waitaha wai

Waterways of Christchurch

Environment Canterbury Regional Council

Christchurch City Council

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This booklet has been produced jointly by Environment Canterbury and the Christchurch City Council. We would like to acknowledge all of the individuals and organisations that have helped in the research and writing of this booklet.

Dr Chrys Horn wrote the text, with assistance from numerous staff at Environment Canterbury and the Christchurch City Council.

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Thanks also to the Department of Conservation, National Institute for Water and Atmospheric Research, Avon-Heathcote Estuary Ihutai Trust and Te Runanga o Ngai Tahu.

In partnership with Te Runanga o Ngai Tahu, we acknowledge the mana of our land, Te Waka o Aoraki, our precious waters that make up Te Waipounamu, and of our ancestors gone before us.

We also acknowledge all of our people that continue to guard over, protect and treasure nga taonga tuku iho o Te Waipounamu.

Nga mihi mahana ki a koutou katoa.

Introduction

Welcome to Waitaha Wai: Waterways of Christchurch, a water education programme developed by Environment Canterbury with the support of the Christchurch City Council. This programme has been designed to educate young people and their communities about the importance of water and waterways in their local environment and how to maintain them for future generations.

Aim of the programme -

'To improve the quality of waterways in urban Christchurch, by encouraging school students to take an interest in their local environment and to be involved in their local communities.'

Christchurch's drinking water, sourced from aquifers beneath the Canterbury Plains, is some of the purest water in the world. However, our urban streams and rivers, many of which are spring-fed from shallow groundwater, are unhealthy according to a number of different indicators.

By learning more about these waterways and the factors that influence their health, we can help to improve their landscape, heritage, cultural, recreational, drainage and ecological values.

The Waitaha Wai book offers teachers and students in Christchurch schools a range of learning opportunities, and invites you to make use of the skills of educators from Environment Canterbury and the Christchurch City Council.

How to use this book

Waitaha Wai is designed as a resource book for teachers of primary and secondary students in Christchurch.
There are three ways to approach the material in the book

1. As an information resource for independent study of freshwater issues in your class or school. You will find general information about fresh water, information specific to Christchurch's waterways, and suggestions for classroom activities and for further study.
2. As part of the step-by-step water education programme offered by Environment Canterbury. This involves classroom visits, one or more field studies, and a student-led project to improve water quality. More details are given in the following section.
3. As background material for your class prior to attending a water-related study trip through the Christchurch City Council's Learning Through Action programme. Learning Through Action gets your students outside the classroom for an up-close experience of water issues in Christchurch city. More details are given on the following page.

It is possible to tailor your own programme, and make use of elements of the programmes offered by Environment Canterbury and Christchurch City Council to enhance your independent classroom water study. However, places are limited for both programmes, so please make contact well in advance to be sure of securing a booking for your class.

Water education programmes offered by the Christchurch City Council and Environment Canterbury

Environment Canterbury – Waitaha Wai water education programme

Environment Canterbury's water education programme uses this book as a starting point for an in-depth study of water quality issues in the rivers of Christchurch and Canterbury. The material in this book is used as a basis for working through a programme that may include:

- In-class lessons and activities
- Inviting visitors to your classroom
- Observing and monitoring your local waterway
- Observing and monitoring another waterway in Canterbury, to compare with your local stream
- Showing off your work to the local community
- Initiating activities that will physically improve your local waterway

If you are interested in taking your class through this programme, contact an Environment Canterbury educator, who will assist you with organising your water education programme. The educator will visit you to explain how the programme is organised and plan a flexible timetable that works in with your existing class programme. Environment Canterbury educators can facilitate introductory lessons in the classroom, lead a field trip to your local stream or river, and suggest other useful people to contact. The programme is available at no cost to Canterbury schools.

The ultimate aim of the programme is to involve students in a long-term project to improve water quality. This is explained in more detail in Section Five – Making a Difference. Some classes plan for this component from the beginning, whereas others may leave the final phase of the programme open-ended, depending on where the students' inquiries take them.

Environment Canterbury
58 Kilmore St/PO Box 345
Christchurch
Fax: 03 365 3194
education@ecan.govt.nz www.ecan.govt.nz/education

Christchurch City Council – Learning Through Action

The 'Learning Through Action' programmes provide authentic, interactive learning experiences outside the classroom (LEOTC).

The surface water programmes give students the opportunity to investigate what lives in the Groynes and Styx Mill streams, explore water quality at the Estuary or go pond-dipping to discover what lives in the water at Travis Wetlands.

The waste water programmes give students access to investigate the real-life workings of the City's sustainable infrastructure, including the Christchurch Wastewater Treatment Plant and Main Water Pumping Station.

All programmes are 2 to 3 hours long and can be used as stand-alone programmes or to supplement the full Waitaha Wai programme. The programmes are:

- Linked to the New Zealand curriculum, including Environmental Education/Education for Sustainability concepts.
- Supportive of the inquiry process.
- Guided by experienced educators and park rangers.
- Free to schools.

For descriptions of the individual Learning Through Action programmes, see Appendix 1 on page 86-87.

Christchurch City Council
PO Box 237
Christchurch 8140
Phone: (03) 941 8298
Fax: (03) 941 8384
learningthroughaction@ccc.govt.nz
http://www.ccc.govt.nz/learningthroughaction

Details for other organisations that may be able to help you with your water studies are given in Appendix 2 on pages 91 and 92 of this booklet.

Structure of this book

The programme is divided into 5 sections:

Section 1: The importance of water

This section introduces students to water by outlining its importance, Christchurch's water cycle and the values of water for Māori. While students may already have an understanding of the water cycle, it will assist in teaching the students the importance of maintaining the health of a river.

Section 2: Canterbury's water

Students will explore the vast sources and unique qualities of water in Canterbury and how Christchurch's water supply, and its streams and rivers, are connected to these water sources. After working through this section, your students will have an understanding of how their local waterway fits into the larger context of Canterbury's water. They will also find out how their daily activities contribute to the quality of water both above and below ground.

Section 3: Investigating a waterway

This section first identifies the healthy, and not so healthy, aspects of a stream before setting out to visit a local waterway to observe and monitor its quality. The stream-monitoring exercise offered here can be guided by an Environment Canterbury educator. If the school chooses to undertake a Christchurch City Council Learning Through Action trip as well, there is an opportunity to compare the water quality of the two waterways. At the end of this section, your students will have an understanding of the effects of contaminants and the overall human impact upon water.

Section 4: Discovering your local waterway

This section provides some of the history of water quality in the main Christchurch waterways and the issues that currently face them. We have also provided some background for a few of the smaller waterways found around the City. If your nearest waterway is not discussed in this section, you are encouraged to choose a local waterway and research its history and to discover any issues it currently faces.

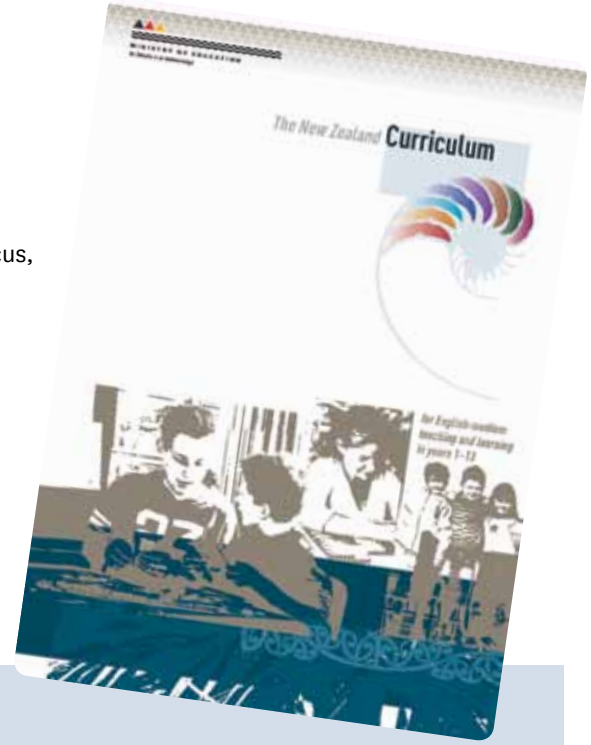
This stage of the programme is a good time to invite speakers who have knowledge of the local history and uses of the waterway. An Environment Canterbury educator will be available to assist.

Section 5: Making a Difference

By now, your students will have gained an understanding of their local waterway and listened to various people talk about its values and issues. They will now be ready to undertake a project that will make a difference to their local waterway. This section helps you to think through possible courses of action. It suggests some activities and encourages your students to show off the great work they have done.

Waitaha Wai and the curriculum

The New Zealand Curriculum



The 2007 revision of the New Zealand Curriculum gives strong support to inquiry-based learning and to involving students in sustainability issues. The **principles** and **values** on which the curriculum is based include future focus, innovation, inquiry and curiosity, as well as ecological sustainability and community participation.

Four of the five **key competencies** align well with the aims and methods of education for sustainability:

- **Thinking** – "challenge the basis of assumptions and perceptions".
- **Managing Self** – "have strategies for meeting challenges".
- **Relating to Others** – "new approaches, ideas and ways of thinking".
- **Participating and Contributing** – "contributing to the quality and sustainability of social, cultural, physical and economic environments".

