Contents

3.0 Corangamite Catchment Region section

Corangamite Catchment Region

Regional information and activities

The information and activities in this section of the *Waterwatch Education Kit* supplement those in the Statewide section of this Kit. One approach is to conduct the Statewide activities first and apply the Statewide questions and activities to your local focus. The following specifically regional activities can then be conducted within an understanding of the broader Statewide issues related to water quality and use.

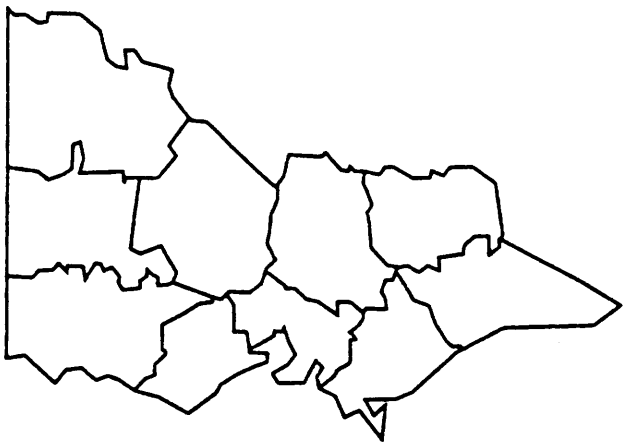
The information and activities in this Kit supplement those in *A Community Water Quality Monitoring Manual for Victoria.*

Corangamite Catchment Region

Corangamite Catchment Region is one of the ten Catchment Regions in Victoria.

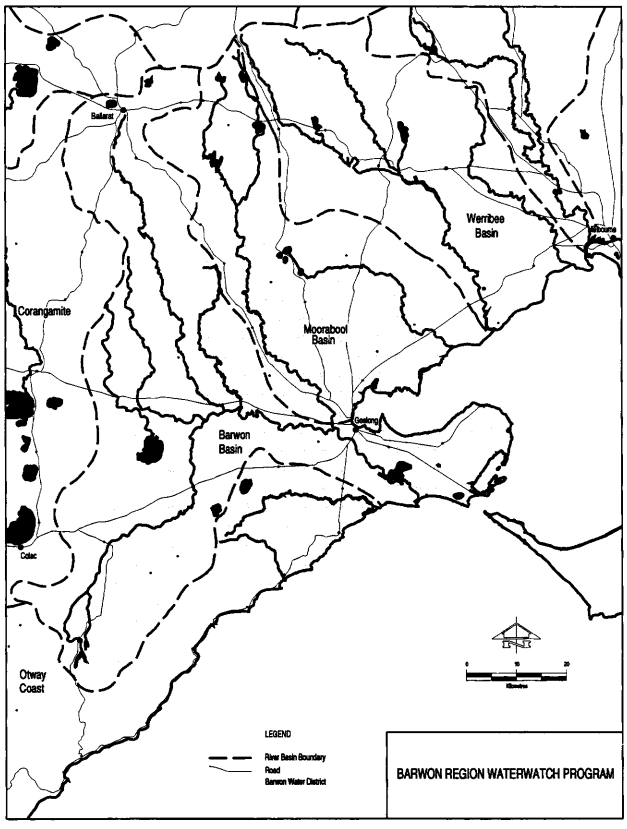
Four major drainage basins - Barwon Basin, Moorabool Basin, Otway Coast Basin and Corangamite Basin - are grouped together to make up the larger Corangamite Catchment Region. A Regional Catchment Strategy has been prepared for the Corangamite Catchment Region to assist with planning and management. Copies of this Strategy are available through your facilitator.

This section provides specific information and activities for the Corangamite Catchment Region. More focus is given to the eastern half of the region, the area covered by Barwon Water's Community Waterwatch Program.

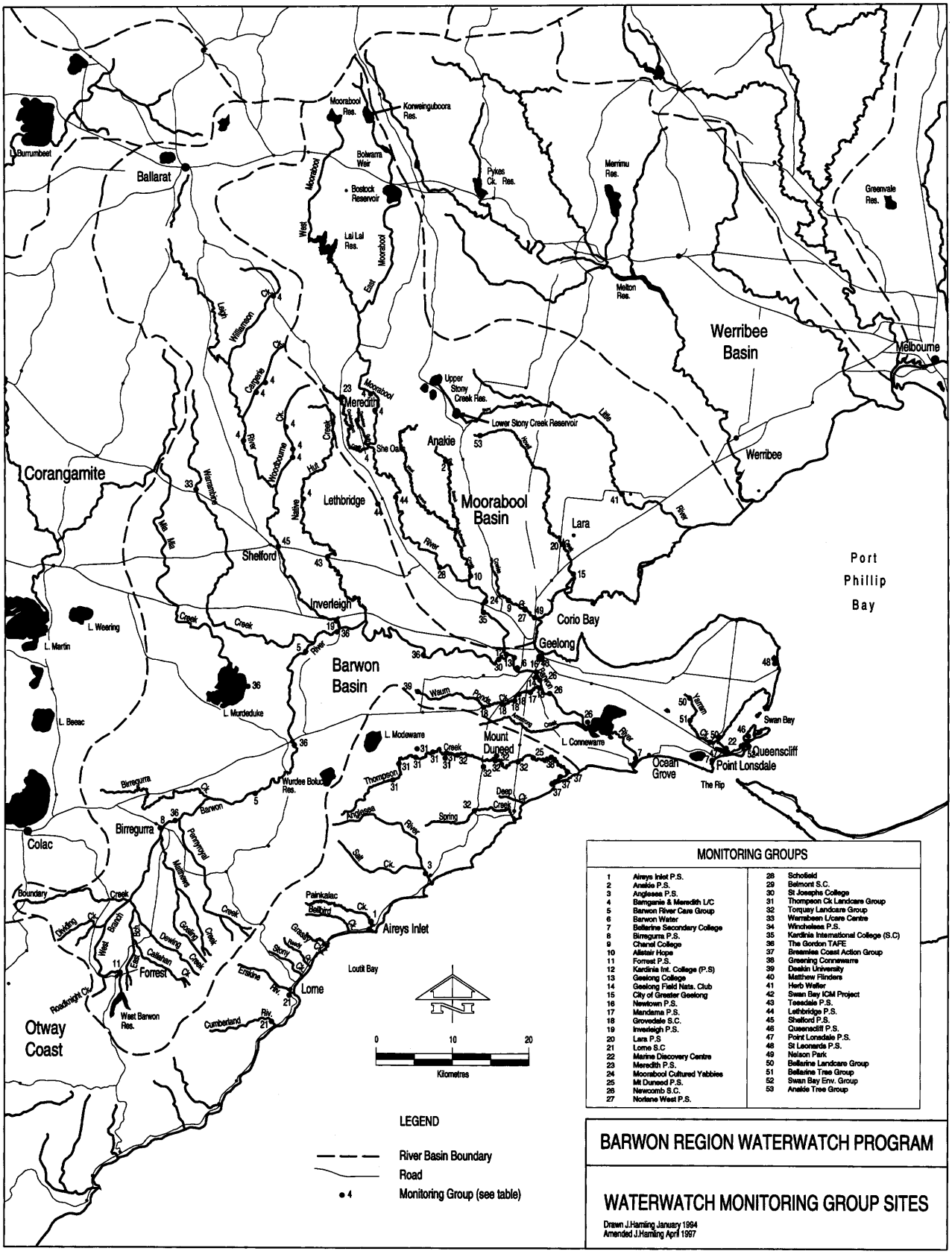


Catchment and Land Protection Act

The *Catchment and Land Protection Act* 1994 laid down a framework for a co-ordinated and strategic approach to catchment management across Victoria. Catchment and Land Protection Boards (CALP) were established in 1994 in each region to advise on the management of land and water resources in their region. The Act required that the CALP Boards prepare a Regional Catchment Strategy for their region. The desired outcome of each region's strategy is that the community manages land and water based on an understanding of and a commitment to sustainable use, conservation and rehabilitation of those resources. In July 1997 nine new Catchment Management Authorities (CMAs) with expanded roles replaced the CALP Boards. Each CMA is made up of local representatives from land and water management agencies, local councils and representative community groups [check]. The CMAs will use the Regional Catchment Strategies as their blueprint for integrating and delivering land and water management programs into the next century.



Corangamite Catchment Region



MONITORING GROUPS	
1 Aireys Inlet P.S.	28 Schofield
2 Anakie P.S.	29 Belmont S.C.
3 Anglesea P.S.	30 St Josephs College
4 Bamganie & Meredith L/C	31 Thompson Ck Landcare Group
5 Barwon River Care Group	32 Torquay Landcare Group
6 Barwon Water	33 Warrnbeen L/care Centre
7 Ballarine Secondary College	34 Winchelsea P.S.
8 Birregurra P.S.	35 Kardinia International College (S.C)
9 Chanel College	36 The Gordon TAFE
10 Allstair Hope	37 Breamlea Coast Action Group
11 Forrest P.S.	38 Greening Connewarre
12 Kardinia Int. College (P.S)	39 Deakin University
13 Geelong College	40 Matthew Flinders
14 Geelong Field Nats. Club	41 Herb Weller
15 City of Greater Geelong	42 Swan Bay ICM Project
16 Newtown P.S.	43 Teesdale P.S.
17 Mandama P.S.	44 Lethbridge P.S.
18 Grovedale S.C.	45 Shelford P.S.
19 Inverleigh P.S.	46 Queenscliff P.S.
20 Lara P.S	47 Point Lonsdale P.S.
21 Lorne S.C	48 St Leonards P.S.
22 Marine Discovery Centre	49 Nelson Park
23 Meredith P.S.	50 Ballarine Landcare Group
24 Moorabool Cultured Yabbies	51 Ballarine Tree Group
25 Mt Duneed P.S.	52 Swan Bay Env. Group
26 Newcomb S.C.	53 Anakie Tree Group
27 Norlane West P.S.	

BARWON REGION WATERWATCH PROGRAM

WATERWATCH MONITORING GROUP SITES

Drawn J.Hamling January 1994
Amended J.Hamling April 1997

Corangamite Catchment Region

Yollinko Wetlands

This wetland had all but vanished until recently. All that remained were the tough water plants that could survive the eating and trampling of cattle (Lignum and Water Couch).

The Yollinko Wetland has been restored as an initiative of Barwon Water. The project has been assisted by the State Government through employment training programs and many community groups have assisted with tree plantings. Boardwalks have been included to let visitors experience this fragile wetland environment without damaging it.

Yollinko Living Station
Yollinko Living Station has been a cooperative venture between the Wathaurong Aboriginal Co-op Barwon Water, the City of Greater Geelong, and Highton Rotary. The gardens surrounding the Aboriginal midden exhibit plants used by the local Koori population.

The wetlands
The wetland is a rich and diverse environment that complements the Barwon River. It is dependent on and urban stormwater runoff from Newtown which is directed into Balyang Sanctuary before discharging into the wetland site. Yollinko Wetland fills with the floods of winter and spring, then gradually dries out during summer and autumn. Its wetland plants have evolved in a cycle of flood and drought. There is a natural succession of plants as the water level changes. Green algae are a normal and important part of ephemeral wetlands as they provide food and cover for invertebrates such as water snails. In summer the algal mats dry out at the muddy margins.

Stan Lewis Walk

This 2.5 km walking track between Queens Park and Princess Bridge has been the site of one of Geelong's largest revegetation projects. From the early 1990s, woody weeds such as Boxthorn and Ash have been removed and replaced with indigenous trees, shrubs and grasses. This project has received several state and federal environmental awards.

Fyansford Information Centre

The centre has information displays about the Barwon River and its human and natural history.

Additional regional resources

The following publications contain useful additional information specific to the Corangamite Catchment Region.

Education materials
The Water Cycle. J. Dart & M. Galletly. Barwon Water. 1993. This education kit includes the following activities and information:

Geelong's Water Supply History information, pages 27-28; activities, pages 33-35.

Geelong's Water Supply Today information, pages 37-39, 57; activities, pages 45-56.

Water Treatment information, page 59; activity, page 61.

Wastewater information, pages 63-65, 73-76; activities, pages 67-72, 77-81

Barwon River information, pages 83-85; activities, pages 87-93

Barwon River History information, pages 95-96; activities, pages 97-101

Barwon River Today information, page 103; activity, page 104

Environment Issues information, pages 105-110, 121,131-132; activities, pages 111-120, 123-129

Barwon River Environment Trail. A unit of work for upper Primary School students. Barwon Water. 1997.

Plant and animal lists
The Water Cycle, pages 88-89

Barwon River Flora. Barwon Water booklet.

Barwon River Fauna. Barwon Water booklet.

Brochures
Yollinko Park Aboriginal Garden. Barwon Water.

Barwon River Environment Trail. Barwon Water.

Cultural heritage
The Cultural Heritage of the Barwon River. A study commissioned by Barwon Water. Bev Roberts. 1993.

Do you remember? Memories of the Barwon. Gordon College and Barwon Water.

These two publications are the sources of quotes in the Wathaurong and European information and activity pages of the Corangamite regional section of this Kit.

Regional catchment strategy
Corangamite Regional Catchment Strategy.
Corangamite Catchment & Land Protection Board. June 1997.

Wathaurong ways

Key Learning Outcomes

Level 4

SOSE: Place and Space
Analyse how people's beliefs & practices influence the ways they interact with places.

Time, continuity & change
Describe ways of life of people in the past.

Portray an event or occasion from a particular perspective.

Resources
Explain factors that affect resource use & development.

Natural & social systems
Describe responses of different elements (including people) to change in natural systems.

Level 5

SOSE: Place and Space
Explain how peoples' use of natural environments changes over time.

Resources
Describe how resources are owned and accessed.

English

Aims

- to develop understandings about how the Wathaurong people used waterways and water related resources in the region

Materials

Information sheet 3: People who belong to the water

Student sheets 1A and 1B: Names and remains along the Barwon

Refer to the Aboriginal uses of waterways information and activity pages in the Statewide section of this Kit.

Additional resources

Barwon River History information pages 95 in *The Water Cycle* . J. Dart & M. Galletly. Barwon Water. 1993.

Barwon River Environment Trail. A unit of work designed for upper Primary School students. Barwon Water. 1997. Activity 8: Yollinko wetland; Activity 10: Useful plants.

Yollinko Park Aboriginal Garden brochure. Barwon Water.

Advanced preparation

1. Duplicate the required number of the information and student sheet listed under Materials.
2. Based on your students' reading levels decide whether the activity will be best done in small groups or individually, or whether you will read the information sheet out aloud to the class in sections, as related to each site to be mapped on Student sheet 1B.

Activities

1. Distribute Information sheet 2 and Student sheet 1A and 1B.
2. Read out, or have students read the information and map the named sites onto Student sheet 1B.
3. Students write a story about a Wathaurong family group, describe their lifestyle, especially the ways in which they collected, used and managed water and water related resources.
4. Summarise as a class some ways in which the Wathaurong people used rivers and wetlands, and how these resources influenced their lifestyle.

Extension

1. Arrange for a local Aboriginal Cultural Officer to meet with your class.
2. Visit the Yollinko Park Aboriginal Garden. The gardens surrounding the Aboriginal midden and mound displays plants used by the local Koori population.
3. The Aboriginal names given to some areas of the river show their significance as sources of particular foods.

   Boonea:Yallock (above Baum's Weir) - a place for trapping eels and fish.

   Porrong:Goop (Boronggoop) - place of quails.

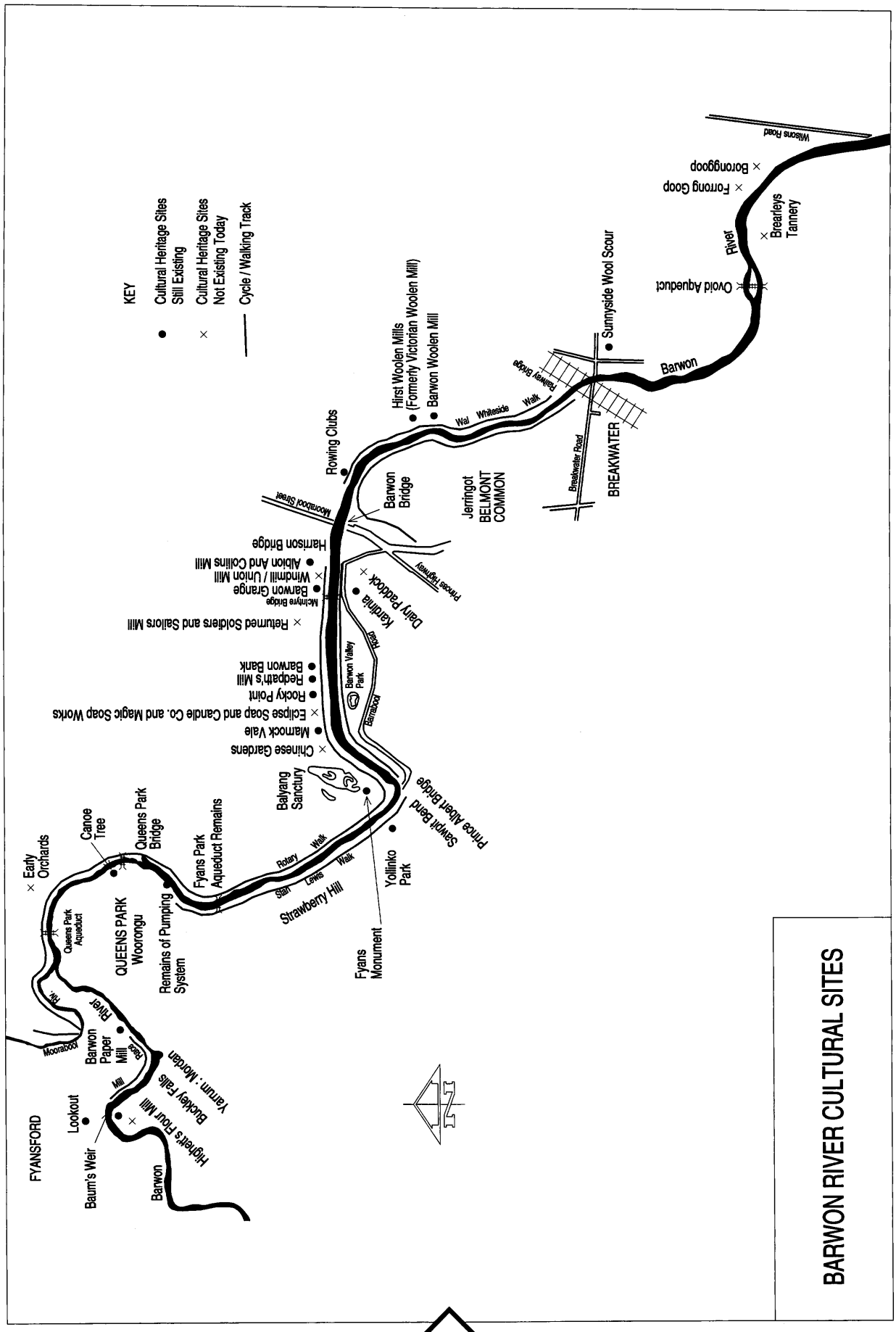
   Liep:Liep (Lap Lap or Lib Lib, near Reedy Lake) - place of the waterbird Lewin's Rail.

