/_2$ teaspoon
park	litter	polystyrene foam, plastic
tourism	litter	paper, plastic
subdivision	soil	$^1/_2$ teaspoon
gardens	baking soda (pesticide)	$^1/_2$ teaspoon
roads	vinegar (acid run-off)	$^1/_2$ canister
industry	soapy water (detergent)	1 drop detergent in full canister of water
tannery	red food colouring in water	5 drops solution in full canister of water

(continued)

The story of a river — information *(continued)*

Instructions

- Photocopy the labels on the previous page. Cut out the labels and tape one to each film canister.
- Give one labelled film canister to each student.
- Fill with the substances listed in the table in the quantities given. (Note: All substances are non-toxic.)
- Place a clear bowl (for example, a punchbowl or small fish tank) containing 4–5 litres of water in the centre of the room.
- Distribute the canisters. Instruct students not to open them until their 'land use' is mentioned in the story.
- On cue, they are to empty their canisters into the bowl of water, which is the 'river'.
- Read the story in a dramatic way, stopping at the end of each section when a character/land use is mentioned. Remind participants to come forward and empty their canisters.

Source: Adapted from Alice Ferguson Foundation 1999, *Who Polluted the Potomac?* Accokeek, Maryland.

The story of a river

This is the story of the travels of a very special river — our river — through its catchment area. It begins in the higher parts of the catchment area where the rain runs off the slopes and begins its long journey to the sea. In the valley below there is a **power station** which generates electricity for the region. It burns large quantities of coal and releases pollutant gases into the atmosphere.

These pollutants combine with moisture in the atmosphere to produce acid rain. Rainfall carries these acids back to the Earth's surface and can pollute the very source of the river. The water gathers momentum as it descends the slopes. The river continues its journey towards the sea through **farming country** where recently some crops were fertilised. Afterwards, they were watered and the run-off into the river has brought with it some of the fertiliser.

The neighbouring farm is a **piggery**. Some of the manure from the pig pens washes into a drainage pipe, which then empties into the river. On the other side of the river are **grazing lands**. There are very few trees remaining and, in some of the lower parts of the pasture, the watertable has risen because the trees are not using the water any more. This water brings the salts in the soil up to the surface, making the land unusable. It also means that run-off from the land is salty and this threatens the freshwater organisms and animals in the river. A grazing **herd of cattle** feed on the vegetation on the banks. When heavy rains arrive, the banks collapse into the river.

The **coalmine**, which supplies raw mineral for the power station, pumps water out of the river to clean its equipment and flush out some of the waste. This includes various acids, which all drain back into the river. Slowly the river starts to wind its way through the outskirts of a major town. Out here there are a number of **hobby farms**. The houses here are not connected to a sewerage system but have their own septic tanks. Occasionally these tanks overflow and untreated sewage seeps directly into the river.

There are a number of people making use of the river around the bend. A man is **fishing** on the banks. Unfortunately his line gets caught around a rock and is left in the water. Other people are **waterskiing**. Their boat needs a service and in the meantime its engine is leaking oil directly into the river. Other groups of people are enjoying a picnic at a **park** overlooking the river. A gust of wind blows some of their rubbish off the table and down into the water.

Further downstream the river is being utilised for **tourism**. A charter boat is giving some people a scenic tour of the river. Drinks are for sale on board, and not everyone uses the bins that are provided.

(continued)

The story of a river *(continued)*

The river now starts to meander through the suburban part of the town. A new **subdivision** is being developed. Many of the trees have been removed and when it rains, the top layer of soil is eroded and contributes to silting up the river. Most houses in the developed parts of the town have a **garden**. To keep those nasty bugs away the gardeners use a range of pesticides. At the end of the day the sprinklers are turned on to water the plants. The pesticides wash off into the stormwater drains and enter the river.