Inquiry Learning

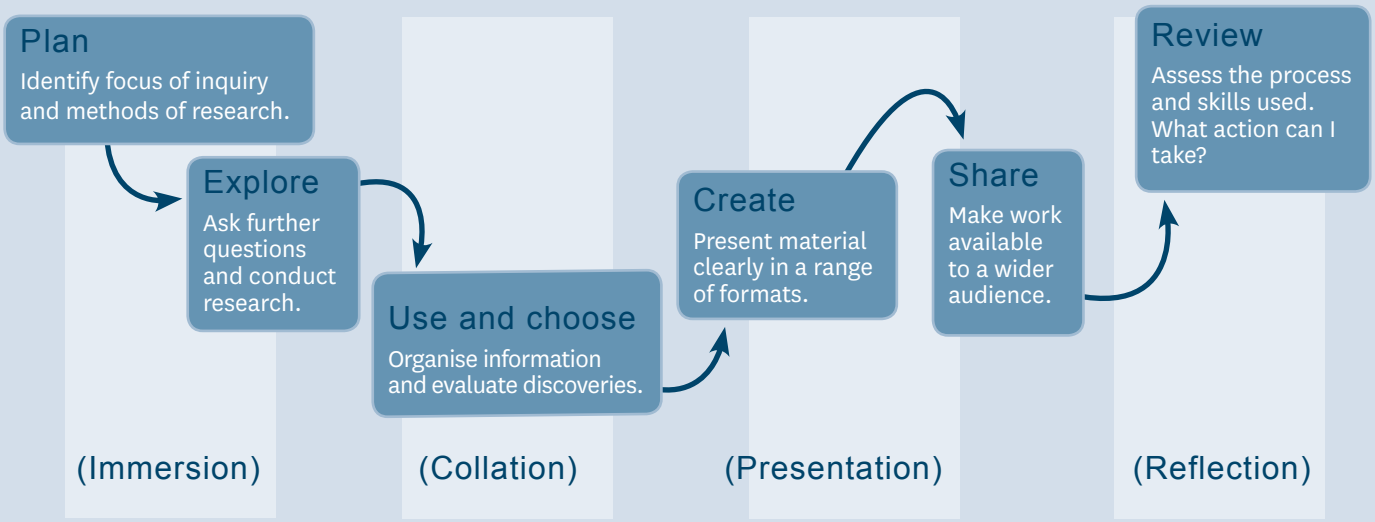
Waitaha Wai works most effectively as part of an inquiry learning programme. Teachers or facilitators using an inquiry learning approach seek to:

- encourage students to formulate their own questions in a chosen area of study
- enable students to research their questions using a variety of methods and contexts
- provide opportunities for students to present their learning to their peers, and sometimes to the wider community, in a suitable way
- assist students to reflect upon and evaluate what they have learned, and to generate ideas for further study and/or action based upon their learning.

This last point – **action** – is central to the approach of Waitaha Wai. The programme's ultimate aim is for your students to create and implement their own plan of **action** to improve water quality in their community.

The **action-inquiry** method is the basis of **Education for Sustainability**, which seeks to engage students in contemporary environmental issues and to meet the challenges of living sustainably.

An Inquiry Learning Template



Education for Sustainability

Education for Sustainability (EfS) further develops the concepts of Environmental Education to explore the cultural, social, political and economic aspects of human interaction with the environment.

The following four points are taken from the Ministry of Education's website http://efs.tki.org.nz/ Visit this website for resources and ideas for developing EfS throughout your classroom programme.

1. Education for sustainability is about learning to think and act in ways that will safeguard the future well-being of people and our planet.
2. The future-focused theme of sustainability is evident throughout the curriculum, in the vision, principles, values and learning areas.
3. Teaching approaches that support effective pedagogy in education for sustainability include cooperative, experiential and inquiry learning.
4. Students taking informed action to participate in creating a sustainable future is the core of education for sustainability.

Environmental Education for Sustainability has three key dimensions:

- **Education about the environment.**
- **Education in the environment.**
- **Education for the environment.**

Throughout the **Waitaha Wai** programme, students will have the opportunity to learn **about** the environment through the written material provided and class activities. Students will gain knowledge in the environment through field observations and interacting with the community. Students will also have the opportunity to be involved in planning and implementing activities that will be beneficial **for** the environment.

Links to achievement objectives

Waitaha Wai can be used with students from junior primary to lower secondary level (Year 1 – 10). The following achievement objectives from Levels One to Four provide examples of how the programme can be linked to the New Zealand Curriculum.

Science

- Investigate the water cycle and its effect on climate, landforms and life. (3, 4)
- Recognise that living things are suited to their particular habitat. (1, 2)
- Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced. (4)
- Appreciate that water, air, rocks and soil, and life-forms make up our planet and recognise that these are also Earth's resources. (3)
- Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations. (3, 4)
- Explore various aspects of an issue and make decisions about possible actions. (3, 4)

Social Studies

- Understand how people make decisions about access to and use of resources. (3)
- Understand how exploration and innovation create opportunities and challenges for people, places and environments. (4)
- Understand how people participate individually and collectively in response to community challenges. (4)

Health

- Take individual and collective action to contribute to environments that can be enjoyed by all. (1)
- Identify and use local community resources and explain how these contribute to a healthy community. (2)
- Plan and implement a programme to enhance an identified social or physical aspect of their class or school [or community] environment. (3)
- Investigate and/or access a range of community resources that support well-being and evaluate the contribution made by each to the well-being of community members. (4)

Section 1:

The importance of water

This section introduces students to water by outlining its importance, Canterbury's water cycle, and the values of water for Maori.

Section 1: The importance of water in Canterbury

Water is the life-blood of Canterbury

It shapes our landscape

It nourishes and supports every living thing

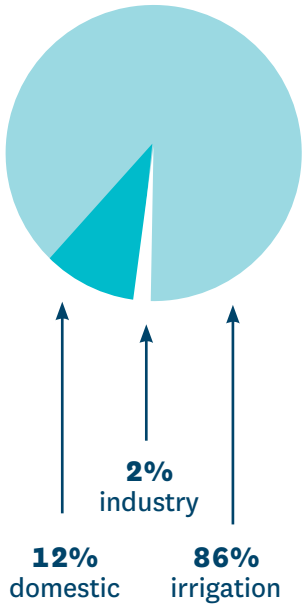
It determines our health and well-being

It provides us with recreation and livelihoods

Its future should be as abundant as its past.

Across the whole of Canterbury 21.5 million cubic metres of water is used for human activities every day – the equivalent of **8600 Olympic swimming pools!**

86% of this is used for agricultural irrigation. Much of the region is farmland and Canterbury is prone to drought conditions, so irrigation is very important in this region. The rest of the water allocated in Canterbury is mostly for domestic use (12%) and for industrial use (2%).

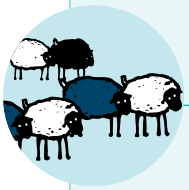
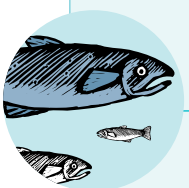


In Christchurch City, we use an average of 450 litres of water per person per day over the whole year. In the summer months, this figure can climb as high as an average of 1000 litres of water per day for each person, much of this from people watering their gardens.

However, the value of our water is not just about our needs in the home, on the farm, or in our factories. In Christchurch, water is important for recreational, ecological and cultural reasons. For Māori, water has spiritual significance, and many of our rivers, wetlands and streams are part of landscapes that people identify as being typical of Christchurch or as having important heritage value. The table below summarises the different ways in which we value our water.

It is easy to take a constant supply of clean water for granted. However, if people use water without any limits, and pollute it as they have in the past, that supply will diminish and deteriorate. This will affect drinking water, the water we need for living, and the plants and animals that rely on it.

It takes much longer to remove pollutants, replenish supplies, and restore life than it does to take and pollute our water.

Water is important for...	Why?	What happens if we use too much or spoil the quality of our water?
 Irrigation	Much of Canterbury is used for farming. The region is prone to drought so irrigation is very important.	Farms would be at the mercy of the weather. There would be enormous loss of production and livestock, affecting the rural economy.
 Domestic use	Almost everything we do in our daily lives needs water.	Just imagine if you couldn't clean, cook, drink, or get rid of your waste from the toilet!
 Industry	The production of most things requires water – not just for cleaning but also for dealing with waste.	Industry and commercial activities could not continue, or would not produce or provide a service of an acceptable standard.
 Recreation	High-quality water is important for many recreational activities, such as boating, fishing, tramping, and swimming.	We might not be able to do any of the things we take for granted about our rivers. How would this make us feel?
 Landscape values	Water bodies and their surroundings are natural features that are part of our identity – part of what defines Christchurch (for example, we are known as "the Garden City").	If the waterways and the land around them are degraded, they are no longer distinctive and are lost to us.
 Plants, birds and fish	The level and quality of water affect the ecology of rivers. Plants, birds, and fish rely on water resources, their habitat, for life.	Fish lose their water passages and space to live. Plants could die so breeding, spawning and nursery areas for fish, birds, and aquatic insects are affected.
Maori values	Fresh water is highly valued with spiritual significance for Māori. It is considered a life-giving gift.	Discharge into rivers is considered repulsive. The mauri or 'life force' is degraded and the water area loses all spiritual and mahinga kai values.
Heritage	Heritage is an important part of Christchurch's identity, and can include sites of natural and cultural significance (e.g. Riccarton Bush is a natural heritage site that also has some buildings of historical interest alongside the Avon River).	Degradation of the waterways can make heritage sites unattractive, so they may lose their distinctiveness or usefulness.

activities

Section 1:

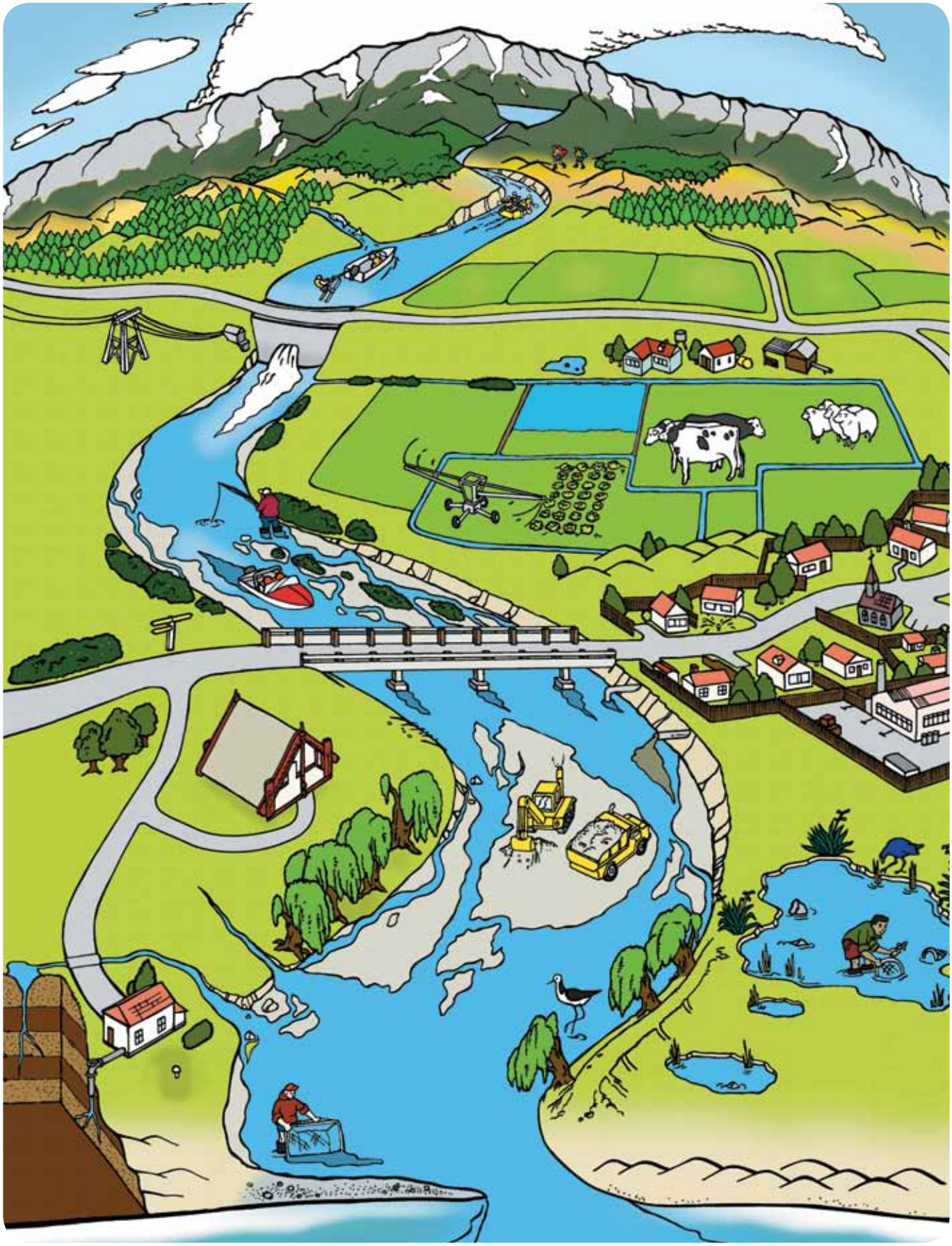
The importance of water

Prepare a special area of your classroom to be dedicated to this water programme. It could be a corner set up with a wall display space and a seating area with cushions. Once you have decided on the area, the class can discuss how they would like to arrange it. Below are some suggestions. You may have some more.

- **Arrange** a small bookshelf to hold books, magazines, CDs, brochures and pamphlets about water. Send students to the school library to choose a selection. Try to get a mixture of books – fiction, non fiction, fun, and serious – that look at water throughout the world and in New Zealand. Your local council, DOC, and Environment Canterbury will be able to send you their publications about local water resources.
- **Divide** the wall space available into sections such as 'Things we learnt about Canterbury's water', 'What we found at our local river', 'How we plan to improve our river'. Add to these as you work through the programme.
- Students each write one sentence under the title 'What water means to me' and sign their names. Make their comments attractive for wall display and cut and paste them around the edges of the water area.
- **Decorate** the area during art time with water-related designs, pictures, posters, or collage material. Hang mobiles and make reflective moody patterns, giving the area a watery feel.

How many different uses for water can you see in this picture?

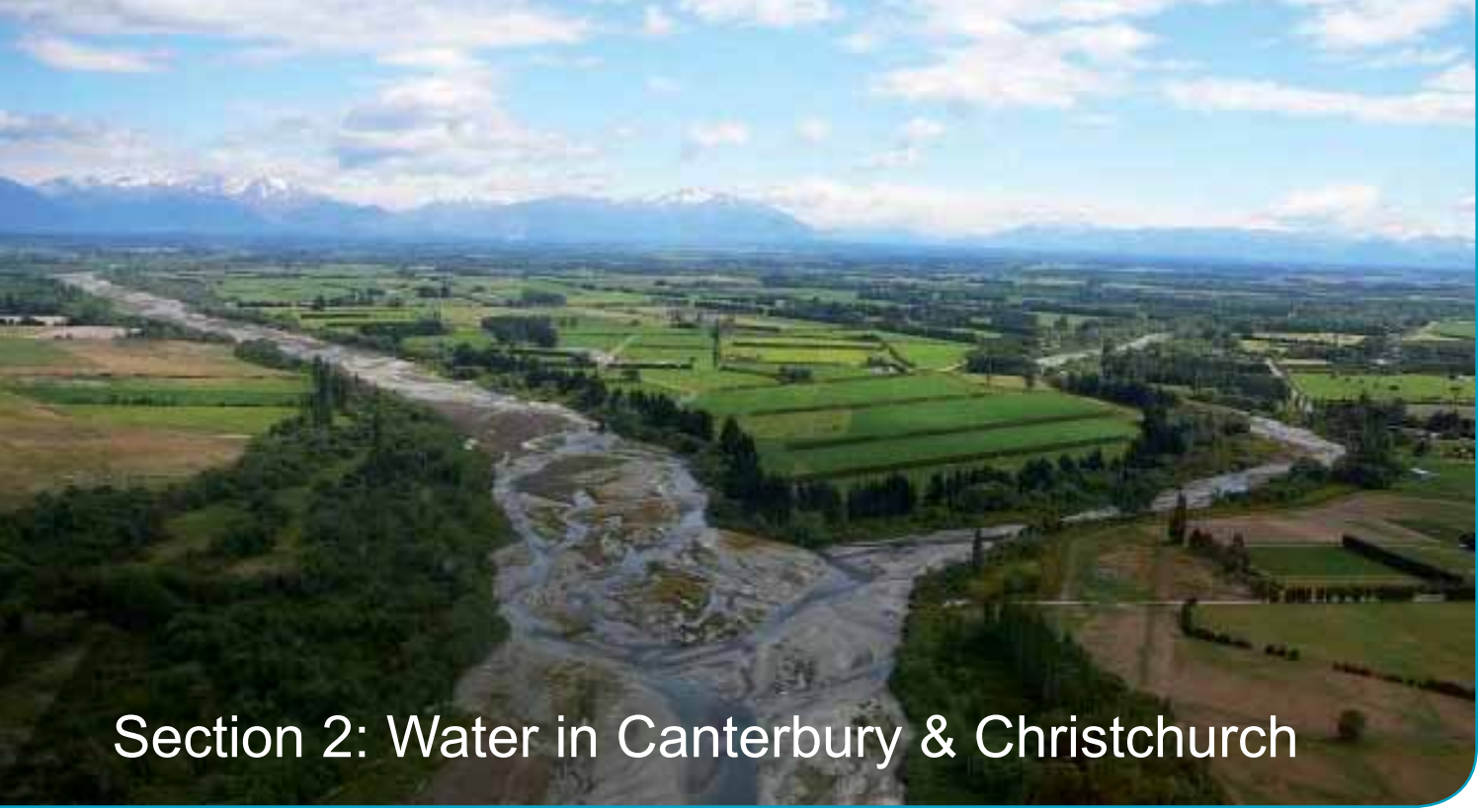
How many different uses for water can you see in this picture? Ask the water educator at Environment Canterbury to supply you with a larger version to put on your wall. Students can then stick on their own lists of what water is being used for, or other comments.



Section 2:

Canterbury's water

Students will explore the vast sources and unique qualities of water in Canterbury. After working through this section, your students will have an understanding of how their local waterway fits into the larger context of Canterbury's water. They will also find out how their daily activities contribute to the quality of water both above and below ground.



Section 2: Water in Canterbury & Christchurch

People in Canterbury talk about groundwater, surface water, braided rivers, tributaries, springs, aquifers, stormwater, wastewater, and drinking water. This section explores what these different terms mean. It also looks at the different kinds of rivers that we find here – from the large braided rivers that cross the plains to the smaller spring-fed rivers that flow in the Christchurch area. First, we begin with some information about rivers in the wider Canterbury region.

Canterbury is a region of braided rivers with wide stony beds. Braided rivers have several channels that run across wide gravel river beds. They originate from glaciers, snowmelt or rainfall in the mountains. Braided rivers provide unique habitats for a variety of wildlife, particularly birds. Islands formed by the rivers provide safe areas protected from predators. They have little vegetation, so visibility is good and they are close to a good supply of food in the river. Canterbury's braided rivers include the Clarence, Conway, Waiau, Hurunui, Ashley/Rakahuri, Waimakariri, Rakaia, Ashburton/Hakatere, Rangitata, Opihi and Waitaki.