   Koo:N:Warre (Lake Connewarre) - mud oyster water.

   Balliang - the place of bulrushes.

Wathaurong Aboriginal Co-operative
About 1200 descendants of Victorian Kooris live in the Geelong - Otway region. The Wathaurong Aboriginal Co-operative based in Geelong is a centre of education and cultural awareness regarding Koori heritage in the area.

Wathaurong ways



People who belong to the water

The Wathaurong

Wathaurong means *'people who belong to the water'*. The Wathaurong tribal area covered most of the present day Barwon and Moorabool River Basins and part of Otway Coast and Corangamite River Basins.

The Barwon River was an important part of the Wathaurong's territory. Their pattern for hundreds if not thousands of years was to move each year between their established camping sites along or near the river. Depending on the food supply they stayed briefly, or for 2-3 months.

The number of Aboriginal people in the Western District was perhaps 2000 to 3000 but, following white settlement, their numbers quickly fell. After only 50 years, the traditional system which had supported the Aborigines for centuries no longer existed. The last member of the Wathaurong tribe died in 1885.

Using the Barwon River

It is the lack of evidence of the Wathaurong's impact on the river which tells us most about their special relationship with it - it tells us they had little impact.

The Wathaurong lived and hunted along the Barwon using the river's natural resources. The river was a source of food, shelter and clothing. Moving from place to place according to the seasons and food sources, they used most sections of the river. The river's estuary, and the coastline and intertidal zone are very rich in food and were the focus of much of their everyday existence.

While the men might trap or spear fish in the river, the women would collect the new young rhizomes of reeds at the water's edge, or fruits, gum and nectar from the riverside trees.

Animal foods
The river itself provided fish, shellfish, eels and water birds. Kangaroos were caught coming to drink. Possums were caught in riverbank trees.

Plant foods
Plant foods were easily collected. The sweet, starchy tubers of Water Ribbons were cooked in earth ovens. The tough starchy roots of Small-leafed Clematis and Blushing Bindweed were cooked in baskets and kneaded into dough on a small sheet of bark. The underground stems (rhizomes) of Bracken were roasted in hot ashes and then beaten to break up its hard fibres. Mistletoe flowers and fruits were used for sweetness, as were Lerps (the surgery covering of a tiny insect that lives on eucalypt leaves).

Tools
To carry water from the river the Wathaurong people made water containers from a sheet of fresh acacia bark about 30 x 50 cm, bent double and sewn up each side with sinews. The seams were caulked up with cement made of wattle gum and wood ash made in hot water. For a small water bag the pouch of a kangaroo was used. A larger water bag was made from the skin of a male Brush Wallaby, cut at the neck and sewn water tight with ligatures.

The plentiful Tea-tree and Reeds were made into spear shafts. Wattle and Red Gum trees were ideal for boomerangs (wanguim). Marine shells and fresh-water mussel shells were used for knives

Bark from the riverside trees provided ready-made cover for shelters. Wood was used to make handles for weapons and tools. Wattle gum was made into glue by chewing balls of the gum or dissolving it in water. Some of the local stone was used for tools. Barrabool sandstone was used for sharpening axe heads or grinding wattle or grass seeds into flour.

Trading

The Wathaurong traded products and resources from their local area. The Barwon River region was known for its trading in stone for axes, special wattle gum for adhesives, and shells for knives.

Bunyips

The Barwon River was also the home of a local mythological creature, the Bunyip. According to members of the Wathaurong, the local Bunyip was a fearsome creature responsible for a number of deaths. Its breast was said to be covered with different coloured feathers, and its usual method of killing its prey was by hugging it to death.

... it did not come on land except on extremely hot days. (its) head resembled an emu with a long bill at the extremity of which was a transverse projection on each side with serrated edges like the bone of a stingray. It's legs were long and resembled a crocodile's with sharp claws, and stood 12 or 13 feet [about 4 metres] *in height. When in water it swam like a frog, and when on land it walked on its hind legs with its head erect.*

1845 quote from a Wathaurong tribe member who believed his mother was killed by the Bunyip.

Names and remains along the Barwon

Names and sites along the Barwon River

1. **Barwon River** -BARRE : WARRE : N: YALLOCK - means the great river (Yallock) that ran from the mountains (Barre) to the ocean (WARRE).
   Aboriginal people don't often name a river because how can you name a river when the water is flowing away from you? Instead they had names all along the river where they camped. In the case of the Barwon they did have a name for it.

2. **Moorabool** - MOORA means ghost.
   There was a very large lagoon on the Moorabool river and the Aboriginal people believed ghosts lived there. The Moorabool also means Cooloo and this is a night bird, so they only heard it, never saw it, so they thought it was the voice of a ghost.

3. **Buckley Falls** - YARRAM MORDONG, YARRAM means a waterfall or rapid and MORDONG means eels.
   The eels don't breed here, they go down to the sea and swim away. When they come back, they are only little tiny things . . . about eight centimetres long, they wriggle up where the water is running over the rocks.

4. **Fyansford** - BUKAR BULAC means a place between two rivers; Fyansford lies at the junction of the Moorabool and the Barwon rivers.
   Bukar:Buloc was a significant area to the Wathaurong tribe as one of the locations on their seasonal food-gathering route which was followed each year. This site was a major source of eels and fish.

5. **Queens Park** - WOORONGA means trees which had protruding gnarls. It is also thought the name represented the shape of the river at this site which curves in a 'gnarly' manner.
   Gnarls were useful when making coolamons (containers). There were lots of trees where they cut these gnarl's off and they would make vats to hold water. The vats were kept with fresh water in them and they used to make nice drinks for the little children by soaking flowers to get honey out of them. They also put gum in it and stirred it up. When the children came back from the morning's foraging they would offer them a honey drink - that was why they needed these great vats to keep water in.

   The stump of a River Red Gum 'canoe tree' can be seen today at Queens Park. The tree's bark has been stripped to make a simple canoe.
   ... a huge dish-shaped sheet or bark was stripped from a mature gum tree. It could be used only on calm water. The flat craft was punted along by a long pole which also served as a fish harpoon ... As well as fishing for eels by torchlight, the canoe was ideal for pursuing aquatic birds in moult or for harvesting their eggs.

6. **Kardinia Creek** - KA: DIN :IU means the hissing of a snake and perhaps refers to the rippling of the tide as it moved upstream. This was a Wathaurong camping place.
   There is a mound at Yollinko Park . . . . There were 800 artefacts on one mound.

7. **Yollinko**. YOLLINKO means yesterday.
   The Wathaurong people camped here in winter for 5000 years. It was an ideal place, sheltered from all winds, and up to 2 degrees warmer than up on the ridge. Fresh water was available from the creek and there were plenty of waterfowl, fish and freshwater mussels to eat. Across the river are the wetlands which provided good hunting. There is also a mound or fishing stage (located where Princes Bridge now is) *which provided a flat space from which fish could be caught when the river was flooding.*

8. Porrong:Goop (Boronggoop) - place of quails.

9. **Belmont Common**- was called JERRINGOT means water all around or a place of billabongs.

10. **Waurn Ponds Creek** - WUURRN YALLOCK means homes along the river.

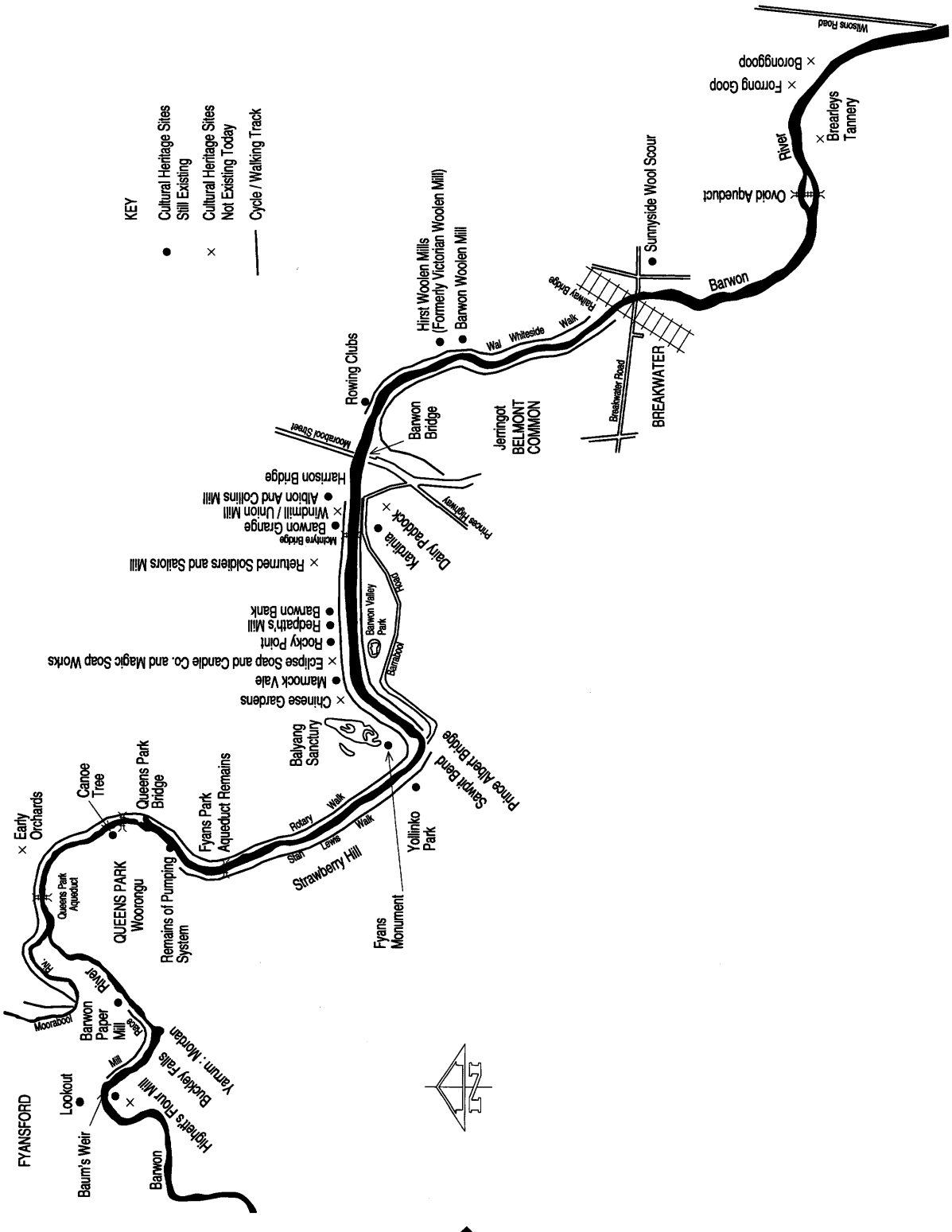
11. **Reedy Lake**- BANGI: BALLA means inert or placid water.

12. **Barwon Estuary** - KOOURIN means neck.

13. **Barwon Heads** - KOLO: ET KOLO means fresh water. Salt water meets fresh water here.

Names and remains along the Barwon

1. Mark onto the map below all the Wathaurong sites mentioned on the previous page.
2. Mark onto the map below all the European sites mentioned in Information sheet
3. European settlement in the region.



European settlement of the region

Key Learning Outcomes

Level 4

SOSE: Place and Space
Analyse how people's beliefs & practices influence the ways they interact with places.

Time, continuity & change
Describe ways of life of people in the past.

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Describe responses of different elements (including people) to change in natural systems.

Level 5

SOSE: Place and Space
Explain how peoples' use of natural environments changes over time.

Resources
Describe how resources are owned and accessed.

English

Aims

- to develop understandings about early European uses of waterways and water related resources in the region

Materials

Student sheet 2: Water supply for Geelong and region

Water Supply information on page 28 *The Water Cycle*

Blackline master 1: Map 1 of Corangamite Region

Blackline master 2: Map 2 of Corangamite Region

Information sheet 3: European settlement in the region

Student sheet 1B: Names and remains along the Barwon

Refer to the European history information and activity pages in the Statewide section of this Kit.

Additional resources

The Water Cycle. Barwon Water. 1993. Geelong's Water Supply History information, pages 27-28; activities, pages 33-3; Barwon River History information, pages 95-96; activities, pages 97-101.

Advanced preparation

1. Look through *The Water Cycle* education kit and decide which activities and information pages from that publication you want to include as part of this topic.
2. Based on your students' reading levels decide whether the reading activities will be best done in small groups or individually, or whether you will read the information sheet out aloud to the class in sections, as related to each site to be mapped on Student sheet 1B.
3. Duplicate the required number of information and student sheets listed under Materials, and required pages from *The Water Cycle*.
4. Prepare an overhead of Blackline master 1: Map 1 of Corangamite Region.

Activities

1. On an overhead of Blackline master 1, locate your town. Can students identify nearby rivers and reservoirs? Show the location of these on the overhead map. Identify the reservoir(s) that now supply your town with water.

   [*Refer to Information sheet 3.*]
2. Make the point that the water that comes out of your taps today comes from nearby rivers [*name them*] and that water from these rivers is stored in reservoirs. Early settlers did not have water on tap and had to obtain it directly from rivers and this affected settlement patterns. It was often quite a task for people in the 1800s to get clean water every day.
3. Distribute copies of page 28 of *The Water Cycle* , Student sheet 2: Water supply for Geelong, and Blackline master 2: Map 2 of Corangamite Region. Students read the information page, complete the timeline and label the mentioned sites onto the regional map.

   Discuss the results as a class to summarise the major events and significance of these to the region.
4. Distribute Information sheet 3: European settlement in the region and Student sheet 1B: Names and remains along the Barwon.

European settlement of the region cont.

5. Read out, or have students read the information sheet and map the named sites onto Student sheet 1B. Emphasize the important role of the Barwon River in the development of the region.

   Use an overhead of the Student sheet 1B to show the historical sites along the Barwon and summarise their impacts on the river and the town, beneficial and detrimental.

6. As a class, list the ways in which the Barwon River was used from the 1830s to 1940s by people and industry.

   [*E.g. for people's drinking water, water for household uses such as washing and gardens, water for livestock; for generating steam power; water for industrial processing in wool, paper and tanning factories; a drain for discharging wastes from these factories; a drain for household sewerage; water for orchards and market gardens.*]

   Discuss why all these uses could not continue.

   [*Some activities polluted the water which meant it became a health hazard and could not be used for purposes that required high quality water.*]

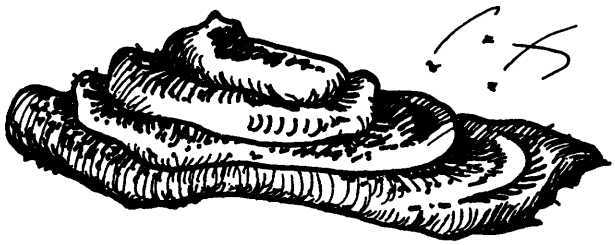
7. Students write a story describing the life of a family of early settlers in the region in the mid 1800s. This could cover a period of drought or flood as well as a time of typical river levels. The essay should explain the ways in which the family collected, used and managed water, what they needed water for (e.g. domestic use, stock, crops), and what the quality of water was like.

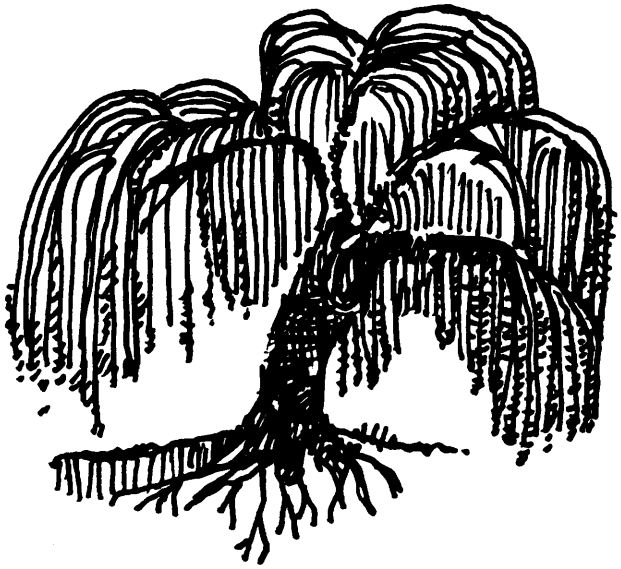
8. Summarise as a class some ways in which early European settlers used rivers, and how these resources influenced where they settled and their lifestyle. *[e.g. needing to travel to the river every day, or buy water in barrels].*

Extension

Maths

Students use the map to estimate the distance water flows from the relevant reservoir(s) to their town.





