Swan River Education Kit

A Sense of Place in the Swan River Environment A teaching approach for Society and Environment

This kit brings together many educational projects and resources which focus on the Swan River and its

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This kit brings together many educational projects and resources which focus on the Swan River and its environment. Thanks go to the dedicated group of teachers who worked on the project 'Swan River Action Sites', which has been adapted for and incorporated in the kit. Many staff members of the Water and Rivers Commission and the Swan River Trust were involved in the development of this resource and their contributions are also acknowledged.

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First Published 1999 © Water and Rivers Commission 1999 ISBN 0-7309-7325-5

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The Swan River Education Kit



The Swan River Education Kit, an initiative of the Water and Rivers Commission and the Swan River Trust, is a broad-based education program with curriculum support materials, developed for use by schools in the Swan River catchment.

The kit aims to encourage a knowledge of the river and provides a meaningful context in which students can develop skills of investigation and attitudes of environmental responsibility.

This resource has been developed for teachers of the Science, and Society and Environment learning areas. It aims to enrich teaching and study in these learning areas by providing a range of themes and ideas for studies of the Swan River that can be easily integrated into the school curriculum.

The kit was developed in the belief that direct experience of the river environment is essential for students to develop a close association with it and an environmentally responsible attitude. These materials have been written on the assumption that the teacher will provide students with the opportunity to visit a river site on at least one occasion to gain practical 'hands-on' experience.

An integrated, whole-school approach to a study of the Swan River environment could be developed within the context of the Curriculum Framework.

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An Urban Catchment Perspective - The Swan River

RESOURCE SHEET	5	THE SWAN-CANNING RIVER SYSTEM	31
RESOURCE SHEET	6	THE SWAN-CANNING ESTUARY	33
RESOURCE SHEET	7	WHAT'S IN A NAME?	34
RESOURCE SHEET	8	ESTUARINE LANDSCAPES	35
RESOURCE SHEET	9	MODIFICATIONS TO THE SWAN-CANNING ESTUARY	37
RESOURCE SHEET	10	DON'T LET YOUR RIVER GO DOWN THE DRAIN	39
RESOURCE SHEET	11	POLLUTION IN THE URBAN CATCHMENT	40
RESOURCE SHEET	12	VEGETATION AND WEEDS OF THE SWAN RIVER SYSTEM	42
RESOURCE SHEET	13	ESTUARIES OF THE SOUTH WEST - FACTS AND FIGURES	44
RESOURCE SHEET	14	URBAN DEVELOPMENT AND RIVER HEALTH	45
RESOURCE SHEET	15	GUARDIANS OF THE SWAN RIVER ENVIRONMENT	47

A Whole-Catchment Perspective - The Swan-Avon Catchment

PRELIMINARY ACTIVITIES	50
ON-SITE ACTIVITIES	53
FOLLOW-UP ACTIVITIES	56

A Whole-Catchment Perspective - Resource Sheets

RESOURCE	SHEET	16	CATCHMENTS	61
RESOURCE	SHEET	17	SUBCATCHMENTS OF THE SWAN-CANNING RIVER SYSTEM	65
RESOURCE	SHEET	18	THE AVON RIVER AND ITS CATCHMENT	66
RESOURCE	SHEET	19	THE SWAN-AVON CATCHMENT	69
RESOURCE	SHEET	20	AVON CATCHMENT LANDSCAPES	70
RESOURCE	SHEET	21	LAND-USE ACTIVITIES AND PROBLEMS IN THE AVON RIVER CATCHMENT	72
RESOURCE	SHEET	22	A BALANCING ACT - AGRICULTURE AND NATURE	73
RESOURCE	SHEET	23	CATCHMENT CONNECTIONS 1 - SEASONAL CHANGES IN THE	
			SWAN-CANNING RIVER SYSTEM	74
RESOURCE	SHEET	24	CATCHMENT CONNECTIONS 2 - NUTRIENTS IN THE	
			SWAN-CANNING RIVER SYSTEM	76
RESOURCE	SHEET	25	SALINITY	78
RESOURCE	SHEET	26	THE AVON RIVER - PERSPECTIVES AND PRESSURES	BO
RESOURCE	SHEET	27	SALINITY IN THE AVON CATCHMENT - SOURCES AND SOLUTIONS	82
RESOURCE	SHEET	28	INTEGRATED CATCHMENT MANAGEMENT	84
RESOURCE	SHEET	29	CATCHMENT PLANNING BY RURAL COMMUNITIES IN THE AVON BASIN	85

Resources

These teaching ideas and support materials are designed to assist teachers to develop understandings, values and skills as they relate to the Swan River and its catchment in particular, and to rivers and their catchments in general

Rationale and aims

The Swan River system is the recreational and scenic heart of Perth, and a very important part of Western Australia's natural and cultural heritage. As a natural wonder, it provides a great diversity of landscapes, flora and fauna. The river system is a magnet for the people of Perth and its visitors, and a valuable resource for a lifestyle that people greatly value.

The Swan River is under environmental pressure. The population of Perth is growing, and the activities of people in both urban and rural subcatchments are contributing to problems of waterway pollution and other forms of degradation. Everyone in the catchment needs to be aware of these issues; since we all live in a catchment, we are all responsible for catchment health.

One way to address issues relating to the Swan River is through education, and the river is an excellent medium for environmental education. A visit to a river site will encourage students to develop an increased awareness of the importance of the river to people, and of the incompatibility of some forms of human activity with river health. It is hoped that this awareness will result in students wanting to contribute to the formulation of landcare and rivercare strategies.

A personal encounter with the river provides interesting and worthwhile experiences for students of Society and Environment. The river is a particularly good setting for focusing on the application of skills and for fostering the values associated with ecological sustainability.

This booklet aims to assist students to develop:

- an awareness of their personal relationship with the riverine environment
- a sense of belonging to, and enjoyment of, the river environment
- an understanding of the relationships between the river and people, both past and present
- an understanding of catchments and the way in which the river functions as part of the water cycle
- an understanding that land-use activities in the catchment can have a negative impact on the river environment
- an awareness of watercare and landcare issues in the urban and rural catchments
- skills of social and environmental investigation
- environmentally responsible values and behaviours, and a willingness to help maintain and improve the health of the catchment

Links to Society and Environment learning area outcomes

This resource assists teachers to address the major outcomes of the Society and Environment learning area as described by the Curriculum Framework. A teaching program using some of the suggested ideas and activities will encourage students to:

- broaden their understanding of river environments and the relationships between the environment and society
- develop knowledge, skills, attitudes and behaviours that will enable them to participate as active informed members of society
- demonstrate major learning outcomes in the Society and Environment learning area

The Investigation, Communication and Participation, and Active Citizenship outcomes underpin the suggested teaching approach. While many activities have a strong link with the Place and Space conceptual strand, others help to develop understanding in other strands, as the following table indicates. Student achievement of outcomes will be dependent on the opportunities presented to them to develop and demonstrate appropriate skills and understandings.

Curriculum connections

RIVER ENVIRONMENT FOCUS	OUTCOME
Personal associations with and use of the river Features of catchments Conservation values and strategies	Place and Space
Aboriginal and other cultural perspectives	Culture
Changes to the river environment over time	Time, Continuity and Change
The catchment's resources and land-use activities	Resources
Water cycle processes – runoff and groundwater	Natural and Social Systems
Observation, discussion, investigation, following up	Investigation, Communication and Participation
Values and behaviours associated with care of the river	Active Citizenship

These materials have been developed to promote the principles of education associated with the Society and Environment learning area that are embedded in good teaching practice. These include:

- the use of students' prior knowledge and interest as starting-points for learning
- development of a positive attitude towards the environment
- promotion of student-centred inquiry learning and action research methodology
- the use of strategies to promote literacy
- commitment to cooperative learning
- commitment to active citizenship

Structural overview

There are three main themes developed in this booklet:

- A Personal Perspective A River Relationship
- · An Urban Catchment Perspective The Swan River
- A Whole-Catchment Perspective The Swan-Avon Catchment

The table below outlines the subject material of each theme, grouped into three main activity sections: *Preliminary activities, On-site activities* and *Follow-up activities.*



Sudent achievement of outcomes will be dependent on the opportunities presented to them to develop and demonstrat oppropriate skills and understandings.

Themes

This resource encourages students to relate to the river at three levels. These represent different perspectives or contexts – and different scales of study of the river environment. The grouping of activities into these levels reflects the different perspectives.

A Personal Perspective

The focus of these activities is more personal and activities ask the students to reflect on what the river means to them, and what effect their recreational activities might have on the river environment. The central themes explored are perceptions, activities at the river and the notion of rivercare.

An Urban Catchment Perspective

Students are asked to move beyond a personal relationship with the river and to look at the place in which they live – the urban catchment of the Swan River and their local area. The focus is on activities that affect river health. The themes developed are features of the river environment (particularly the estuarine environment), water flow patterns, river health and rivercare strategies.

A Whole-Catchment Perspective

Students move beyond the urban catchment and into the whole regional catchment of the Swan-Avon river system. Themes include features of the catchment, water movement, land-use activities in the semi-urban and rural catchments and their impact on the river, and management strategies.

Activities

Activities within each theme have been grouped into:

- Preliminary activities that motivate students, elicit prior knowledge, encourage questions and facilitate planning of investigations.
- On-site activities that encourage development of skills of observation, investigation and teamwork at the river site. See suggestions for suitable sites on the *Swan-Canning River and Estuarine System Map.*
- Follow-up activities that encourage interpretation and evaluation of findings, consolidation of knowledge and action.

Activities are written as broad suggestions for the teacher. Many are quite open-ended to allow teachers to make modifications to suit their students. Resource Sheets accompany some activities, and are found at the back of each theme. They comprise information sheets on various topics, maps, diagrams and tables. There is variety in the type of activities suggested, the amount of time recommended to complete them and the level of understanding and skills required as background by students. Some activities refer to strategies contained in other teachers' manuals, such as Ribbons of Blue.

Suggestions for using this resource

Rather than offering a step-by-step program of lessons, this resource encourages teachers to choose activities to develop a teaching program that will suit the interests and needs of students. There is no prescribed way in which to use the activities. A minimalist approach might see you dip your toe in the shallow end or you could wade in at the deep end and become fully immersed!

When developing a balanced program you could select activities from any of the themes in this booklet according to:

- · Society and Environment learning area outcomes you want to develop
- the riverside sites(s) you want to visit
- · any cross-curricular links you wish to establish
- the concepts within a theme that you wish to focus on and follow through
- · focus questions suggested in this booklet or devised by you or your students
- particular excursions in the booklet Excursions in the Swan River Environment

The river is an ideal setting in which students can explore the values associated with ecological sustainability. They can start to develop watercare strategies and take action to help ensure a sustainable future for the river.

TEACHER NOTES



eocher	Class	Site location	
		date(s) of site visit(s)	
Chosen themes and topics			
ink to Society and Environm	ant outcomes		
and to obtain and chartening			
Key lask and locus questions			
Activities chosen, sequence a	nd timing, and assessment details		
Preliminary activities			
Site visit activities			
ollow-up activities			
	A		
Assessment opportunities			

A Sense of Place in the Swan River Environment

A Personal Perspective ~ A River Relationship

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These activities are designed to heighten students' awareness of the Swan River environment by encouraging an examination of their relationship with it. Students will consider their feelings about the river, and those of other people. They will identify how the river affects them and how they in turn affect the riverine environment. 1

A Personal Perspective ~ A River Relationship

The **preliminary activities** are 'tuning in' strategies. **On-site activities** are for reflection, for looking, for feeling and for thinking. **Follow-up activities** encourage clarification of feelings and the development of rivercare ideas.

This section examines the following ideas:

- People develop personal relationships with river environments.
- People and communities, both past and present, may perceive the river differently
- The river is a valuable natural resource that is used in a variety of ways
- River environments need to be cared for and river recreation needs to be planned and managed.

Focus questions

- What feelings do I have about the river, and what do others feel.
- How do I relate to the river?
- How should people care for the rive

Responsible environmental behaviour stems-from a personal awareness of and commitment to natural places

V

Perceptions

To show that they are able to discuss their feelings about the river environment (based on their prior knowledge, experiences and interests) and to consider how other people and communities might view it, students could:

- Interview an older person (a parent, grandparent or neighbour) to find out what the river used to be like and what they think about it.
- Make a word association chart or card cluster about feelings associated with the river.
- ^D State their interest in the river environment.
- Study photographs of the river and discuss the feelings that these images evoke. See Resource Sheet 1, Images of the river.
- Research how traditional Aboriginal people might perceive the river environment. See Resource Sheet 2, Aboriginal people and the Swan River, or refer to the Ribbons of Blue primary school manual, Classroom Activities: Aboriginal Water Use.
- Collect and read poems, stories or legends about a river, or listen to some music that evokes images of water and rivers. Discuss feelings and perceptions.
- Think of a river in another part of the world and suggest its significance for the people who inhabit the area.
- Recall a legend, ritual or ceremony related to water and rivers, e.g. the Rainbow Serpent, an American Indian rain dance, Christian baptism and Muslim ablutions before prayer.



Resource Sheet 1, Images of the river

Resource Sheet 2, Aboriginal people and the Swan River

OTHER RESOURCES

Ribbons of Blue primary school manual

RELATIONSHIP

A RIVER

08

PERSONAL PERSPECTIVE

Use of the river

To show that they are able to think and discuss how they and other people use the river, students could:

- Discuss the idea of the river environment as a resource.
- Discuss the idea that there is a relationship between peoples' perceptions of a river environment, the value they place on it and the ways in which they use it.
- Brainstorm a list of ways that people use the river and the foreshore in an area near their school or home.
- Classify these activities as either recreational or non-recreational.
- Devise a classification of recreational uses and consider whether these uses are compatible with each other.

River health

To identify issues that relate to their use of the river environment and to consider the need for regulated use of recreational areas at the river, students could:

- Discuss the meaning of the term 'river health', and draw and label their idea of a healthy river environment.
- Discuss whether they think the river in their local area is healthy.
- Discuss rules they know of that apply to people using the river foreshore area.
 Suggest why the rules might be needed.
- Brainstorm a list of words or expressions they have heard that are about caring for environments and suggest what they mean, e.g. conservation, preservation, sustainable development, landcare, watercare.
- Imagine that they are an animal that lives in or visits the river, e.g. a fish, bird or crustacean, and write a list of 'river rules' aimed at protecting the environment.
- Draft a design for a logo, badge or T-shirt, which promotes the idea of caring for the river environment.
- Discuss the meaning of either of these statements in relation to rivers: 'Help, or at least do no harm' or 'Be part of the solution, not part of the problem'.
- Brainstorm a list of rules to be followed when groups of students visit the river. Develop the list into a poster-sized 'code of conduct' that can be adopted when visiting a river site.



PERSONAL

Perceptions

To respond personally to the site, students could:

REFERENCE CHECKLIST

Resource Sheet 1, Images of the river

OTHER RESOURCES

Excursion 1, How do I feel?, in the booklet Excursions in the Swan River Environment

Excursion 2, Needs auction, in the booklet Excursions in the Swan River Environment

Gould League

- In 'quiet time' sit, look around and reflect on the river environment. Look closely at the water and observe such things as movements, colours, reflections and objects in the water. Record their impressions.
- Use senses other than sight to make observations about the river environment, e.g. pairs of students, one of whom is blindfolded, could follow a 'sense trail' through the site. The blindfolded student describes the sounds, smells and feelings

around them while their partner guides them and ensures their safety. Ideas for other activities involving the senses are available in Gould League publications.

- Create a 'Thought for the Day' that relates to the river.
- Draw a map of the site from the perspective of an animal such as a frog, heron, dolphin, snake or fish; or write a story or poem about how the animal perceives the environment.
- Imagine they are the river bank, and respond to these questions: 'How would you feel about... people walking over you; weeds invading you; students planting trees to protect you; frogs burrowing into you; people digging into you to put in drains, pipes or cycle paths; people lighting fires on you to keep warm while they are fishing; people leaving rubbish on you; birds nesting on you; families picnicking on you?'
- Assess the way in which the river affects their perceptions and feelings. See Resource Sheet 1, *Images of the river*. Refer also to Excursion 1, *How do I feel*?, in the booklet *Excursions in the Swan River Environment*.
- Survey other classes about their perceptions of the river. Summarise similarities and differences in perceptions.
- Think about the perceptions of people in the past, such as Aborigines and the first Europeans to visit the area.
- Compare the perspectives, needs and values of different site users. Complete Excursion 2, Needs auction, in the booklet Excursions in the Swan River Environment.