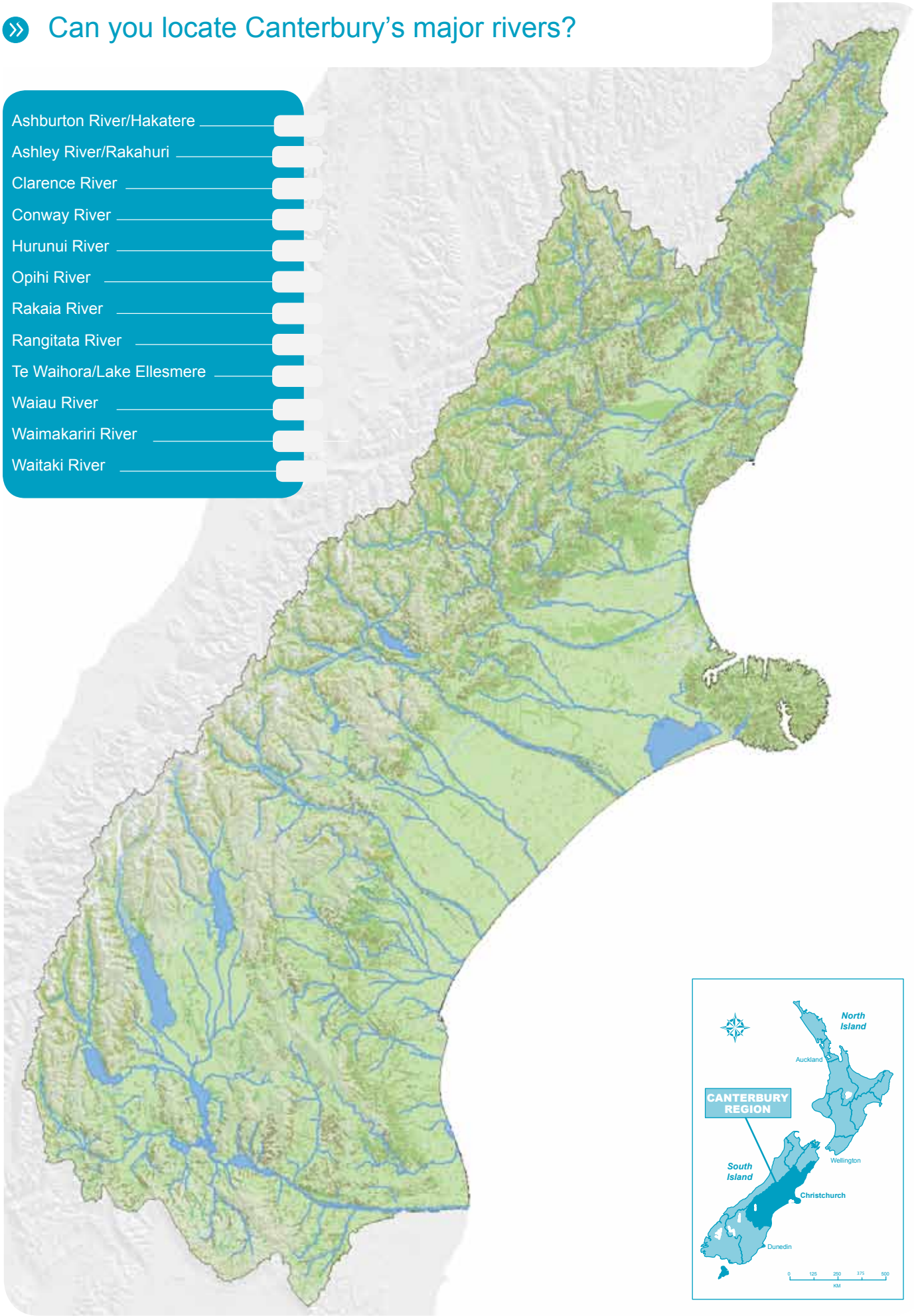
If a river flows into another river, we say it contributes to that river and is therefore a tributary. Throughout Canterbury, smaller rivers eventually find their way either to the sea or to a larger river. Thus, anything that happens in a smaller stream eventually affects the larger rivers, so it is really important to make sure that small streams stay clean and healthy. Often it is the smaller rivers or streams that people and their activities can really affect.

Facts about water in Canterbury:

- The Canterbury plains lie in the rain shadow of the Southern Alps.
- The mountains intercept the nor'west winds, causing large amounts of rain and snow to fall on them.
- Most of the rain that falls in Christchurch and on the Plains comes from southerly and easterly storms.
- 70,000 million cubic metres of snow, rain, and hail fall each year in Canterbury.
- 30,000 million cubic metres of water evaporates back into the atmosphere each year.
- 40,000 million cubic metres of surface water and groundwater flow through our waterways to the coast each year.
- Storm rain falling on the main divide takes about 24 hours to flow down the rivers and reach the Pacific Ocean.
- Most of the rain that falls on the plains drains into the ground, with little direct run-off into the rivers.

Can you locate Canterbury's major rivers?

- Ashburton River/Hakatere _____
- Ashley River/Rakahuri _____
- Clarence River _____
- Conway River _____
- Hurunui River _____
- Opihi River _____
- Rakaia River _____
- Rangitata River _____
- Te Waihora/Lake Ellesmere _____
- Waiau River _____
- Waimakariri River _____
- Waitaki River _____



Christchurch's many different waters

Christchurch was once a mosaic of wetlands and small waterways formed by the past actions of the Waimakariri River and its underground aquifers. Most of the waterways in the City are spring-fed. In fact, Christchurch has one of the biggest spring-fed river networks in New Zealand.

Groundwater

In Christchurch, the water that comes out of our taps, our drinking water, which we use for washing and watering our gardens as well as drinking, comes from groundwater or aquifers. Aquifers are vast areas of sand and gravel that are like underground rivers. Water flows slowly through the gravel towards the sea.

Some of this groundwater can be very old, having travelled slowly underground from the Alps to Christchurch. Drinking water in Christchurch may contain raindrops or snowflakes that fell in the mountains when moa roamed the Canterbury Plains, or it might contain water that resulted from a nor'wester in the Southern Alps 15 years ago.

The water in the aquifers under Christchurch is very pure – some of the highest quality water in the world. However, groundwater can become contaminated. Rain on the surface of the land percolates through the ground recharging the aquifers and their springs, and contaminants can move into the aquifers with it. Contaminants can include:

- chemical spills and leaks from petroleum or industrial solvents.
- micro-organisms such as bacteria from septic tanks.
- nutrients, such as nitrates, from farming activities on the land surface.

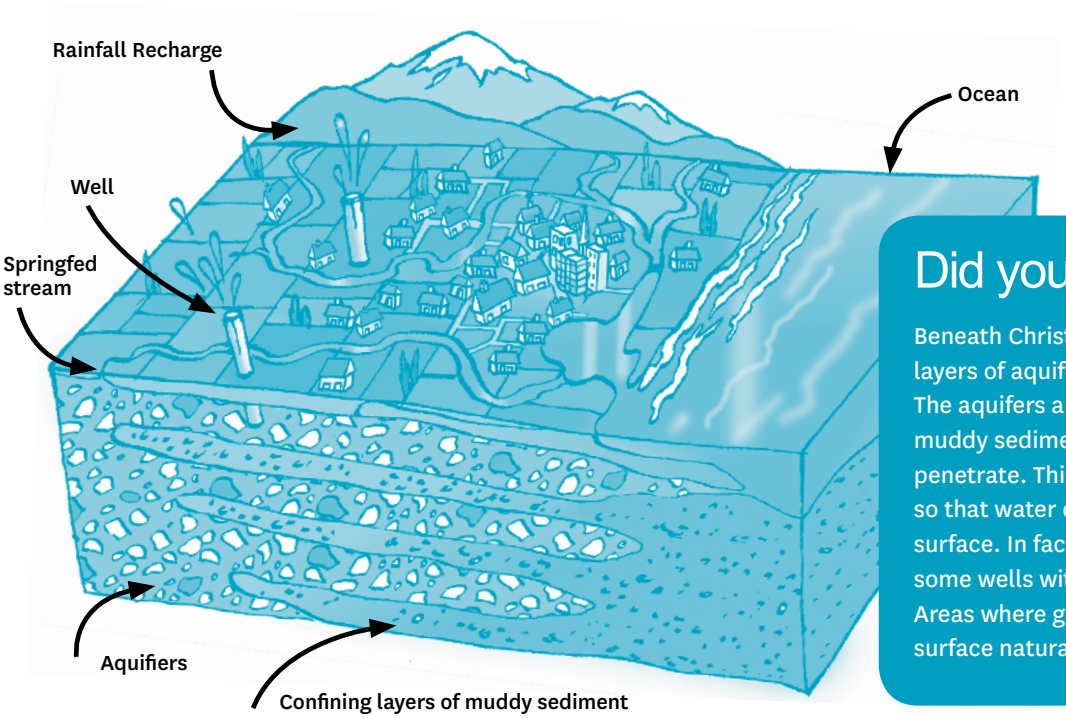
If we want our underground aquifers to remain a source of clean drinking water, we must be careful of what we do on the land surface.

Springs

The aquifers are also very important because they are one of the sources of our surface water which we see in our wetlands and waterways that are fed by water welling up from the ground through springs. How does this happen?

Out on the plains, the groundwater is able to flow freely down towards the sea through the sand and gravel in what are called unconfined aquifers. However around Christchurch the water becomes confined, or trapped, by layers of mud or clay that seal the water in. If the water in a confined aquifer suddenly runs into a dead end because of barriers such as the rocks of Banks Peninsula or a wall of clay, the pressure builds up, a bit like putting your finger on the end of a running hose. This pressure forces the water up to the surface. When the water erupts through the surface it is called a spring.

The confined aquifers below Christchurch cover an area from the coast to about 6-15 kilometres inland. If you were to draw a line about 10 kilometres inland from the Rakaia River to the Ashley River/Rakahuri, this would mark the beginning of many of our smaller streams and rivers, such as the Avon River/Ōtākaro and the Heathcote River/Ōpāwaho.