Water supply for Geelong and region

1. Read the information on page 28 of *The Water Cycle*.

Complete this timeline.

1866 Geelong's first reservoir is made by building a dam across _____Creek in the Brisbane Ranges.

1898 After a drought that year, it was decided to divert water from the _____ _____River to Stony Creek Reservoir.

19___ The Geelong Waterworks and Sewerage Trust began sewering the city.

1914 K _____ Reservoir near Ballan was built.

1954 Geelong was in danger of running out of water in times of drought, even though the _____near Winchelsea and the Bostock Reservoir on the _____ _____ _____ had been built.

19___ The West Barwon Reservoir was built to overcome drought water shortage.

1970s Geelong Waterworks and Sewerage Trust began testing for_____

1972 The _____Dam is built on the West Moorabool River. This water is shared with _____.

1984 A number of smaller water authorities in the region merged with Geelong Waterworks and Sewerage Trust to become the Geelong and District Water Board.

1994 Barwon Water is the new name for the region's water authority.

1997 Barwon Water merges with Otway Water but retains the name 'Barwon Water'.

2. Label the rivers, waterways, water storages and other mentioned sites onto your map of the region.

European settlement in the region

The region

European Settlement

The vast open grasslands of the Western Volcanic Plains attracted early European settlers with their flocks of sheep. By the end of the 1830s much of the northern Corangamite area had been taken up by large pastoral runs held under the leasehold from Crown - at an annual fee of ten pounds.

The severe drought in 1839-40 led to a number of pastoral runs changing hands as settlers struggled with the lack of water, loss of livestock and the fluctuating markets.

In 1847 those graziers that remained won the right to tenure their Crown leases. This new found security led many of them to replace their old timber slab and iron huts with more established dwellings, often made out of the local bluestone. Family life was well established by 1850 and supported growing local centres like Colac, Geelong and Ballarat with produce.

The Gold Rush

The discovery of gold around Ballarat in 1851 led to population explosions in goldfield areas. Pastoralists and farmers in rural areas soon lost many of their workers to the 'gold rush'. Some people did not join the 'rush' itself but set up shops and services to supply the miners with food and goods. Until 1854 all of the extracted gold was alluvial, that is, removed from the beds of existing or ancient streams.

Sutherland Creek which flows from the Brisbane Ranges has silted up mainly because of goldmining activities at Steiglitz in the 1890s.

Changing Landscape

The gold rush changed the landscape and waterways dramatically. Rivers were dredged and surrounding forests felled for timber and fuel. A whole range of exotic European fauna was introduced including foxes, hares, European Carp and European Perch (fish), skylarks, sparrows and deer. The release of rabbits into the Australian wild occurred in the Corangamite region. The Austin family who owned Barwon Park near Winchelsea, released rabbits for sport and recreation in 1859.

Most of the Western Volcanic Plain was originally covered with native grasslands and so naturally had few trees. Pastoralists quickly settled on these native grasslands with their introduced sheep and cattle. Grazing by stock, and the use of fertilisers such as superphosphate in the 1900s, has led to the loss of most of these native grasslands as they became invaded or replaced by introduced pasture plants and weeds.

The Railway

Railway lines were laid during the 1870s and provided people with quicker and easier travel. Most importantly they provided a cheap way to transport goods to larger cities and towns. Railways had a significant impact in the Otway region. Before railways, Otway farmers were isolated; afterwards they had good access to markets from which to sell their goods. By 1900 timber was a big industry in the Otway area. This resulted in forest clearing and led to dairying, grazing and cropping in the Ranges.

The Barwon River

The Barwon River has been very important to the development of Geelong. The land surrounding the river was gradually occupied by European settlers looking for pastures for their flocks of sheep. In 1836 sheep owned by Dr Alexander Thomson were landed at Point Henry. He set up his run on the south bank of the Barwon, his sheep ranging over most of the area which is now the suburbs of Belmont and Highton. By the end of 1836, there were 30,000 sheep in the Geelong area and land within 25 miles of Geelong was taken up by squatters.

One of the essentials of a newly established colony is an adequate and reliable water source. Some people questioned the suitability of the Barwon as a fresh water source.

The river is generally salty or brackish, and is subject to the influence of the tides. It is joined about three miles from the western extremity of the Port by another river. The scarcity of fresh water makes it in some parts ineligible for sheep farming.

(An 1836 report quoted in B. Roberts 1996).

The Breakwater

The water in the river was affected by ocean tides and was salty up to Buckley's Falls. This was especially so in the summer months when the river was not flowing as steadily and the water was getting low. To overcome the problem of fresh water supply, a breakwater (or dam) was built to stop the flow upstream of salty water at high tide. Fyans Breakwater was built by convict labour from 1839-1841. This meant that water upstream of the breakwater was of drinking quality (i.e. not salty) but it also permanently changed the condition of the river and its aquatic inhabitants.

European settlement in the region cont.

A local resident speaking about the improved water quality said:

The tide formerly flowed above the town, rendering the river water undrinkable, this is now completely remedied by Fyan's Breakwater, which is a solid mass of rough masonry (stonework) in the bed of the river, broad enough on the top to let two or three drays pass each other, and having a covered channel above high water mark for the 'flow' of the 'excellent' fresh water. The success of this great work has been triumphant; at the present moment the water on one side is quite salty, on the other pure and fresh.

(Quoted from B. Roberts 1996)

For those living downstream from the Breakwater, the need for fresh water continued to be a problem. Anne Drysdale (after whom the town of Drysdale is named) wrote in her diary of 1842 that they had to go to the breakwater every day to collect their fresh water, a journey of two miles. Their stock-keeper also had to take the cattle to the breakwater every day to drink.

Distributing water

After removing the salt, the next difficulty for the growing town was the need to distribute the water. The first efforts were made by Josef Griffin and William Gray. They installed pumps on the river bank to obtain water without polluting it with mud. They sold this water by the bucket at the river bank or loaded into barrels to sell in town. There were problems with this system when it was found the water was not clean. Gray's second scheme (in 1850) was to lay pipes to carry the water from the river to a large tank in Market Square. Here carriers purchased water from the tank for four pence a load.

In the years to come the need for clean, safe and cheap water was a major issue in Geelong. A number of proposal were put forward by the then Town Council. These proposals included the construction of dam above Buckley Falls and a pumping system, and the removal of the Breakwater which:

... could be dispensed with and the river thrown open to manufacturing and industrial pursuits and be, what it ought to be, the natural drain of the south part of the town and its suburbs

(Quoted from B. Roberts 1996)

Neither of these schemes ever came off. After the Board of Commissioners of Waterworks was established in 1856 its biggest concern was the quality and supply of water to the town. The results of the water quality tests lead to fears that:

the waters of the Barwon, in the neighbourhood of the town - near Buckley falls, were not sufficiently good quality to encourage a supply from that source .. and (there was) danger of contamination arising from the winter floods bearing along with them down the Leigh, and so into the Barwon, the waters of Ballarat in a state totally unfit for domestic uses.....

(Quoted from B. Roberts 1996)

The Barwon and industry

For the first 40 years of settlement the Barwon River was Geelong's source of drinking water, and its drain. Highett's Flour Mill, Barwon Paper Mill, the woollen mills and tanneries all drew water out of the river for various industrial processes and also disposed of their waste products into the river. In the 19th century water power and steam provided by the Barwon powered industries such the flour mill and later starch factory, and the Barwon Paper Mill at Buckley's Falls. Steam drove a four-storey flour mill in Latrobe Terrace and another in Chilwell. In addition steam was used for soap and candle-making.

Geelong became known as "textile town" because of its links to wool-based industries. Geelong provided a sea port for the transport of wool and supported the wool-growing industry. In 1865 Geelong became the site of Victoria's first woollen mill 'The Victorian Woollen and Cloth Manufacturing Company'. By 1875, there were 14 mills operating along the river and 15 000 people living in Geelong. These woollen mills relied on river water.

The 'noxious' animal-based trades of tanning, fellmongering, scouring and tallow rendering were traditionally located together. In 1890 there were 21 tanneries in Geelong. Some of the practises of the sheep-based industries include the following:

Tanning- impregnating hides and skins with tannic acid to make leather items.

Fellmongering - removing wool from the pelt of dead sheep, by soaking in vats.

Scouring - washing fleece with detergent, then rinsing it in the river.

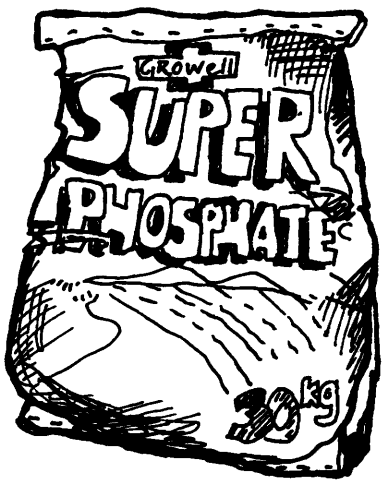
Tallow rendering-boiling down sheep to make candles and soap.

European settlement in the region cont.

As the Barwon River became polluted with industrial effluent and household waste (carried from street channels into the river), other sources of drinking water were found. The Moorabool River system began to be used in the 1880s and the upper reaches of the Barwon River in 1927. A sewerage system for Geelong was constructed in 1911.

In the 1920s, the river was described as 'malodorous' and a 'cesspool', particularly in summer. The Geelong Waterworks and Sewerage Trust created special areas and required owners of industries to settle out solids and greases and discharge their effluent into sewers rather than directly into rivers.

Eventually other sources of power were introduced into the area. In 1910 the Commonwealth Woollen Mill was established in North Geelong, the first mill not sited on the Barwon River. With the exception of the use of water in emergencies during the drought, the river was no longer used to the degree of early settlement times.



The Barwon and Agriculture and Horticulture

Due to its fertile plains the Barwon River and its banks were used to grow a large variety of cultivated crops. Market gardens and private gardens flourished along the river. In Fyansford valley, water from the Barwon and Moorabool Rivers allowed orchards, vines, nurseries and market gardens to the flourish. The area was noted for these from the 1940s. Below Deviation Road opposite Queens Park, orchards were planted until the mid 1900s. One of the earliest orchards, at Walker's Newtown Valley farm, was washed away in the great flood of 1880.

Further downstream there were a number of nurseries and gardens. Of these were the Chinese gardens established at the riverside and in other sites in Newtown and Belmont.

Traditional water collection methods were used by the Chinese gardeners who carried buckets supported by shoulder yokes. Another method for carrying water to more distant gardens was with dray carts and barrels. Exotic crops such as tobacco and chicory were also planted at Queen's Park and various stretches of the land adjoining the river was used as pastures.

Sources

Corangamite Regional Catchment Strategy. CALP . 1996.

Do you remember? Memories of the Barwon. Barwon Water and Gordon Technical College.

The Cultural Heritage of the Barwon River. A study commissioned by Barwon Water. 1993. Bev Roberts. 1996.

Your local catchment

Preparing a map of your local catchment is necessary for understanding your monitoring site.

Key Learning Outcomes

Level 4

Science: Living together
Identify living and non-living things that affect the survival of organisms in an ecosystem.

SOSE: Natural & social systems
Describe responses of different elements (including people) to change in natural systems.

Level 5

Science: Living together
Explain the effects of various environmental changes on living things in ecosystems.

SOSE: Place and space
Compare natural and human environments and describe factors affecting them.

Aims:

- to develop understandings of the main factors that affect water quality
- to understand how pollutants get into waterways
- to understand how waterways and water quality can be improved

Materials

Information sheet 4: Corangamite Catchment Region

Blackline masters 1: Maps 1 of Corangamite Region

Blackline masters 2A-D: Maps of Corangamite Region

Contour map of the local area

Additional materials

Statewide section, Teacher sheet 18: Mapping your catchment.

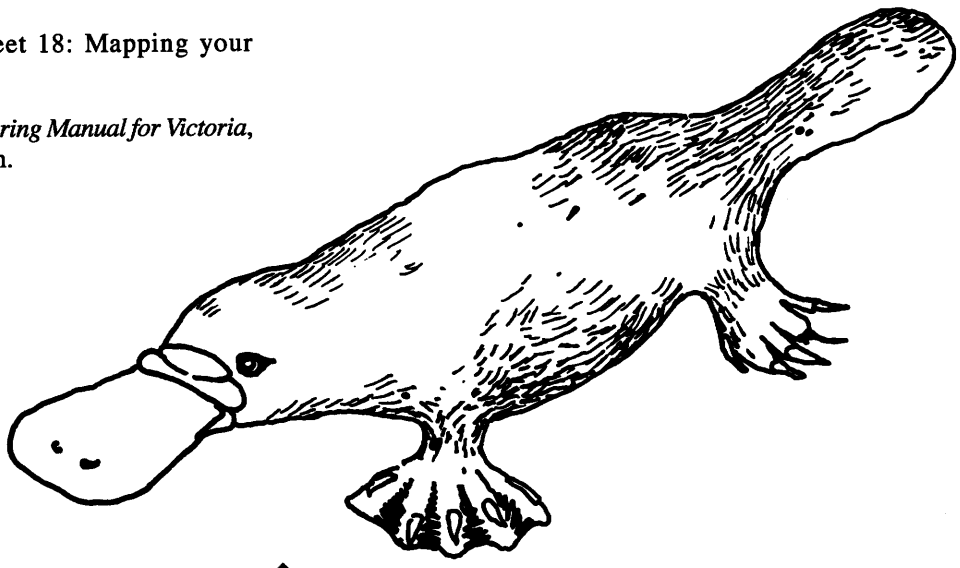
A Community Water Quality Monitoring Manual for Victoria, pages 3-12, Getting started section.

Advanced preparation

1. Decide which of the maps from the Blackline master 2 series is most suitable for your students to use.
2. Duplicate the required number of maps, and relevant sections from Information sheet 4.
3. If you need additional information (e.g. on soil type, landuse, catchment size and boundaries), contact your local Waterwatch Co-ordinator and local Council.

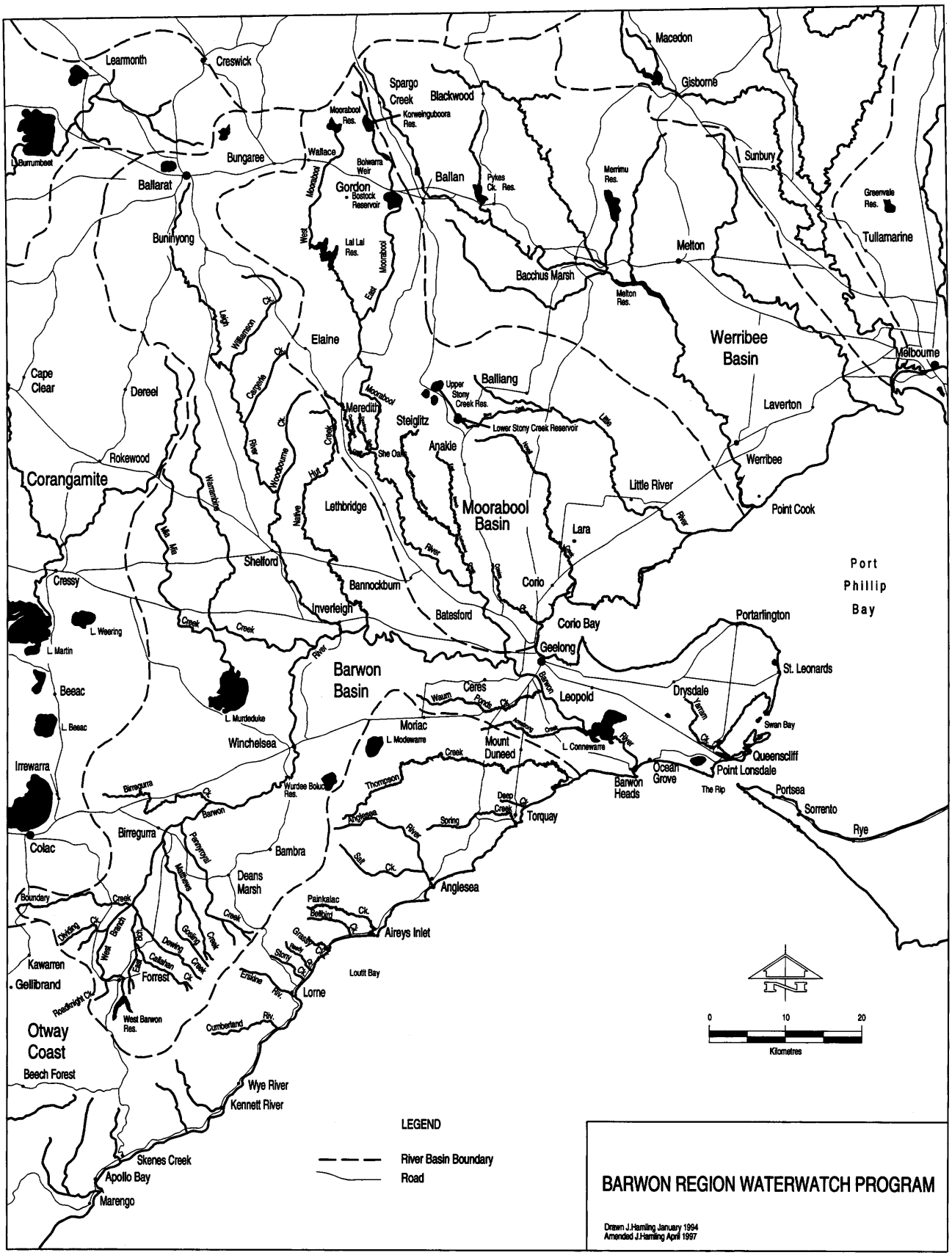
Activity instructions

1. Students use the map(s) provided to draw up a base map for their local catchment showing the length of their waterway and all of its tributaries.
2. Use the maps provided and local knowledge (or a field trip) to map onto their local base map:
   - major population centres
   - rainfall isohyets
   - contours (if required)
   - major landuses and industries
3. Summarise the major factors influencing your monitoring site.