People who have spent the day at work are now starting to drive home. In large towns there are many cars. Oil drips out of many of these cars and sometimes they brake in a hurry, leaving traces of rubber on the **roads**. Every time it rains, these pollutants are carried into the stormwater drains and straight into the river.

Industry along the river here uses detergents to keep its production equipment clean. Sometimes the dirty water is hosed out of the factory into the gutter where it disappears into a stormwater drain. Once again, this water flows straight into the river. If there are phosphates in the detergent, it will cause excess algae to grow in the river. When the algae die and begin to rot, this uses up oxygen which animals in the water rely on. They may suffocate as a result.

Redevelopment is occurring on the opposite bank. Demolishers have discovered a few drums of something mysterious. They won't be able to sell the drums as scrap. Someone suggests emptying them into the river. Everyone agrees, and the waste from the old **tannery** is released into the river to the detriment of all the organisms and animals living in it.

With one final bend, the river finally arrives at its mouth and flows into the sea [or a large inland lake]. But look at what flows out with it!

What can we do with our river? A heavy rainstorm would help. The fresh supply of river water from rain can help flush out many pollutants. Indeed, rivers can be a major way of flushing and cleaning ecosystems. However, this only moves the problem to a coastal area [or inland lake] where other ecosystems will be affected. We must reduce the amount of pollution that is entering the river.

Source: Adapted from Alice Ferguson Foundation 1999, *Who Polluted the Potomac?* Accokeek, Maryland.

Good versus poor catchment management

Part A

Read the following statements and decide whether each one represents good or poor catchment management. In your journal, write the number of each statement, whether you think it shows good or poor catchment management, and then give your reasons for that decision.

Statement 1

A property developer decides to cut costs in developing her estate. She orders the bulldozer driver to push over only the small trees and shrubs on each actual house site, leaving all the big trees, the large clumps of trees and any other vegetation. She also requests that the vegetation should remain on the steep ridges, gullies and natural drainage lines. Any clearing should take place only on the flatter areas.

Statement 2

A rural landholder decides to increase the area of land under cultivation in an attempt to increase his farm's productivity. He decides to clear 30 hectares of moderately steep hillside. After clearing all the land, he ploughs the land several times until the topsoil is fine and powdery. He ploughs the furrows up and down the hill since he believes this will assist water drainage.

Statement 3

Two fishers notice that there is a green scum on the surface of the dam. The water from the dam has an unpleasant taste and smell. They are concerned that the fish in the dam might be contaminated with toxins from the scum. They enlist the help of other fishers and residents around the dam. They are all keen to find out why this problem is occurring and then find a solution. Members of the group contact the local council, the government agencies concerned with the environment and pollution, several industries along the river, and the local farming association. They believe everyone must work together to solve their fishing problem.

Statement 4

A large feedlot for 3000 cattle was set up near a river. The owners were concerned that the manure and urine from the cattle could contaminate the river. After checking local and state regulations and industry 'best practice' guidelines, they designed the yards so that a tractor could easily clear and collect the manure. The manure was then composted and sold to earn extra income.

(continued)

Good versus poor catchment management *(continued)*

Statement 5

A property developer bought 10 hectares of land on a bay. The property has a creek flowing through it and includes a strip of mangroves adjacent to some mudflats. The developer applied to the local council for permission to build a canal estate so that the residents would be able to moor their boats next to their houses. Construction of the canals will involve clearing some of the mangroves and digging some very large channels in the mud.

Part B

In the table below, match the number of each statement in Part A as it relates to one of the issues included on Resource Sheets 4–8.

Catchment management issue	Statement number
Soil erosion in cropping lands	
Blue-green algae in waterways	
Sediment control in building sites	
Feedlot waste management	
Acid sulfate soils	

Fact sheet: Feedlot waste management

What is a feedlot?

A feedlot is usually defined as a confined yard in which prepared or manufactured stockfeed is fed to beef cattle. There are currently about 400 feedlots in Queensland, which accommodate anywhere between 20 and 50 000 cattle. Because grain is a major component of the feed, larger feedlots are located close to grain-growing areas west of the Great Dividing Range.