Did you know...?

Beneath Christchurch's coastal area, the layers of aquifers are like a club sandwich. The aquifers are separated by layers of muddy sediments that don't let water penetrate. This causes a build-up of pressure so that water can be easily pumped to the surface. In fact, groundwater flows from some wells without any pumping at all. Areas where groundwater is forced to the surface naturally are called springs.

Surface water & stormwater

Surface water is what we see in our rivers, lakes and drains. Springs are one source of surface water and another source is rain. Rain that falls out on the plains soaks into the ground and slowly drains into rivers and lakes. However, rain that falls onto the hard, impermeable surfaces of the city such as concrete and tarmac cannot percolate into the ground. Instead, when the rain is heavy enough, it runs quickly off into our streams and rivers as stormwater.

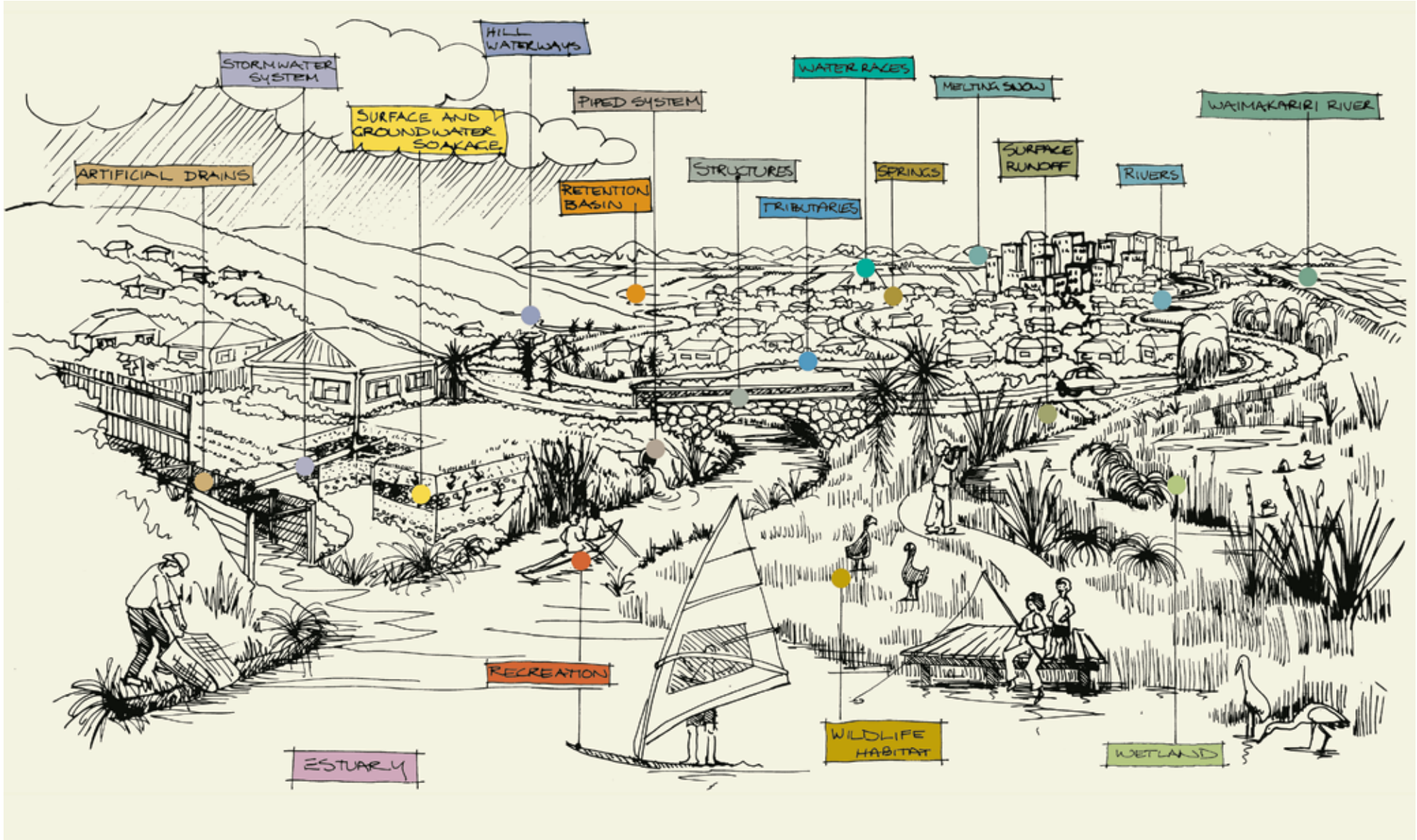
Our stormwater system takes water into our drains and streams and then out to sea through the four main river systems – the Halswell/Huritini to the south, the Avon River/Ōtākaro and the Heathcote River/Ōpāwaho, and the Styx River/Pūrākaunui to the north.

Wastewater

The water that goes down the drains from inside our houses after we do our washing, flush the toilet or bathe is called wastewater. All of the wastewater from Christchurch City goes into the sewer system and is pumped to Bromley, where it is processed and purified through the sewage treatment plant and discharged out to sea. Most of our stormwater, on the other hand, goes directly into our rivers and out to sea without being treated.

This booklet provides information mainly about surface water and stormwater.

This illustration shows the “components” of Christchurch’s many different waters.



Christchurch's waterways

There are more than 400 named waterways in Christchurch. Surprisingly there are only 356 km of open waterways (less than 1 km per waterway!), but there are also another 500 km of underground pipes.

As the 'Black Map' on the opposite page shows, much of Christchurch used to be wetlands covered with harakeke and raupo. The wetlands provided a buffer against floods and droughts by acting a bit like a sponge, which soaks up water at times of high rainfall and releases it slowly after the rain has stopped. Since 1850, most of the wetland "sponges" have been drained and cleared as Christchurch city has grown, but the water that they held still needs to go somewhere if it can't get down the streams. For example, during winter, it is common to see most of the farmland in Henderson's Basin in south-west Christchurch lying under large areas of water.

Water runs very quickly off new housing developments with their many impermeable surfaces, and as more houses have been built, the flooding in Henderson's Basin has become worse. To deal with these kinds of problems, water retention areas and wetland reserves are being developed to store stormwater. There are now water retention areas in Wigram and Henderson's Basins, for example. These places are generally dry over the summer months but may hold a lot of water during the winter.

Raupo

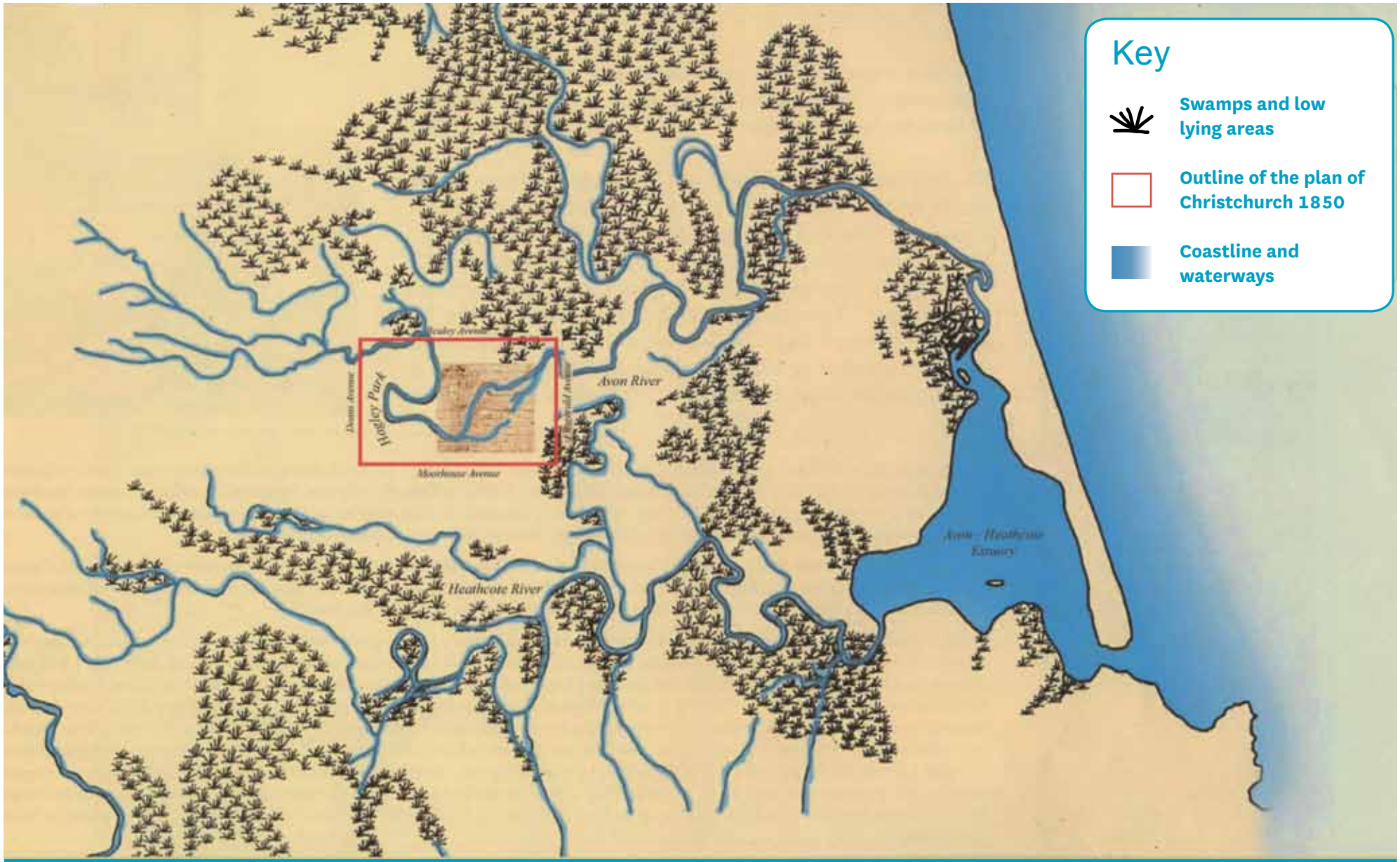
Raupo

The water retention areas help to store stormwater and filter out contaminants before water enters streams and rivers. The areas also provide attractive landscapes and potential habitat for insects and birds.