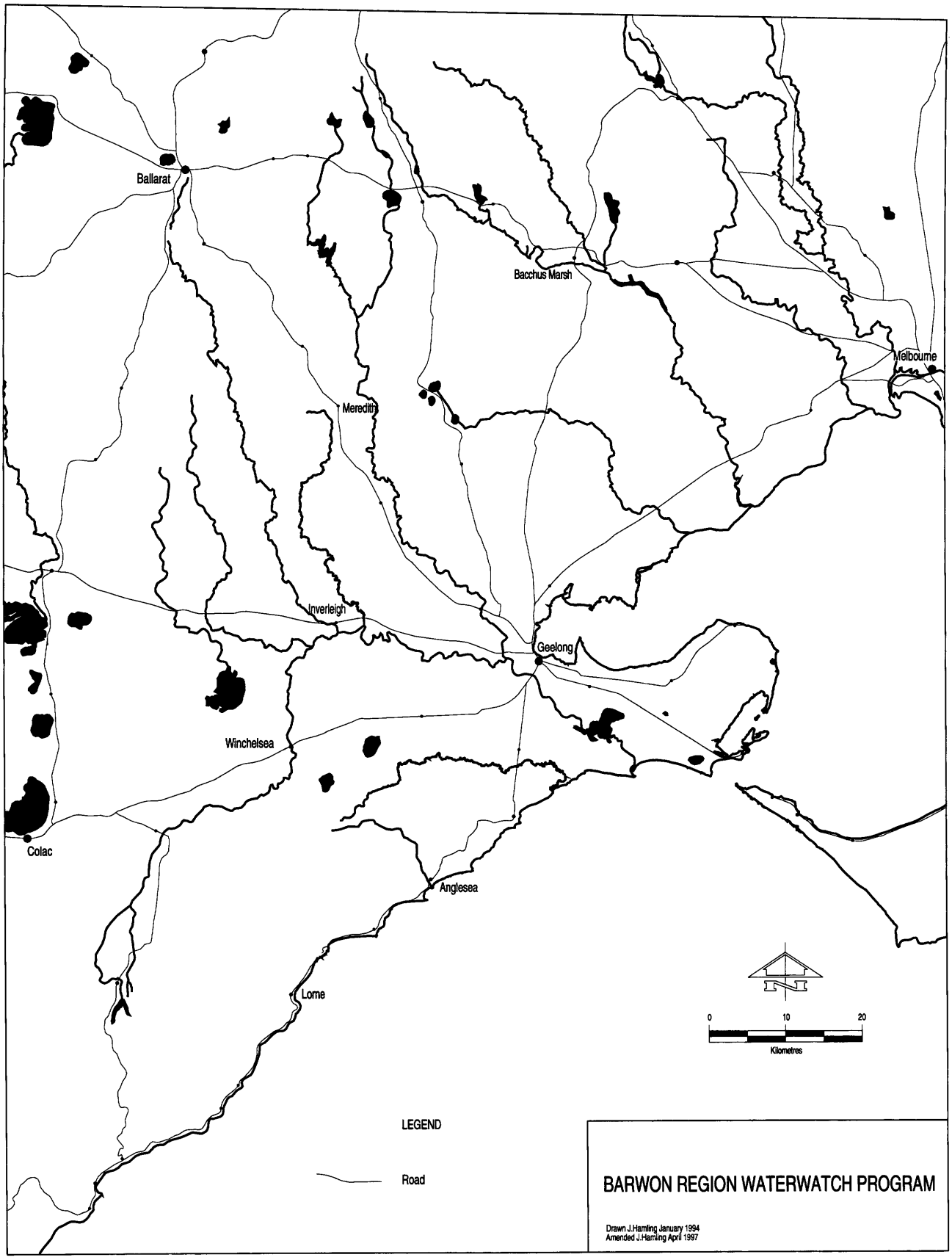
Blackline master 1

Map 1 of Corangamite Region

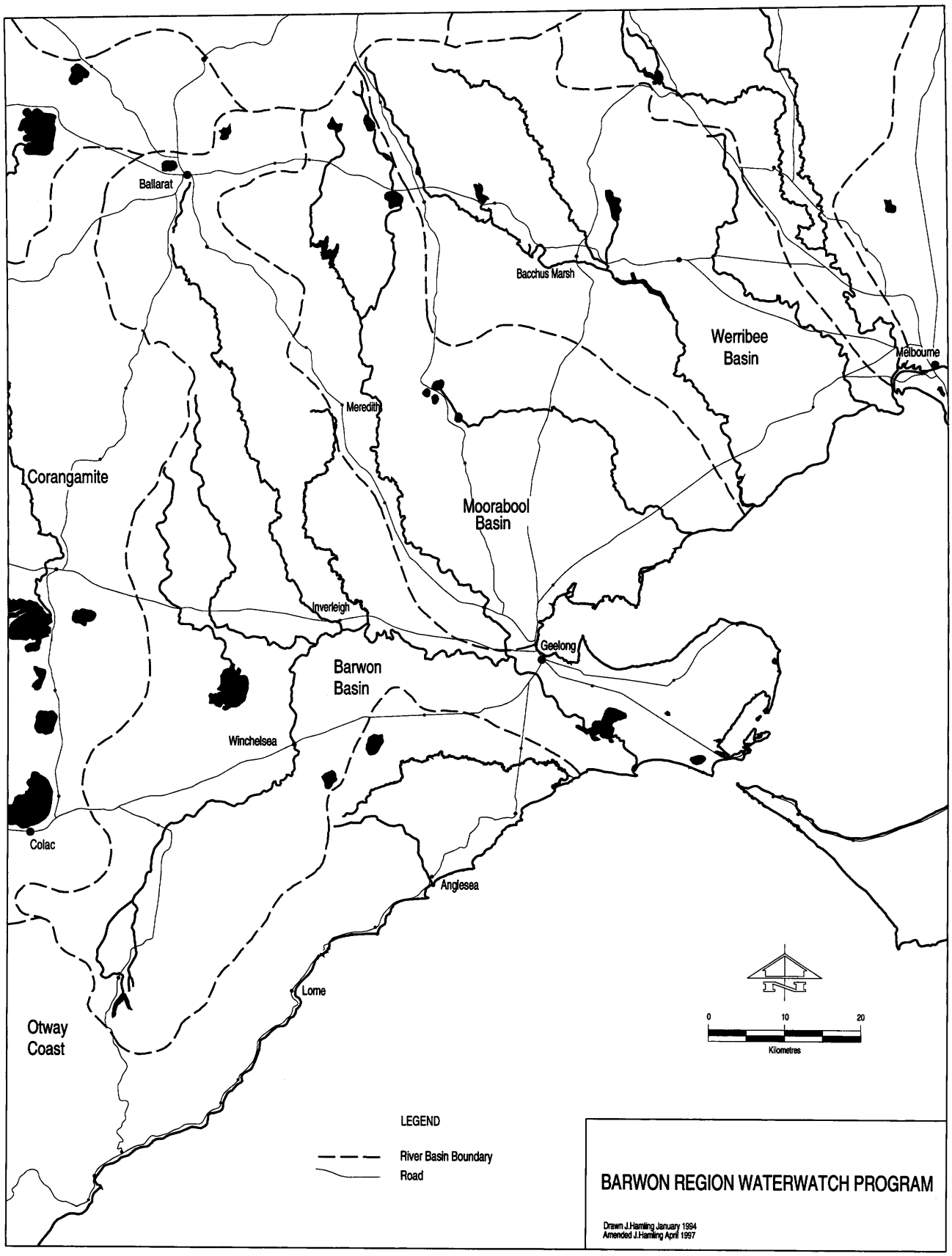


Blackline master 2

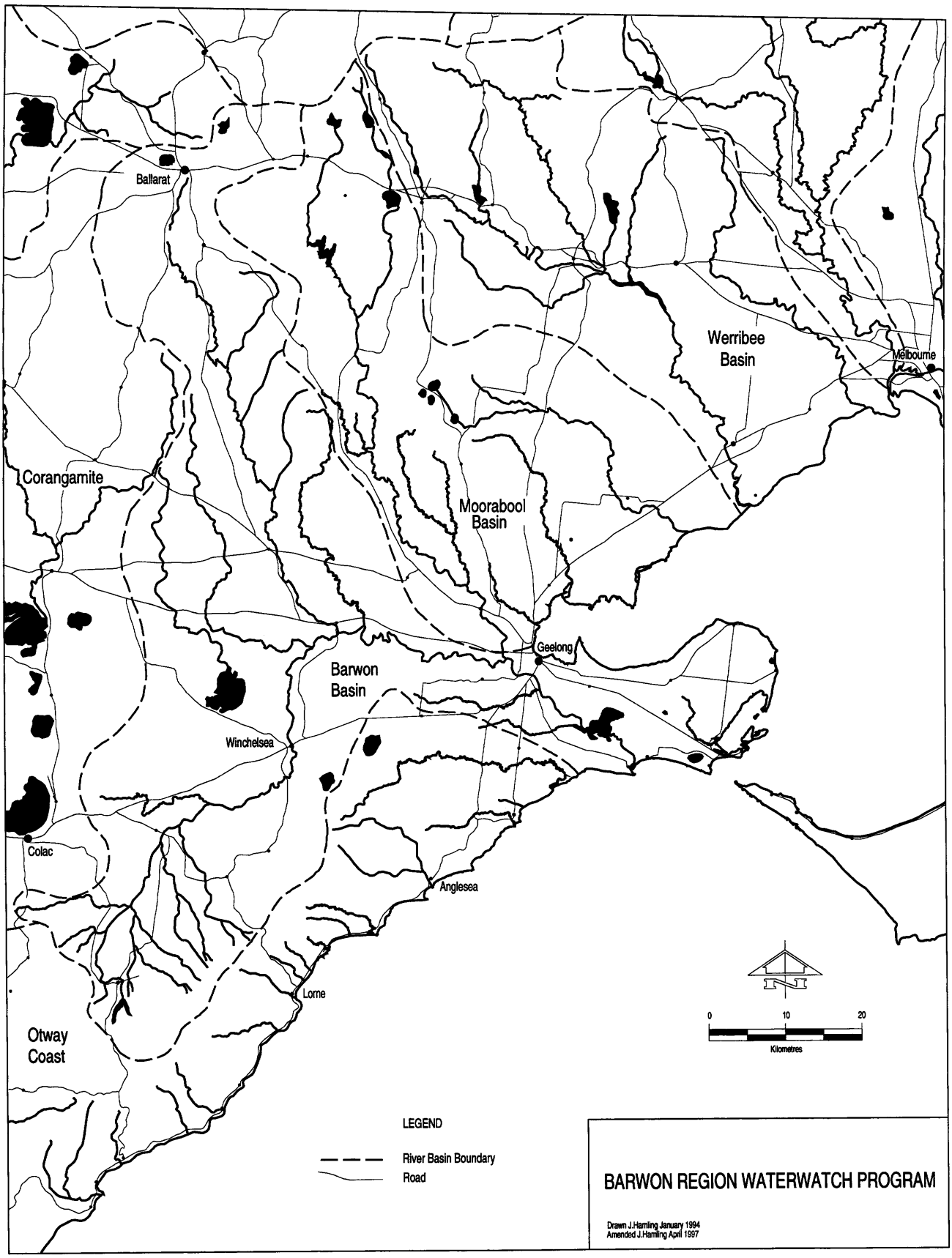
Map 2A of Corangamite Region



Map 2B of Corangamite Region



Map 2C of Corangamite Region



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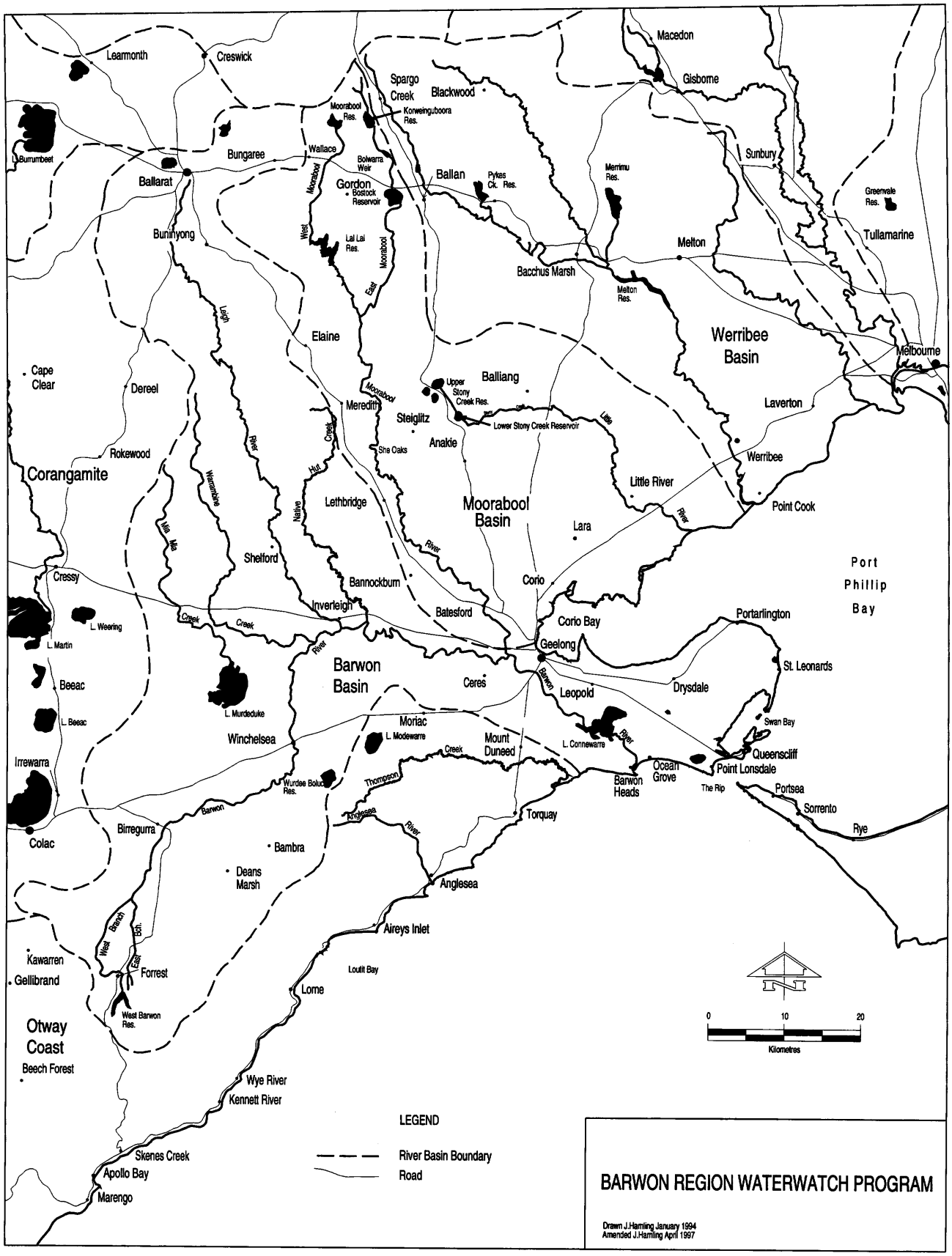
Map 2D of Corangamite Region



Information sheet 4

Corangamite Catchment Region

For the purposes of managing water resources, information on a river basin or catchment basis is needed. The Corangamite Catchment Region contains 4 major river catchments or drainage basins, i.e. all of Barwon Basin, Otway Coast Basin and Lake Corangamite Basin, and the Moorabool Basin.

[For more information about catchments, refer to the Statewide section of this Kit, Teacher sheet 18: Mapping your catchment, and Getting Started section, pages 3-6 in *A Community Water Quality Monitoring Manual* for Victoria.]

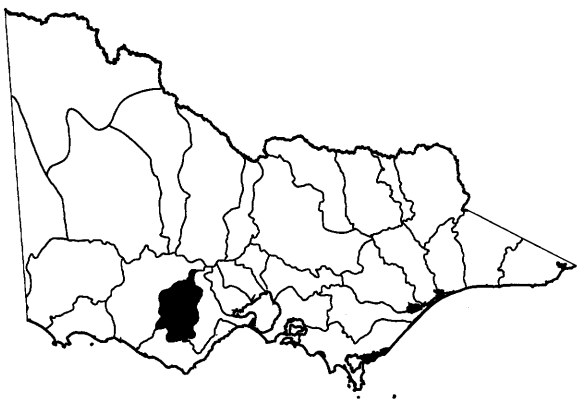
The **Barwon Basin** covers 390,000 ha. It contains two major river systems:

- the Barwon River
- the Leigh (or Yarrowee) River

Four wetlands within this Basin are listed on the Ramsar Convention as wetlands of international significance: Swan Bay, Lake Connewarre, Reedy Lake and Lake Murdeduke.

Other waterways and wetland sites include:

- Waurn Ponds Creek
- Lake Victoria
- Native Hut Creek
- Yarram Creek
- Bergola Wetlands



The Lake Corangamite Basin is not covered in detail in this edition.

The **Moorabool Basin** covers 217,000 ha and contains three major systems:

- Moorabool River
- Little River
- Hovells Creek

Minor creeks include:

- Cowies Creek
- Coolebarghurk Creek
- Sutherlands Creek

Limeburner's Lagoon at Hovells Creek estuary is listed on the Ramsar Convention as a wetland of international significance.