Use of the river

To indicate the various ways in which people use the river site, students could:

- List all observable human uses of the river (recreational and non-recreational), then speculate about other activities that might occur here. See Resource Sheet 3, *River recreation*.
- ^a Create a location map of the site's recreational activities and suggest what makes the site suitable for those activities.
- Draft a design for a travel brochure or poster that promotes the qualities of the site either for one particular type of river user or for multiple users.
- Prepare some quick sketch maps of the site labelling its features from the perspective of some different people who might use it, e.g. a family on a picnic, an adventurous child, a traditional Aboriginal hunter and gatherer, a waterskier, a builder, a birdwatcher, a pioneer settler, a camper, an explorer.
- Play a recreational game at the site. Then, through discussion, determine whether the site is an appropriate one for the game.
- Write a legend or create and perform a water ritual, ceremony or river dance that reflects the importance of the river environment.
- Suggest how the Aborigines who lived in the area might have met their daily needs, e.g. how they might have selected the best campsite, obtained drinking water and disposed of wastes.

REFERENCE CHECKLIST

Resource Sheet 3, River recreation

River health

To show understanding of the ways in which the site has been modified and the effects of such changes, students could:

- Identify and map the site's built structures and suggest why they were constructed, e.g. jetties, walls, signposts, islands, bridges. Discuss what effect the construction of some of these might have on the environment.
- State how they would feel about drinking the water, swimming or having a picnic at the site.
- Construct a summary table of activities that occur at the site. Consider the possible impact of each activity on people, animals and the river environment, and then state whether these activities are harmful or beneficial to the environment. Complete Excursion 3, *Effects of human activities at the river*, in the booklet *Excursions in the Swan River Environment*.
- Imagine that they are landscape architects and redesign the site to better suit the specific needs of different river uses, e.g. fishing, windsurfing, birdwatching, cycling. Complete Excursion 4, Site design for recreational use, in the booklet Excursions in the Swan River Environment.
- Through role play, assess the compatibility of different recreational river uses and suggest solutions for conflict-free multiple use of the river. Complete Excursion 5, *River uses compatibility survey*, in the booklet *Excursions in the Swan River Environment.*
- Consider the effect that traditional hunting, fishing and burning of the landscape by early Aboriginal inhabitants may have had on the environment. See Resource Sheet 2, *Aboriginal people and the Swan River*.
- Debate who should bear responsibility for the river environment's health.
- Discuss any negative effects that the class visit might have had on the environment.
- Brainstorm a list of unknown factors about degradation of the river environment.
 Suggest investigations that could be pursued after the river site visit.

REFERENCE CHECKLIST

Resource Sheet 2, Aboriginal people and the Swan River

OTHER RESOURCES

Excursion 3, Effects of human activities at the river, in the booklet Excursions in the Swan River Environment

Excursion 4, Site design for recreational use, in the booklet Excursions in the Swan River Environment

Excursion 5, River uses compatibility survey, in the booklet Excursions in the Swan River Environment

Perceptions

To clarify and demonstrate aspects of their personal relationship with the river, students could:

- Record their feelings associated with the site visit, perhaps by way of a journal entry, an illustrated story, poem, song or drawing.
- Make a chart or mobile of key words that signify feelings elicited by the visit to the river.
- D Make an illustrated postcard of the site and send it to a friend.
- Make a class scrapbook of the visit entitled 'Perceptions of our River Site', complete with pictures, poems, stories and sketches.
- ^D Create a brochure that advertises the features of the site to visitors.
- Using a large sheet of paper, show by means of cutouts or drawings of peoples' faces and conversation balloons what people with different lifestyles/occupations might have to say about the river site.
- Invite a senior citizen who used to visit the river site as a child to talk to the class. Find out about changes that have been made to the river in their lifetime and whether his/her perceptions and feelings have changed over time.
- Devise an action plan to provide a framework for finding out about the history associated with the part of the river they have visited.
- Research history aspects of the site, e.g. the Aboriginal groups that visited the area; the first European explorers to see the site and the circumstances of their arrival; and where and how the first settlers in the area lived, and their relationship with the river.
- Research the spiritual significance of a river for one society in another part of the world, e.g. the Ganges (said to flow from the mouth of a silver elephant).
- Imagine being an early settler journeying up the river, and write a diary entry to describe what they saw and felt at this part of the river.
- Make sketches to show the river environment before European settlement, the way it is now and how it might be in the future.
- Write to the Swan River Trust or the Water and Rivers Commission to present a student perspective on the current state of the river environment.

Use of the river

To clarify and demonstrate their ideas about the way in which the site is used, students could:

Design survey questions (for either school students or for the local community) to investigate aspects of recreational use of the river. Ask people why they use the river, when they use it, how often they use it, what they like about it, what concerns they have about it, and how they think these concerns might be addressed. Conduct the survey and analyse the results.



- Make a collage depicting all human uses of the river at the site. See Resource Sheet 3, *River recreation*.
- Find out which particular areas of the Swan River are used for specific types of recreational activities, and the areas that are for multiple recreational use.

River health and rivercare

To act on some of the issues identified at the river site, students could:

- Draft a letter to the local council outlining concerns they have about one environmental issue that the site faces, e.g. litter, weeds, eroding river banks. Suggest a strategy that might help, e.g. revised wording on signposts at the river, provision of more rubbish bins.
- Find out what regulations and restrictions apply to various river activities in the area, e.g. boating rules, fishing restrictions, and rules for digging for baitworms. Reach class consensus about whether the regulations are fair. Decide how regulations should be enforced and by whom. See Resource Sheet 4, *Managing the river for recreation*.
- Write a story that begins 'My wish for our river is . . .'
- Present the results of their work at the river to a wider audience, e.g. at an assembly or as one or more articles in a school newsletter or the local newspaper.
- Debate the need for rules and regulations concerning recreational use of the river environment.

REFERENCE CHECKLIST

Resource Sheet 3, River recreation

Resource Sheet 4, Managing the river for recreation

A Personal Perspective ~ A River Relationship

Resource Sheets



Images of the river



A PERSONAL PERSPECTIVE

15

RESOURCE SHEETS



Drain outlet



Fishing for bream, Maylands



Bluegreen bloom, Canning River



Launching ramp, Canning River



Cormorant, Maylands



Duckweed

Aboriginal people and the Swan River

The south-west of Western Australia was inhabited by the Aboriginal (Nyungah) people for thousands years before the arrival of European settlers in 1829. The Nyungahs valued the moderate climate and the plentiful food and water supplies of the area. The major river systems that flowed from the Darling Ranges and westwards to the coast provided the coastal plain with good, (probably) fresh water in both summer and winter.

Hunters and gatherers

The Nyungahs were hunters and gatherers who moved over their hunting territory (their tribal lands) with the seasons. They tended to stay on the coastal plain in summer and move further inland during winter. Their seasonal migrations took place in response to changes in the climate, the ripeness of various fruits, the availability of edible roots and the habits of land and water animals.

Effects on the environment

Like the Europeans who came later, the Nyungah people had an impact on the waterways. In addition to using the resources of the river and its catchment, they used fire to manage the environment. Alongside the rivers and wetlands and on the coastal plain, fire was used to produce a more open landscape. This helped the Nyungahs to hunt, as animals could be more easily spotted and chased. The broad scale of environmental management practised by Aborigines was evident from the network of trails and tracks throughout the catchment. Some present-day roads follow the line of these trails.

Although it is generally thought that the Nyungahs' activities did not negatively affect the environment, it is likely that over time there would have been some impact on catchment areas. For example, fire reduced the different types and overall density of vegetation by favouring the fire-resistant species. It is possible that the reduction of vegetation caused erosion and sedimentation of the waterways. It could also have caused a rise in the watertable, with a consequent increase in salinity and further de-vegetation of some areas. It is unlikely, however, that there was significant impact.

A spiritual view of the land

The Nyungahs' view of the land was spiritual rather than economic. They saw themselves as part of the land, with responsibilities for its protection and conservation, and as protectors or guardians of the Warndoolier (Swan River) and the Dyarlgarro (Canning River). This was an important part of their spiritual beliefs.

Collaboration

Today the Aboriginal community works closely with various rivercare groups on issues related to river protection and management and on general foreshore maintenance projects. The Nyungah community shares the goal of maintaining the integrity and health of the river with the non-Aboriginal community.







resource sheet



RESOURCE SHEETS

18

A PERSONAL PERSPECTIVE

River recreation

Rivers and their estuaries are wonderful places to live near and to visit. Together with Perth's beaches, the Swan-Canning river system provides the major recreational focus for the people of Perth and for visitors.

Patterns of use

The most frequent users of the river are people from

the Perth metropolitan area. In summer the many families and visitors who flock to the river for water sports and activities can cause facilities in some areas to become crowded. In winter, ferries and boats can still be seen as can people walking and cycling along the river banks, but there is not the

same pressure on the resources of the river.

Why people use the river

The river is a significant tourist attraction and recreational facility for families who live close by. People like to use the river environment for recreation for many reasons. Many appreciate the view and the quiet and peaceful atmosphere, and appreciate watching the wildlife or water sports. The many recreational activities associated with the river include: crabbing, prawning, swimming, canoeing, yachting, rowing, paddling, waterskiing, parasailing, jet-skiing, power boating, fishing and windsurfing. Along the river banks, walking, cycling, exercising dogs, birdwatching, photography, sunbathing, picnicking, playing games and using play equipment are popular. Some people find that just sitting by the river and gazing at the view is a wonderful way to relax.

Recreational areas

Some recreational activities are permitted only in particular locations in and around the river. For example, speedboats are permitted only in areas where they will have minimal environmental impact. Social and safety considerations are also important, as some activities (such as jet ski riding) are noisy or dangerous and may be of concern to people who use or live along the river. Much of the foreshore area, especially under the Causeway and Canning Bridge, is flat and has been walled and developed into grassed parklands and playing fields, providing limited access to the water. However river sites such as Point Walter enjoy higher and more diverse use. Some areas, like the broad, deep areas of Melville Water, are very popular for larger boats, while shallower areas further up the river are more suited to smaller boats.

Popular recreational areas

Popular recreation areas around the estuary include:

- The Preston Point boat ramp, Freshwater Bay, Point Walter, Matilda Bay and Mosman Bay foreshores (picnics)
- Deep Water Point (waterskiing)
- · Perth Water (ferry cruises and surfcat hire)
- The upper reaches of the Swan (wine cruises)
- Many of the jetties, bridges and foreshores (fishing)
- Lucky Bay and the Nedlands boat ramp (windsurfing)





Managing the river for recreation

Pressure on the river

A combination of population growth, rising demand for waterway recreation and new activities, is creating



an increased pressure on the Swan-Canning river system and its resources. More recreational activities mean that more facilities have to be constructed. These include new toilets, cycleways, pathways,

car parks, jetties, launching ramps, river moorings, marinas, play equipment and recreational club facilities. If these facilities are constructed in an unsuitable area, or if they are overused, there is a cost to the environment.

Careful river management is needed so that the many different types of recreational users are able to enjoy the river environment – and so that the river environment remains healthy. It is also important to make sure that new activities are compatible with existing ones.

Development principles

People responsible for planning river foreshore facilities need to be aware of the possible negative effects of their actions. The main consideration of all development must be the ability of the environment to tolerate these uses without damaging effects. Where possible, development should:

- · be multi-use to reduce user pressure on the river
- maintain and enhance the quality of the river environment
- · recognise rights of all river users
- keep the waterways safe
- not cause erosion
- not damage fringing vegetation or shallow banks
- not allow pollutants to be leached into the estuary
- protect fish resources
- encourage public participation in planning and decision-making

Environmental care by recreational users

People using the river for recreation can prevent environmental damage from occurring by:

- only taking the right size and number of crabs, prawns and fish
- taking care not to leave plastic, rubbish and fishing line behind
- making sure that petrol and oil from boats does not enter the estuary
- only launching boats from approved launch ramps and obeying boating regulations
- ensuring that all litter is put safely in the rubbish bin (better still, take it home!)
- not cutting down trees and branches for barbecues
- digging for worms on the river bank only in approved areas
- preventing dogs from chasing birds on the foreshore
- taking care with fire

Cooperation with other recreational users

Some positive actions can be taken to ensure that areas can be enjoyed by everyone. For example:

- keeping dogs on their leads in crowded areas
- parking cars correctly so there is room for others
- riding bikes slowly on dual-use paths
- obeying boating regulations to ensure the safety of others is not endangered
- not holding other people up on boat ramps
- leave all areas that were used in a tidy condition
- making sure that music played in vehicles or at foreshore areas does not disturb other river users



A Sense of Place in the Swan River Environment

An Urban Catchment Perspective ~ The Swan River

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The perspective developed here is an urban (or suburban) one. Students will view the local area as a catchment draining to the river and make a connection between activities in the suburban catchment, surface water and groundwater flow and the health of the river environment.

An Urban Catchment Perspective - The Swan River

This section examines the following ideas

- The Swan River environment has distinctive features
- Land-use activities in the urban catchment impact on the river environment through surface water and groundwater flow.
- Communities need to manage their activities to reduce their negative impact on the river

Focus questions

- What are the features of the local river environment?
- What is the Swan-Canning estuary like, and how does water move into it:
- How do our activities affect the river
- What can our community do to preserve the river environment?
- What action can I take to help?

of the Swan River environment (the coastal plain catchment), the activities of people and the effect they have on the health of the environment.

Features

To demonstrate understanding of the physical and cultural features of the urban catchment (especially their local area), students could:

- Recall knowledge of the Swan-Canning river system and the Swan-Canning estuary. See Resource Sheet 5, The Swan-Canning river system.
- Look at a map showing the path of the river/stream in relation to the local area, e.g. the front page of the Metropolitan Street Directory. From this and other maps, prepare a large map of the local area to show the shape and course of the river, local place names, access points to the river and tributaries and drains leading to it.
- Using a topographical map, locate the river access site closest to the school. Use the universal grid reference system to give the exact location in northings and eastings. Locate other points of interest in the local area in the same way. Refer to the Ribbons of Blue primary school manual, *Field Work: The Grid.*
- Study a map of the estuary. Write a description of its physical attributes, e.g. shape, tributaries, mouth. See Resource Sheet 6, The Swan-Canning estuary.
- Examine the Swan-Canning River and Estuarine System Map for the names of features. Consider how these places were named. See Resource Sheet 7, What's in a name?
- Examine photographs that show Swan River estuarine landscapes and compare vegetation and habitats. See Resource Sheet 8, *Estuarine landscapes*.
- Recall knowledge of a part of the estuarine environment with which they are familiar and draw a picture of that place. Produce a display of these pictures.
- Consider what the urban area and the estuarine environment would have been like before occupation by Europeans. Consider ways the estuary might have been changed by people in the past. See Resource Sheet 9, *Modifications to the Swan-Canning estuary.*
- Compile a file of newspaper clippings about the estuary. Present the information contained in one clipping as 'news'.

REFERENCE CHECKLIST

Resource Sheet 5, The Swan-Canning river system * Resource Sheet 6,

The Swan-Canning estuary

Resource Sheet 7, What's in a name?

Resource Sheet 8, Estuarine landscapes Resource Sheet 9, Modifications to the Swan-Canning estuary

OTHER RESOURCES

Ribbons of Blue primary school manual

Swan-Canning River and Estuarine System Map (poster)

Water flow

To develop understanding of how water flows in their local area and in catchments, students could:

- Discuss prior knowledge of the movement of water in their local area: where river water comes from and where it goes. Consider movements of rainwater, water in drains, water used on gardens and groundwater.
- Discuss or draw the idea of local catchments as areas of land that drain to one point.
- Make a simple model of a catchment using sand or plastic in a large tray. Use a watering can to simulate rainfall.
- Identify the 'catchments' of their homes or school grounds by observing the slope of the land, types of surfaces, where the water comes from (e.g. roofs and land surfaces), where it goes to (e.g. gutters, tanks, drains, natural drainage lines and underground) and where it eventually ends up. Produce a map of these features and indicate the flow direction of the water.
- Suggest the various ways in which water from their home or the school might reach the river – surface flow in streams and creeks, overland flow, groundwater, via a drain.
- Use a topographical map of the area to determine the catchment boundary of the local area near the river.

SWAN RIVER

River health

To show understanding of the link between land-use activities, water movement and the health of the estuary, students could:

- Brainstorm the various uses of the local area/sub-catchment, e.g. water for agricultural, industrial and domestic uses; land for residences, transport, industries, grazing, cultivation, recreational use; habitat for wildlife.
- Recall knowledge of activities in other parts of the urban area and attempt to categorise these, e.g. recreation (parks, lawns and gardens), light industry (factories and warehouses), commerce (shops and offices), residential areas (houses and transport links) and others (e.g. waste disposal areas, car parks).