While there are problems in the winter with too much water in some places in Christchurch, there are also problems with not enough water during the dry summer months. Once the many wetlands stored water and slowly released it into the streams over the drier months. Now there are few wetlands left to hold flood waters back and fewer springs feeding the streams over the dry months. As a result Christchurch waterways are more prone to flooding in times of heavy rain and to drying out during the summer.

Anzac Drive Retention Pond

Extract from “Black Maps” 1850 - 1860



Land Drainage Circa 1855. Source: Lands and Survey “Black Maps” 1850 - 1860

Image courtesy of CCC

Draining Christchurch

Christchurch is sited on a low lying, flat area. Consequently, draining the City has presented an ongoing challenge for engineers since European settlers arrived in the area.

At first, local Māori and settlers got their drinking water from the rivers and streams which were very clean and pure. However, because Christchurch was so flat and swampy, the surface water soon became polluted with wastewater as the population increased. People got very sick and died. Christchurch had a very high incidence of typhoid fever, scarlet fever and diphtheria – much higher than in the rest of New Zealand. A typhoid epidemic in 1875 and 1876 caused 152 deaths in the city.

This led to two things.

- Wells were drilled deeper to see if cleaner water could be found. This led to the discovery of the underground aquifers that now provide the City with its water.
- Very early on, the city developed separate systems for disposing of stormwater and wastewater.

Broadening our approaches to water management

Until 1999, the managers of waterways and wetlands in the City focused mainly on preventing flooding. This required a drainage system that got excess water out of the City as efficiently and quickly as possible. However, in 1999, Christchurch City Council started to manage waterways as resources for local ecology, landscape, recreation, heritage and culture as well as drainage. Also, as demand for water has increased, people have increasingly recognised that water is a finite resource and that we must limit the amount of water we take for human use.

As a result of this change in philosophy, people looking after the waterways have started to reshape and restore some Christchurch wooden sided drains to a more natural condition. To do this, they must widen the streams, so this approach is not possible for every waterway in the City. In a few places, they are also opening up underground drains to expose them to light. This work helps improve water quality and habitat for the plants and animals that call the waterways home.

The banks of the streams that have been restored have been planted with native plants, which provide shade and shelter for fish and aquatic invertebrates, and help to keep the water cleaner and cooler. Naturalising streams also makes parks and riversides into interesting landscape features for people to enjoy.

Papanui Stream at Erica Reserve, 1996 (left) and 2010 (right)

Integrated catchment management

Another recent change in water management is the move towards integrated catchment management. As our cities grow, and as land use changes in our rural areas, it has become more and more obvious that we need to think about water management from a whole catchment perspective. For example, the health of the Estuary is affected by the condition of the waterways that run into it. The waterways are affected by the activities of everyone living/travelling nearby. So the Estuary is affected by nearly everyone living in Christchurch and all the activities that they do, from driving their cars to walking their dogs, gardening, painting their houses or washing their cars. To improve the health of our waterways we all need to understand how our actions affect these waterways, and to change what we do to minimise our impact on them.

Climate change

Flooding remains a potential problem for people managing Christchurch waterways and it may become more of a problem in the future. Current climate change scenarios suggest that sea level may rise by half a metre by 2100. This will have a big impact on low lying areas such as the lower Heathcote River/Ōpāwaho and the lower Styx River/Pūrākanui, which already experience problems with flooding.

Oddly, while the climate in Canterbury will get gradually drier, experts think that climate change will also result in more floods in Christchurch. They predict that rain will fall less often but when it does fall it will be heavier. This is a problem because the current stormwater system is built to cope with smaller, more frequent flood events rather than larger, less frequent events.

Fewer, larger falls of rain will also mean that our waterways are more likely to dry up between floods. To add to this problem, the springs feeding our rivers may also stop flowing if water is taken for irrigation higher up on the plains, or simply because there is less water flowing through the underground aquifers.

Cultural values: **Ngai Tahu's relationship with water in Christchurch**

As the Māori tribal group in the Christchurch and Canterbury region Ngāi Tahu have occupied the Christchurch area for many hundreds of years. Water is considered a taonga, as are the resources living in the water and the resources in the wider environs that are sustained by the water. Tangata whenua have an important role as kaitiaki of water use, care, and management.

It is important to understand the significance and value of water to Ngāi Tahu and other affected parties as part of a change from focusing management mostly on water consumption and use, to a management approach that includes cultural and ecological values as well.

Mahika Kai Tuaki – Collecting Cockles,
© Craig Pauling, 2001

Mahinga kai

Water plays a unique role in the traditional economy and culture of Ngāi Tahu. The most direct physical relationship that Ngāi Tahu have with water involves the protection, harvesting, and management of mahinga kai. The term "mahinga kai" refers to natural resources and the area in which they are found. It includes the way resources are gathered, the places they are gathered from, and the resources themselves, for example, fish such as tuna and inaka, materials such as harakeke, and paru, which are used for dyes.

Mahika Kai Kowhitiwhiti – Collecting Watercress,
Mahana Paerata, 2001

The Ōtākaro/Avon River, the Ōpāwaho/Heathcote River and the Ihutai/Avon Heathcote Estuary were highly regarded as mahinga kai by Māori living around or near what is now the Christchurch area. There are many significant sites where settlement or harvesting took place along these waterways. In the 1800s Ngāi Tahu made unsuccessful attempts to have some of these sites made into mahinga kai reserves, and were effectively excluded from exercising their kaitiaki responsibilities in the development of the City and the management of the Ihutai catchment. The advent of the sewage outfall at Bromley made this situation worse, as it involved mixing polluted and clean waters. The outfall had detrimental effects on the health of the Ihutai and helped to make it unsafe to harvest food resources from the area.

In this respect, the relationship between Ngāi Tahu and the Ihutai and its tributaries was weakened.

Restoring the mahinga kai values of the Ihutai/Avon Heathcote Estuary is a key aim of the Ihutai Management Plan. Ngāi Tahu, the Christchurch City Council and Environment Canterbury are working together to implement the Plan, under the guidance of the Avon Heathcote Estuary Ihutai Trust. You can read more about the work of the Trust on page 68.

The kete is a traditional bag for collecting mahinga kai.
Photo courtesy of DOC, © DOC.

Taumutu tuna up close,
© Craig Pauling, 2001

Mauri

Mauri is the "life force" or "life essence" and the links between all natural things. An understanding of mauri allows us to develop ways of living sustainably and to work with the natural elements. Water is perceived as containing a mauri or life essence.

Rahui

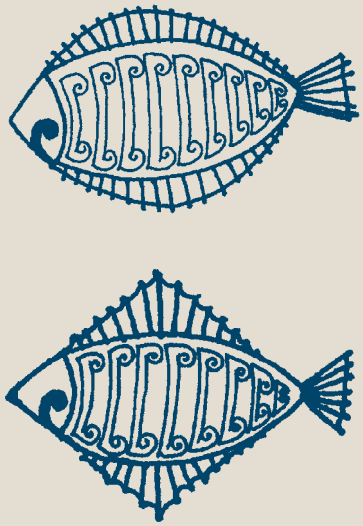
A complex system of cultural and spiritual practices, customs and rules were developed to protect the mauri by managing and controlling the interactions of people with the natural world. This system was the means by which Ngāi Tahu sought the sustainable management of resources. There is currently a rahui on shellfish gathering at Port Levy/ Koukourarata because the shellfish beds have been severely depleted and need to regenerate.

Pawhara Tuna – Taumutu rangatahi preparing an eel,
© Craig Pauling, 2001

In modern times

In modern times Ngāi Tahu's relationship with waterways in Christchurch is, perhaps, most strongly demonstrated through recreation. While it seems unlikely that Ngāi Tahu will ever feel it is safe to gather food and other resources from local waters again because of the range of pollutants present in them, there are some who participate regularly in whaka ama, rowing and kayaking in the Otakaro near Kerrs Reach.

Acknowledgement
Some information on this page has been taken from Te Rūnanga O Ngāi Tahu Freshwater Policy and from the State of the Takiwa Report (2007). We would like to thank Te Rūnanga O Ngāi Tahu and Craig Pauling.



Patiki designs by Taumutu Hakui Cath Brown, which can be seen on the kowhaiwhai panels at Ngati Moki Marae, Taumutu.

Threats to waterways

There is a lot of water available in Canterbury and the groundwater is of a very high quality. However, demand for water is increasing and some groundwater supplies have started to dry up at times of drought. Groundwater could also become polluted if we are not careful.

Although there is pristine, drinkable water below ground in Christchurch, much of the surface water is not of a high quality. Regular monitoring by the Christchurch City Council indicates that many contaminants in waterways around the City exceed recommended guidelines at least some of the time. Water quantity is also of concern around Christchurch and Canterbury. Some streams in the City have run dry permanently because the springs that fed them have dried up or have been disrupted as a result of industrial or housing developments.

Forests, grasslands and wetlands act like sponges that slow down and absorb water when it rains. However in cities, these areas are often replaced with impermeable surfaces such as roads, footpaths and car parks. Water is no longer absorbed by the action of the plants and instead flows directly into streams via storm drains.