Issues

A typical feedlot beast weighing 450 kilograms eats about 12 kilograms of food each day and drinks 50 litres of water. This means that one beast can produce up to 27 kilograms of fresh manure each day and 10 tonnes of fresh manure in one year. Fresh manure contains a large proportion of water, which evaporates over time. The dry manure that accumulates on the feedlot pen surface is removed by regular cleaning using a box scraper, front-end loader or bobcat. The manure is commonly stockpiled or composted, before being applied to crops and pastures as an organic fertiliser to improve the structure of the soil. A 10 000 head feedlot can produce 8000 tonnes of manure for application onto crops or pastures each year. By applying the manure at appropriate rates and employing good soil conservation practices in the manure application areas, the valuable fertiliser potential of the manure can be utilised without contaminating nearby watercourses or underground water supplies.

Run-off from feedlots is collected in an effluent retention pond. Feedlot run-off can have high nutrient levels, making it valuable as a fertiliser, but it can contaminate water resources if not appropriately managed. The effluent stored in the retention pond is applied to crops and pastures by irrigation. Like manure, feedlot effluent can be utilised sustainably, making use of its valuable water and nutrient content while protecting the environment.

When nutrients such as nitrogen and phosphorus find their way into watercourses, they can stimulate extensive growth of algae and water plants. This can choke the waterways and deplete the dissolved oxygen levels, resulting in the death of aquatic organisms. Blue-green algal blooms are toxic to animals and humans. Special treatment is required to make water affected by blue-green algae suitable for human and animal consumption.

Groundwater is any water that is stored below the plant root zone; it is more commonly thought of as water that occupies openings, cavities and spaces in layers of rocks and other geological materials well beneath the surface of the earth. The source of most groundwater is rainfall and surface water that percolates below the surface. It is an important water source in Queensland and is used for town water supplies, watering stock, crop irrigation, mining and industry. It can also eventually flow out into rivers.

(continued)

Fact sheet: Feedlot waste management *(continued)*

Water that percolates underground can flow many kilometres. It is important, therefore, to ensure that appropriate management practices are applied in feedlots to ensure that nutrients are not leached into groundwater.

Preventing problems

The action of hooves in stamping down manure creates a hard, impermeable layer on the floor of the feedlot that prevents the nitrates from the manure from seeping into the groundwater below the yards. To be of benefit, the hard, well-compacted layer should be between 25 millimetres and 50 millimetres thick. When the yards are cleaned, it is important that this compacted layer is not disturbed.

Feedlot yards need a slope of approximately 3 per cent so that they are well drained. They need to be cleared of manure regularly. Problems arise when excessive amounts of manure are allowed to accumulate. Regular clearing improves drainage from the yards, helps prevent odour problems, improves cattle health and reduces the amount of manure in the run-off after rain.

The sale of manure for fertiliser can provide an additional source of income. Stockpiles of manure can be composted under warm, moist, aerobic conditions. The manure requires regular mixing, and the addition of straw can also improve aeration.

Source: Queensland Department of Primary Industries 1998, 'Feedlot Waste Management', *Prime Notes* CD-ROM, version 6.2.

Fact sheet: Acid sulfate soils and mangrove ecosystems

R5 Resource Sheet 5

Mangroves are trees and shrubs that grow on the intertidal flats of estuaries and bays in warm sheltered areas. They are very hardy and can withstand immersion in salt water.

Mangrove communities are highly productive and provide habitats for many different kinds of marine animals and plants. Bacteria and fungi break down (decompose) fallen leaves from mangrove trees. Small fish, such as mullet, eat small leaf particles partly decomposed by prawns and crabs (crustaceans). The remaining leaf particles are returned to the estuary, decompose further, and are eaten by molluscs, small crabs and prawns.