- Generate a list of pollutants that might enter a drain and eventually reach the river. Draw a flow chart to show how one pollutant might enter the drain and cause problems in the river.
- Find out about drains in the local area how many there are, whether they are open or covered, whether they lead to the river or to compensation basins, and their potential to transport rubbish to the river.
- Use Resource Sheet 10 as a prompt to discuss pollutants other than litter that might reach the river via drains. See Resource Sheet 10, Don't let your river go down the drain.
- Discuss the meaning of the term 'groundwater', suggest how water enters the ground and design a simple experiment to investigate what types of ground surfaces allow rain water to soak in and what surfaces cause it to run off over the land.
- View the video What is Groundwater?
- D Consider why more pollutants than ever before are entering the river.
- Consider what types of pollutants might enter the groundwater in suburban catchments and how they might do so. See Resource Sheet 11, *Pollution in the urban catchment*. Refer to the Ribbons of Blue primary or secondary school manual, *Water Catchments: Pollution* and *Classroom Activities: Pollution*.
- View the video Algal Blooms and Nutrients, and discuss the role of nutrients in supporting plant and animal life, and when they might be considered as pollutants.

REFERENCE CHECKLIST

Resource Sheet 10, Don't let your river go down the drain

Resource Sheet 11, Pollution in the urban catchment

OTHER RESOURCES

Ribbons of Blue primary or secondary school manual

What is Groundwater? (video)

> Algal Blooms and Nutrients (video)

Features

To demonstrate familiarity with features of the river site, students could:

- Explore the area and list all observable features, classifying them as either natural features or cultural (built) features. Alternatively students could choose a suitable vantage point from which to draw a picture/landscape sketch or a sketch map to show many of the natural and built features.
- Through observation and discussion build a description of the site's features by surveying the site and completing a site survey sheet. Refer to the Ribbons of Blue secondary school manual, *Fieldwork: Site Survey*.
- Produce a sketch map that shows the location of various types of vegetation at the site. Produce a vegetation transect by sketching an outline of the different types of vegetation found with increasing distance away from the water's edge. Complete Excursion 6, Alien plant game, in the booklet Excursions in the Swan River Environment. Refer also to the Ribbons of Blue secondary school manual, Field Biology: The Flora Around your Water Monitoring Site and the booklets Native vegetation of estuaries and saline waterways in south Western Australia and Native vegetation of freshwater rivers and creeks in south Western Australia.
- Take photographs or produce a video to record both natural and cultural features of the site.
- Begin to think about aspects of the estuary that might change over time, e.g. tidal movements, salinity, temperatures, amount of fresh water flowing in, turbidity.

OTHER RESOURCES

Excursion 6, Alien plant game, in the booklet Excursions in the Swan River Environment

Ribbons of Blue secondary school manual

> Native vegetation of estuaries and saline waterways in south Western Australia

Native vegetation of freshwater rivers and creeks in south Western Australia

Water flow

To develop understanding of water flow in the catchment, students could:

- Conduct experiments on different types of ground surface at the site to determine whether water flows over the land surface to the river or soaks in and enters the river via groundwater.
- Produce a map or cross-section to show the flow of water into the estuary at this point.

Rivercare

To show appreciation of the concept of landcare in the estuarine environment and the ability to suggest rivercare strategies, students could:

OTHER RESOURCES

Excursion 7, Action plan for site revegetation, in the booklet Excursions in the Swan River Environment

Excursion 8, Decisions, decisions!, in the booklet Excursions in the Swan River Environment

- Explore the area for evidence of environmental good practice, e.g. appropriate parking design, suitable control of access ways, retention or rehabilitation of vegetation, provision of wide river verges and erosion control works.
- Explore the area for evidence of on-site landcare and watercare activities that may be occurring.
- Brainstorm a list of actions they could take to care for the site, e.g. conduct a litter cleanup, remove weeds, monitor water quality. Choose one of these and make an action plan to carry it out. Complete Excursion 7, Action plan for site revegetation, in the booklet Excursions in the Swan River Environment.
- Clarify ideas about the way in which the river and foreshore should be used, managed and cared for, and compare ideas with those of other people. Complete Excursion 8, *Decisions, decisions*, in the booklet *Excursions in the Swan River Environment*.
- Draft a design for a poster entitled 'Urban Kids Care for Waterways'.

River health

To identify types of land-use activities that occur in the urban catchment and consider the impact on river health, students could:

- On their way to the river, record evidence of the land-use activities in the local area.
- Examine the built features at the river site according to categories of land-use activities developed in the preliminary stage, e.g. recreational, light industrial, commercial, residential, waste disposal, vehicle parking.
- Produce a colour-coded map of the land uses of the area around the site. Categorise and colour code the land uses, e.g. light green for parks, gardens and lawns, red for light industry, orange for commercial use, yellow for housing, dark green for areas left vegetated.
- Brainstorm possible types of degradation produced by the land-use activities identified, e.g. pollution, erosion (wind and water). Write about the effects of the problem on the environment, aquatic life and people.
- Make a list of types of pollutants that could be carried into the river at this site, and how they might be carried in.
- Locate drains or tributaries that flow into the river. Estimate how much water they add to the river. Determine whether turbidity (muddiness) is a problem and if the drains have deposited sediment in the river. If there is sedimentation, try to identify the source.
- Determine whether the river bank is eroding and suggest possible natural and human-induced causes, e.g. the effects of floods, tides, bends in the river, slope of the bank and its type of soil, type and amount of foreshore vegetation, the effects of boats, trampling, ramps, groynes, drains, riverbank walls and the removal of vegetation.
- Investigate whether dredging has occurred in the area and, if it has, state why it took place and what effect it might have had on water quality.
- Examine the site for evidence of weeds and consider why weeds are a problem in the river environment. See Resource Sheet 12, Vegetation and weeds of the Swan River system. Refer also to Excursion 6, Alien plant game, in the booklet Excursions in the Swan River Environment.
- Produce an environmental impact map showing areas of degradation, e.g. those affected by weeds, erosion, rubbish, pollution. Rate the problems according to their severity.

REFERENCE CHECKLIST

Resource Sheet 12, Vegetation and weeds of the Swan River system

OTHER RESOURCES

Excursion 6, Alien plant game, in the booklet Excursions in the Swan River Environment

Features

To demonstrate their ability to collate and communicate findings about the physical and built features in the local urban area, both past and present, students could:

- Produce a map of the local area to show all water features drains, wetlands, creeks. Display the map in the school library.
- Make a display of drawings, photographs and other information about the natural and built features found in the area, now and in the past.
- Discover more about how the estuary has been changed. See Resource Sheet 9, Modifications to the Swan-Canning estuary.
- Compare their site with that examined by another school and exchange information.
- Interview some Aboriginal people to find out more about their relationship with the Swan River environment.
- Discover more about the physical characteristics and hydrology of the estuary and other estuaries in the south west of Western Australia. See Resource Sheet 13, *Estuaries of the South West – facts and figures.*

Note: Resource Sheet 13 was compiled using the following references:

- Hodgkin, E. P. and Lenanton, R. C. 1981, 'Estuaries and coastal lagoons of south Western Australia', in *Nutrient Enrichment in Estuaries*, eds Neilson & Cronin, Humana Press, New Jersey, pp. 309-21.
- Hesp, P. A. 1984, 'Aspects of geomorphology of south Western Australian estuaries', in *Estuarine Environments of the Southern Hemisphere*, ed Hodgkin, WA Department of Conservation and Environment, Bulletin 161, Perth, Western Australia, pp. 61-83.
- Hodgkin, E. P. & Hesp, P. A. 1998, 'Estuaries to salt lakes: Holocene transformation of the estuarine ecosystems of south Western Australia', *Marine and Freshwater Research*, vol. 49, pp 183-201.
- Kinhill Engineers, 1988, Peel Inlet and Harvey Estuary Management Strategy: Environmental Review and Management Programme – Stage 2, A Report for the Department of Agriculture and Department of Marine and Harbours, and assessed by the Environmental Protection Authority of Western Australia.
- Congdon, R. A. & McComb, A. J. 1980, 'Nutrient pools of an estuarine ccosystem the Blackwood River Estuary in South-Western Australia', *Journal of Ecology*, vol. 68, pp 287-313.

Water flow

To show how they can apply and extend their knowledge of subcatchment water flow problems in the urban area (or in their school grounds), students could:

Investigate the permeability ratings of different surfaces around the school or near home, e.g. grassy slopes, bare slopes, mulched areas, freshly turned soil, bricked areas. Determine what proportion of the water contributes to groundwater recharge and to surface water runoff.

REFERENCE CHECKLIST

Resource Sheet 9, Modifications to the Swan-Conning estuary

Resource Sheet 13, Estuaries of the South West – facts and figures
Water flow (contd)

- Work out the proportions of permeable land surfaces (e.g. gardens, parks and bush) and impermeable hard surfaces (e.g. roads, car parks and pavements) from which water runs into stormwater drains. (Use a metropolitan road map.)
- Review the catchment model made in the pre-visit stage, and determine how it could be improved. Make the changes. Refer to the Ribbons of Blue primary school manual, *Classroom Activities: Catchments*.

River health

To demonstrate their knowledge of pollutants and how they enter the river, students could:

- Produce a large concept map that summarises the types of land-use in the urban catchment.
- Clarify ideas about the connection between urban growth, pollution and water flow patterns in the urban catchment. See Resource Sheet 14, Urban development and river health.
- Conduct an investigation into ways polluted water from the school grounds may enter the groundwater or drains to eventually reach the river. List pollutants that might be washed off these surfaces and those that might end up in the ground, e.g. detergent, fertiliser, leaves, oil, sewage, chemicals, dirt and silt. Consider how pollutants affect water life. Present findings as a brief report for submission to the school principal. Refer to Water facts 2, *River and Estuary Pollution*.
- Investigate a local parking area to find out what substances are washed into the drains when it rains. What harmful things might people be emptying into them? Work out what percentage of the local area has hard surfaces.
- Watch the video Living on Groundwater Part 2 Urban WA. Design an ideal urban environment which has no detrimental effect on groundwater.
- Watch the video Algal Blooms and Nutrients. Discuss the role of nutrients as river pollutants. Design an ideal urban environment to maintain a healthy river.
- Survey local businesses to find out how the waste they produce might affect the river (e.g. nutrients, chemical solvents, heavy metals, hydrocarbons) and to determine the level of awareness of waste disposal problems.

OTHER RESOURCES

Ribbons of Blue primary school manual

REFERENCE CHECKLIST

Resource Sheet 14, Urban development and river health

OTHER RESOURCES

Water facts 2, River and Estuary Pollution

Living on Groundwater Part 2 – Urban WA (video)

> Algal Blooms and Nutrients (video)

Rivercare

To show their understanding of the importance of members of the community becoming involved in reducing the impact of their own activities, and to show how they can take positive action to care for the river, students could:

- Write a detective story about two children who discover a major fish kill in the river and follow clues to find the culprit who had flushed old engine oil into a stormwater drain. Create a positive ending to the story.
- 'Adopt' a drain and put stencils on it to increase the community's awareness that drains lead to the river. (Contact the Swan River Trust for details.)
- Write a story or a comic book entitled 'The Diary of a Drain', or design an attractive signpost with a catchy message, e.g. 'Help Halt our Drain Strain'.
- Find out about ways in which problems in the urban catchment are being managed. See Resource Sheet 15, Guardians of the Swan River environment. Refer also to the Swan-Canning Cleanup Program Action Plan.
- Choose an environmental problem identified at the estuary and draw up an action plan for solving it. Complete Excursion 7, Action plan for site revegetation, in the booklet Excursions in the Swan River Environment.
- Role play a public meeting at which people in the local community express their concerns about problems associated with the river environment.
- Adopt the role of an investigative reporter to find out more about urban watercare problems. Publish findings in a special newspaper article.



 Contact the local council, a local environmental group, the Swan Catchment Centre or the Swan River Trust to find out about urban landcare or rivercare activities in which they could become involved,

e.g. installing wetlands near new urban developments, restoring a drain to a living stream, planting vegetation buffers or revegetating a degraded site. Make a video showing the class at work helping to solve problems. Refer to Water facts 4, *Living Streams*.

Invite an Aboriginal guest speaker to talk about their cultural associations with the river. As a follow-up activity, design a watercare logo that illustrates these relationships.

REFERENCE CHECKLIST

Resource Sheet 15, Guardians of the Swan River environment

OTHER RESOURCES

Excursion 7, Action plan for site revegetation, in the booklet Excursions in the Swan River Environment

Swan-Canning Cleanup Program Action Plan

Water facts 4,

Living Streams

URBAN CATCHMENT PERSPECTIVE

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THE SWAN RIVER

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An Urban Catchment Perspective ~ The Swan River

Resource Sheets

The Swan-Canning river system

The Swan-Canning river system refers to all rivers, watercourses, drains and tidally affected waterbodies on the coastal plain around Perth. The coastal portion of the Swan-Canning river system catchment accounts for 2117 square kilometres out of a total catchment (including the Avon River basin), of approximately 141 000 square kilometres.

The Swan and Canning rivers flow through the heart of metropolitan Perth, a city of approximately 1.4 million people. The total estuarine portion of the Swan-Canning river system, which includes the tidal portions of the tributary rivers and estuarine basins, occupies an area of 55

square kilometres. The Swan-Canning system and the nearby coastal plain are an important historical, economic and recreational focus for Western Australia and have been since the establishment of the Swan River Colony in 1829.

The Swan River is a major system that consists of a river, some tributaries, an estuary and many creeks, which form a network connecting metropolitan and rural communities to the Swan River.

Tributaries

The Swan River and the Avon River are in fact the same river. There is no confluence. The two names simply represent an historical anomaly. The Avon River 'becomes' the Swan River where it meets Wooroloo Brook in Walyunga National Park, about 30 kilometres north of Perth. The major tributaries of the Avon River are the Dale River (between York and Beverley), the Mortlock River (below Northam Weir), Toodyay Brook and Brockman River, which flow into the river upstream from the coastal plain (near Bullsbrook, north-east of Perth). Ellen Brook, the Helena River and other smaller brooks, (Wooroloo, Susannah and Jane Brooks) feed into the Swan River on the coastal plain. A number of large drains which service extensive areas of the metropolitan region also flow year round into the Swan River.



The main tributaries of the Canning River are the Southern River, Bickley Brook and Yule Brook. There are 31 major subcatchments in the coastal portion of the Swan-Canning river system. (Refer also to Resource Sheet 17).

The Swan-Canning estuary is the large shallow body of water formed near the mouth of the Swan River where it broadens before reaching the sea. The river discharges into the sea at Fremantle through a long narrow inlet channel that passes Chidley Point golf course and Leeuwin Barracks.

The Swan-Canning river system has a Mediterraneantype climate characterised by wet winters and dry hot summers. Rivers flow with fresh water during the winter but dry out during the summer. Groundwater may discharge into the river channels throughout the year, but it is of substantially less quality than that of winter runoff. The Avon River provides most of the flow to the Swan River.

The Swan-Canning estuary

The lower reaches of the Swan-Canning system form an estuary created by geological conditions over 10 000 years ago. The estuary is part of the Swan-Canning river system.

Estuarine conditions extend inland to Ellen Brook (60 kilometres from the ocean) and to the Kent Street Weir on the Canning River.

Open, sunny, slow-moving, shallow river conditions and sandy soils with poor nutrient-binding properties create conditions ideal for algal growth and make the Swan-Canning river system naturally susceptible to blooms.



Swan River Education Kit



Cyclical changes in low-pressure and high-pressure systems affect the weather, tidal levels and wind patterns. Winds are dominated by south westerlies and north westerley storm fronts, which also influence

wave patterns and shore erosion. Seasonal rainfall and weather patterns allow the ocean tide and salty marine water to enter the estuary (through the artificially widened mouth), when river flows start to decrease in spring.

Tides cause the Swan-Canning river system to vary between being fresh-to-brackish in winter and salty in summer. It takes up to two months of rainfall in the subcatchments in late autumn/early winter before freshwater discharge is substantial enough to push the summer salt water downsteam to the middle-to-lower regions of the estuary. In spring, the catchment dries out and freshwater discharge decreases, causing salt water to move upstream.

Algal blooms in the Swan River

In the early 1900s, algal blooms in the Swan River, fish deaths and particularly toxic blue-green blooms, which prevented recreational use of the Canning River upstream of the Kent Street Weir for several months in 1994, focussed community concern on the deteriorating health of the river system. The level of algal blooms was unacceptable to the public. Monitoring showed that high concentrations of nutrients entering the river from its catchment were fuelling the blooms.