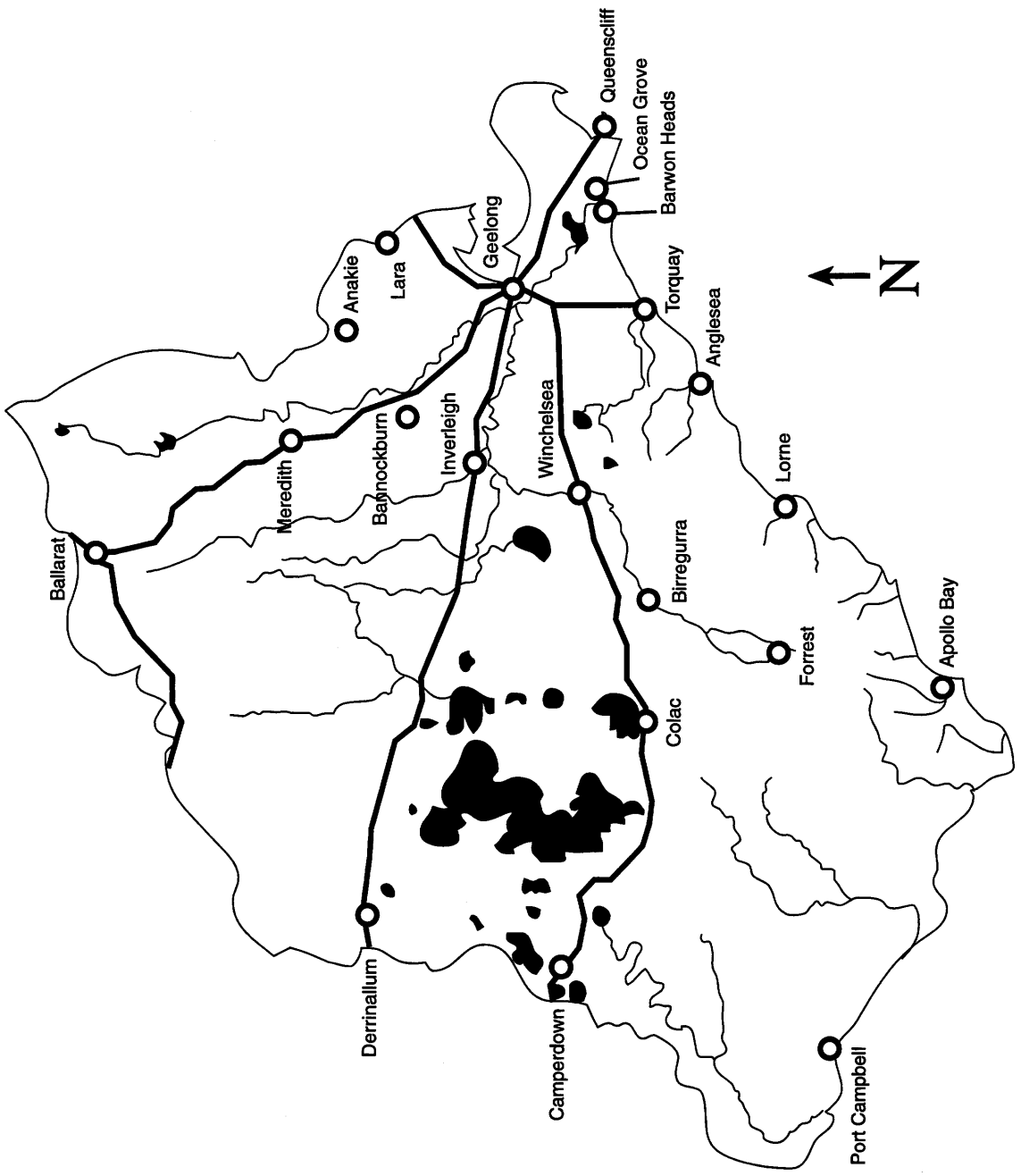
The Moorabool River flows into the Barwon River at Geelong and discharges into Bass Strait at Barwon Heads. Little River and Hovells Creek discharge into Port Phillip Bay via Corio Bay.

The **Otway Coast Basin** drains an area of 390,000 ha of the southern slopes of the Otway Ranges. Major streams in this basin include:

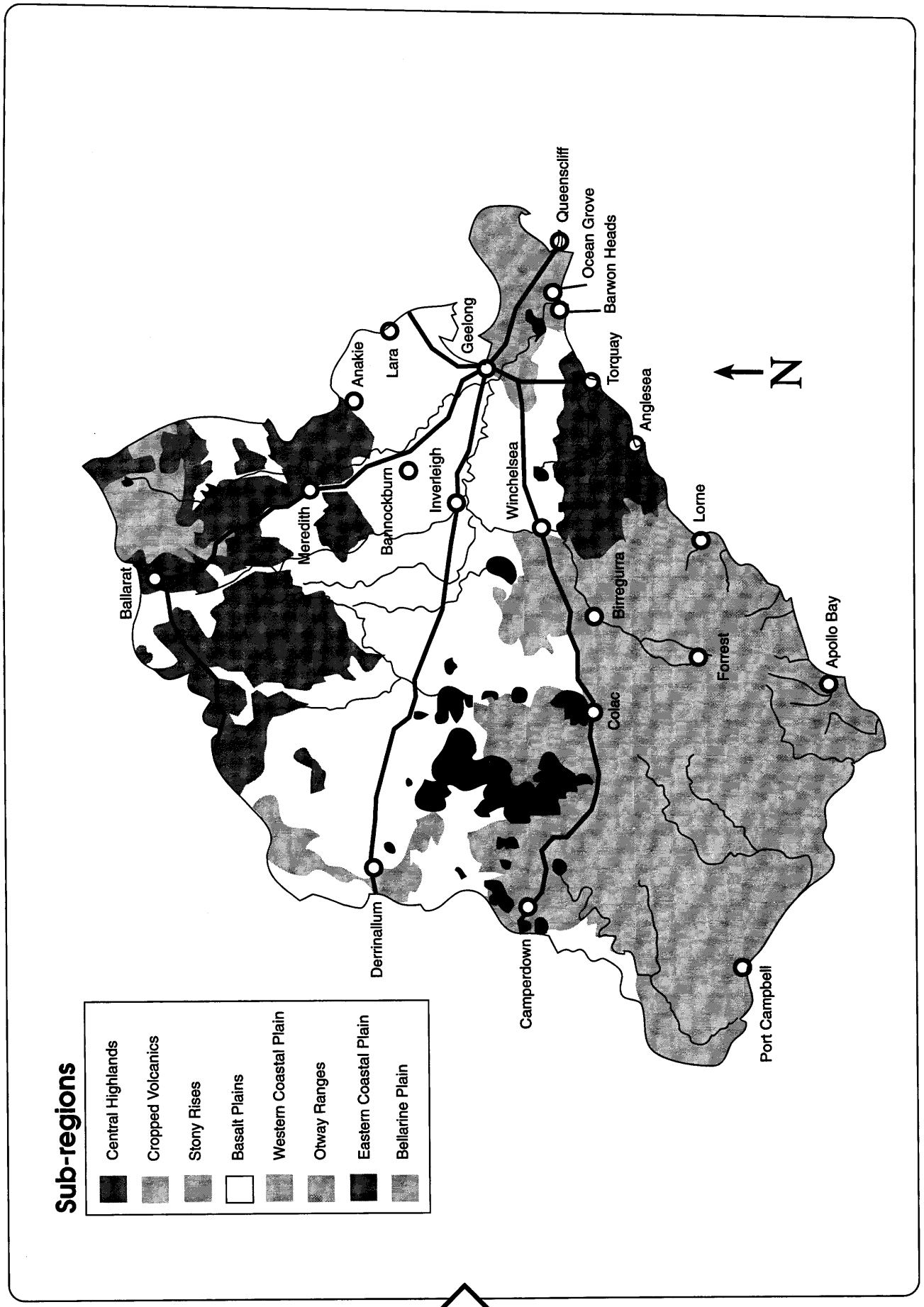
- Thompson Creek
- Anglesea River
- Painkalac Creek
- Erskine River
- Cumberland River
- Gellibrand River
- Aire River

The Otway Basin contains the headwaters of the Barwon River. Its other waterways discharge into the ocean.

Map 3 of Corangamite Region



Map 4 of Corangamite Region



Corangamite Catchment Region cont.

The nature and condition of waterways is influenced by the type of landform, soil, and climate in that particular part of the catchment. These factors form a basis for distinguishing sub-regions within each Catchment region.

Sub-regions

Broadly speaking, the Corangamite Catchment Region consists of highlands to the north (the Central Highlands around Ballarat and Daylesford) and the south (the Otway Ranges), with a broad flat plain in between. Within this broad physiography, differences in geological make-up and geomorphological formation have created different landforms and soils.

Map 4 shows the nine sub-regions which have been distinguished in the Corangamite Catchment region. Each of these sub-units has distinctive landform, soil, landuse and climate conditions which distinguish it from the other sub-regions within the Catchment region.

- Central Highlands
- Basalt Plains
- Otway Ranges
- Stony Rises
- Eastern Coastal Plain
- Western Coastal Plain
- Bellarine Plain
- Cropped Volcanics
- Coastal Fringe

The sub-regions in which most Barwon Water Waterwatch Monitoring Groups currently operate are described below.

Central Highlands

The Central Highlands main east-west ridge forms part of the Great Dividing Range and reaches 740 m. Its landscape features rolling hills with gentle and steep slopes. The northern portions of the Moorabool and Little River catchments lie in the Central Highlands. The Woady Yaloak, Yarrowee/Leigh and Moorabool Rivers have their headwaters in the Central Highlands. The soils, mostly derived from sedimentary rocks and granite, are shallow and have poor structure and nutrient levels. There are isolated tongues of more productive basalt derived soils. Surface water runoff is generally intermittent and often saline.

The Central Highlands sub-region was once extensively forested with Stringybark (*Eucalyptus obliqua*) and Peppermint (*Eucalyptus nitens*) but much of this forested area has been cleared. It now contains the Greater Ballarat urban area and grazing and cropping land. Remaining forests are mainly Crown Land, used for timber production and conservation reserves.

Western Volcanic Plains

The Western District Volcanic (Basalt) Plains are an extensive east-west formation between the Western Highlands and Otway Coast ridges. Soils are heavy clays. These plains have poor surface drainage systems and many fresh to saline lakes and wetlands, most of which have no natural outlet to the sea. The eastern reaches of the Volcanic Plains lies the Moorabool and Barwon catchments.

The extensive native grasslands that originally covered the Western Volcanic Plains have been reduced to scattered remnants (less than 0.01% of native grassland remain, making it rarer than temperate rainforest in the region). Scattered across the grassy plain were woodlands of Drooping Sheoaks (*Allocasuarina verticillatta*) and Silver Banksia (*Banksia marginata*) while scattered trees occurred along watercourses and around scoria cones. The small remnants are now mostly in linear reserves. Many Sugar Gums (from South Australia) have been planted.

The Plains are now used mainly for crop production, beef, and to a lesser degree, dairy cattle farming, and sheep farming for both wool and meat. The main crops are barley, wheat and oats. Some irrigation farming occurs on the lower reaches of Little River.

Otway Range

The Otway Ranges reach 650 m and form an east-west ridge between the Volcanic Plains and the sea. The ranges are flanked by an extensive foothill system. The sedimentary soils are unstable and relatively prone to erosion. The soils vary from deep and fertile on the main ridge to infertile on the slopes. Drainage lines are well defined, deep, and generally run north-south. The headwaters of the Barwon River are in these Ranges.

Much of the Otway Range sub-region is forested and publicly owned. Its higher rainfall and areas of more fertile soils support tall eucalypts such Mountain Ash (*Eucalyptus regnans*) and Messmate (*Eucalyptus obliqua*). Significant areas have been protected in the Otways National Park. High rainfall, steep terrain, roads, agriculture and forestry operations all contribute to the relative instability of the area and its land slip and erosion.

Today the Otway Ranges is still mainly forest areas of Crown Land, used for either hardwood production or conservation.

Coastal Plains

Coastal Plains occur on the Bellarine Peninsula and on the gently sloping areas between the Otway Ranges and the Volcanic Plains. The surface waters from these plains flow intermittently and are often highly saline.

Corangamite Catchment Region cont.

Soils

The sedimentary rocks of the region were deposited by the sea 560 million years ago when what is now Victoria was a deep ocean. These sedimentary rocks have since been uplifted, folded, cracked and faulted to form the hills we see today. Because of the marine origin of these sedimentary rocks, the sedimentary soils derived from these rocks are naturally higher in salts than many other soils.

The soils of the Central Highlands, the Basalt Plains and the Coastal Plains are very prone to waterlogging in winter. The wet environment together with the unstable soil conditions leads to severe tunnel erosion, gullying and land slip.

The cultivation of crops on the sandier soils makes these soils prone to wind erosion in summer. Soil fertility is very variable and fertiliser use is high across the region.

Climate

Map 5 shows the rainfall isohyets for the region. The Corangamite region in general has a temperate Mediterranean climate with dry hot summers (average mid-summer maximum temperatures of around 27 degrees C) and cool wet winters (average mid-winter minimum temperatures of around 5 degrees C). Rainfall varies from less than 500 mm per year in rain shadow areas around Lara to a State high of up to 2000 mm in the Otway Ranges (falling on more than 200 wet days).

Rainfall in the Moorabool River Basin is influenced by the rain shadow on the Werribee Plains.

Rainfall in the Barwon Basin is very high in the Otway Ranges, the headwaters of the Barwon. Its northern section receives 700 mm per year while the central parts of this catchment averages 500 - 600 mm per year.

Along the coastal section of the Otway Coast basin, rainfall averages 900 mm, decreasing to 500 mm in the far east around Torquay. The Otway Ranges also cause rain shadow effects in areas around Lara.

Interpreting water quality results

Streams within the Moorabool, Barwon and Lake Corangamite catchment basins all have similar flow characteristics. Water levels in the region are generally highest in August and lowest in March.

Because of the steepness of the catchment and good drainage, creeks in the Otway Ranges have a 'flash' flow pattern after rainfall and the area's unstable soils make these waterways very prone to erosion problems.

Present landuse

The type of landuse on the land surrounding waterways has a major influence on water quality. Map 6 shows that the major landuses at present in the Corangamite Catchment region is agriculture; mainly wool, milk, meat, crops and timber.

The Geelong urban area is an important industrial centre. Major industries include the manufacture of transport and other machinery and equipment, metallic products, textiles, food, beverages and tobacco.

The water industry is very important to the region as most of the primary and industries require water of a suitable quality and quantity. The total annual domestic and rural water used throughout the region is about 67,000 ML (megalitres).

Interpreting water quality results

Landuse upstream from your monitoring site will influence water quality at your monitoring site.

Agricultural land may contribute

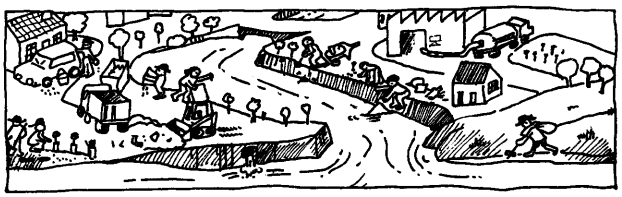
- excess fertiliser runoff
- excess sediment from eroding riverbanks or ploughed land
- chemicals from pesticides and herbicides

Industry may contribute

- chemicals
- heated water
- excess sediment from clearing vegetation and soil disturbance

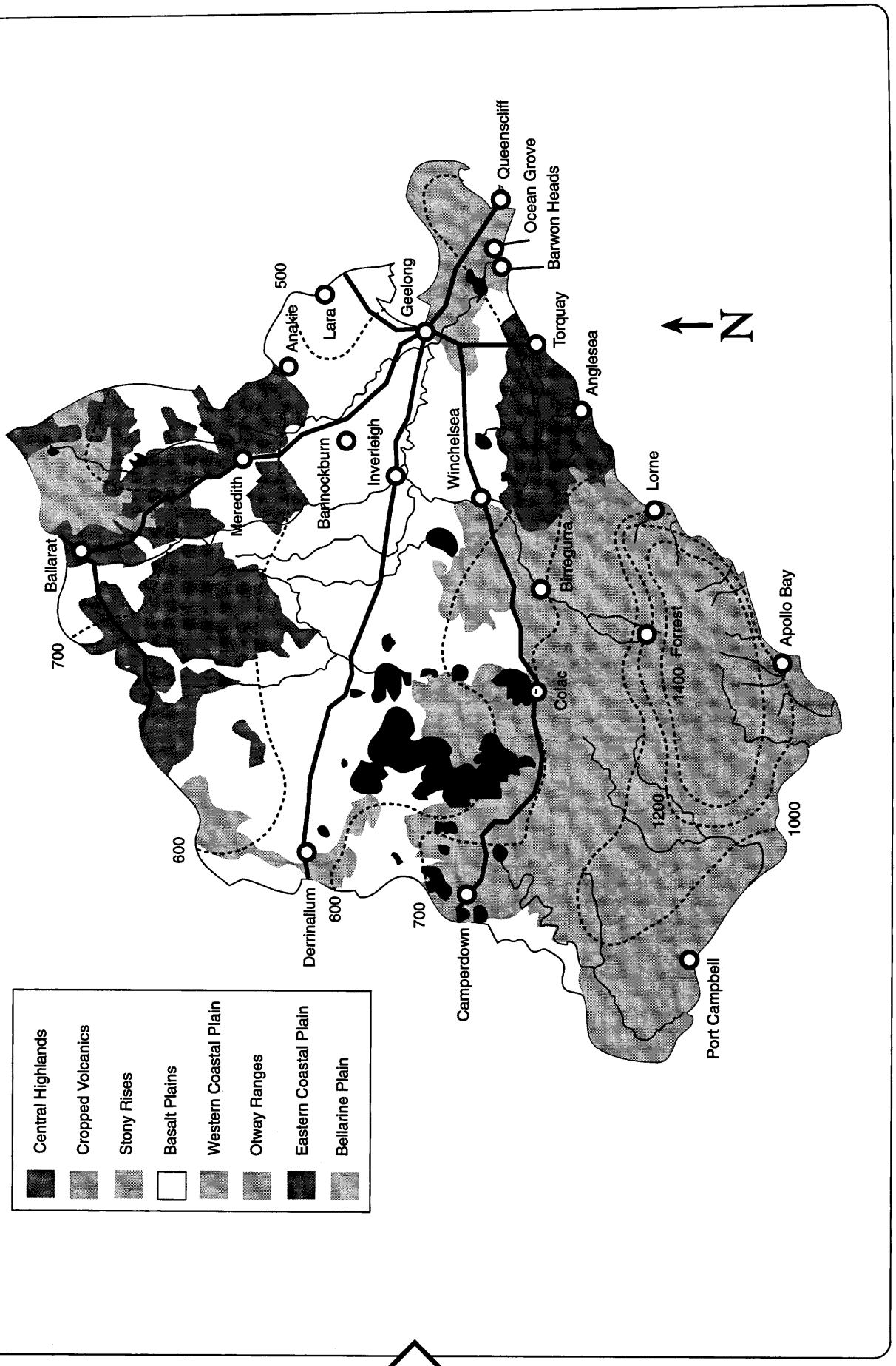
Urban centres may contribute

- excess nutrients and chemicals via stormwater drains
- excess sediment from development sites