Mangrove areas also contain many tiny free-floating marine animals and plants (plankton), which are eaten by larvae of fish, prawn, crab and mollusc. In the adult form, many of these animals are important to commercial fishers. They include bay and banana prawns, mud crabs, barramundi, mackerel, mullet, threadfin salmon, bream, whiting, luderick and flathead.

Acid sulfate soils

Mangroves are often found on soils that contain iron sulfides. These are known as acid sulfate soils. An estimated 2.3 million hectares of acid sulfate soils are along 6500 kilometres of Queensland coastline. The iron sulfides were formed by a chemical reaction that occurred when the sulfate salts in seawater mixed with land sediments and organic matter in the absence of oxygen in deeper waterlogged muddy sediments.

When they are waterlogged, acid sulfate soils do not affect the environment. When these soils are disturbed and exposed to air, sulfuric acid (battery acid) is produced. Often toxic quantities of other heavy metals, such as aluminium, are also released.

The acid and heavy metals can seep into waterways, causing disease or killing fish and other aquatic plants and animals. A change in the acidity of the water can also cause a change in the types of species that occur in an area.

Land uses that can cause disturbances to acid sulfate soils include road construction, canal developments, marinas, aquaculture, golf courses, residential developments and drainage works.

Avoiding the problem

Ideally, development should be avoided in areas that have been identified as having acid sulfate soils. To some extent, problems associated with acid sulfate soils can be managed by mixing lime into the soil to neutralise the acid. Another strategy is to immediately reflood an area to prevent the production of acid.

Source: Queensland Department of Primary Industries 1998, *Mangroves*, DPI Note F-98011; Queensland Department of Natural Resources 1999, *Acid Sulfate Soils in Queensland,* Land Fact LC60; Sammut, J. & Lines-Kelly, R. 1996, *An Introduction to Acid Sulfate Soils*, Department of the Environment, Sport and Territories, Canberra.

Fact sheet: Erosion control in cropping lands

Farming methods

Around 3 million hectares (2 per cent of the area of Queensland) are used for growing crops such as wheat, sugarcane, sorghum, oats and cotton. Farmers have been cultivating land in Queensland since the 1850s, using farming practices developed in southern Australia and Europe where soil erosion by water is not a serious problem. By the 1950s, soil erosion by water was seriously threatening the ability of the soils to produce crops in some areas. Farmers realised that they needed to change their farming methods to reduce soil erosion.

Why is soil erosion a problem in Queensland?

Queensland has high rainfall intensity. Heavy rainfall on bare soil causes it to seal. Water run-off increases, taking the soil with it. Most rainfall occurs in summer, which is also when most erosion takes place. Most of the soils used in Queensland for cropping erode easily. They do not hold together well when wet and are readily moved by water. This happens because of the type and texture of clays and other minerals in the soil. Soils on steeper slopes are most susceptible to erosion.

What happens when soils erode?

Soil erosion results in the loss of topsoil, which reduces the ability of the soil to grow crops. Yields are reduced and farm profitability suffers. Severe erosion can result in the formation of deep gullies that make ploughing, planting and harvesting more difficult and costly. Soil from eroded paddocks ends up in creeks and rivers. Some is carried as sediment for long distances downstream to lakes, estuaries and even out to sea. Aquatic life in these areas can be harmed.

How can the effects of soil erosion be controlled?

On very steep lands, it may not be possible to prevent excessive soil erosion, so these areas should not have crops. They can have cattle or sheep. Soil erosion may be controlled where there are good quality soils on flatter land.

Maintaining surface cover

Maintaining surface cover on cropping lands is the most important way of controlling soil erosion. This can be achieved by growing a crop at those times of the year when rainfall is most likely to occur. Those parts of the crop left in the paddock after harvesting can provide valuable protection to the soil surface. For example, leaving the remains of the sugarcane plant on the soil surface, rather than burning as was done previously, results in a

(continued)

Fact sheet: Erosion control in cropping lands *(continued)*

blanket of protective vegetation that is highly effective in preventing soil erosion, even in steeper areas. Farmers use new types of farm machinery to control weeds without disturbing the crop residue. Herbicides are also used to control weeds.