The number of algal blooms in the Swan River has remained at levels that the public believe are unacceptably high. Unlike earlier occurrences, which were composed of macroalgae, current blooms are composed more of phytoplankton. In contrast to the siutation in the early to mid 1900s, current water quality problems are due to nutrient enrichment from diffuse and smaller point sources across the urban and rural catchments of the Swan-Canning system. These are much harder to control and manage than large point sources. River managers' concern that toxic algae would become established in the Swan River and the estuary is reinforced by the fact that toxic blooms already occur in fresh water upstream of the Kent Street Weir in the Canning River.

The Swan-Canning Cleanup Program

In 1994, the State Government commissioned the Swan River Trust to establish a five-year program to investigate and prepare a plan to reduce algal blooms. This became the Swan-Canning Cleanup Program (SCCP). A Task Force was established in late 1995 to advise on this program, to prepare an action plan and to report back to the Trust and Government.

In addition to SCCP, a range of projects are conducted across the areas of catchment management, monitoring, research, community awareness and trials to develop river intervention techniques. These projects have improved understanding of water quality and ways to measure the ecological health of the estuary and rivers. Many of these were carried out in partnership between organisations including the Water and Rivers Commission, Agriculture Western Australia, the Ministry for Planning and local government. The Cleanup Program works in collaboration with national programs, especially Swan-Avon Integrated the Catchment Management program, which is funded through the National Landcare Program (now the Natural Heritage Trust).



The Swan-Canning estuary







What's in a name?

River systems were the main means of transport in the early days of settlement, and navigating, mapping and naming the rivers, lakes, estuaries, bays, coves and landmarks occurred at a rapid pace. Imagine the excitement of being the first white person to discover and name a river or lake.

Unlike today, however, there were no laws governing the naming of natural features, streets or properties. Therefore it is not surprising to find that our pioneers found some interesting ways of naming the features they observed on their expeditions.

Researching the origins of our rivers and their features provides us with an interesting view of the early history of Western Australia. Local histories such as *First Stage South*, a history of the Kelmscott area by D. Popham, highlight the importance of rivers in the infant colony and provide more information about the lives of the people after whom many of our waterways and landmarks have been named.

Naturally there were already Aboriginal names for various parts of the river environment, and many of these continued to be used by the new colonists. For example Booragoon still names the area around the lower reaches of the Canning River. In recent years there has been more interest in cultural heritage, and the original Aboriginal names of significant places throughout the State are being recognised. Aboriginal names associated with the Swan River system include: Warndoolier (Swan River); Jenalup (Blackwall Reach); Dycondalup (Point Walter); and Dyarlgarro (Canning River).

Some landmarks were named after ships, for example Success Hill and Point Resolution. The Swan River and Blackadder Creek acquired their names from prevalent wildlife. It is not difficult to understand the naming of Mill Point and Freshwater Bay, but not so easy to discover why Lucky Bay earned its name.

English place names were often used, the Avon River being a prime example, but the most favoured system was to use the names of people. Royalty and noteworthy public figures featured, but the wives, mothers, sisters and other relatives of the pioneers also had the honour of having a river or landmark named after them as the following list shows:

Helena River	was named after Ensign Dale's sister Helen.		
Jane Brook	was named by Captain James Stirling after Jane Currie in 1829.		
Susannah Brook	was named after Susannah Smythe, who died in 1840. Her grave is located on the river bank.		
Matilda Bay	was named by J. S. Roe in 1829 after his wife.		
Mount Eliza, Kings Park	was named by Captain James Stirling after the wife of Governor Darling of New South Wales.		
Salters Point	was named after the Salter family, who lived in the area.		
Chidley Point	was named after Frederick Chidley Irwin, who was assigned a block of land at that location.		

Yule Brook, Mount Henry, Heirisson Island, Melville Water, Alfred Cove, Waylen Bay, Mount Henry, Bull Creek, Point Belches and Point Walter were also named after important identities. A Sense of Place in the Swan River Environment

Estuarine landscapes







Foreshore development



Natural forest vegetation, Maylands



Rottnest ferry with city skyline, off Barrack Street

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Canoeing on the Conning River



Mounts Bay Sailing Club



Natural foreshore vegetation, Bullcreek

Modifications to the Swan-Canning estuary

The banks and foreshore areas of the Swan and Canning rivers have been greatly modified since the arrival of the first settlers in the Swan River Colony. Work has been undertaken to help navigation, reclaim land, prevent erosion and construct various facilities. Some of these alterations have had little effect on the environment; others have been harmful.

Dredging

In the past, dredging was done to remove the build-up of sediments in the river and provide deeper channels for boats. For example, a channel through the banks at Heirisson Island near Perth Water was dredged, the Claisebrook Canal was constructed, the estuary was dredged

near the Barrack Street foreshore, and the jetties on the South Perth foreshore required dredged channels for access. Dredging was also undertaken to mine coarse sand for use in concrete and embankments particularly around Bayswater and the upper Swan.

Reclamation

Dredged material was used to provide new land for parkland, jetties and rubbish tips. Examples of reclaimed land include Langley Park, the Esplanade, Sir James Mitchell Park, the shoreline at the foot of Barrack Street, the foreshore upstream of the Causeway, Heirisson Island, Preston Point and the Narrows Bridge entrance.

Jetties

Jetties were constructed in the early days of the colony and were seen as being essential for river transport, communication, trade and commerce. For example, the jetties at the end of William Street, at North Fremantle, Point Walter, Mill Point, Mends Street and Claremont, and the ferry jetties at the foot of Barrack Street, were built for local boating traffic.

Draining lakes

The low-lying, flat land to the north of Murray Street in the Perth city centre was originally covered by a scries of lakes which drained into Claise Brook and from there into the Swan River. These areas would occasionally flood, causing a lot of damage to property. They were also considered a health hazard. The combination of minimising flood risk, reducing health hazards and promises of rich farming land provided pressure to drain the lakes.

Quarrying

Limestone was quarried for building materials at places like Mosman Heights and Rocky Bay in the early years of the colony. A number of buildings in Perth and Fremantle, and some river walls, were built from this limestone.

Bridges

Bridges constructed over the years include the Canning Bridge, the Narrows

Bridge, the Causeway Bridge, the Helena Bridge, the North Fremantle Bridge (and the Fremantle and Guildford railway bridges.

Construction of reservoirs

In the first years of European settlement people relied on water from either their own well or from a well that served a number of households. There was no deep sewerage, and unlined cesspits were shared by up to twenty or more households. There was great potential for pollution because the cesspits were often only a metre or so away from the wells. These problems resulted in construction of the Victoria Reservoir and, later, those on the Canning and Helena rivers to provide a clean water supply for the growing population. Dams reduce the seasonal flow of fresh water into the river.





Foreshore development

River training projects

These projects have been carried out at some places to deepen the river and reduce the risk of seasonal flooding, to reduce crosion by tides or winds, and in some cases to 'clean up' muddy reed-vegetated areas. These training projects changed the river's course, removed silt from the riverbed, removed sandbars and destroyed reed beds. They also destroyed the river's natural flow patterns and often displaced erosion to other parts of the system.

River walls

Walls have been built at various places along the river foreshore to prevent erosion and in some cases to make an area 'more attractive'. An example is the limestone wall at the river bank between Barrack Street and the Causeway. Unfortunately river walls are expensive, require maintenance and reduce valuable habitat for animals.

Fremantle Harbour

Fremantle Harbour was constructed in the late 1890s by dredging. Jetties, wharves and bridges were built on areas reclaimed from the river. The development involved the construction of two stone breakwaters and the blasting of the rocky barrier or 'sill' that extended across the mouth of the river. Wharves were constructed on the harbour's south side and piers on the north side. Deepening the sill at the mouth of the Swan-Canning Estuary has altered the system significantly and is believed to have made the system more brackish and salty.

Don't let your river go down the drain







Pollution in the urban catchment

Water pollution occurs when waste products or other substances – e.g. litter sewage, contaminated runoff – change the water quality. Pollution may cause environmental problems. Pollutants are carried over the land and into waterways in the drainage (surface flow or runoff in stormwater drains) from land used for urban, rural or industrial purposes. They can also be leached through soil into the groundwater that flows into the river.

Sources of pollutants

Pollutants come from a number of different places in our urban area. Some come from a particular point or locality; this is known as point source pollution. However, most pollution comes from a wider or more diffuse area. • Pollution from our homes

includes: fertilisers, pesticides and herbicides; lawn clippings and

animal droppings washed from gardens; detergent from the water used to wash cars; oil and chemical spills; and nutrients and bacteria from septic tanks which let waste materials soak into groundwater.

- Pollution from our suburbs comes from runoff from roads and parking lots, which washes oil, heavy metals and rubber from tyre, wear into drains. Other sources are chemicals, bacteria and nutrients from waste disposal sites soaking into the ground, and fertilisers and animal droppings from parks and street verges.
- Pollutants from the air are carried by rain or wind in the catchment and then into the waterways.
- Sources of pollutants from industries include: accidental chemical spills that are not cleaned up; waste water containing chemicals or nutrients that are disposed of to groundwater or stormwater instead of being treated and disposed of to a sewer; outdoor activities or cleaning that contaminate stormwater; and wastewater treatment systems not maintained properly or overflowing.

• Pollutants from the agricultural areas nearer the edge of the city (in semi-urban areas) come from rainwater and irrigation water that washes fertilisers, soil, salt, animal waste, pesticides and herbicides into the waterway. These pollutants are also leached into the groundwater and reach the river in this way.



Point source pollution



Diffuse sources of pollution (Water facts 10, Groundwater Pollution)

Solutions

Various rivercare groups, industries and local government are tackling pollution problems in a number of ways. One method is to create basins that retain the water and filter pollutants before they reach waterways. Another is to encourage industries to improve their waste management and prevent pollution. Community groups are being encouraged to paint drains with the stencils 'Drains to the River' and 'Clean Water Only' to raise awareness that whatever goes down the drain ends up in our river. The Swan River Trust cleans up accidental spills of oil and other pollutants that could threaten the river.



Homeowners are encouraged to develop environmentally responsible attitudes. In order to reduce the amount of pollution entering street drains, homeowners are advised to:

- wash their car on the lawn or at a car wash that recycles water and detergents
- use fertilisers sparingly and only use slow release fertilisers
- plant native shrubs and groundcovers to reduce water-hungry lawn and hard concrete surfaces, and reduce the need for fertilisers
- never tip paint, oil or chemicals down the street drain or into gutters
- clean up after pets dog droppings are rich in nutrients
- · use pesticides and herbicides with care, and avoid using them near drains or streams
- water the garden, not the roadway
- water wisely, and give the plants only what they need
- recycle oil by taking it to a local garage
- prevent litter from entering drains
- · avoid dumping garden waste in or near drains or streams
- use soak wells to stop water flowing into drains, and maintain them
- maintain septic tanks regularly
- join or support local community conservation groups
- · report any sign of pollution in drains or the river to the Swan River Trust

Note: If people are unsure about how to dispose of chemicals, the Department of Environmental Protection should be contacted.

ΛN



arum lily

Vegetation and weeds of the Swan River system

Importance of fringing vegetation

Fringing vegetation is important in maintaining a healthy river system and preventing erosion of the river banks. It provides food and shelter for a variety of animals and acts as a filter to maintain the quality of water that enters the estuary. Fringing vegetation strips out sediment and takes up nutrients;

it also stabilises (traps) and aerates sediments, and so prevents murkiness.

Natural vegetation

There is a variety of fringing and aquatic plants in the Swan River environment. Many different types of trees, shrubs, sedges and rushes, samphires,

herbs and grasses can be found living in either salty or freshwater conditions. The plant community found along a river bank and on the strip of land behind it is different from areas further back that are flooded by tides or river floods.

Weeds

The existence of weeds (alien or introduced plants) in waterways and in the fringing vegetation zone is a serious problem. Weeds compete with local plants for space and light. They often spread easily and can overtake the natural vegetation. Many common garden plants can become weeds in waterways.

The prolific growth of aquatic weeds clogs waterways, causing silt and organic material to build up and the water to become shallower.

Aquatic plants and animals may be deprived of oxygen and light, and the water can stagnate, causing the death of aquatic life. Habitats for birds

and other animals may also be lost.

Causes of environmental weeds

Foreshore weeds generally come from nearby gardens or farms. Seeds are blown or washed into bushland and drains leading to streams. Birds can bring seeds into an area in their droppings; dogs



and cats on their fur. People often costor oil bush thoughtlessly dump garden waste containing seeds, bulbs or cuttings in bushland near the river.

Imported aquarium plants can become aquatic weeds if they find their way into streams or wetlands. When aquatic plants are introduced to a river they can grow rapidly because of the fresh slow-moving water and good nutrient supply.

Clearing and overgrazing of the natural vegetation along waterways can worsen the environmental weed problem. Native vegetation may grow more slowly than weed species and be overtaken by weeds. In Perth many old creeklines and open drains are weed-infested due to the clearing of natural vegetation.

Recognising environmental A weeds

Environmental weeds can be recognised in a number of ways. Their leaves are generally bright green, large, soft or broad, and flowers are usually large and colourful.

SCA .

bridal creeper

salvinia

A leafy vine or creeper is almost certainly a weed, as is any plant that looks like a garden plant, lawn or a plant grown from a bulb. A plant that looks lush and healthy in winter

and spring but looks yellow and dead in summer and autumn is probably an annual weed.

Examples of environmental weeds

Environmental weeds in the fringing vegetation

zone include evergreen Japanese pepper and the deciduous poplar, morning glory and bridal creeper vines, the castor oil bush and the tree lucerne. Alien herbs include the watsonia, arum lily, dock, dense flat sedge and bulrush. Grasses include giant reed, flaxleaf fleabane, pampas grass, buffalo grass, couch and kikuyu.

hydrocotyl

Examples of aquatic weeds are free-floating salvinia, hydrocotyl, water hyacinth, water lettuce, alligator weed, parrot's feather and ribbon weed.

Getting rid of weeds

Prevention is better and cheaper than cure. Educating people not to dump garden waste near drains or the river, and never to empty aquarium plants

from fish tanks or backyard ponds into rivers or drains is an important strategy. Pond owners can use local aquatic plants such as the fern-like *Azolla* rather than potential weeds.

Removal of alien plants by hand is the most common approach to stopping the spread of weeds around the Swan River. Sometimes it is necessary to use appropriate herbicides carefully. Replanting with native vegetation helps to re-establish habitats.

alligator weed



water hyacinth

Swan River Education Kir



Estuaries of the South West – facts and figures

CATCHMENTS	SWAN-CANNING ESTUARY	PEEL-HARVEY ESTUARY	LESCHENAULT ESTUARY	HARDY INLET
Catchment details				
Area (km²)	ceastal plain 2300 total Swan-Aven catchment 140 000	11 300	4933	coastal plain 2300 greater Blackwood 160 000
Av. annual runoff (mil. cu. metres)	Swan 377 Canning 300	Murray 420 Serpentine 62 Harvey 90 Minor drains 5	Collic 300 Preston 190	Blackwood >105 Scott 1030
Salinity at point of discharge (parts per thousand)	Swan 10-35 Canning 5	Serpentine 0.5-40 Murray 0.5-30 Harvey 0.5-42	Collie 0.5-35 Preston 0.5	Blackwood 10-30 Scorr 5
Av. annual rainfall (mm)	Perth 871	Mandurah 885	Bunbury 900	Augusta 992
Estuary details				
Tidal rivers (length from mouth in km)	Swan 60 Canning 12.5	Serpentine 20 Murray 15 Harvey 3.5	Collie 14 Preston 4	Blackwood 42 Scott 4
Total area of estuary (hectares)	5300	13 620	2540	1183 (inc. Molloy Island)
Greatest depth (metres)	Blackwall Reach 20	centre of Peel 2 Ward Point 2,5	Southern half 2	Central Basin 2
Inlet channel length (km)	8	5	0.4	2.5
Depth at mouth (metres)	dredged 11	dredged 2	dredged 2	2
Tidal range (% of oceanic)	80	10-15 (pre- Dawesville Channel 45-65 (post- Dawesville Channel	70	70
Perimeter (kilometres)	Fremantle- Causeway 52 Causeway- Middleswan 52 Canning-Bridge Riverton 21 km	94	33	45
Navigable area in hectares (>0.6 metres)	3760	6330	1250 (half is <0.6m)	600 (half is <0.5m)

* Salinity: Scawater=35 ppt, Fresh=5 ppt, Brackish=5-30 ppt

Urban development and river health



The Swan-Canning catchment is home to most of Perth's people with a population of 1.4 million. The river is the focal point of the city, and much of the land around the Swan River has been developed for urban purposes. The city contains a mix of high density urban land uses – residential, commercial, business, industry, recreation, transport and special purpose. As the population of Perth has grown, the urban area has pushed outwards into agricultural land.

Impact of land uses

The growth of Perth and the replacement of the area's natural environmental features with urban structures has had a number of negative impacts on the river

environment. Pollution has increased, the water balance in the Swan River catchment has been altered and habitats have been lost. These problems are outlined below.