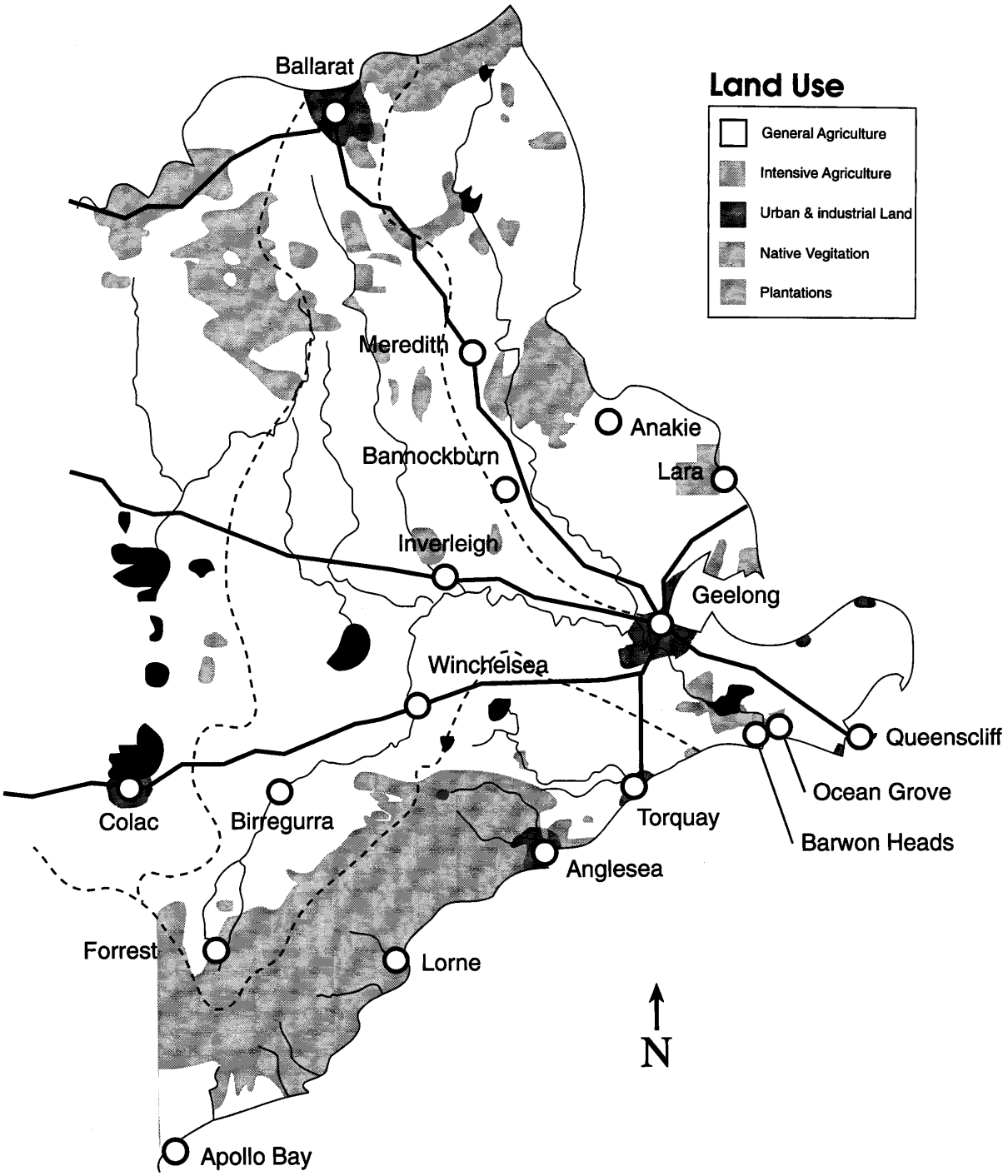


Blackline master 5

Map 5 of Corangamite Region



Map 6 of Corangamite Region



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Corangamite Catchment Region cont.

Population

The Corangamite Region has a highly urbanised population. Most people live in the north (around the upper reaches of the Leigh/Yarrowee River which flows into the Barwon) or the east (around the lower reaches of the Barwon itself). Of a total population of about 356,000, more than 70% live in or around the major centres of Geelong, Colac and Ballarat. These centres have continued to grow in recent times as agricultural land is converted to residential and small block subdivisions.

The region's coastal attractions draw many visitors. In addition to the permanent population, 280,000 people annually visit the region.

The population concentration in the north, east and coastal areas of the region has consequences for landuse and water quality. For example, the water quality of the Leigh/Yarrowee River in its upper catchment is lower than might be expected because of high populations living near its headwaters. Ballarat City discharges treated sewerage into the Leigh/Yarrowee River in its upper catchment.

The following table shows where the greatest population growth is expected to occur in the early part of the 21st century. Water quality around and downstream of these areas may be expected to decline unless actions are taken to reduce people's impact. These increased population centres will also want the water they receive from upstream areas to be of good quality.

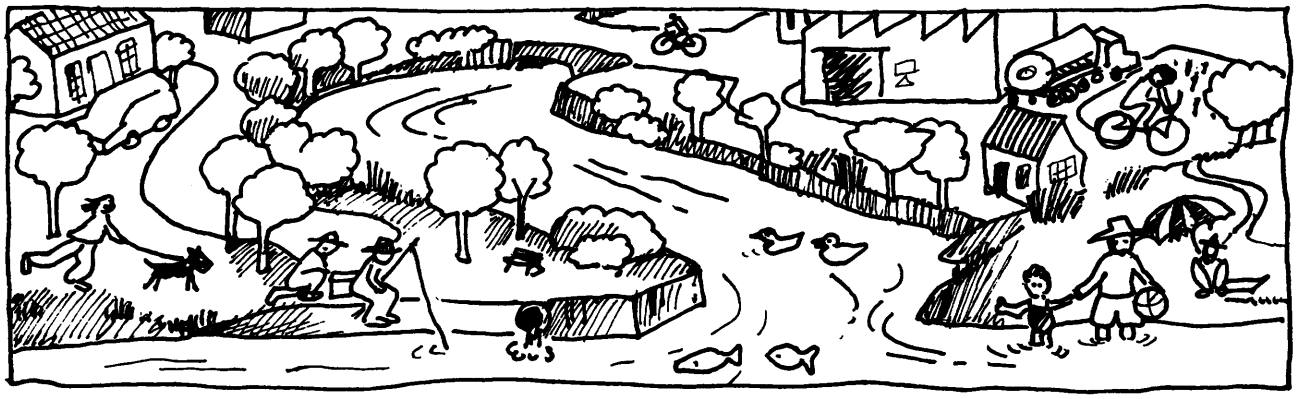
Interpreting water quality results

When interpreting water quality results along your waterway as part of your Waterwatch monitoring program, it will be helpful to take into account current population levels along the river. For example, a large town located along the river may be a cause of reduced water quality immediately downstream from the town.

Population estimates

City/Shire	Population in 1994	Estimated pop. in 2011
Ballarat City	75,870	85,000
Geelong City	182,550	217,000
Colac Otway Shire	21,400	22,900
Corangamite Shire	18,130	16,950
Golden Plains Shire	14,150	19,200
Moorabool Shire	24,630	36,000
Queenscliff Shire	3,290	3,400
Surf Coast Shire	16,340	26,500
Totals	**356,360**	**426,950**

Source: Dept of Planning and Development 1995.



Corangamite Catchment Region cont.

Conservation

The region contains waterways and wetlands of national and international significance. These include the relatively undisturbed rivers of the Otway Ranges and Basalt Plain, and coastal and estuarine wetlands. Several wetlands in the area including Lake Corangamite, Reedy Lake and Lake Murdeduke are listed as Ramsar sites (wetland sites of international significance).

Heritage Rivers are rivers of National, State or regional significance because of their outstanding nature conservation, scenic, recreation and/or cultural values. Parts of the Aire, Gellibrand and East Moorabool Rivers are classified under the *Heritage Rivers Act* 1992.

Wildlife

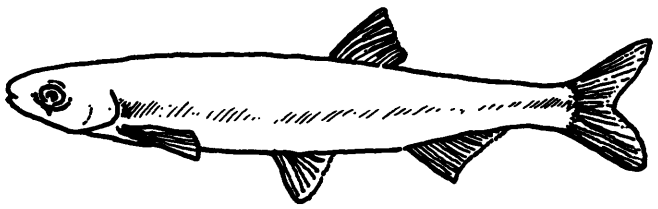
The area's rapid pastoral development has caused the extinction and declining numbers of many native species.

Animals

The now uncommon Brolga still breeds in suitable wetlands in the region.

The Platypus and Eastern Water Rat are common and are found in freshwater streams in most parts of the area. Both species have been sighted near Buckley Falls in Geelong. Platypus and Water Rats nest in the banks of watercourses and forage for crustaceans, insects, molluscs in the water.

The Australian Grayling is considered to be vulnerable and at risk of becoming endangered. The Grayling is found in the Barwon and Moorabool Rivers. Broad-finned Galaxiid (found in Painkalac Creek) and Spotted Galaxiid (found in Painkalac Creek and Barwon River) both have restricted distribution in Victoria.



Plants

The River Red Gum (*Eucalyptus camaldulensis*) is the main eucalypt found along the region's waterways and supports a large diversity of wildlife in and around rivers.

Introduced plants that increase flood risk and reduce habitat value include Poplars and Willows. Gorse (also known as Furze) and Fennel are the two most common riparian noxious weeds. Serrated Tussock, Blackberry, Sweet Briar and Boxthorn are also relatively common. To improve the heath of waterways these exotics need to be removed or controlled.

Estuaries

Estuaries are important feeding, spawning and nursery areas for many species of fish, waterbirds and invertebrates. Major estuaries in the region occur in the Barwon, Curdies, Aire Rivers and the Painkalac, Spring, Erskine and Hovells (at Limeburners Bay) Creeks.

For information on plants and wildlife, refer also to the Statewide section:

Information sheet 1: Adapted for living in water and

Information sheet 2: Victoria's wetland life,

and local references such as:

The Water Cycle

Barwon River Flora. Barwon Water booklet.

Barwon River Fauna. Barwon Water booklet.

Corangamite Catchment Region cont.

Water resources in the region

Creeks are generally spring fed in the upper catchment, and runoff fed further downstream.

Water supply for the region (including the cities of Ballarat and Geelong) is drawn mainly from the upper reaches of the Barwon and Moorabool Rivers. Groundwater resources are used when required. Some coastal towns such as Airey's Inlet and Lorne collect and store water from local streams.

The region's water and wastewater supplies are managed by Barwon Water and Central Highlands Water. In areas not serviced by water mains, people rely on collecting rain water in tanks.

The Barwon catchment

The Barwon River dominates drainage in this basin. It rises on the northern slopes of the Otway Ranges and flows in a north-easterly direction before turning south-east and flowing into Bass Strait at Barwon Heads. The Barwon flows through a large system of lakes and swamps (including Lake Connewarre) just before it flows into the ocean.

The West Barwon and Wurdee Boluc reservoirs, both important components of the Geelong water supply system, are located in the upper and middle reaches of the Barwon Basin respectively.

The Moorabool catchment

The headwaters of the Woady Yaloak and Moorabool Rivers are in the Central Highlands. Water storage supplies in the Moorabool Basin include the Bungal (Lal Lal) dam, and Stony Creek, Bostock and Koreinguboora reservoirs.

Otway Coast catchment

The Otway Coast receives freshwater from numerous small river systems. Although some of these systems are dammed for town water supplies, there are no major water storages in the Otway Coast basin.

Environmental flows

Although water is extracted from river systems for town water, industry, stock and agriculture, these extractions must be licensed. The Water Bureau must add the total of all the extractions and make sure there is enough natural river flow remaining to enable the ecosystem to function. The minimum flow is called the environmental flow.

Geelong's water supply

About 60% of Geelong's domestic and industrial water is supplied by West Barwon Dam where water is transferred by channel to Wurdee Boluc. The remaining 40% comes from the Moorabool basin via Bostock, Koreinguboora, Lal Lal and Stony Creek reservoirs. One third of the available water from the Lal Lal reservoir on the west Moorabool River is available to Geelong. This reservoir is shared with Ballarat. In times of drought, Geelong's water supply can be supplemented by 8,000 ML of water from groundwater bores at Barwon Downs.

Water storages	
Lal Lal	59,000 ML*
Moorabool	6,790 ML
Bostock	7,460 ML
Stony Creek	9,500 ML
Koreinguboora	2,090 ML
West Barwon	21,000 ML
Wurdee Boluc	19,000 ML

* One ML (megalitre) equals 1 million litres, about the volume of an Olympic size swimming pool.

Water drainage diversion schemes

Two major schemes operate to divert water from the adjacent Lake Corangamite Basin to the Barwon River. Both have been the subject of much public debate as the water they divert is more saline than natural Barwon River flows and so result in some water quality decline in the Barwon River.

The *Lough Calvert drainage scheme* diverts water from Lake Colac and the Lough Calvert system along Birregurra Creek and into the Barwon River near Rickett's Marsh, and was designed to protect agricultural land in the Lough Calvert system from flooding. The scheme operates under a series of rules that does not permit diversions to occur that would result in salinity levels in the Barwon River at Winchelsea exceeding 2,500 EC units, nor to occur between 1st October and 30th April.

The *Woady Yaloak River diversion scheme* diverts water that would otherwise have flowed into Lakes Corangamite, Gnarpurt and Martin, into Warrambine Creek and then into the Barwon River. The scheme was designed to protect agricultural land around Lake Corangamite and adjacent water bodies from flooding. This scheme also operates under a series of rules that does not permit diversions that would result in Barwon River salinity levels downstream of Inverleigh exceeding prescribed values depending on the time of year.

Corangamite Catchment Region cont.

Although the scheme has been effective in reducing Lake Corangamite's water levels, it has also resulted in the Lake's salinity levels increasing significantly to the extent that there is now concern that its value as a waterbird habitat will be reduced or lost if the scheme continues to operate. The Western District Lakes are a declared Wetland of International Importance under the Ramsar Convention. The Commonwealth and Victorian Governments are obliged to 'formulate and implement planning so as to promote the conservation of the listed Ramsar areas'.

Waste water treatment

Central Highlands Water discharges treated sewerage effluent from its Ballarat South Wastewater Treatment Plant into the Leigh/Yarrowee River, a tributary of the Barwon. Barwon Water discharges treated effluent from Colac to Lake Colac, an occasional tributary of the Barwon River via the Lough Calvert drainage scheme. The majority of sewerage effluent from the Geelong area is discharged after treatment to the ocean at Black Rock. Barwon Water also operates some regional treatment plants with disposal to irrigated woodlots at Winchelsea and Portarlington.

Most (but not all) industries in the region discharge their effluent to municipal sewage systems. Run-off from dairy farms and seepage from septic tanks in rural residential areas are some sources of nutrients which detrimentally affect the health of the region's waterways.

Rural properties and smaller country towns are not connected to the sewerage system but have septic tanks.

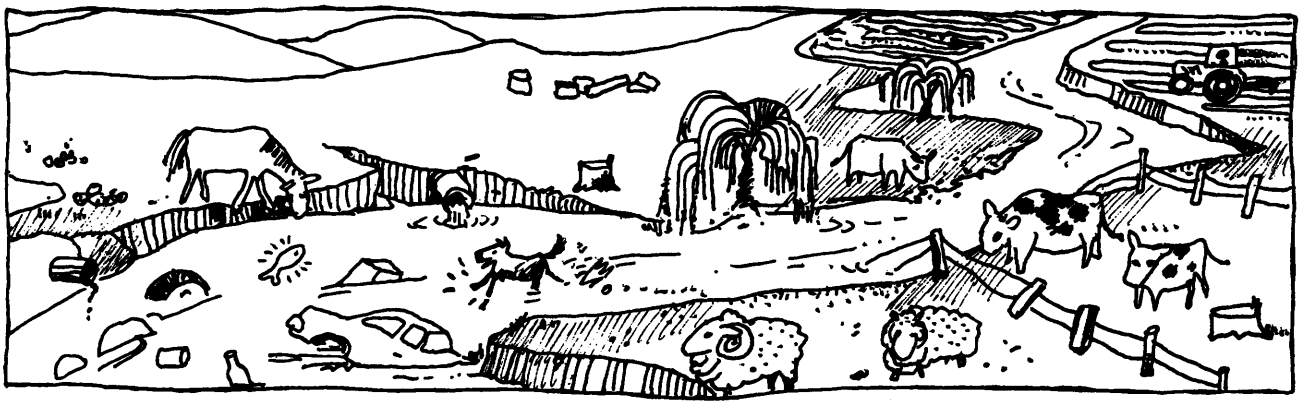
Flooding

Flooding damages low-lying agricultural areas (about 500 ha) around lakes, major streams, estuaries and some urban areas of Ballarat and Geelong. Barwon Heads, Ocean Grove, Geelong and Inverleigh are all urban areas subject to flooding from the Barwon River. A flood mitigation strategy has been developed to reduce flood impacts on urban areas. Being low-lying, rural areas along most of the Barwon valley are prone to some degree of nuisance flooding.