The concrete and tarmac surfaces in urban areas drastically increase the speed at which water enters streams and rivers.

Factors that can affect an urban stream include:

- Water, unable to soak through the ground and recharge aquifers or rivers, instead runs along gutters and into stormwater drains, collecting pollutants and litter along the way.
- Riparian (river bank) vegetation is often removed for building or other developments, or so that people can see the waterways.
- Large amounts of sediment can be washed into the waterway as a result of new building developments or the building and extension of houses.
- Erosion of unstable stream banks.
- A greater variation in river flows – much lower flows when there is little rain and much shorter, sharper floods in times of heavy rain because the water runs off quickly rather than soaking into the ground and recharging aquifers.
- Straightening of stream channels and piping of waterways, which decreases the amount of habitat available for invertebrates and fish.

Pollution

Pollution is caused when substances (usually made or concentrated by human activity) contaminate the natural elements, such as air, land and water. Water is polluted when chemical, biological or physical material gets into fresh or ocean waters in amounts that do not occur naturally. Raised levels of contaminants such as heavy metals affect the quality of the water and the health of the plants and animals that live there.

In cities such as Christchurch, these pollution problems are made worse by many hard, impermeable surfaces (e.g. roads, car parks). When it rains, the water runs quickly across these surfaces, washing contaminants into our waterways.

Swales (vegetated drainage channels) reduce contaminants entering streams and rivers.

These contaminants can include:

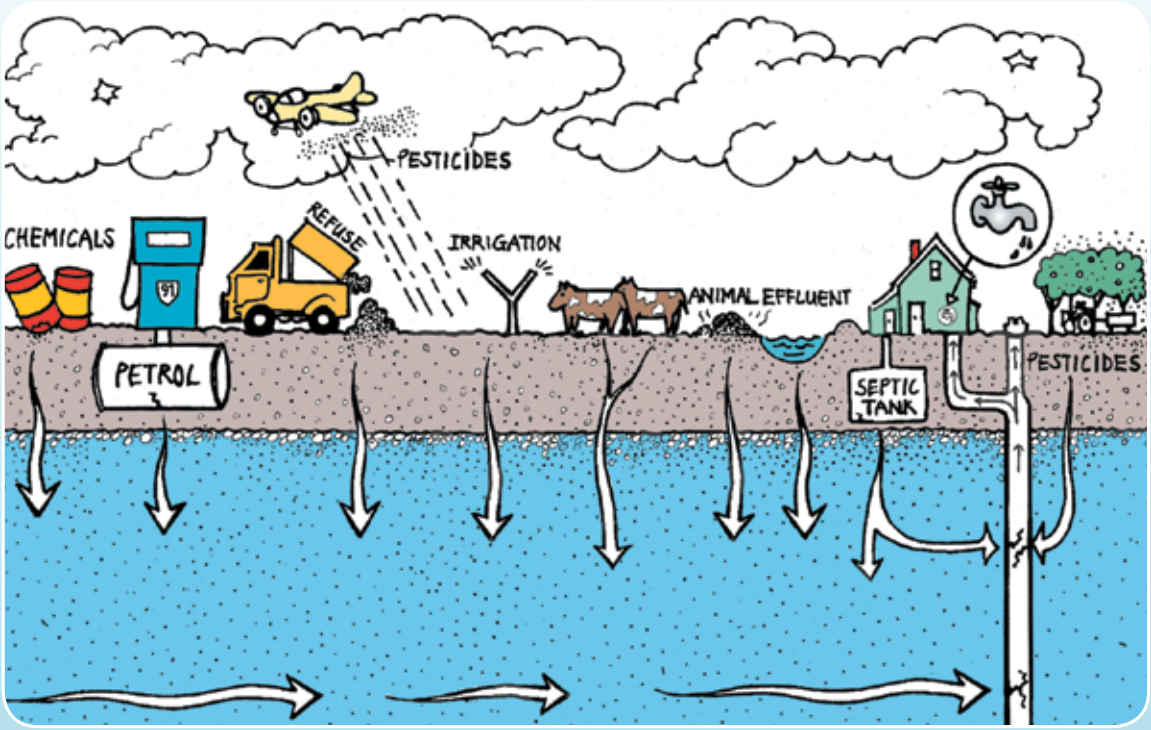
- Brake pad dust and rubber from vehicle tyres.
- Metals such as lead, copper and zinc, some of which come from roofing materials
- Fine particles of chemicals from industrial processes or from vehicle exhausts, which drop out of polluted air or are washed out of polluted air when it rains.
- Chemicals that collect on impervious surfaces. Some examples are oil that leaks from cars or trucks onto the roads, polycyclic aromatic hydrocarbons (PAHs) from the use of tar seal, detergents used when people wash their cars on their driveways, or paint chemicals that get into the stormwater system when people wash their brushes outside.
- Faeces from mammals (such as dogs, hedgehogs, possums) and birds. Too much faecal matter in the water means that there are likely to be pathogens present in the water. The amount of faecal matter in the water is measured by the number of E.coli bacteria (short for Escherichia coli) per 100 ml. This measurement is used to decide when it is safe to drink the water, to eat shellfish that have been in the water, or to swim.

- Chemical spills can also cause pollution. Nowadays, chemicals spills are usually accidents. An example of a recent chemical spill was in 2008 when blue ink was spilled into the Heathcote River.
  In this case the pollution was easy to see, but some chemical spills can remain invisible and only become obvious when the river smells (as happened when diesel was spilled into the headwaters of the Heathcote River in 2005) or when plants and animals start to die. All of these contaminants can affect the environment for a very long time. In Christchurch, these contaminants get into our rivers and may eventually end up in the sediments of the Avon-Heathcote Estuary/Ihutai.

Most of the time, these contaminants are below guideline values in the City's rivers. However, in places that have a relatively dry climate as Christchurch does, pollutants can build up over long, dry periods and run into the waterways in high concentrations the next time it rains. To stop these spikes of pollution, first-flush basins and other treatment devices are now being added to new developments within the city to remove contaminants before they reach the rivers.

Pollution may also arise from unexpected sources. For example the release of exotic fish into retention basins (that are designed for water quality treatment) for recreational fishing is a form of pollution. The danger to the environment and native fish is not always realised by the public.

Common causes of pollution



paint
chemicals
farm effluent
stock effluent (cow poo)
engine oil
fertilisers
dog and bird poo
silage pits
detergents
herbicide
pesticides
stormwater drains
grease
septic tanks
heavy metals
silt from erosion

Examples of water pollution and its sources.

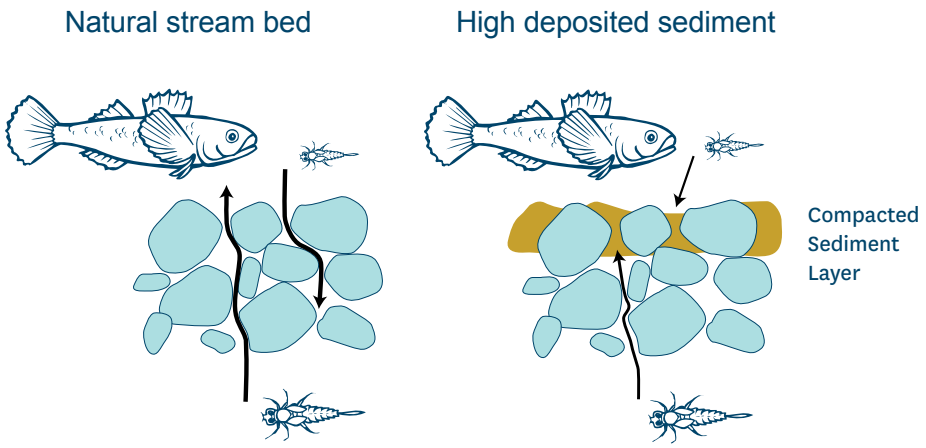
Pollutant	Source	How did it get there?	Effect	Solution
Stormwater (all the pollutants below can enter rivers via stormwater)	Run-off from roofs, driveways, gutters.	Run-off after rain, drainage. Storm-flow.	Clogs up waterways; degrades habitat, potential to kill life.	Detention and treatment, of run-off from streets and roads, such as rain gardens, swales, restored wetlands.
Animal waste	Dog poo in town. Stock grazing in rural areas. Bird droppings.	Run-off after rain. Birds and stock pooing directly in the water.	Bacteria & nutrients present in water. Unsafe to drink or swim in river.	Pick up after your dog. Fence streams to keep stock out. Don't feed the ducks.
Litter (including leaf litter)	Gardens and parks, people dropping litter in the streets.	Wind and run off after rain.	Clogs up waterway. Increases bacteria and nutrients in water.	Pick up and compost leaves. Pick up litter and/or ensure it is properly disposed of.
Metals & PAHs	Cars & trucks, industry, unpainted galvanised iron roofs.	Run-off after rain	Collects in sediments & in shellfish etc. Mahinga kai/food gathering becomes unsafe.	Keep car use to a minimum. Detention and treatment, of run-off from streets and roads, such as rain gardens, swales, restored wetlands.
Oil	Vehicles, storage.	Storm-flow.	Unsightly, coats bird feathers.	Keep car serviced to avoid leaks. Installation of oil storage safety systems to prevent accidental spills.
Chemicals	Industry (many different types).	Accidental release.	Potential to kill aquatic life, water unsuitable for drinking or swimming.	Treatment and disposal of waste elsewhere.
Fertiliser	Agriculture and gardens.	Run-off after rain, drainage.	Promotes weed growth and clogging-up of waterway. Degrades habitat for aquatic life.	Use only required amount for target plants.