More pollutants

The number and types of pollutants likely to contaminate waterways have increased. Examples include dust, animal faeces, tyre rubber, oil and grease, metal particles, industrial chemicals, nutrients, pesticides, herbicides and litter. Pollutants come from various places, e.g. wastewater disposal from industrial sites, septic tank seepage, sewage overflows, oils from vehicle service centres, waste from landfill sites, runoff from roads, parks and gardens, and fertilisers from market gardens and broadacre farming. Nutrients (especially nitrogen and phosphorus) are serious pollutants in river systems because they lead to nutrient enrichment, which can cause algal blooms.

Rising groundwater levels

Groundwater levels have generally risen as a result of clearing vegetation (such as deep-rooted native trees) for urban development. The native plants, which took up a lot of the water and released it into the atmosphere, kept the groundwater at lower levels. The use of scheme water on gardens and parks has also contributed to the elevation of groundwater levels.

Increased surface runoff

Before urban development the area's natural drainage networks collected water and drained it back into the land. This occurred in a way that sustained natural habitats so that minimal

erosion occurred. There was also a balance with groundwater recharge. Channelling the runoff into stormwater drains and the building of hard surfaces (including roads, driveways, and carparks) has increased the volume of runoff and the rate at which pollutants are transported to the river. These hard surfaces are impervious, and so do not allow water to infiltrate the soil. This leads to erosion, reduced foreshore productivity and increased surface runoff when it rains.

Lost habitats

Increased urban development has resulted in the destruction of the river and bushland ecosystems and fringing wetlands of the Swan coastal plain. This has severely impacted on mammals, birds and reptiles, and on plant diversity and populations.

Management for the future

All of these factors have reduced the health and amenity of the river system. It is important to manage the river so as to protect and restore habitats and maintain its attractiveness for recreation and its scenic values. In the catchment, management is focussing on reducing the input of pollution, especially nutrients, to improve the quality of the river water.



Urban development and river health

Guardians of the Swan River environment



There is a need to improve the health of the Swan River, and there have always been people and groups within the community wanting to assist in achieving this. The problems they work on include pollution from industrial and urban areas, algal blooms fed by excess nutrients in the Swan and Canning rivers, urban bushland being cleared and degraded, urban sprawl and riverside developments taking over natural landscapes, and loss of foreshore vegetation through clearing, fire, grazing and weed infestations.

Community groups

Hundreds of active community groups are working to conserve, protect and restore the natural environment within the catchment. These groups include 'friends of', rivercare and bushland conservation groups. Their activities range from regular rubbish collection and weed removal in natural areas, to planting and restoring degraded areas, through to lobbying and environmental advocacy.

Integrated Catchment Management (ICM) groups

An increasing number of Integrated Catchment Management groups are establishing in the Swan catchment. Integrated Catchment Management involves the whole community – including local government and state agencies, industries and business groups – working together to manage all the natural resources in a catchment. The Bayswater Integrated Catchment Management (BICM) program is a good example. The Bayswater Main Drain collects surface runoff, industrial effluent and groundwater and directs water into the Swan River. It is the largest urban catchment in the Perth metropolitan area. BICM is active in trying to minimise the pollution entering the drainage system in order to improve the local environment and reduce pollution to the river. The group has developed a management plan which aims to monitor sites in the catchment and the river to discover how much pollution comes from different land uses and soil types and to assess their impacts. Various task groups are tackling aspects of this issue - nutrients, education, pollution from industry, drainage, wetlands and sewerage. Restoring the environment of the drain will provide benefits to local people as well as improving water quality downstream in the river.

The Swan River Trust

The Swan River Trust was established in 1989 to preserve and enhance the Swan-Canning river system. The Trust works in partnership with community groups and local and state government agencies to offer advice on development proposals and to undertake restoration and enhancement projects. The Trust is also involved in pollution control, catchment management and promoting public awareness of river issues through education and community involvement.

Water and Rivers Commission

The Water and Rivers Commission was formed in 1996 to integrate water resource and waterways management in Western Australia. The role of the Commission is to investigate, measure and assess the State's water resources between competing interests while ensuring the sustainable use, conservation and protection of these valuable resources.

Ribbons of Blue

Ribbons of Blue is an environmental education program aimed at increasing community awareness about local water quality and taking action for a better environment. The program is part of the Waterwatch Australia network, and involves school students, community groups and local governments in monitoring water quality. Data collected from the sampling provides valuable information for identifying environmental problems and preparing management plans.

Curriculum frameworks have been developed for subject areas including Science and Society and Environment, and are ideally suited to introduce environmental concepts to students. The primary school package is integrated with a number of subject areas from Mathematics to English, and the secondary package complements all areas of the curriculum.

The Swan-Canning Cleanup Program (SCCP)

SCCP is a major program coordinated by the Swan River Trust. It began due to a concern about the increasing occurrence of algal blooms in the upper reaches of the Swan and Canning rivers. The program aims to control algal blooms, improve catchment management to reduce the flow of nutrients that feed the algae, and encourage widespread community participation in all stages of the cleanup.

In recent years, the Swan-Canning river system has been showing symptoms of a

system under environmental stress. Algal blooms in the Swan and toxic bluegreen blooms in the Canning have given rise to community concern about the deteriorating



health of the rivers. The level of blooms was unacceptable. Action was needed to protect and restore the river system.

The Swan-Canning Cleanup Program was launched by the Western Australian Government in May 1994. The Swan River Trust established a Task Force to draw together expertise from government agencies, scientific organisations, local government and the community. A large number of projects were funded, including river and catchment monitoring, algae and nutrient research, computer modelling of estuary processes, stormwater design and development of catchment management plans. The five-year program improved understanding of the problem and generated an Action Plan to reduce algal blooms. The Draft Action Plan was released for public consultation in July 1998, and community input was considered in developing the final plan which was released in 1999. A Sense of Place in the Swan River Environment

A Whole-Catchment Perspective ~ The Swan-Avon Catchment

C

The scale of study is the Swan-Avon catchment and the focus is on semi-rural land-use activities in the Darling Scarp area and rural land-use activities in the wheatsheep belt of the Darling Plateau and the landcare and watercare problems that they create.

A Whole-Catchment Perspective ~ The Swan-Avon Catchment

The central idea is that activities upstream from the Swan-Canning estuary affect the river environment further downstream and that Integrated Catchment Management is required to help solve problems.

Fieldwork in the hills area or in the wheatbelt is recommended!

This section examines the following ideas

- The Swan-Canning catchment is part of the larger Swan-Avon catchment.
- Activities in semi-rural and rural catchments impact upon the Swan River system.
- Integrated Catchment Management is needed to ensure an ecologically sustainable future for the river.

Focus questions

- What are the features of the Swan-Avon catchment and how are places connected.
- What is the link between rural land-use activities and river health?
- What is being done to improve the health of the regional catchment?

This section focuses on developing in students an idea of the big picture – the whole (regional) catchment

Catchment connections

To demonstrate use of prior knowledge of the features of regional catchments, and indicate an understanding of the link between the urban catchment and the larger catchment for a whole-river system, students could:

- Define or redefine the term 'catchment' and discuss the idea that water links everything in a catchment. See Resource Sheet 16, *Catchments*.
- Brainstorm terms that relate to catchments and river systems. Research their meanings, then develop a glossary, e.g. catchment, subcatchment, tributary, watershed, drainage basin, estuary, mouth.
- Draw a large sketch map or picture of a river system in an imaginary catchment and label some of the features listed in the glossary. Mark these features on the map: coastal plain, hills, mountains, a plateau, areas of sand dunes and coastal cliffs, forest, areas of coastal vegetation and wetlands.
- Discuss and illustrate the idea that all people live in a catchment.
- Refer to Resource Sheet 17 and locate the subcatchment boundaries for: the Canning River, Southern River, Helena River, Yule Brook, Blackadder Creek, Jane, Susannah, Ellen and Bennett Brooks and the Bayswater Main Drain. Compare the size of the various catchments. See Resource Sheet 17, Subcatchments of the Swan-Canning river system.
- Use maps of the Swan-Avon catchment to find the source of the Swan-Avon River and to follow its path to the sea. Determine the different types of landscapes it passes through (plateau, scarp and coastal plain). Sketch a map of the Swan-Avon catchment to show some of its features. See Resource Sheet 18, *The Avon River and its catchment*, Resource Sheet 19, *The Swan-Avon catchment*, Resource Sheet 20, *Avon catchment landscapes*, and the *Swan-Canning River and Estuarine System Map*.
- Think about the estuary being at sea level and suggest what impact this will have on the estuary's water levels. Collect tidal information from the *West Australian* newspaper to work out how often tides occur, and the average height of the tide at various places along the river.
- Use background knowledge of the climate of the south-west of Western Australia to suggest how the estuary might vary from summer to winter in terms of water flow, salinity, temperature and sediment levels.
- Draft a design for a model of a regional catchment and present an annotated sketch of their proposed model, outlining materials and methods they will use.
 Complete Excursion 9, *Creating a catchment model*, in the booklet *Excursions in* the Swan River Environment.

REFERENCE CHECKLIST

Resource Sheet 16, Catchments

Resource Sheet 17, Subcatchments of the Swan-Canning river system

Resource Sheet 18, The Avon River and its catchment

Resource Sheet 19, The Swan-Avon catchment (map)

Resource Sheet 20, Avon catchment landscapes

OTHER RESOURCES

Excursion 9, Creating a catchment model, in the booklet Excursions in the Swan River Environment

Swan-Canning River and Estuarine System Map (poster)

Land uses and catchment health

To demonstrate that they are able to investigate the links between rural land-use activities in the regional catchment and catchment issues, students could:

- Brainstorm a list of rural ('in the countryside') and semi-rural land-use activities, e.g. market gardening, viticulture, forms of horticulture, fruit-growing and more extensive forms of agriculture such as wheat farming, sheep and beef cattle grazing, dairying, forestry, mining, wildflower and honey production, tourism and national parks.
- Consider how traditional Aborigines may have used the resources of the catchment.
- Think about what effects the following activities and conditions might have on water quality and flow: burning off, jarrah dieback, construction of dams and mining.
- Use atlas maps to identify the main land uses in the Darling Scarp and Avon basin. Study a landscape photograph of jarrah forest and the extent of the clearing in the wheat-sheep belt of Western Australia.
- Recall/research land-use problems in the Avon River catchment. See Resource Sheet 21, Land-use activities and problems in the Avon River catchment, and Resource Sheet 22, A balancing act – agriculture and nature.
- Make contact with a farmer or school students in the Avon Valley to find out what happens on a wheat/sheep farm.
- Draw two pictures to show how the cultural landscape of a rural catchment might differ from that of an urban catchment.
- Explore more fully the idea that what happens in one catchment is likely to affect the rest of the catchment – that is, land-use in the upper catchment is linked to water quality in the lower catchment.
- Explore links between water pollution and activities in a catchment. Complete Excursion 10, A story of an unhealthy river, in the booklet Excursions in the Swan River Environment.
- Sort a jumbled list of catchment activities and their subsequent effects on the environment, and make connections and links between them, e.g. disappearance of wildlife, soil erosion, mining, weed invasion, removal of trees, water quality, silting of estuaries, filling in of wetlands, salinity, industrial pollution, tourist developments, overgrazing, eutrophication, loss of fertility in soils, loss of native plants, flooding.

REFERENCE CHECKLIST

Resource Sheet 21, Land-use activities and problems in the Avon River catchment

> Resource Sheet 22, A balancing act – agriculture and nature

OTHER RESOURCES

Excursion 10, A story of an unhealthy river, in the booklet excursions in the Swan River Environment

Land uses and catchment health (contd)

- Consolidate their knowledge of groundwater by viewing the groundwater videos What is Groundwater?, Living on Groundwater Part 1- Country WA, and Living on Groundwater Part 2 - Urban WA.
- Suggest what effect clearing too much land on a steep slope can have on the flow of water and on soil.
- Conduct simple experiments to compare catchment surfaces for water and wind erosion potential. Compare bare ground with vegetated or mulched ground, or contoured slopes with smooth slopes, and compare the effects of 'light rain' and 'heavy rain'.
- Conduct simple experiments to test aspects of salinity, e.g. to determine how salty water is, to show how salt 'moves up' and so on.
- Start a file of newspaper clippings about rural landcare issues such as salinity, erosion, loss of natural habitats and water quality of rural streams.
- Design and plan a water quality investigation. Refer to Water Quality Investigations activities in the booklet Working Scientifically in the Swan River Environment.
- Action! Plan a trip into a semi-rural catchment of the Swan River system or the rural catchment of the Avon River.

OTHER RESOURCES

Working Scientifically in the Swan River Environment

What is Groundwater? (video)

Living on Groundwater Part 1 – Country WA (video)

Living on Groundwater Part 2 – Urban WA (video)

Catchment connections

To show their ability to investigate and use evidence of connections between this site and places further up and down the catchment, and to relate water cycle processes to the whole catchment, students could:

- In quiet time, reflect on how the river might look, what it might be like further upstream, and what the landscape might be like.
- Draw a quick diagram or a map to show this spot relative to the river's source and the sea.
- □ Role play the processes of the water cycle. Refer to Water facts 7, The Water Cycle.
- Imagine being the river and write about or draw the different stages in its journey to the sea.
- Imagine being a raindrop and discuss or draw the alternative routes they could have taken to get to this point.
- Describe aspects of water movement at this site the volume of water flowing through it, the direction of water flow, the possible influence of tides and of freshwater flow.
- Look for signs of sediment in the water and speculate about the source. Also consider whether there would be more sediment in the river at particular times of the year.
- Identify visible features and suggest invisible features of the river environment at this point that could be related to activities that occur further up the catchment.
- Brainstorm the conditions of the estuary that might change over time and predict how these characteristics (particularly the flow) would change at different times of the year. Look for evidence of flood times and consider when floods might happen. See Resource Sheet 23, Catchment connections 1 – seasonal changes in the Swan-Canning river system.
- Measure the tide level on a fixed stake every 15 minutes during the course of the visit. Determine the change in water level, how much water this represents and the approximate volume of water that flows in and out of the estuary with each tide.



REFERENCE CHECKLIST

Resource Sheet 23, Catchment connections 1 – seasonal changes in the Swan-Canning river system

OTHER RESOURCES

Water facts 7, The Water Cycle

Land uses and catchment health

To show that they have developed a sense of personal responsibility for the whole-catchment, students could:

- Check the water for conditions that could be harmful to humans and to plants and animals that live in or near the water.
- Conduct the water quality investigations that were planned in the preliminary activities. Test the water for turbidity, salinity and the presence of excess nutrients. Suggest reasons for results that give cause for concern. See Resource Sheet 24, *Catchment connections 2 – nutrients in the Swan-Canning river system*.
- Look for evidence of degradation at the site. Suggest reasons for any problems. Imagine a time thirty years into the future and tell a story about how the class made the site cleaner, more attractive and more natural – and therefore a better place for wildlife and people.
- Brainstorm a clever way to alert people (who visit the site) to the fact that conditions at the site are to some extent the result of what happens further up the catchment and that what happens at this site will affect the river further downstream.



REFERENCE CHECKLIST

Resource Sheet 24,

Catchment connections 2 nutrients in the Swan-

OIN-SIte

Action!

To indicate that they have improved their knowledge of rural and urban catchments by conducting fieldwork beyond their local catchment, students could:

- Take the Catchment Caters' Trail, which runs through the forest near the Helena Reservoir, to improve understanding of forest management issues that affect Perth's water. Refer to the publication *Catchment Carers' Trail*, issued by the Department of Conservation and Land Management.
- Take the Avon Ascent Drive Trail. Do a self-drive tour up the Avon River via places of environmental interest, e.g. Avondale Discovery Farm (a working research farm) and the Landcare Centre. (Contact the York Tourist Bureau for more information.) Refer to *The Avon Ascent A self guided tour of the Avon Valley.*
- Take a walk in Perth's hills area (Darling Scarp), e.g. the John Forrest National Park area, skirting the Glenbrook Dam. For details of this and other walks refer to the book *Family Walks in the Perth Outdoors*, published by the Department of Conservation and Land Management.
- Visit a working wheat and sheep farm to gain first-hand knowledge about how the farm operates and how the farmer is attempting to address salinity and soil erosion problems.
- Visit the Tammin Alcoa Landcare Education Centre. (Contact the Shire of Tammin for information.)