Controlling run-off

Approximately 85 per cent of the soil lost as a result of poor cover can be trapped and retained in the paddock by using contour banks. These are large soil banks, constructed along the contours of the land at intervals ranging from 30 metres to 100 metres. They slow the speed at which water flows down the slope and feed the water into grassed waterways. Farmers should get expert advice about laying out and constructing contour banks to ensure that the flow of water from one farm to another is coordinated.

Source: Carey, B. & Harris, P. 1997, *Erosion Control in Cropping Areas*, DNR Land Facts LC13, Queensland Department of Natural Resources, Brisbane.

Fact sheet: Control of stormwater pollution from building sites

Why does stormwater pollution happen? Soil erosion on building sites can be a major source of stormwater pollution. Soil, sand, sediment and litter washed from building sites all have the potential to cause both short-term and long-term problems when they are deposited in drains, creeks, rivers and bays.

Sediments from building sites can cause a range of problems. Mud can be washed into new homes only months after an estate opens because the drainage system becomes blocked with sediment. Mud can also be washed onto roads and intersections and cause significant public safety problems. Valuable topsoil can be lost from the building sites.

Sediments can cause muddy creeks. The fine particles can settle down-stream and make the bottom habitat unsuitable for many animals. The cloudiness of the water (turbidity) also reduces the light penetration through the water, limiting growth of beneficial aquatic plants. Some aquatic weeds can thrive, however, when the competition from native aquatic plants is reduced in this way.

Fine sediment particles may even reach as far as the estuarine waters near the mouths of rivers. Seagrass beds, which are important feeding habitats for a range of marine animals such as dugongs, are adversely affected by silting from rivers.

Because many types of pollutants (nitrogen, phosphorus, pesticides and metals) attach to sediment particles, an increase in the amount of sediment will usually result in an increase in the other types of pollutants.

Principles of effective stormwater pollution control

When the site layout, building location and earthworks are planned, it is possible to reduce the number of sediment control measures required by minimising the amount of earthworks necessary for construction. A temporary sediment barrier should be built at the lower end of the site to catch any sediment. This sediment barrier is usually a fence made of a specially manufactured, strong, woven material.

It is also important to minimise the clearing of vegetation. This can be done by carefully removing only those trees that interfere with the building site. Soil coverage can also be maintained using grass, leaf litter, mulch, gravel or erosion control matting. Retention of vegetation down the slope from the work site is especially important for filtering out sediment.

Once building is complete, all the areas disturbed by the building activity should be quickly revegetated so that they can no longer act as a source of sediment.

Source: Brisbane City Council 1998, *Best Practice Guidelines for the Control of Stormwater Pollution from Building Sites.*

Fact sheet: Blue-green algae in waterways

R8 Resource Sheet 8

What are blue-green algae?

Blue-green algae, despite their common name, are a type of bacteria called cyanobacteria. They have a similar external appearance to algae and much the same requirements for light, nutrients and carbon dioxide. They normally look green but may look bluish when present in excessive numbers.

They are very small and can be seen under the microscope as a single cell or as large accumulations of cells (colonies), which may be in long strings. Certain types of blue-green algae have tiny gas vesicles or pockets in their cells and float to the surface or sink to the bottom in response to variations in the amount of light. This gives blue-green algae a competitive advantage over other types of algae in obtaining light and nutrients when there is very little vertical mixing of water in dams or waterways. When millions of colonies of blue-green algae accumulate in a dam or river, a blue-green algal bloom occurs.

What problems do they cause?