Land degradation

Land degradation over the whole Corangamite Landcare region costs Victorians the equivalent of many millions of dollars in economic, social and environmental losses each year. Since European settlement:

- trees have been lost from three-quarters of the region
- more than 10,000 ha of agricultural land has been degraded through salinity
- rabbits have spread throughout the region, severely degrading about 15,000 ha
- 12,000 ha have become severely eroded
- 20 species of native plants and animals have become extinct, and a further 50 are endangered



Corangamite Catchment Region cont.

The state of the waterways in the region

As much of the upper catchments of the Moorabool and Barwon Rivers have been cleared, downstream flows regimes tend to be quite 'flashy'. These flashy flows cause increased erosion resulting in high turbidity and suspended solids.

Barwon River's downstream salinity levels increase, mainly due to water diversion from the Lake Corangamite Basin drainage schemes and to natural saline inflows between Winchelsea and Inverleigh.

The northern tributaries of the Barwon, especially Native Hut and Bruce Creeks have eroded significantly in the recent past and are still being degraded. Warrambine Creek has eroded due to operation of the Woady Yaloak River diversion scheme and consequent increases in both flow volume and salinity have occurred. The most dramatic erosion in the area has occurred along streams flowing northward to the Barwon from the Otway Ranges, notably Wormbete, Retreat, Yan Yan Gurt, Deans Marsh, Matthews and Timmins Creeks. Moderate to severe erosion is occurring along many upper tributaries in the Woady Yaloak, Leigh and Barwon River systems.

About 50% of the waterways in the Barwon Basin, and 30% in the Moorabool Basin do not have good riparian vegetation cover.

Water quality in the region

Chemical pollutants, salinity and nutrient and sediment loads of the major streams are all increasing throughout the region.

Woady Yaloak River - water quality is poor in the upper reaches because of high total nitrogen levels.

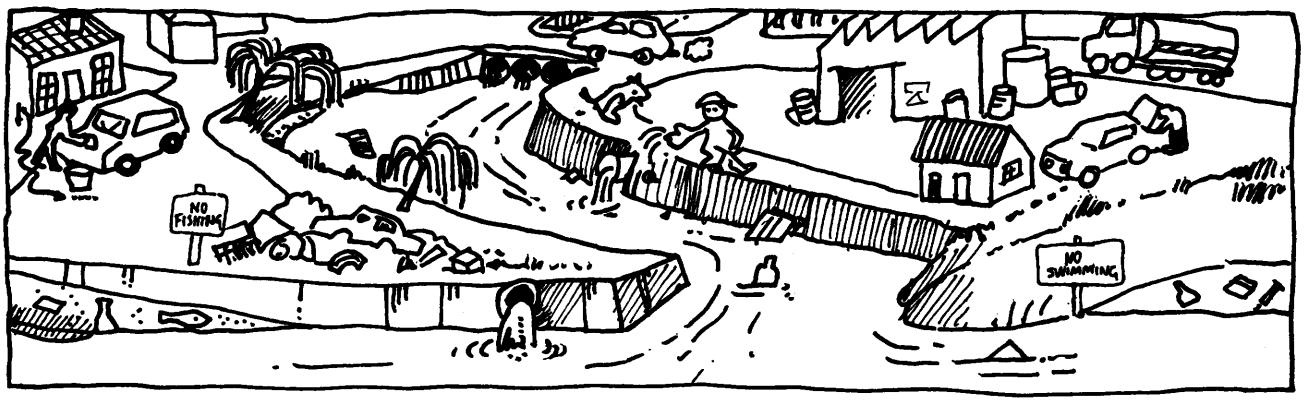
West branch Moorabool River (flows into Lal Lal Reservoir). Nutrient increases are a major concern.

Yarrowee/Leigh River has a high nutrient status; contributed by urban run-off at Ballarat, agricultural runoff, and treated effluent from Ballarat South treatment plant.

In summer, three-quarters of the flow in the Leigh/Yarrowee River is from the Ballarat South Treatment Plant. It is of interest that a number of farmers rely on this nutrient rich water for irrigation.

Toxic algal blooms are increasing across Victoria and this region is no exception. Water based recreational activities have been affected by these blooms. Outbreaks have also occurred in water storages in the upper Moorabool catchment and levels of nutrients are increasing in these storages. The increase in algal blooms in the streams and wetlands throughout the region indicates increased nutrient contamination, particularly by nitrates and phosphates. There is major concern about maintaining groundwater quantity and quality to meet current and projected demands, while increasing levels of nitrate are of particular concern.

Much of the water from the Woady Yaloak, Leigh, Moorabool, Lower Barwon, Curdies and Gellibrand Rivers therefore require treatment for safe human consumption. This has both economic and environmental costs through the increased cost of treatment, limited availability of suitable water for domestic or stock consumption and loss of habitat for wildlife and fisheries.



Corangamite Catchment Region cont.

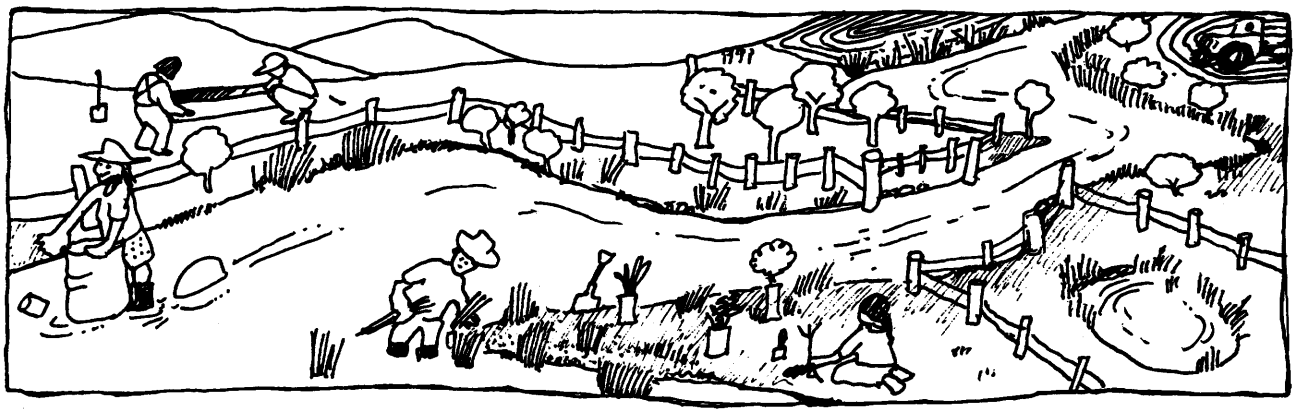
Summary of major water quality problems in the region

Central Highlands sub-region

- Dryland salinity severely affects approx 1000 ha of agricultural land within this sub-region, limiting agricultural production, inducing soil erosion and degrading aquatic environments. Salinity problems occur on the Woady Yaloak River at the southern end of the Central Highlands, with tributaries from the Kuruc-A-Ruc Creek to the Naringhil Creek compounding the problem. The upper catchment of the Woady Yaloak is identified as a salinity hot spot.
- The sedimentary derived soils of this region are prone to erosion and as phosphorus frequently moves attached to soil particles, erosion increases the nutrient loads in the above waterways.
- Turbidity is unacceptably high for drinking quality purposes at some stages in the Moorabool River. [Barwon Water is to install a water treatment plant at considerable cost to address issues including colour and turbidity.]
- Riparian vegetation is classified as poor, is usually extensively cleared and invaded by exotic species. Sites on the Moorabool River within Lal Lal State Forest and the upper reaches of Woady Yaloak River have relatively undisturbed riparian vegetation.
- Streambank erosion ranges from moderate to severe.
- The environmental conditions of streams is very poor in cleared areas of the Central Highlands.
- Soil loss through water erosion is a large problem. The Ordovician sediments of this region have inherently low fertility and can ill afford further loss of topsoil.
- There is concern that new mining operations may affect water quality in Yarrowee/Leigh River. An example of this occurred in October 1997 when a pipe in a mining operation burst, spilling 14 tonnes of cyanide into the river. The spill had the potential to affect not only the downstream water users but all the river's plant and animal life.

Basalt Plains sub-region

- Dryland salinity affects 10800 ha of land across the north-central plains area with many hot spots identified in western section, and the lake and dune system around Winchelsea and Moriac.
- Streambank erosion is prevalent in some catchments such as the Woady Yaloak and occurs in Little Woady Yaloak Creek, Leigh/Yarrowee River. Some localised erosion occurs along the Barwon River.
- Riparian vegetation - no sites in this sub-region are in excellent condition, only one site in good condition, the rest are in moderate to very poor condition.
- Nutrients - the Leigh River at Mount Mercer was considered one of the most degraded sites in Victoria in terms of high nutrient levels (due to discharge of sewage effluent). Modifications to the treatment plants have since reduced nutrient concentrations.
- Water quality of the Barwon River as it passes through this sub-region is generally considered degraded or poor for physical and chemical factors. The highest nutrient loads have been monitored in the Barwon Water system close to Geelong. In its middle reaches the Moorabool River was classified poor for total nitrogen, while total phosphorus improved to good; near Geelong the river is classified as moderate for total phosphorus and deteriorated for total nitrogen.
- Most algal blooms in the Barwon River Basin [five between 1992 and 1996] have occurred in areas extensively used for recreation including the Barwon River at Geelong.
- Downstream portions of Barwon River tend to be very saline. The Moorabool River increases in salinity as it nears Geelong.
- Increasing salinity levels are impacting on native blackfish.
- Carp and other introduced fish are degrading waterways and lakes.
- Drainage, grazing and trampling of freshwater wetlands threatens Brolga breeding habitats.



Monitoring Corangamite's waterways

Refer to Statewide section (Teacher sheet 21: Monitoring with Waterwatch) for general overview information and instructions on water quality monitoring.

Key Learning Outcomes

As for Teacher sheet 21: Monitoring with Waterwatch, in Statewide section.

Aims

As for Teacher sheet 21, in Statewide section.

Materials

Waterwatch equipment kit.

A Community Water Quality Monitoring Manual for Victoria.

Completed Site Description, Habitat and Physical and Chemical Tests Record Sheets from your *Waterwatch Monitoring Records Book.*

Student sheet 22: Water quality results summary in Statewide section.

Blackline master 7: Water quality ratings for Corangamite.

Advanced preparation

1. Familiarise your students with the equipment, waterways and water quality by conducting the activities described in earlier pages of this Kit. Make sure the students practise using the equipment and taking readings *before* they commence water monitoring in the field.

Additional references

Barwon Water Internet site address
http://www.barwonwater.vic.gov.au/

Activity instructions

1. Using maps supplied, map your monitoring site's catchment and identify the source(s) of the water that flows into it.

   [*Refer to Teacher sheet 18, Statewide section.*]

2. Monitor your local wetland/waterway as part of the Waterwatch program (use the Waterwatch Kit, Waterwatch Manual and Monitoring Book supplied to you). Conduct the tests as described on the instruction sheets in the equipment kit.

3. Record your results in the Waterwatch Monitoring Results Book.

   [*Refer to Teacher sheet 18: Monitoring with Waterwatch, Statewide section.*]

4. As soon as possible after monitoring, send a copy of each completed record page from your Monitoring Results Book to:

   Corangamite Waterwatch Scientific Co-ordinator
   Barwon Water Laboratory
   40-44 Lonsdale St
   South Geelong, 3220

5. **Sample data**

   Complete the example data exercise(s).

   [*Example data - Statewide section, Teacher and Student sheets 5: Interpreting sample data, and Corangamite Region, Teacher and Student sheets 5: Barwon and Moorabool River sample data*].

6. **Present your results**

   a) After each monitoring session at your site:

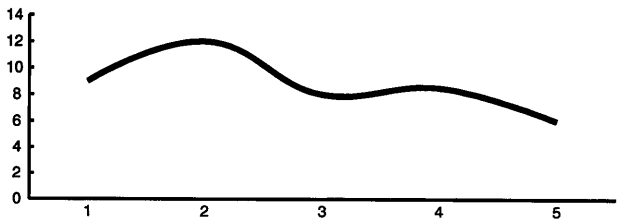
   Distribute Student sheet 22 and Blackline master 7: Water quality ratings for Corangamite.

   Students collate the results for all the tests conducted at that time onto Student sheet 22. Students use Blackline master 7 to rate the water quality at the site. Do the readings show that water quality at your monitoring site is Excellent, Good, Fair, Poor or Degraded?

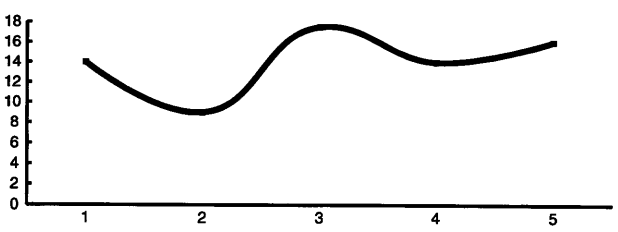
   b) After the second monitoring trip:

   To help interpret their results over the year, students also prepare a graph for each of the parameters tested. The graphs will build up a picture of what happens over the year(s).

Dissolved Oxygen

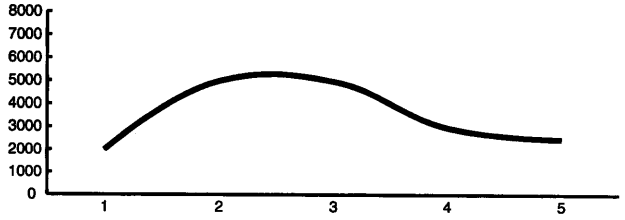


Temperature



Monitoring Corangamite's waterways

Conductivity



7. **Analyse and interpret your results**

   [Follow points 6 and 7 on Teacher sheet 22: Monitoring with Waterwatch, Statewide section of this kit.]

   Do your results for any of the parameters change much from one monitoring time to the next?

   Compare the summary sheets and graphs of your results over the course of the year.

   Has the reading for that particular factor increased or decreased over time? If so, ask students to suggest what might be some reasons for the change in the reading? Could it be a natural change with the season? [*e.g. temperature increase of the water in summer, decrease in water flow in summer*] If it is not likely to be a natural change, ask students to suggest possible reasons for the increase/decrease in the reading.

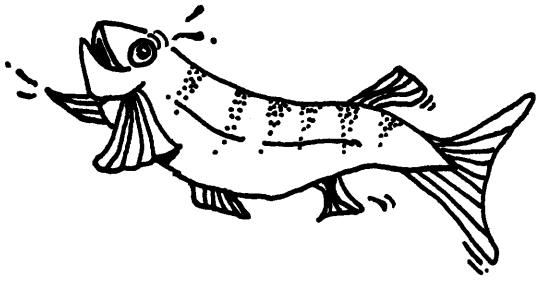
8. To develop an understanding of water quality in your catchment review any other data collected by groups further upstream or downstream of your waterway. Use data provided by your local Waterwatch Co-ordinator, or from Barwon Water's Waterwatch Internet site.

   a) If results are available, prepare graphs or compile a map and tables to show sites along the length of the river. Suggest possible reasons for any changes in water quality readings at different sites along the river.

9. Prepare a Catchment Condition Report each year (see Teacher and Student sheet 6).

Extension

Compare your data with other Waterwatch data in other regions of Victoria, Australia or the world. Interpret their results. What is the condition of these waterways? What are people doing to look after their waterway? From your comparisons with other groups and sites, list the ideas it gives you about what to do to help look after waterways and water quality.



Water quality ratings for Corangamite

Corangamite Catchment Region

Water quality scientists have developed rating guidelines for each chemical test to judge the quality (Excellent to Degraded) of your water sample. Use the tables below to check fresh water quality in the Corangamite Catchment region. But remember these figures are guidelines only.

Turbidity
Suspended solids (NTU)

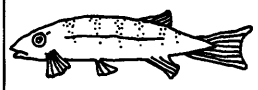
Excellent	Good	Fair	Poor	Degraded
10 or less	More than 10 but less than 20	More than 20 but less than 30	More than 30 but less than 50	More than 50
				

Conductivity
(ms/cm)

Excellent	Good	Fair	Poor	Degraded
0 - 400	More than 400 but less than 800	More than 800 but less than 2000	More than 2000 but less than 5000	More than 5000
				

Water quality ratings for Corangamite

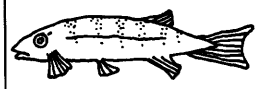
pH

Excellent	Good	Fair	Poor	Degraded
Between 6.5 and 7.5	Between 6.0 and 6.5 or between 7.5 and 8.0	Between 5.5 and 6.0 or between 8.0 and 8.5	Between 5.0 and 5.5 or between 8.5 and 9.0	Less than 5.0 or more than 9.0
				

Dissolved oxygen (%)

Excellent	Good	Fair	Poor	Degraded
Between 80 and 110	Between 70 and 80 or between 110 and 130	Between 50 and 70 or between 130 and 150	Between 40 and 50 or between 150 and 160	More than 160
				

Phosphorus (mg/L)

Excellent	Good	Fair	Poor	Degraded
Less than 0.01	Between 0.01 and 0.025	Between 0.026 and 0.05	Between 0.06 and 0.1	More than 0.1
				

Corangamite region sample data

Key Learning Outcomes

Level 4 Science: Living together
Identify living and non-living things that affect the survival of organisms in an ecosystem.

Level 4 SOSE: Natural & social systems
Describe responses of different elements (including people) to change in natural systems.