OTHER RESOURCES

Catchment Carers' Trail

Family Walks in the Perth Outdoors

The Avon Ascent – A self guided tour of the Avon Valley



Catchment connections

To demonstrate an understanding of water cycle processes in rural catchments, students could:

- Create a diagram of the water cycle with the Swan River at the centre. Draw and label processes of precipitation, surface water flow, groundwater flow, transpiration and evaporation. Suggest ways that activities in the catchment could change the movement of water and what it carries. Refer to Water facts 7, *The Water Cycle*.
- Write a story about the travels of one drop of water through the Swan-Avon catchment. Include its time as water in rain, in soil, on the surface, in the river, in plants and in clouds. Refer to Water facts 7, The Water Cycle.
- ¹¹ Make a collage depicting aspects of the water cycle in the Swan-Avon catchment.
- Design and conduct an experiment modelling one of the processes involved in the water cycle.
- Make a poster entitled 'Groundwater You're Standing on It', to illustrate that groundwater brings salts to the surface.
- Make a terrarium to illustrate the concept of a closed system.
- Research how clearing of the land affects groundwater and surface water flow in rural catchments.



OTHER RESOURCES

Water facts 7, The Water Cycle

Land uses and catchment health

To show understanding of land uses in the Avon catchment and their effect on water quality, students could:

- Research the effect of one of the following on water quality and flow: dieback disease, mining, farming, bush fires and dam construction.
- Contact a company that mines in the Darling Scarp to find out about attempts made to minimise negative effects on the environment.
- Improve the practical experiments on land surfaces and salinity that were conducted in the preliminary stage. Write them up in a form suitable for students in other classes/schools.
- Investigate salinity problems in the rural part of the catchment. See Resource Sheet 25, Salinity. Refer also to the Ribbons of Blue secondary school manual, Classroom Activities: Salt and Watertable.
- Map the areas affected by salt in Western Australia and then write a clear explanation of how extensive land-clearing causes salinity problems and how waterways are affected. Brainstorm ideas about salinity control. Refer to the Western Australian Salinity Action Plan.
- Design a cartoon that draws salt problems to the attention of people.
- Find out more about the Avon River and the problems that it faces. See Resource Sheet 26, The Avon River – perspectives and pressures.

REFERENCE CHECKLIST

Resource Sheet 25, Salinity

See Resource Sheet 26, The Avon River – perspectives and pressures

OTHER RESOURCES

Ribbons of Blue secondary school manual

> Western Australian Salinity Action Plan

Catchment care

To show their ability to identify catchment problems and show an understanding of Integrated Catchment Management (ICM), students could:

- Design a perfect wheat-sheep farm, chicken farm or vineyard that would have no detrimental affect on the riverine environment.
- Contact a farmer to ask what can be done about landcare problems on the farm. See Resource Sheet 27, Salinity in the Avon catchment – sources and solutions.
- Find out about Swan-Avon Integrated Catchment Management and the work of Land Conservation District Committees (LCDCs) in the Avon River basin. See Resource Sheet 28, Integrated Catchment Management.
- Discuss whether land uses might come into conflict in catchments, and what can be done about it. Complete Excursion 11, *Catchment care dilemma*, in the booklet *Excursions in the Swan River Environment*.
- Imagine they are a rural catchment care group and hold a class meeting to air concerns about pollution and degradation. Brainstorm a list of achievable prevention measures. Vote on actions to be carried out and develop an action plan. See Resource Sheet 29, *Catchment planning by rural communities in the Avan basin.*
- Find out about the work done by various catchment care groups (e.g. Australian Waterwatch programs or groups), revegetation groups (e.g. Men of the Trees, Greening Western Australia), catchment support groups (e.g. the Peel-Harvey Catchment Support Group), the Department of Conservation and Land Management, Tammin landcare groups, the Avon River Management Authority, etc.
- Find out the name of a sponsor, school group, tertiary education group, community group, scientific organisation, government agency, sporting group, or local government agency that work towards solutions to catchment problems.
- Write advertisements for the 'situations vacant' section of the newspaper advertising for a team of managers who will be in charge of coordinating and developing catchment care programs in the Swan-Avon catchment.
- Brainstorm all possible futures (good, bad and neutral) for either the river site visited or for the whole-catchment. Decide which future is preferable and how it might be achieved.
- Design a catchment care game or jigsaw puzzle of a perfect catchment.

REFERENCE CHECKLIST

See Resource Sheet 27, Salinity in the Avon catchment – sources and solutions

Resource Sheet 28, Integrated Catchment Management

Resource Sheet 29, Catchment planning by rural communities in the Avon basin

OTHER RESOURCES

Excursion 11, Catchment care dilemma, in the booklet Excursions in the Swan River Environment

SWAN-AVON CATCHMENT

Action!

To show that they have taken some action towards achieving the best possible future for the Swan-Avon catchment, students could:

- Design and display posters with a positive catchment message or revise the code of conduct that was developed earlier to incorporate a whole-catchment perspective and display it somewhere in the school. Alternatively, write and perform a play about catchment care.
- Form a group called 'Waterwatchers' and develop an action plan. Contact some landcare, bushcare and waterwatch groups (e.g. Save the Bush, One Billion Trees, Ribbons of Blue) to find out what these groups are trying to do and how they may be able to help. Let the local community know about their work, e.g. do a display/presentation in the local library, school foyer, shop

windows, local hall or shopping centre or at a community gathering on an appropriate day (e.g. World Environment Day).

Contact students in other schools to find out what catchment studies they have done. Plan to do some future work with them. A Whole-Catchment Perspective ~ The Swan-Avon Catchment

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Resource Sheets





A catchment is an area of land from which all the water (both surface water and groundwater) flows to a common low point. The low point might be a lake, a river or stream, a wetland or the mouth of a river where it enters the sea. The high points might be the tops of steep slopes where the water starts to flow.

Catchments vary in size

Catchments can be very large or quite small. A large catchment usually has mountain ranges, hills or ridges as its high points, and contains major drainage networks of creeks, rivers and groundwater. These large catchments are sometimes called regional catchments. The Swan-Avon catchment, which drains a large region of Western Australia, is an example.

Regional catchments are made up of many smaller subcatchments. These may be bordered by low hills, and may be drained by only a small stream. The Swan catchment is an example, as it lies within the larger Swan-Avon catchment. The Ellen Brook subcatchment is part of the Swan catchment, as Ellen Brook flows into the Swan River. Within subcatchments there might also be even smaller subcatchments. A local subcatchment might consist of all the land that drains down towards a spot on the river. Your suburban area or neighbourhood is a local catchment for a stream, wetland or groundwater area. Your school can also be viewed as a catchment.

The water cycle

Water links everything in a catchment. Within a catchment, water moves through the atmosphere, the rivers, the lakes and the ocean, over the land, through the soil and through living things. The water occurs as a gas (water vapour), as a liquid and in some catchments even as a solid (snow or ice).

A number of processes make the water cycle work. The cycle begins with *evaporation* from the sea, other waterbodies and land. This is caused by the sun's energy. Plants return water to the atmosphere by *transpiration*, and animals, including humans, return it by *respiration*.
The water cycle (contd)

The invisible water vapour in the atmosphere then forms water droplets due to *condensation*. These water droplets may join and fall as *precipitation* (rain, hail or snow) on to the land or waterbodies. Most rain soaks into the soil by the process of *infiltration*. Some moves back up through the soil and is then evaporated, and some of it sinks into the watertable (the zone of permanently saturated water). Trees draw on this water through their roots and lose it through their leaves by *evapotranspiration*. Any water that does not move underground runs off over the land, where it is carried away by the network of streams and rivers. This process is called *runoff*.

People live in catchments

Catchments contain a range of natural resources: water, natural vegetation, soil, rocks, air and wildlife. We all live, work and play in a catchment using its resources in a number of ways. Within a large catchment, land-use activities include different types of agriculture (crop-growing and raising animals) and urban land uses (towns and cities contain residences and gardens, recreational facilities, transport links, offices, shops, warehouses and factories). Mining, industry, forestry and water supply also occur in catchments.

Catchment problems and management

Catchments are coming under pressure as our population grows and our use of technology increases. We are damaging the catchment's water and land resources and upsetting the natural balance of our environment as we create environmental problems such as soil erosion and water pollution.

Because all places in a catchment are linked, whatever problems we create in one part can affect the quality of our water and land elsewhere in the catchment.

Some organisations and communities are taking action to improve the health of our catchments. They are working on landcare and watercare programs in local catchments, subcatchments and regional catchments. People who work to improve conditions in the smaller catchments are helping to improve conditions in the regional catchment.

Since we all live in a catchment we should all work to improve the conditions within it!



Water from across the catchment eventually finds its way into the estuary. This means that pollutants from all land uses in the catchment can also end up in the estuary.





Urban catchment

Subcatchments of the Swan-Canning river system





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The Avon River and its catchment

The Avon River is one of the great rivers of Australia. The main channel (from near Wickepin down to where it becomes the Swan River at the confluence with Wooroloo Brook) is over 260 kilometres in length. Above this channel there is a vast drainage basin stretching to Dalwallinu in the north, to the east beyond Southern Cross and to the south beyond Lake Grace. The Avon basin is divided into three distinct catchments: the Avon, Yilgarn and Lockhart. As the river descends through the Darling Range, the waters of the Avon eventually become part of the Swan River estuary, before flowing into the Indian Ocean at Fremantle. This basin has an area of over 120 000 square kilometres, larger than the State of Tasmania.

The waterways feeding the Avon arise initially as

seepages, soaks, small streams and salt lakes deep in the catchment. In the drier sections of the catchment, the waterways join up and discharge into the Avon River only in aboveaverage wet years or when heavy summer rains (associated with a cyclone or rainbearing depression) are followed by a wet winter. At other times, the inland subcatchments drain internally

into salt lakes or chains of salt lakes.

The river has a number of significant tributaries, the major ones being:

- the Dale River and Spencer Brook, which drain western sections of the middle catchment;
- the Mortlock rivers (North, South and East branches);
- the Mackie River, which drains catchments to the north and east of the middle catchment; and
- the Yenyenning Lakes/Salt River valley system, which drains the Yilgarn and Lockhart catchments to the north-east and south-east of the river.

A feature of the middle section of the main river channel (between Beverley and Toodyay) is the deep pools, which once had high aesthetic, nature conservation and recreational value. These pools have been filled or are filling with sediment, and are one of the most threatened aspects of the Avon system. From a geographic perspective the Avon River is unusual in two respects. Firstly, in contrast to conventional rivers it arises in a broad, flat geologically ancient landscape and for most of its length has a very low gradient. As it leaves the areas of ancient drainage and flows downstream through mature and then rejuvenated landscape, the river valley becomes steeper, more rugged and narrower. Secondly, the river flows only intermittently, with streamflow commencing in the autumn and continuing through to mid-summer, after which it dries up to pools and billabongs.

The Avon is a highly disturbed river, its hydrology, ecology and streamflow having been upset by the clearing of the catchment woodlands for agriculture, the establishment of urban populations in towns in several places along the river bank, and the clearing of the river banks and deepening of the river channel for flood mitigation. These factors offer a special challenge to river managers.



Before and during the early days of European settlement, the Avon River had many natural physical and cultural values. The main river channel was originally braided, with many small channels interweaving between thickly vegetated islands, and punctuated by numerous deep, shady pools. The river and

its adjacent woodlands abounded with animal and bird life. Deeper in the catchment beautiful lakes were surrounded by wooded hills.

The river (like all rivers) did originally contain sediment and a bedload of sand and silt, but prior to settlement this material was in equilibrium, with natural gains (through erosion of stream banks, etc.) and losses (through downstream transport) being in balance.

The river was a prime food and a profound spiritual resource to the Aboriginal people, and it is still part of a significant songline or dreaming trail.

After settlement, the river was used for domestic and stock watering, as a source of fish and game, and as a source of recreational pleasure to local people. It was also an interesting feature of the ecosystem, with characteristic riparian and aquatic vegetation and wildlife. The river is a central landscape feature of the region and of the towns of Beverley, York, Northam and Toodyay.

The physical characteristics of the Avon River

The Avon River and the Swan River are in fact the same river. There is no 'confluence'. The two names simply represent an historical anomaly. The Avon is taken as that part of the river inland of its confluence with the Wooroloo Brook at Walyunga Narional Park. The main waterway of the river is discernible upstream to Wickepin. The South Branch of the Avon arises near Pingelly, flows through Brookton and joins the main river channel downstream of the Yenyenning Lakes. Along most of its course down to Toodyay the gradient of the riverbed is gentle, falling at only about 0.8 metres per kilometre. Below Toodyay it steepens to 1.6 metres per kilometre. The river valley is very wide (77 kilometres) near its source and narrows to 5 kilometres or less below Toodyay.

The Upper Avon River (above Beverley) is a meandering watercourse with a very low rate of descent. This section of the river and its catchment lies to the east of the Meckering Fault, a line which separates the ancient landscape of low relief and broad valleys from the younger and rejuvenated landscapes to the west, which is characterised by steeper valleys and swifter streamflow. The Upper Avon is connected to the Yenyenning Lakes, which in turn are connected to the vast inland catchment via the Salt River Valley and chains of salt lakes stretching to the east and south.

The Middle Avon River (Beverley to Toodyay) is a well-defined watercourse with numerous pools and braided reaches, flowing generally north and northwest. In this section the river is joined by a number of significant tributaries. Of these, the Mortlocks are particularly significant in terms of their contribution to streamflow (especially in dry years) and salt load.

The Lower Avon River (below Toodyay) flows westward through the Darling Range, with increasingly narrow gorges, rapids and waterfalls. This high rainfall area makes a significant contribution to river flow, especially from the main tributaries (Toodyay/Yulgan Brook, Jimperding Brook, Julimar Brook, Red Swamp Brook, Wooroloo Brook and Brockman River).



The Avon River basin

The Avon River basin is the largest catchment in the South-West Drainage Division of Western Australia. Located east of Perth, the basin extends inland to the goldfields, covering an area of approximately 120 000 square kilometres. The basin comprises three main catchment areas, the Yilgarn and Lockhart catchments in the east and the Avon catchment in the west.

Yilgarn and Lockhart catchments

The Yilgarn and Lockhart catchments are the areas where the Swan-Avon river system has its origin. These catchments contain large areas of salt lakes and sand plains and poorly defined drainage lines. Sometimes during wet seasons, floodwaters will join the salt lakes up, and the water will drain into the Swan River through the Avon River.

The Avon catchment

Within the Avon catchment lie the Avon, Mortlock and Dale river subcatchments. The Avon River subcatchment supports 54 000 people who live in rural communities, about 40 per cent of these people being farmers.

The main tributaries that flow into the Avon tend to have a more permanent flow, being fed by aquifers in the zones in the upper reaches of the valleys. Although the Avon catchment occupies only about 10 per cent of the total catchment, it contributes 80-90 per cent of the flow.

The Swan catchment

The Swan catchment is the western margin of the Swan-Avon catchment and includes the Swan River. From here the river discharges into the sea at Fremantle.

The smaller subcatchments of the Swan catchment include the Canning River, Southern River, Helena River, Blackadder Creek, Jane Brook, Susannah Brook, Ellen Brook and Bennet Brook catchments. The metropolitan main drains, such as the Bayswater Main Drain, also empty into the Swan River.

The Swan catchment is sometimes referred to as the 'urban' catchment since it supports most of Perth's 1.4 million people. In fact, about 80 per cent of Western Australia's population live on the Swan coastal plain.

(Please refer also to Resource Sheet 19, *The Swan-Avon catchment.*) The information contained in this resource sheet was sourced predominantly from the *Draft Avon River Management Programme*, Water and Rivers Commission and Avon River Management Authority, 1999.



Avon River

The Swan-Avon catchment



resource sheet



The catchment of the Swan and Avon rivers represents one of the largest in Western Australia. It covers over one-twelfth of the State, being about 140 000 square kilometres in area. This is about the size of Tasmania! The Swan-Avon catchment extends inland from the coast at Perth and stretches from Dalwallinu in the north, past Southern Cross in the east and through to Lake Grace in the south-east. The Swan-Avon catchment supports more than 75 per cent of Western Australia's population.

Swan River Education Kir



A Sense of Place in the Swan River Environment

Avon catchment landscapes



Confluence of Yilgarn and Lockhart catchments



Moore River near Guilderton



Uberin, north of Dowerin



Nambadilling, Corrigin



South Tammin catchment



Land-use, Deepdale, Toodyay



Land-use activities and problems in the Avon River catchment

Land-use activities

The Avon River catchment is a very important agricultural region of Western Australia. It generates over a third of the state's agricultural wealth. It produces half of the state's wheat and barley and has around ten million sheep that supply wool and meat. Some farmers also raise pigs and graze beef cattle. On many farms a mixture of cropping and grazing activities occur, mainly wheat and sheep. This is why the area is often referred to as the wheat-sheep belt.