A blue-green algal bloom can seriously affect water quality. It can discolour the water, form scums, produce unpleasant tastes and odours, and affect shellfish and fish populations. Some blue-green algae produce toxins that can cause problems with drinking water. Boiling the water does not destroy these toxins, and the water must be specially treated. The toxins also cause disorders, such as skin rashes, swollen lips, eye irritation, sore throat, hayfever symptoms and asthma. Laboratory studies have indicated that blue-green algal toxins might even promote skin, liver and gut tumours.

Why do algal blooms occur?

During long, dry, warm periods, there is very little water movement in waterways. The water tends to become stratified (layered) with the light, warm water floating on top of the denser, colder water. Where there are sufficient nutrients in the water, particularly phosphates and nitrates, blue-green algae numbers can build up excessively.

What can be done?

In the short term, if the presence of blue-green algae in the water is suspected, alternative water sources should be used. If there is no alternative, the water can be filtered through activated charcoal, but this is not always successful. Attempts to kill the blue-green algae with algicides results in the release of more toxins into the water.

While it is difficult to control blue-green algal blooms, a number of strategies can help the problem. One method is to try to limit the

(continued)

Fact sheet: Blue-green algae in waterways *(continued)*

R8

Resource Sheet 8

introduction of nutrients into the waterways. Controlling the run-off from agricultural land could do this since animal wastes and fertilisers have a high nitrogen content. Improved treatment of sewage could remove nitrogen and phosphorus before it is released into waterways. Reducing the use of detergents containing phosphorus also assists.

As dams and weirs regulate the flows in many downstream waterways, it may be possible to release some water specifically to maintain the mixing of water in waterways. For dams and lakes, it might be possible to mix the water artificially with paddles or air bubblers.

Source: Chudek, E. 1995, *Blue-green Algae: General Information*, DNR Water Facts W3, Queensland Department of Natural Resources, Brisbane.

Trees and watertables

These two experiments need to be set up and left for about three days (the number of days could vary, depending on the weather).

Part A: Thirsty seedlings

Each group of students will need:

- 5 beakers (250 mL)
- 4 tomato seedlings
- measuring cylinder
- marking pen for labelling beakers

Mark your group name or number on each of the beakers and number them from 1 to 5.

Put 250 mL of water into each beaker.

Carefully wash the soil from the roots of the four tomato seedlings and put them individually in the beakers numbered 1 to 4.

Place the beakers in a sunny position.

After three days, carefully remove the seedlings from the beakers and measure the volume of the water remaining in each beaker.

Design a table to record the results of the experiment.

Points for discussion

- Name the factors that cause water to be lost to the plant/beaker system.
- What were the controls in this experiment?
- Compare the results of this experiment with what would be happening in nature.
- Discuss the usefulness of this experiment as a simulation of the effect of trees on the watertable.
- Suggest ways that the simulation could be improved.

(continued)

Trees and watertables *(continued)*

Part B: Salty soil

Each group of students will need:

- a beaker
- soil
- cooking salt (sodium chloride)
- teaspoon

Label the beaker with your group name or number.

Put about 1 mm of salt at the bottom of a beaker; then fill the beaker about two-thirds full with soil.

Carefully pour in enough water to fill the beaker to the top of the soil. Try not to disturb the soil as you pour.

Stand the beaker in a sunny position.

After three days observe any changes in the salt in the beaker.

Write a sentence or two describing your observations about the changes that have occurred to the salt in the beaker.

Role-play: Clearing the hills

R10

Resource Sheet 10

Role cards are provided for each of the characters listed below:

1. Grazier 1 — Lee Cannon
2. Grazier 2 — neighbour
3. Conservationist
4. Department of Natural Resources officer
5. Farmer
6. Fisher
7. Landcare representative
8. National park officer
9. Shire councillor
10. Shire engineer
11. Town resident
12. Water quality officer
13. Chair

(Each character may be either male or female.)