Level 5 Science: Living together
Explain the effects of various environmental changes on living things in ecosystems.

Level 5 SOSE: Place and space
Compare natural and human environments and describe factors affecting them.

Maths

Aims:

- to develop understandings of the main factors that affect water quality
- to understand how pollutants get into waterways
- to understand how waterways and water quality can be improved

Materials

Student sheets 5: Corangamite Region sample data.

Information sheet 4: Corangamite Catchment Region.

Blackline master 1: Map 1 of Corangamite Region, and others as required.

Blackline master 7: Water quality ratings for Corangamite.

Advanced preparation

Duplicate required number of Student sheets 5.

Prepare overheads of the maps.

Activity

1. Distribute the student sheet and map(s) for small group work.
2. Interpreting the readings in the table:

   [*In the Barwon River nutrient levels keep increasing from site 1 in the upper catchment to site 4 in the middle catchment, then reduce slightly through the lower catchment. pH and EC increase from the headwaters to the boat ramp at Ocean Grove. The highest values for turbidity are at Wilsons Road access to the river.*]

Water quality data collected along the Barwon River

	SITE 1 upper catchment of East Branch	SITE 2 upper catchment of West Branch	SITE 3 middle catchment	SITE 4 middle catchment Pollocksford	SITE 5 lower catchment	SITE 6 lower catchment; estuary
Phosphates mg/L	0.024 Good	0.034 Fair	0.040 Fair	0.220 Degraded	0.110 Degraded	0.043 Fair
Water temp	11	11	15	15	16	18
D.O. mg/L	10	8.75	9.75	10	9.6	10
pH	6.9 Excellent	6.6 Excellent	7.6 Good	7.9 Good	7.9 Good	8.4 Fair
EC µS/cm	160 Excellent	240 Excellent	1400 Fair	1900 Fair	1700 Fair	41000 Estuarine water
Turbidity mg/L	5.7 Excellent	5.4 Excellent	14 Good	18 Excellent	9.6 Good	8.2 Excellent

Source of data: *Barwon River and Lake Colac System Nutrient Study Monitoring Program.* Report prepared for Southern Rural Water. Oct 1996. WES Report No 105/96. Water EcoScience. Page 8.

Corangamite region sample data

3. When interpreting water quality readings it is useful to know what type of landform, landuse and climate conditions occur in the vicinity of the waterway as all of these factors influence the condition of the water. Use the regional maps provided as overheads or handouts for students to map any influencing features onto the river map provided.

   [*E.g. upper catchments will be steeper and usually have cooler water; estuaries will be naturally high in salt (high Conductivity readings).*]

Water quality data collected along the Moorabool River

	Lal Lal upper catchment	**Morrisons** middle catchment	**Batesford Site** middle catchment
Discharge (ML/Day)	25 Lower discharge because in upper catchment and above the Bungal Dam.	125	108
Stream temperature (°C)	12	13	14
pH	7.6 Good	7.7 Good	7.6 Good
D.O. (mg/L)	9.7 (= 92%) Excellent	9.5 (=95%) Excellent	8.7 (= 85%) Excellent
Turbidity (NTU)	11.3 Good	7.3 Excellent	8.6 Excellent
Conductivity (µs)	387 Excellent	634 Good	1421 Fair Increase due to land use practices and influence of tributaries, e.g. Sutherland Ck.
Phosphorus soluble (mg/L)	0.041 Fair Slight increase in P levels may be due to land clearance on the West Moorabool.	0.017 Good Lower levels could be due to the East and West Moorabool meeting at this site, and the East Moorabool having slightly lower P levels.	0.042 Fair Nutrient levels increase may be caused by human influence, e.g. storm water drains from towns.

Note

The above results for the Barwon and Moorabool Rivers are the cumulative, *median* values [*see Introduction section, page 4*] for all the readings taken between 1975 to 1994 on each river. The median rather than the average of all the figures is used because if there are occasional atypically high or low readings, the average of all the figures is too high or low to be an accurate representative figure.

Corangamite region sample data

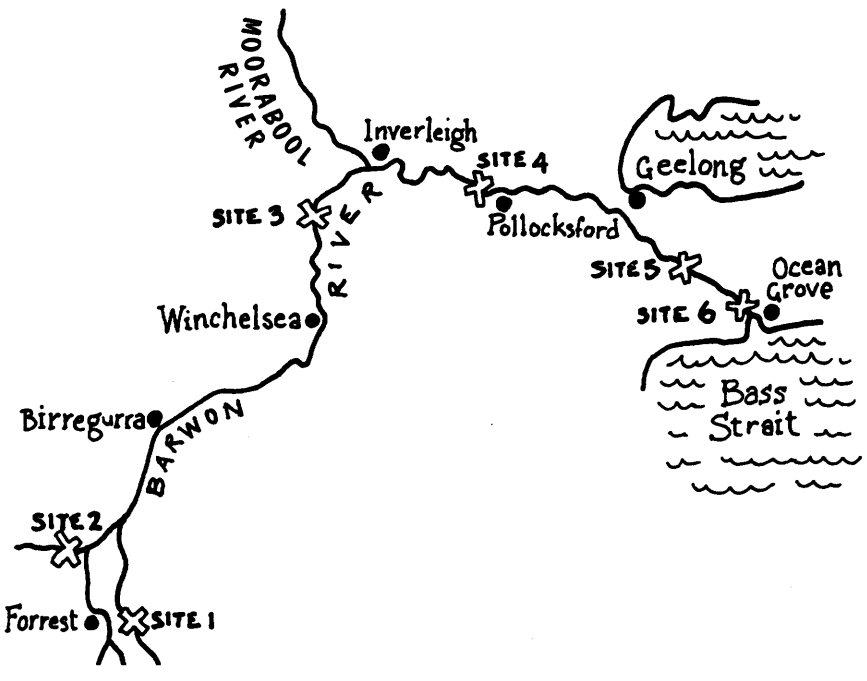
Activity instructions

1. Scientists have measured water quality at sites along the Barwon River since 1974. The following table shows their results (the median value for readings from 1975 to 1994).

Table 1: Water quality data collected along the Barwon River

	SITE 1 upper catchment of East Branch	**SITE 2** upper catchment of West Branch	**SITE 3** middle catchment	**SITE 4** middle catchment Pollocksford	**SITE 5** lower catchment	**SITE 6** lower catchment estuary
Phosphates mg/L	0.024	0.034	0.040	0.220	0.110	0.043
Water temp °	11	11	15	15	16	18
D.O. mg/L	10	8.75	9.75	10	9.6	10
pH	6.9	6.6	7.6	7.9	7.9	8.4
EC µS/cm	160	240	1400	1900	1700	41000
Turbidity mg/L	5.7	5.4	14	9.6	18	8.2

Source of data: *Barwon River and Lake Colac System Nutrient Study Monitoring Program.* Report prepared for Southern Rural Water. Oct 1996. WES Report No 105/96. Water EcoScience.



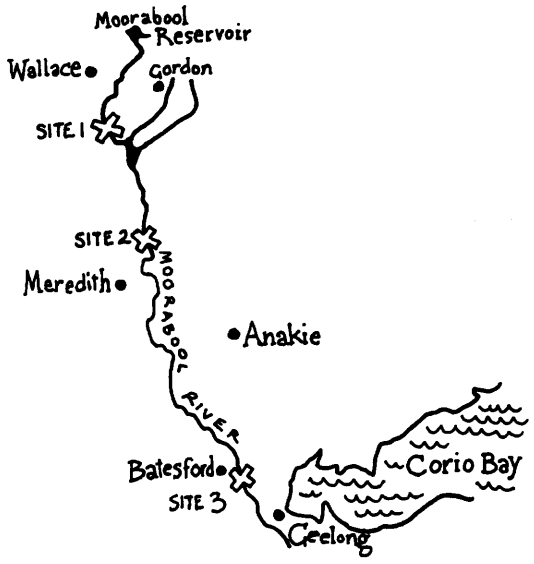
Corangamite region sample data cont.

2. Scientists have measured water quality at the 3 sites along the Moorabool River since 1974. The table below shows their results.

Table 2: Water quality data collected along the Moorabool River

	Lal Lal upper catchment	**Morrisons** middle catchment	**Batesford Site** middle catchment
Discharge (ML/Day)	25	125	108
Stream temperature (°C)	12	13	14
pH	7.6	7.7	7.6
D.O. (mg/L)	9.7	9.5	8.7
Turbidity (NTU)	11.3	7.3	8.6
Conductivity (µs)	387	634	1421
Phosphorus (mg/L)	0.041	0.017	0.042

VWQM Network Annual Report 1994.



3. Interpreting the results

Below each figure in Table 1 and 2, write in whether the reading is Excellent, Good, Fair, Poor, or Degraded. (Refer to the Water quality ratings for Corangamite tables.)

For each river, write a sentence to explain how the readings for each test changed along the river from its upper catchment to its estuary.

Using the supplied maps, draw onto each location map to show the type of landform and landuse along the length of the river.

Suggest possible reasons for the water quality readings along the length of these rivers.

Teacher sheet 6

Catchment condition report

Complete a Catchment condition report at least once a year after undertaking water monitoring at your site and preparing a map of your catchment.

Key Learning Outcomes

Level 4 Science: Living together
Identify living and non-living things that affect the survival of organisms in an ecosystem.

Level 4 SOSE: Natural & social systems
Describe responses of different elements (including people) to change in natural systems.

Level 5 Science: Living together
Explain the effects of various environmental changes on living things in ecosystems.

Level 5 SOSE: Place and space
Compare natural and human environments and describe factors affecting them.

Maths

Aims:

- to develop understandings of the main factors that affect water quality
- to understand how pollutants get into waterways
- to understand how waterways and water quality can be improved

Materials

Student sheet 6: Catchment condition report.

Teacher information sheet 4: Corangamite Catchment Region.

Corangamite Maps 1 - 6.

Completed Student sheet 22: Water quality results summary, and prepared tables and graphs [see Teacher sheet 4: Monitoring Corangamite's waterways.]

Completed local catchment map [Teacher sheet 18: Mapping your catchment, Statewide section].

Advanced preparation

1. Get together all the summaries of the water quality tests you conducted at your site.
2. Prepare an overhead of a completed catchment map of your monitoring site.
3. Duplicate the required number of Student sheet 6.
4. Duplicate any required sections of Information sheet 4: Corangamite Catchment Region.
5. If you need more information (e.g. soil type, landuse, catchment boundaries), contact your local Waterwatch Co-ordinator and local Council.

Activity instructions

1. In their small groups, students review their water quality Results Summary sheets for the year.
2. Show the overhead map of your catchment and ask students to point out any major influences on your monitoring site.
3. Explain median compared to average figures.
4. Students complete Q1a - c of the Catchment condition report. Which tests, if any, consistently indicated 'Degraded' results at your site?
5. Summarise and discuss the results as a class.
   - Do any of the results vary much throughout the year? Might there be some natural causes for this?

   [*E.g. Does the rainfall graph explain any results (e.g. storm events)? If your site has high salinity levels, can you see any link between rainfall and salinity at your site? Does the temperature graph explain any results (e.g. unusually high or low temperatures)?]*
   - Does your site have high salinity or phosphorus levels? If so, where might the excess salt or nutrients come from? Was there any visual evidence at your site of high nutrient levels, i.e. excess algal growth or high salinity levels, i.e. dieback of salt sensitive plants?
   - Can they see any relationships between any of the test results (e.g. high temperatures and low D.O.; high turbidity and high salinity levels)

   [*Refer to Information sheets 4-8, Statewide section* .]
   - Could there be any major errors in your results caused by faulty equipment or operator errors?
   - Which test result indicates the cause of greatest concern for water quality at your site?
   - Compare your site's results with the average result for you catchment.
6. Students complete the remainder of their Catchment Condition Report. Review these as a class and prepare one Catchment Condition Report for your local Waterwatch Co-ordinator.
7. Discuss and decide on a course of action to help improve or maintain the water quality at your site

   [*See Teacher sheets 23 and 24: Local action, in Statewide section*]
8. If you have previous year's results, identify and celebrate any improvements in water quality from previous results. Discuss what may have led to these improvements. Similarly, identify any decreases in water quality and discuss what may have caused these.

Catchment condition report

Prepare your report using these headings.

1. Water monitoring results

Name of your waterway and site: _____

Name of your monitoring group: _____

Date: _____

1a. Site description

Briefly describe your monitoring site. (e.g. type of waterway, its location in the catchment, it's upstream tributaries.)

Describe any special visual observations at your site (e.g. upstream storm water drains, eroded banks, excessive algal growth.)

1b. Water quality results

Record the median result for each test you conducted over the year. Using this median result, tick the relevant water quality rating for each test you conducted.

Results for (name of site) for (year)

Date: _____	Median reading	Excellent	Good	Fair	Poor	Degraded
Stream habitat						
Macro-invertebrates						
Conductivity						
pH						
Turbidity						
Dissolved oxygen						
Phosphorus						

Using information from the table, write a paragraph to explain your conclusions from the tests.
(e.g. list any tests which indicate an Excellent/Good water quality rating, and list

Catchment condition report

2. Catchment condition

2a. Catchment description

Briefly describe your waterway's catchment (e.g. sub-region, local climate, soil or landform influences.)

2b. Landuse and industry

List the major upstream and adjoining landuses and industries in your local catchment. In what ways may these affect water quality at your site?

Landuse or industry	Influence on water quality

2c. Conservation values

List any special or significant aquatic or riverside plants or animals that live in or around in your waterway or monitoring site.

List any cultural heritage sites in or near your monitoring site.

2d. Water quality issues

Identify and briefly describe any particular issues that affect your waterway.

e.g.
Erosion
Weeds
Pest animals
Conservation issues (e.g. threatened species)
New developments on or near your waterway
Others

3. Summary

Write a paragraph or two to summarise any particular water quality issues for your monitoring site (e.g. turbidity, salinity, nutrient increases).

4. Actions

Using the information in steps 1, 2 and 3, write a paragraph or two to suggest ways that water quality at your site could be improved.

Describe any waterway improvement actions that your class/school/community group have completed or plan to undertake.

Attach to this Catchment Condition Report your completed local catchment map. (show landuse and any other relevant influences on water quality at your monitoring

Information sheet 5

Local issues

Some current local issues are outlined below to provide ideas to discuss, debate or investigate further.

Stormwater

Litter (paper, cans, plastics, dog poo. etc.) from streets and nature strips is carried by rain into stormwater drains and is discharged into waterways. Some illegal discharges are made into stormwater drains. (Factories and industries are required to obtain licenses to discharge their wastes so that the quantities can be minimised to safe levels and monitored. Factory discharges are to be made into the sewerage system where the wastewater can be treated.) Stormwater is not treated before it flows into waterways.

Watersports Complex

This major development of the lower reaches of the Barwon River aims to provide a secure future for rowing and other water sports in Geelong.

This development could be used to discuss, debate or investigate issues including:

- financial
  - it will be costly and perhaps become a 'white elephant'
- aesthetic
  - a long straight channel which will be very visible from Moorabool Street Bridge
- effects on the natural environment
  - river flow slowed due to the new course
  - potentially increased levels of sedimentation
  - potentially increased occurrences of algal blooms
  - damage to migratory birds' habitat, especially that of Latham's Snipe
  - destruction of 6,000 trees for the facility
  - short and long term effects on Gheringot Wetlands
- effects on interest groups
  - relocation of Barwon Valley Golf Course
  - dog obedience club
  - Geelong Field Naturalist (Gheringot Wetlands' custodians)

Fish migration

The migration of native fish up the Barwon River system is impeded by man-made structures. A fish way was installed beside the lower breakwater in 1996. Fish can now migrate to the next impediment, Buckley's Falls/Baum's Weir.

Mining activities

Is mining increasing sedimentation in Moorabool River?

Forestry

Is the construction of access roads for forestry operations increasing sedimentation of waterways flowing from the Otways Coast catchment?

Blue-green algae

(see *The Water Cycle*, page 131-2)

Piggeries

The development of piggeries near waterways in the region is emerging as an issue. Intensive farming near waterways has the potential to pollute waterways with animal manure, leading to increased nutrient levels in waterways.

Sewage treatment

The Government is stipulating that country towns are to be sewered and septic tanks phased out. This requires the building of lagoons near each town to dispose of waste water, or the tertiary treatment of waste water and its disposal to inland waters. Concerns have also been raised about disposal of inadequately treated sewage out to sea by some coastal towns.

Recreation

In Geelong there is increasing pressure to balance the needs of recreationists with the maintenance the health of the river. The reeds and waterplants in the river are cut to allow for rowing, canoeing, waterskiing and commercial cruising. An effect of this weed cutting is that the weeds are no longer there to reduce the impacts of wave action on the river banks and this leads to bank collapse and the river widening. This in turn causes the river to slow and may increase the rate of sedimentation.

Flood plain management

Geelong's 1995 flood inundated some businesses and houses, leaving silt and rubbish and damaging trails and even bridges. Floods raise questions as to whom should pay to fix the damages they cause? Should flooded industries be compensated, and if so, by whom? Should money come from Council or Government? Should houses and industry be built on floodplains in the first place since by nature, these areas are occasionally flooded. What flood warning systems are in place? Unprotected industries can no longer obtain flood damage insurance. Godfrey Hirst Mills has since spent more than $1 million to erect a flood wall.

Reedy Lake rejuvenation

Reedy Lake is a shallow lake with surrounding marsh fed by the Barwon River. In the natural pattern of occasional droughts, the lake would have occasionally dried out and this drying out period allowed some of the aquatic and fringing plants to reproduce. However over recent decades the lake has not dried out; fringing vegetation has not reproduced and the lake became infested by European Carp, reducing its environmental value. The Geelong Field and Game Club installed water level controlling structures after convincing the Department of Natural Resources and Environment of the need. Reedy Lake subsequently dried out and the carp died. The Lake is now refilling.