A variety of other land-use activities occur in the catchment. There are a number of urban centres such as the country towns of Toodyay, Northam, York, Beverley and Brookton. These towns, which are located on the Avon River, provide goods and services to the people in the rural areas. Some of the larger towns have industries like tanneries, abattoirs and flour mills. The catchment's lakes are a valuable resource for water sports such as waterskiing, and the Avon River is a popular recreational site.

The impact of land uses

Like many other Australian catchments, the Avon River catchment is showing signs of land degradation. Almost three-quarters of the native vegetation of the catchment has been cleared for farming. The main problems are salinity, soil erosion, destroyed soil structure and fertility, degraded waterways and habitat loss.

- Salinity. Salinity is one of the catchment's most serious environmental problems. Over-clearing of the natural vegetation has caused this. The deeprooted native trees, which previously took a lot of water out of the soil, have been replaced with shallow-rooted pastures and cereal crops. This has caused the watertable to rise, bringing dissolved soil salts to the surface. Vegetation is destroyed by salinity and soil becomes infertile. The salt can find its way into streams.
- Nutrient enrichment. Nutrient levels in river water are often high. The nutrients come from fertilisers, animal faeces and waste from various activities in towns.

- Soil erosion. Soil erosion occurs when soil is washed away by water (water erosion) or blown away by wind (wind erosion). Erosion occurs because native trees and shrubs, which help to bind the soil together, have been cleared. Another consequence is that there are no fallen leaves to help protect the soil and make it more fertile. A further problem is that the soil eroded from the catchment can be carried into streams and rivers, turning them turbid (muddy) and causing them to silt up.
- Poor soils. The use of nitrogen fertilisers has led to soils becoming increasingly acid, which reduces plant growth, and continual over-cultivation and the trampling of the soil by animals can cause the structure of the soil to break down. Some farming practices have also caused the soils to become increasingly water repellent.
- Loss of habitat. Only small patches (remnants) of natural vegetation have been left in the catchment and along the river, so valuable animal habitats have been lost. Some animals like the numbat have faced possible extinction. This is partly because of clearing and also due to the introduction of the fox. Some wildlife refuges have been destroyed because natural pools have been filled with silt resulting from disturbance of the banks and erosion of stream channels. The loss of foreshore vegetation areas through clearing, fire, salinity, grazing and weed invasions is also a problem.

River management

The river requires coordinated management by individuals, community groups and government agencies, and much work is currently being done to improve the Avon River. (Refer also to Resource Sheet 28, Integrated Catchment Management.)

These changes occur because of the estuary's connections with the rest of the catchment. An estuary is an enclosed or semi-enclosed coastal body of water having an open or intermittently open connection to marine waters and fresh input from land runoff which measurably reduces salinity. Water levels vary in response to ocean tides and river flows.

resource sheet

A balancing act – agriculture and nature



Swan River Education Kit



A Sense of Place in the Swan River Environment

Catchment connections 1 – seasonal changes in the Swan-Canning river system

The Swan-Canning estuary, like other estuaries, is an environment of great change. The water characteristics (hydrology) of the estuary are constantly changing – in terms of the amount and type of water flowing in, salinity, and temperatures within the estuary and tides. Changes occur from day to day, weekly and with the seasons.

Seasonal changes in water movement and salinity

The Swan River estuary changes greatly in terms of the amount of fresh water flowing into it and in terms of its salinity. There are great differences in the salinity of the estuary between summer and winter. The south-west of Australia, including the Swan-Canning system, is affected by a Mediterranean climate with wet winters and dry hot summers. South westerly winds dominate and north westerlies bring in strong fronts. Barometric pressure influences fronts, wind patterns and tidal heights.

Winter pattern

Because rain falls mainly in winter in the south-west of Western Australia, the Swan River flows only in winter. Salinity tends to be much lower at this time because the water flowing into the estuary from streams further up the catchment is fresh. It flows strongly enough to prevent sea water moving too far into the estuary on the incoming tide, so the upper estuary remains 'fresh' in winter.

In early spring, rainfall decreases and so the freshwater flow into the estuary is reduced. Sea water can then move into the estuary, assisted by the tides. The density of salty sea water is much greater than that of fresh water, so the bodies of water do not mix readily but tend to form layers. The sea water flows upstream beneath the overflowing lighter fresh water, producing a 'salt wedge'.

Summer pattern

In summer, two bodies of water are gradually mixed by the force of the wind and the salinity of the surface water increases. As weather conditions become even drier and there is very little freshwater flow (most fresh water at this time is groundwater leaking into the river), the mixed water progresses further upstream. By the end of summer, the whole estuary normally has a high salinity level – similar to that of the sea. In fact, it is sometimes even saltier than seawater because of the high evaporation rates.

In spring and early summer, the estuary's salt wedge can result in deeper bottom waters becoming isolated from the water's surface. Very little oxygen can diffuse from the air through the surface layer of water and into the deeper waters because of density differences caused by salt in the water. This can sometimes result is the bottom layer of water becoming deoxygenated. Millions of invertebrates that live in the mud and sand on the estuary floor may die as a result of the lack of oxygen. Sometimes the deoxygenated water is pushed to the surface in a process called 'overturn', resulting in the death of large numbers of fish.

Tides, storms and temperature

Other changes can occur in the waters of the estuary. For example tide levels vary from time to time and place to place. Winter storms increase water levels as more sea water enters the estuary (due to low barometric pressure), but in calmer sunny weather levels can fall as water moves out of the estuary (due to high barometric pressure). Water temperatures in the estuary also change seasonally and vary from place to place along the estuary and with the depth of the water. Other factors that affect temperatures are the inflowing water, the atmospheric temperatures and the degree of mixing of waters.







Salt wedge

Swan River Education Kit



A Sense of Place in the Swan River Environment

Catchment connections 2 – nutrients in the Swan-Canning river system

Nutrients are chemicals that plants and animals need for their growth and well-being. Nutrients are present in the river in soluble form and are attached to sediment particles. They can enter the river directly, in surface runoff or in groundwater. Organic material, such as animal waste and leaf litter, is also a source of nutrients.

Eutrophication

Nutrients are essential for life. However, large quantities of certain nutrients are harmful in a waterway. More and more nutrients are being added to the river system due to our activities in the Swan-Avon subcatchments.

This process of increasing the amount of nutrients (nutrient 'load') entering the river system is called nutrient enrichment or eutrophication – and it can be very

harmful. Eutrophication is a natural process of accumulation of nutrients leading to increased aquatic plant growth in lakes, rivers, harbours and estuaries. Human activities contributing fertilisers and other high-nutrient wastes can speed up the process, leading to excessive algal blooms and deterioration of water quality.

The most important nutrients contributing to the eutrophication of the Swan River estuary are nitrogen and phosphorus. To some extent carbon, in the form of animal waste and plant material, is also contributing to nutrient enrichment.

The amount of nutrients that enter the waterway at various places in the Swan-Avon catchment depends on the type of land-use activities, the amount of water flowing through the area and the type of soil. Soil type is important because it affects the ability of the soil to hold nutrients. The soils of the Swan coastal plain are sandy and do not hold nutrients well – so nutrients find their way easily into groundwater and the waterways. Erosion also allows soil and sediments with attached nutrients to wash into the waterways.

Algal blooms

Algal blooms are a symptom of eutrophication. The term eutrophication, or excessive nutrient enrichment of an estuary, river or water body, refers to the effects of sudden increases in nutrient inputs caused by



human activity in the estuary and its catchment. This leads to a sudden accumulation of macroalgae and large phytoplankton blooms, including toxic blooms.

Algal blooms at certain times of the year

can cause a number of problems that threaten commercial, recreational and environmental values of the river:

- Water movement and light penetration is reduced, so valuable seagrass beds can be shaded out or smothered.
- When algae die and decompose, they use up oxygen required by other organisms.
- Oxygen depletion in the deeper waters of the estuary can cause the death of worms, crabs and other invertebrates, and in some cases fish.
- The strong-smelling slimy scum of algal blooms is a nuisance to people and a potential cause of skin irritation and health problems.
- Some blooms can be toxic to people and animals.



Where nutrients come from

Excess nutrients come mainly from a variety of urban and agricultural land uses in the Swan-Avon catchment. Sources of nitrogen and phosphorus include:

- commercial fertilisers that are applied to crops and pastures
- waste from animal feedlots and intensive animal industries (such as piggeries) and from grazing areas
- industrial wastes from food-processing factories and a variety of light industry and commercial activities
- leachates from rubbish tips
- watercraft discharges
- phosphates in detergents, waste from sewerage and septic tank systems
- · fertiliser runoff from parks and gardens in urban areas

Excess nitrogen and phosphorus in the Swan River come not only from its own subcatchment but also from the Canning and Avon catchments. The subcatchments that contribute most of the nitrogen loads are the Mills Street and Belmont Main Drains, and the Southern River subcatchments. Ellen Brook and the Southern River contribute more than half of the total load of phosphorus, and the Bayswater Main Drain also carries large amounts.

Management

Reducing algal blooms and improving water quality can be achieved by:

- conducting research into algal blooms and their causes
- reducing the nutrient input to waterways from the catchment
- changing the conditions in the estuary so that algae are less likely to bloom
- conducting cleanup programs to remove accumulation of algae on the shoreline
- increasing flushing to remove nutrients

Integrated Catchment Management encourages urban and rural landholders to work together and tackle the problem at its source. Industries and land managers are being encouraged to adopt Best Management Practices to reduce the impact of land uses on the river.

Water from across the catchment eventually finds its way into the estuary. This means that pollutants from all land uses in the catchment can also end up in the estuary.

For more information refer to Water facts 6, Algal Blooms, the Swan-Canning Cleanup Program Action Plan and the video Algal Blooms and Nutrients.



Swan River Education Kit



Salinity

Salinity is one of the State's most critical environment problems, threatening major economic and social consequences. It is preventable and, in the long term, reversible. Complete elimination is not realistic, but we can dramatically reduce its impact.

This requires coordinated action from agricultural landowners, the Government and the broader community. Catchment management and community participation are crucial to the Government's Salinity Action Plan, which aims to:

- reduce further deterioration and, whenever possible, recover existing salt-affected land
- protect and restore key resources and high value wetlands
- maintain natural (biological and physical) diversity
- protect designated infrastructure affected by salinity

These aims will be actively pursued over the next several decades.

The Issues

Salinisation of land and water in the south of the State is one of the most critical environmental problems facing Western Australians.

WA has over 70 per cent of Australia's reported dryland salinity (refer to the table overleaf). An estimated 1.8 million hectares of farmland are already salt-affected to some extent, and this area could double in the next 15 to 25 years and then double again before reaching an equilibrium.

As a result of the current levels of dryland salinity, more than a third (36 per cent) of the State's divertible water resources are brackish or saline and a further 16 per cent is of marginal quality.

As well as damaging farmland and threatening water supplies, salinity poses a major threat to the environment, including streams and rivers, and to rutal towns, capital infrastructure, tourism and recreation areas, and our ability to support new export industries.



Water balance before clearing



Water balance after clearing

Cause

Salinity is caused by replacing deep-rooted native plants with shallow-rooted crops and pastures. More rainfall passes below the root zone and accumulates as groundwater so that watertables rise. The groundwater mobilises natural salts in the soil as it rises and carries them towards the surface, eventually degrading land and streams.

Successful salinity control requires management of saline groundwater. Deep-rooted perennials, especially trees and shrubs that can restore nature's balance, will be a fundamental part of all salinity management strategies.

Solutions

To achieve the Salinity Action Plan's aims the Government will ensure:

- another three million hectares of trees and shrubs are planted across the agricultural area
- other commercially viable water management practices complement these plantings to maximise water-use and economic benefits
- remnant vegetation is protected and managed to maintain it in perpetuity

The Salinity Action Plan will be applied on the basis of three rainfall zones:

 greater than 600 mm per annum, where farm forestry is largely proven and other perennial options exist

 between 400 and 600 mm per annum, where the high wateruse capacity of woody perennials will be especially important because of the combination of high groundwater recharge and high salt storage

 less than 400 mm per annum, where extensive use of high water-use cropping systems, complemented by strategically distributed revegetation with woody perennials, will be the major focus

State	Area salt-affected in 1982 (ha)	Area salt-affected in 1996 (ha)	Potential area at equilibrium
Western Australia	264 000	1 804 000	6 109 000
South Australia	55 000	402 000	600 000
Victoria	90 000	102 000	unknown
New South Wales	unknown**	120 000	5 000 000
Tasmania	unknown**	20 000	unknown
Queensland	unknown**	10 000***	74 000
Northern Territory	unknown**	minor	unknown
Total	na	2 476 000	>11 783 000

Area of land reported to be affected by dryland salinity in Australia*

initial estimates from Robertson (1996) revised with assistance of National Dryland Salinity Program State representatives

salinity was likely to be present but its extent had not been assessed
only severe salinity recorded

(Information from: Salinity, a Situation Statement for Western Australia, jointly published by Agriculture Western Australia, Department of Conservation and Land Management, Department of Environmental Protection, Water and Rivers Commission.) For more information, refer to the Western Australian Salinity Action Plan, Draft update, State Salinity Council, 1998.



The Avon River – perspectives and pressures

The Avon River is part of a huge inland drainage system. The river, which flows through the Avon Valley, drains into the Swan River, then into the estuary and out to sea, is a precious resource that has come under pressure since European settlement.

An Aboriginal perspective

Aborigines have lived in the Avon valley for many thousands of years. They moved over the land, using its resources for water, food and tools.

An Aboriginal legend tells of the creation of the Avon River by Tjitti Tjitti (Willy Wagtail). Tjitti Tjitti's

Dreamtime, who took both human and animal form. One day, Tjitti Tjitti became very angry because Dwert the dog and Kulbaine the pigeon used his spear and ate his food. Tjitti Tjitti drove his spear into the ground so forcefully that he started a flood. But the Waugal (Wagyl), the Rainbow Serpent who formed the hills and valleys of this land, saw what was happening. Waugal carved out a channel so that the water could flow away. The Avon River carries the water to the Swan River and out to sea to this day. (Story as told in Coondebung's 'Kalleepgur', a Heritage Trail of the Nyoongah Community.)

The Aborigines were hunters and gatherers who used the water resources of the Avon River catchment in sustainable ways. They caused minimal change to the environment and saw themselves as part of the land, with responsibilities for its protection and conservation.

European settlement and impact

Settlement by Europeans has brought the river under pressure. Within ten years of the Avon Valley's European discovery in 1830, farmers and townspeople occupied all of the land along the river. The chain of permanent pools in the river, which attracted wildlife, also became an attraction for people. In winter the river would overflow its channel and flood the surrounding floodplain – a natural event in

the river's cycle. Once every ten years or so flooding caused serious damage to towns and agricultural land near the river. To control this, trees, logs and branches were removed from a section of the river and the river bed was ripped in places to speed up the flow

and reduce the flooding. This process of 'river training' was carried out from the 1950s to the 1970s.

A number of important changes have been brought about as a result of river training. The river now flows much faster and, although flood levels have dropped, the risk of flash floods has increased. The removal of vegetation from the river channel and banks has increased the movement of silt (sediment or ropsoil). This silt and other sediments from erosion of the land, and the stream bank, combined with other soil disturbances, are filling the river's deep permanent pools.

There are other problems too. Over the years a let of the natural fringing vegetation has been cleared or damaged by grazing animals, so now there are only patches left. The river water has become saltier and the water quality is threatened by pollution, including nutrients from excess fertilisers and pesticides, which feed algal blooms.





Avon River

Rivercare

The river is still an important recreational resource today. The dry summer river bed changes in winter into a turbulently flowing stream which allows the annual Avon Descent whitewater boat race from Northam to Perth. In Northam, people visit the river banks for recreational purposes, many to see the famous white swans.

Protecting and replanting the river foreshore are important steps in returning the river to a healthy state. The few pools and patches of vegetation that have been left are vital for the survival of local wildlife. Various community groups are making efforts to:

- rehabilitate river pools as habitats and establish wildlife corridors along the river
- control saline water flow from the surrounding land and saltwater lakes
- fence and plant trees along the river banks and creeks to trap silt and nutrients
- control erosion of the banks, fire, weeds and feral animals
- control pollution from fertilisers, pesticides, stormwater drains and industries

For more information see the Draft Avon River Management Programme, Water and Rivers Commission and Avon River Management Authority, 1999.



A Sense of Place in the Swan River Environment

Salinity in the Avon catchment – sources and solutions



Salinity in the Avon catchment is caused mainly by clearing native vegetation to grow crops and graze animals. Salinity degrades the land, water and vegetation and causes lost agricultural production.

The salt stays down

The very old soils of the Avon catchment contain large amounts of salt. In the western part of the catchment, the soil can hold up to 1000 tonnes of salt per hectare. Brought in by rain from the sea over millions of years, the salt is a naturally occurring substance and causes no real harm as long as it is kept deep in the soil – in the watertable, which is the layer of saturated soil beneath the land surface.