Introduction

Grazier Lee Cannon has just purchased a property in the hills of the Ross River Catchment basin and is considering clearing the trees from about 300 hectares of the hills to increase the number of cattle that can graze. Lee is not sure whether this will affect other people in the catchment area. Lee discusses the matter with several neighbours and with people in the nearby small town. The local Landcare representative suggests that a community meeting be called. Lee agrees and hopes this meeting will resolve any potential problems. The Landcare representative organises the meeting.

Role cards

Grazier 1 — Lee Cannon **Age:** 35

Case: You are considering clearing trees from 300 hectares of hills to increase your cattle herds. Although prepared to compromise, you feel you must increase cattle numbers to survive tough economic times.

Grazier 2 — neighbour **Age:** 60

Case: You have been in the district all your life. Large proportions of the hills on your property have been cleared. You have only a few places that have obvious erosion.

Conservationist **Age:** 26

Case: You believe the entire area should be left alone and declared an Environmental Reserve. As well as having koalas and native possums, the gullies have some unusual ferns. Little study has been done on many of the plants and animals of the area so it is unknown what damage may occur if the area is cleared.

(continued)

Role-play: Clearing the hills *(continued)*

Department of Natural Resources (DNR) officer (soil conservation) **Age:** 46

Case: You have been in the department for years and know a great deal about soil erosion prevention and control. You believe that trees should be left on all the steeper areas and along stream banks and drainage lines, that extra pastures should be sown on the cleared gentle slopes, and that cattle numbers should be controlled to prevent overgrazing.

Farmer **Age:** 42

Case: You moved to the area 12 months ago. Your previous farm was in a region with areas of salinity from too many trees having been cleared. You do not want to see this happen to your new farm.

Fisher **Age:** 43

Case: You make a living from fishing in the bay. The fish population has started to decline, and you think this is due to the mangrove areas silting up. (Fish breed in the mangroves.) If the fish numbers decrease further, you will go broke.

Landcare representative **Age:** 22

Case: You believe in the balanced approach. You appreciate the need to increase productivity while maintaining unique flora and fauna and allowing for sustainable production. You suggest leaving some pockets of trees to allow a source of seed for revegetation when required. You are mindful of salt problems and invasion by weeds and point out that clearing steep land would provide only poor grazing land.

Increasing turnover of stock through improved pastures, rather than increasing numbers of stock, could increase productivity.

National park officer **Age:** 32

Case: Your main concern is the protection of the habitat area of a large koala and native possum population. You fear that clearing these trees would isolate these animals in small pockets of remaining vegetation, which would cause them to die out.

(continued)

Role-play: Clearing the hills *(continued)*

Shire councillor **Age:** 62

Case: Productivity of rural industries, especially grazing, is vital to the shire and to maintaining businesses in the local town. If the rural income decreases any further, unemployment will soar and local businesses will become bankrupt.

Shire engineer **Age:** 48

Case: You believe that engineers have been able to handle most problems in the past. Bigger levee banks and river diversions can handle the increased flooding that has occurred in the town in the last few years. Siltation can be countered by dredging.

Town resident **Age:** 27

Case: You believe strongly in human rights and freedom. If the graziers want to clear their land, that's all right so long as it does not harm other people. You think the main problem is that the river might be polluted by farm chemicals.

Water quality officer **Age:** 54

Case: Increased filtration of the water to remove silt and other foreign matter requires extra staff and more money. Your department is being criticised constantly for declining water quality, but you have no money for more staff and treatment facilities.

Chair **Age:** 45

Personality: You are very fair and want all participants to have an opportunity to present their cases.

Case: You need to control the meeting — quieten the noisy, talkative ones and encourage the others. You must be strong to prevent some people from dominating the discussion. A consensus must be reached. You can ask people to explain their statements more clearly, and you should summarise the ideas presented. At the end of the meeting, you must restate the options available to Lee (list on the blackboard or butcher's paper) and arrange for the whole class to vote.