Native trees and shrubs help to keep the salt down in the soil. They have large, deep root systems, so they can use and evaporate large quantities of water from the watertable. They do this by taking in water and nutrients from the soil through small roots, and transporting it to their leaves. Moisture is then released (transpired) from the leaves back to the atmosphere. Because deep roots reach water stored deep in the soil and because they grow actively for most of the year, the native trees act like natural water pumps, taking water out of the soil and keeping salty watertables down.

The salt comes up

In the process of clearing the land to make way for farms, a lot of the native vegetation in the Avon catchment has been cleared and replaced with nonnative crops and grasses. These have shallow roots, so they use less water than native vegetation. Therefore more water can enter the deeper layers of the soil. The watertable rises and brings the dissolved salts with it. The salts are left on the surface when the water evaporates. This happens especially at the bottom of slopes and in depressions in the land because that is where the water drains to and where the watertable is close to the surface. The salt forms a large white scar, sometimes called a salt scald.

The problem with salinity

Salt destroys vegetation, soils and water. Plants become stressed by the salty conditions and may die. When salinity kills vegetation it also causes bare areas, which are prone to erosion. Grazing animals like to gather on these sites to lick the salt, and the trampling of their hooves makes the erosion problem worse. The salty water flows into the river and lake systems and can cause water quality problems further down the catchment. So salinity affects people in the urban catchment as well as the rural catchment.

Farmers fight salinity

When farmers took up the land and cleared the vegetation they could not have known of the potential salinity problem. Today, many farmers are working hard to fight it by:

- planting more trees along fences, streams and roads and on higher land on the farm
- moving or diverting salty water into basins where it can evaporate (to stop the salt entering rivers and affecting areas downstream)
- reducing the number of animals on salt- affected areas

- fencing off areas that have become bare because of salinity and fencing off pockets of bush and streamlines
- planting salt-tolerant grasses, herbs, shrubs and trees on salt-affected areas
- using a mulch made of old hay or straw, or even old carpet, to protect the soil
- installing drainage beneath the soil surface to carry water away from depressions that are waterlogged and salty
- building small banks called interceptor banks on slopes to catch the water and move it away from the low areas
- planting pastures that use a lot of water
- rotating crops to improve soil
- ploughing around the slopes, not up and down, and putting seeds directly into the ground
- increasing their understanding of salinisation and the importance of developing a whole-farm plan to tackle the problem
- becoming involved in catchment and regional planning





Integrated Catchment Management

Clean water is a resource that many people living in the Swan-Avon catchment take for granted. Its availability is being threatened by the high demand for the catchment's resources and by environmental degradation.

Before European settlement, the catchment contained a large range of ecosystems: forest, woodland, scrubland, wetlands and rivers. Much of the catchment has been cleared to make way for agriculture and for urban and industrial uses, resulting in changes to riverine ecosystems, lowland areas, bushland and freshwater and saltwater wetlands of the Swan coastal plain. Also affected are the Avon River's pools and tributary streams, the remaining natural vegetation of the wheatbelt and the Swan-Canning estuary. Degradation has resulted from rising salty groundwater, introduced plants and animals, weed infestations, erosion and sedimentation, pollution by nutrients and chemicals, and algal blooms in the Swan and Canning rivers.

There are many different types of groups concerned with landcare, bushcare and watercare in the urban and rural catchments. They include Integrated Management Committees, Catchment Land Conservation District Committees (LCDCs), sponsor groups, revegetation groups, local community groups, local government, professional groups, schools and other educational institutions, scientific organisations, sporting groups, local farming groups and state government agencies, (e.g. the Swan River Trust, the Water and Rivers Commission and the Avon River Management Authority). These groups want to see healthy waterways surrounded by healthy ecosystems, prosperous land uses that don't degrade soil or waterways, and clean industrial processes. They also want to see local communities conserving the resources we have and acting to improve the health of both urban and rural catchments.

The need for Integrated Catchment Management (ICM)

While the work of the various groups is very valuable, it is necessary to look at the 'big picture' in terms of catchment management. There is a need for a total management system to enable people to continue to use the catchment's resources in an ecologically sustainable way. ICM is a way to link and coordinate the activities of various groups to manage all the catchment's resources and to address the major environmental problems across the catchment. It enables the whole community to work together to manage the catchment into the future. The Swan-Avon Integrated Catchment Management Program was established in 1995 as WA's first regional initiative to protect land and water resources. The aim of the program is to involve the community in planning for sustainable economic development of the landscape while ensuring that biological diversity and ecological processes are protected. It incorporates numerous catchment and community groups and involves state agencies, local authorities and peak community bodies. This program is one of a number throughout the State.

The ICM process

ICM operates in the following ways:

- a person or group expresses a concern about an issue in a catchment
- they talk about it to community groups, council members, local industries, land conservation committees and state government groups
- some members of these groups join together to form a 'Catchment Coordinating Group'
- this group determines the actual boundaries of the catchment, identifies the issues and works out what they want the future of the catchment to be
- it then ranks the issues in order of importance and perhaps carries out some research on them
- the group prepares a Strategy and Action Plan and puts it into place

The Swan Catchment Centre in Perth and the Avon Network Centre in Northam are the central contacts to find out about ICM in the Swan-Avon catchment.

Catchment planning by rural communities in the Avon basin

Cie 29 resource sheet

Swan River Education Kit

Farming communities are working to prevent and control land degradation problems in the Avon catchment. Many farmers are using various strategies in an attempt to prevent salinity and erosion problems and achieve sustainable productivity on their own farms. However, people working together can achieve more than individuals acting separately.

Farmers are forming neighbourhood catchment groups in their local areas and working out strategies to tackle the problems of salinity, soil erosion, loss of soil fertility, loss of water quality and the disappearance of native vegetation.

The aim of neighbourhood catchment groups is to reduce the causes and impact of land degradation and make agricultural systems more sustainable.

Catchment planning by neighbourhoods or community catchment groups encourage people to set common goals to work together. Improvement in one part of a catchment may also benefit another part, for example downstream water quality.

There are now more than 1000 farmers involved in 100 catchment groups in the Avon River basin. That is about 50 per cent of all farmers working together to develop more sustainable farms for the future.

Catchment groups develop and put in place catchment management plans and farm plans for their local area. Catchment planning is conducted on a catchment or subcatchment basis or even at the level of a tributary stream. The participants are mostly landholders, local shire representatives, government agencies (e.g. Agriculture WA, Department of Conservation and Land Management) and other people who have a personal interest in improving catchments.

The procedure that these catchment groups follow for catchment planning is to:

- hold a meeting to define problems and set goals
- obtain maps and photographs that provide information on the catchment
- conduct surveys to gather information about features of the catchment
- consider the problems identified from the survey and prioritise them
- identify land management units on the basis of soil types

- conduct planning workshops to map resources and problems, draft catchment and farm plans and determine strategies for sustainable farming
- finalise the integrated catchment plan
- develop a timeline to put the strategies in place on the farm and then monitor changes

A number of other groups contribute to catchment management in the Avon basin. For example, many Land Conservation District Committees (LCDCs) have been formed to promote sustainable land management systems, solve land degradation problems, carry out land conservation works and advise on appropriate land conservation techniques. These committees consist of representatives from many different groups – land-usets, government agencies and producer organisations.

Other organisations and companies such as Men of the Trees (revegetation group) and Alcoa of Australia Ltd (mining company) are also involved in rehabilitation of the catchment and improved land management practices. Alcoa is involved with the Avon Landcare Project, which is concerned with defining problems and monitoring them, planting trees and shrubs and developing picnic sites for recreation and education in the western part of the Avon catchment. Alcoa has helped local farming groups to 'fast track' their landcare work to demonstrate what can be achieved.

The State Government is also helping and supports catchment planning. In 1996, for example, Agriculture WA, Department of Conservation and Land Management, Department of Environmental Protection and the Water and Rivers Commission jointly developed the Salinity Action Plan. These government agencies continue to work collaboratively with landowners to help address the State's salinity problem. The Water and Rivers Commission works with the community to manage water resources and the Avon River.



This kit contains the following resources:

Booklets

- Excursions in the Swan River Environment, Fieldwork and activities to support studies in Science, and Society and Environment, Water and Rivers Commission/Swan River Trust, 1999
- Working Scientifically in the Swan River Environment, A teaching approach for Science, Water and Rivers Commission/Swan River Trust, 1999
- A Sense of Place in the Swan River Environment, A teaching approach for Society and Environment, Water and Rivers Commission/Swan River Trust, 1999

Map/Poster

· Swan-Canning River and Estuarine System Map, Water and Rivers Commission, 1999

Data disc

• Water Quality Data, Swan River Estuary and its Catchmenn, Ribbons of Blue, 1999

Video

· Living with Streams, Water and Rivers Commission/Swan River Trust

Posters

- H2Only, Swan River Trust
- · Don't Let your River go down the Drain, Swan River Trust

Water facts

- · Water facts 1, Water Words, Water and Rivers Commission, 1996
- · Water facts 2, Macroinvertebrates and Water Quality, Water and Rivers Commission, 1996
- · Water facts 3, River and Estuary Pollution, Water and Rivers Commission, 1997
- Water facts 6, Algal Blooms, Water and Rivers Commission, 1998
- Water facts 7, The Water Cycle, Water and Rivers Commission, 1998

Brochures

- A Guide to Our Services, Water and Rivers Commission, 1999
- A Guide to Our Services, Swan River Trust, 1998
- A Guide to Our Services, Ribbons of Blue, 1998
- 5 Entertaining and Educational Ways to Find Out More About Our Most Vital Resource: Groundwater, Wetlands, Rivers (video order form), Water and Rivers Commission, 1996
- An Educational Video on the Swan and Canning Rivers, New Release: Algal Blooms and Nutrients (video order form), Water and Rivers Commission, 1998
- WaterTalk, Wetlands, Water and Rivers Commission, 1998
- . The Avon Ascent, A self-guided drive tour of the Avon Valley, Avon River Management Authority, 1995

Other resources available from the Water and Rivers Commission/Ribbons of Blue/Swan River Trust:

Videos

- · Living with Wetlands, Water and Rivers Commission/Swan River Trust
- · What is Groundwater?, Water and Rivers Commission
- · Living on Groundwater: Part 1 Country WA, Water and Rivers Commission
- · Living on Groundwater: Part 2 Urban WA, Water and Rivers Commission
- · Algal Blooms and Nutrients, Water and Rivers Commission/Swan River Trust

Posters

- · Living streams I can do that!, Water and Rivers Commission
- · Clean water I can do that!, Water and Rivers Commission
- · Healthy wetlands I can do that!, Water and Rivers Commission
- · Catchment friendly gardens I can do that!, Water and Rivers Commission

Manuals

- Ribbons of Blue manual: Environmental Awareness to Action, A water quality monitoring program for primary school students, Waterways Commission (now Water and Rivers Commission)
- Ribbons of Blue manual: Environmental Awareness to Action, A water quality monitoring program for secondary school students, Waterways Commission (now Water and Rivers Commission)

Brochures/Pamphlets

- Native vegetation of estuaries and saline waterways in south Western Australia, Water and Rivers Commission/Department of Conservation and Land Management, 1997
- Native vegetation of freshwater rivers and creeks in south Western Australia, Water and Rivers Commission/Department of Conservation and Land Management, 1997
- · A wetlands/waterways health check, Rating your local wetland or waterway, Waterwatch Australia
- Caring for our waterways: information and advice for people living near rivers, estuaries and harbours, Water Advice no. 1, Water and Rivers Commission, 1996
- · Growing local plants to protect water resources, Water Advice no. 6, Water and Rivers Commission, 1998
- · Water facts 4, Living Streams, Water and Rivers Commission, 1998

Other

- · Riverview (newsletter), Swan River Trust
- Rivercare Directory, Swan River Trust
- Swan-Canning Cleanup Program Action Plan, An Action Plan to clean up the Swan-Canning Rivers and Estuary, Swan River Trust, 1999
- Controlling Weeds in Waterways and Wetlands, Swan River Trust/Department of Environmental Protection, 1995
- · Drains to the River, Clean Water Only (stencils), Swan River Trust

- Western Australian Salinity Action Plan, Agriculture Western Australia, Department of Conservation and Land Management, Department of Environmental Protection, Water and Rivers Commission, November 1996
- · Western Australian Salinity Action Plan, Draft update, State Salinity Council, 1998
- Draft Avon River Management Programme, Water and Rivers Commission and Avon River Management Authority, 1999
- Stream Foreshore Assessment in Farming Areas, Luke Pen, 1995

Note: The *Water facts* and some other useful publications are available on the Water and River Commission website, www.wrc.wa.gov.au. You can also access a complete list of publications and order copies using the publication order form on the website.

Some other useful resources

- Landcare In Your Hands, Land Conservation Activities for Secondary Science and Social Studies, Department of Agriculture, 1991
- · RGC wetlands teachers' manual From Sand to Ducks, RGC Wetlands
- · Web of Life Manual, Year 11
- Stepping out Literacy and Learning Strategies, Education Department of Western Australia, Western Australia 1996
- Catchment Carers' Trail, Years 5 7 Teacher and Student Notes: Notes for a trail as Part of an Upper Primary School Excursion, Department of Conservation and Land Management and Water Corporation, 1996
- · Family Walks in the Perth Outdoors, Department of Conservation and Land Management
- Waterwatch and your Catchment: Involve Me and I'll Understand, Department of Primary Industries, Queensland, 1995
- · Catchment Care Education Kit, Department of Primary Industries, Queensland, 1992
- · Frog Symphony Unit, Environmental Education Unit, Murray Darling Basin Commission, 1998
- Metropolitan Street Directory
- · Topographical maps of the Perth region
- · Aerial photographs of the Perth region (Department of Land Administration)
- Landscape photographs of the south-west of Western Australia and Swan-Avon catchment (Department of Land Administration)
- Atlas maps

68

Organisations/Departments/Associations

- APACE
- Avon Network Centre
- · Avon River Management Authority (ARMA)
- Australian Association for Environmental Education (AAEE)
- Birds Australia
- Cockburn Wetlands Centre
- · Department of Conservation and Land Management (CALM)
- Ecoplan
- Environmental Weeds Action Network
- · Fisheries Western Australia
- Frogwatch CSIRO
- · Gould League
- Herdsman Lake Wildlife Centre
- Institute for Earth Education
- Men of the Trees
- Peel-Harvey Catchment Support Group
- Perth Zoo Education Centre
- RGC Wetlands
- Ribbons of Blue
- · Science Teachers' Association of Western Australia (STAWA)
- Swan Catchment Centre
- Tammin Alcoa Landcare Education Centre
- WA Museum
- WA Naturalists
- Water and Rivers Commission (WRC)
- Water Corporation
- Wildflower Society of WA
- York Tourist Bureau

Catchment groups within the Swan-Canning system

CATCHMENT GROUPS	DATE ESTABLISHED
Bayswater Integrated Catchment Management (BICM)	1991
Swan Working Group (Swan Catchment Council) (coordinating group for the Swan-Avon ICM Program in the Swan-Canning catchment)	1995
Canning Catchment Coordinating Group	1995
Litoria Catchment Care Group	1995
Bennett Brook Catchment Group	1995
Upper Canning/Southern-Wungong Catchment Team	1996
Ellen Brook Integrated Catchment Group	1996
Bannister Creek Catchment Group	1996
Blackadder Woodbridge Catchment Group	1997
Jane Brook Catchment Group	1997
Claisebrook Catchment Group	1997
Belmont Catchment Management Group	1998
Helena River Catchment Group	1998
Gingin Land Conservation District Committee	1984
Wooroloo Brook Land Conservation District Committee	1989
Chittering Land Conservation District Committee	1991
North Swan Land Conservation District Committee	1997

16

Integrated Catchment Management (ICM)

ICM is the process of coordinated planning, use and management of water, land, vegetation and other natural resources on a river or groundwater catchment basis. It involves the whole community of the catchment including landholders, businesses, residents, local government and state agencies.

Swan Catchment Centre

The Swan Catchment Centre was established in 1995, in response to community requests to provide support to ICM groups. The centre is open to everyone and is a place where you can find information and get advice on environmental issues in the Swan Catchment. It provides a place for the community to work together with Government and Local Government.

Getting in contact

Some catchment groups in the metropolitan region have employed coordinators who are involved in implementing catchment management activities. Catchment groups may be able to assist teachers in implementing some of the activities contained in the education kit. Teachers are encouraged to contact their local catchment group coordinator (or chairperson) if they are interested. Contact details for catchment groups are available from the Swan Catchment Centre on (08) 9221 3840.



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