Information on poor management practices

R12

Resource Sheet 12

1. Overclearing of forests on steep slopes exposes the land, which in turn leads to landslips and erosion of the soil that is eventually washed into the streams.
2. Poor quality dirty water results from soil being washed into the storage from the cleared hills. The storage gradually becomes filled with silt.
3. Cultivation and overgrazing on steep slopes can lead to erosion.
4. Cultivation down the slope is more likely to cause soil erosion and create massive scars in the landscape.
5. When trees are not maintained along stream banks or on farms, soil suffers erosion from water and wind.
6. Poorly maintained farmland contributes to:
   - erosion;
   - declining yields and farm income;
   - deteriorating quality of farm water supplies;
   - silting of streams.
7. Overclearing of trees in the upper catchment area causes dry land salinity, severely restricting the use of the land for years to come. Inefficient irrigation practices on poorly drained land can also result in salinity problems.
8. High velocity water breaking out of creeks or rivers causes severe gullying on bare cultivated land on the flood plain.
9. Uncontrolled discharge of industrial and domestic wastes can harm the environment by lowering water quality, rendering water unsuitable for human use and possibly killing fish and other forms of aquatic life.
10. Sediments washed down from eroded areas block the river mouth (and other parts of the stream), preventing navigation and increasing the risk of flooding.
11. Poorly sited public facilities and unplanned use of the beachfront can cause coastal erosion and destroy the attractiveness of the area.
12. A bay polluted by rubbish and the discharge of wastes and sediments from the river is unattractive and harmful to humans and unsuitable for aquatic life.
13. Higher than naturally occurring levels of nitrogen and phosphorus from sewage, soils and fertiliser may smother and weaken the reef community. Fuels and oil discharge can disrupt the reef ecosystems; overfishing will deplete fish supplies.

Source: Adapted by the Queensland Department of Natural Resources from a poster by the Victorian Department of Conservation and Environment.

Information on good management practices

R14 **Resource Sheet 14**

1. Forests maintained on steep slopes protect the soil and maintain water quality. National parks provide wildlife habitats and cater for recreational areas and tourism.
2. The high quality of the water in the storage is maintained because the water has been 'filtered' by the forested area. The water is clear and suitable for farm, domestic and industrial use.
3. Pasture should be maintained and conservatively grazed on steep slopes.
4. Contour cultivation and a system of contour banks, waterways and conservation cropping enable the use of land while minimising soil erosion.
5. Trees maintained along stream banks help prevent stream bank erosion. Strips of trees provide wind breaks to prevent soil erosion, shade and shelter for livestock and wildlife and improve the appearance of the farm.
6. Well-managed farmland that maintains a good ground cover of trees, grasses or crops helps to:
   - minimise erosion;
   - increase yields and farm income;
   - maintain high quality farm water supplies;
   - prevent silting of streams.
7. The maintenance of trees in the upper catchment and efficient irrigation practices on well-drained land ensures sustained use of land.
8. Strip cropping and conservation cropping practices reduce erosion on the flood plain.
9. Treatment of industrial and domestic wastes ensures that discharges do not harm the environment.
10. A clear river mouth enables navigation of boats upstream and ensures the most efficient discharge of river water and nutrients into a bay.
11. Carefully sited public facilities and a well-managed beach ensure a pleasant and stable environment for future generations.
12. A clear bay provides a pleasant environment for human activities and encourages the growth of seagrass to maintain a healthy environment for aquatic life.
13. Wise disposal of all waste materials allows a reef to prosper naturally, and prudent fishing will ensure continued fish stocks.

Source: Adapted by the Queensland Department of Natural Resources from a poster by the Victorian Department of Conservation and Environment.

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This sourcebook module should be read in conjunction with the following Queensland School Curriculum Council materials:

Years 1 to 10 Science Syllabus

Years 1 to 10 Science Sourcebook: Guidelines

Science Initial In-service Materials

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