Sediment

Sediments are particles of rock or soil that fall into the water. This can be caused by erosion from wind or water but is often accelerated by human activities such as earthworks (for example, on building sites), drain cleaning, or from stock trampling the edges of waterways.

Sediment may not be poisonous but it makes the water dirty and covers the bottom of a waterway. Fine sediment can fill the spaces between river stones, changing the habitats where invertebrates and fish live and breed. As sediment builds up in the waterway, it begins to clog up the gills of fish and aquatic insects so they can't breathe. Once this happens, these animals can no longer live in the waterway.

Effects of deposited sediment on biology of urban streams



- Interstitial spaces provide refugia from floods and predators
- Animals live in the zone beneath the stream bed

Loss of water flow

In Christchurch, many of the streams are fed by springs, but as the City has developed and grown, many of the springs have stopped flowing or have been diverted. The water underground has dried up, or earthworks have destroyed the surface aquifers that feed the springs. This means that some waterways in the Christchurch area are now dry for most of the year.

Pests

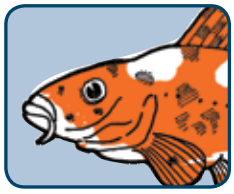
As well as pollutants there are a number of plants and animals that are a problem for our waterways and wetlands. Pest plants and animals can take over our waterways, replacing the native species that live there and changing the nature of waterway and wetland habitats.

Pest fish

Rudd, tench and koi are introduced fish and are part of the carp family, along with goldfish. They were brought to New Zealand for sport and as ornamental pond fish. These fish have made their way into our waterways by accident or from being released by people. They harm freshwater ecosystems and threaten many native species.

Rudd, picture courtesy of Sonia Frimmel, © DOC.

Rudd



Koi, picture courtesy of Stephen Moore, © Doc

Koi Carp

Rudd compete with native fish for habitat and food. They remove aquatic plants, which decreases oxygen levels and increases the muddiness of the water, because there are no plant roots to secure the mud and silt to the waterway bed. They also eat native invertebrates, and native fish and their eggs. Rudd, are listed as 'noxious' in Canterbury by Biosecurity New Zealand.

Tench like to live in still waters and can grow to 4 kg in weight. They are widespread in Canterbury and like to eat insects, crustaceans (such as shrimps, snails and freshwater shellfish). They are prolific breeders, producing hundreds of thousands of eggs in a single year.

Koi Carp love warm muddy water and can quickly muddy clear water by digging into the banks and waterway bottom looking for food and wallowing about. The muddy water and increased water temperature make the environment uninhabitable for many invertebrates, native fish, trout, and salmon. Koi is listed as an 'unwanted organism' by Biosecurity New Zealand.

Aquatic pest plants

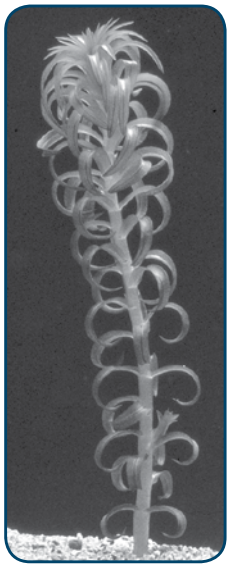
Some introduced water weeds have found their way into our waterways. A few are serious pests, because they grow very fast and quickly cover an area of water. They take over fish and invertebrate habitats and stop sunlight from reaching the deeper parts of water. These weeds also slow down water flows and block culverts so flooding can often be worse.

Three of these pest plants got into our waterways when people grew tired of looking after their pet fish and emptied their aquariums into ponds and streams. Two are oxygen weeds called Lagarosiphon and Egeria. The other is called hornwort. The oxygen weeds root on the waterway bottom and grow quickly, forming tall thick towers of weed as they reach for the surface. Hornwort does not need to root anywhere so can grow where it likes, often covering the surface of a pond or stream.

Egeria

Egeria. Photo courtesy of Plant Protection Society

Lagarosiphon



Lagarosiphon. Photo courtesy of NIWA

The Christchurch City Council keeps a close eye on pest plants in waterways around the City. They have managed to get rid of them from most places where they were a problem.

Pest plants of riparian zones

Yellow Flag Iris is a yellow iris plant that particularly likes stream banks. It produces seeds which can be carried down the waterways to other sites. It can also grow from pieces of plant that break off when the plant is disturbed (e.g. in a flood). Yellow Flag is a problem on the lower Avon River/Ōtākaro and has also been found on the Heathcote/Ōpāwaho and Styx/Pūrākanui Rivers. It is a prohibited species under the National Pest Plant Accord.

Purple Loosestrife (Lythrum salicaria) grows 1-2 metres tall and has tall pink-purple flowers. It has been recorded in a number of places in Christchurch along river banks and in Christchurch wetlands. Purple loosestrife is a serious threat to our wetland biodiversity and can grow quickly and stop other plants growing. The tall plants can change the habitat of wetland and waterway sites so that the species that used to grow there are no longer able to survive. It can also affect wetland birds' habitat and food supply. The Department of Conservation (DOC), Ngai Tahu, Environment Canterbury and the Christchurch City Council are working together to try to eradicate purple loosestrife from Canterbury.

"Otahuna" Sedge (Carex pendula). Also known as Giant Sedge, this large ornamental sedge originally came from Europe. It looks similar to native sedge species but it is very tall with stems up to 2.5 metres high and leaves up to 2 cm wide. Over the past few years Otahuna Sedge has been seen spreading along the Heathcote River in Christchurch, from opposite Princess Margaret Hospital, through the Ernle Clark reserve, and down to Colombo Street. People working in the Ernle Reserve on the Heathcote River have been controlling this. Like Purple Loosestrife, it shades out other plants and spreads quickly. It can also grow in shaded areas some way away from the river bank.

Rural issues

Rural and urban streams have different characteristics, land uses, pollutants, and water quality. In a rural environment, paddocks are regularly fertilised, irrigated, and tilled. Livestock are moved from place to place, sometimes trekking through streams. Factories, such as meat processing plants, sewage treatment works, and sawmills, are often situated in rural regions.

Factors that can affect a rural stream include:

- Wind and rain collecting excess fertiliser and pesticides and adding them to the stream.
- Stream bank erosion made worse by stock access.
- Ploughed up soils flowing into streams.
- Taking water for irrigation.
- Bacteria from farm/stock effluent, treated and untreated sewage.

In all catchments, the direction of water flow means that the quality and quantity of water for downstream users is affected by water and land uses upstream.

Looking after our water

Environment Canterbury is responsible for the management of Canterbury's natural water resources. Christchurch City Council is responsible for the management of the water supply, the sewer system, the wastewater treatment system and the stormwater system, including the wetlands and waterways in Christchurch City.

Environment Canterbury:

- gauges flows and make sure there is enough to go around.
- works with the community to set rules and guidelines about how the water will be used.
- makes sure people who want to take a lot of water or build a dam or a bridge on a river do so properly. Before any water can be taken from a river or an aquifer, it must be allocated.

People wanting to use the water must apply for a resource consent from Environment Canterbury. Environment Canterbury looks at the amount of water available, and the effects of taking it for that use, before deciding whether or not to allocate the water to that user.

Christchurch City Council:

- Looks after Christchurch's 360 km of open waterways, 50+ wetlands and 500 km of underground stormwater drains.
- Naturalises some stream channels and undertakes riparian planting.
- Develops new stormwater facilities to improve flood management and water quality, and to enhance ecological and landscape values.
- Maintains the water supply infrastructure (the pipes and pumps etc) of Christchurch.
- Manages applications for, and approval of, new residential or commercial water connection and stormwater systems.
- Treats 170 million litres of wastewater per day from Christchurch homes, shops, and business premises.
- Maintains 1717 km of sewer mains.
- Has some responsibility to look after the native plants and animals that live in and around our waterways.
- Manages aquatic and riparian plant pest species.
- Both Councils monitor what is happening in our waterways. To do this, they:
  - regularly test surface water to see if it is clean and survey the City streams to see what is living in them. Environment Canterbury also does this across Canterbury.
  - respond to calls from people who are concerned about water pollution in their area. Pollution response staff visit the pollution scene, attempt to stop the pollution, clean it up, and find out what caused it. People who see a pollution incident can phone the Pollution Hotline: 366 4663

Both Environment Canterbury and the Christchurch City Council work with other individuals, organisations and community groups to improve the health of waterways and wetlands in Christchurch. Much of their work centres around pollution prevention and it includes:

- requiring developers to show how they are minimising sediment run off as part of getting permission to develop.
- requiring the use of swales and rain gardens in new developments.
- running campaigns to get people to think about what they put down the stormwater drains and to change their behaviour.
- working with industry to make sure that chemicals and hazardous substances that they store and use do not get into the stormwater system.
- finding ways to treat stormwater, particularly at the beginning of rain events when pollutants are at their highest levels, before it gets into the rivers. At the moment the Christchurch City Council treats the first 25 mm of rain that runs off roads and pavements by putting it through treatment systems that store water and allow sediments to settle or filter out of the water before it goes into rivers and drains.
- ensuring that people with consents to discharge water are meeting the conditions of those consents and if not, ensuring they change their practices and systems so they do.

Addington Rain Garden

Urban Water Health Programme for Christchurch

Environment Canterbury research has shown that Christchurch residents are concerned about the state of urban waterways and expect Councils to provide information and tools on how to improve the health of waterways.

Environment Canterbury established an Urban Water Health Programme following a commitment to the Christchurch community made after the February 2005 Heathcote River diesel spill.

The programme uses a variety of techniques – including scientific research, policy and planning, compliance and enforcement, pollution prevention, community education and engagement, as well as general awareness campaigns – to achieve the overall goal of improved urban waterway health.

Okeover Stream Community Education and Engagement

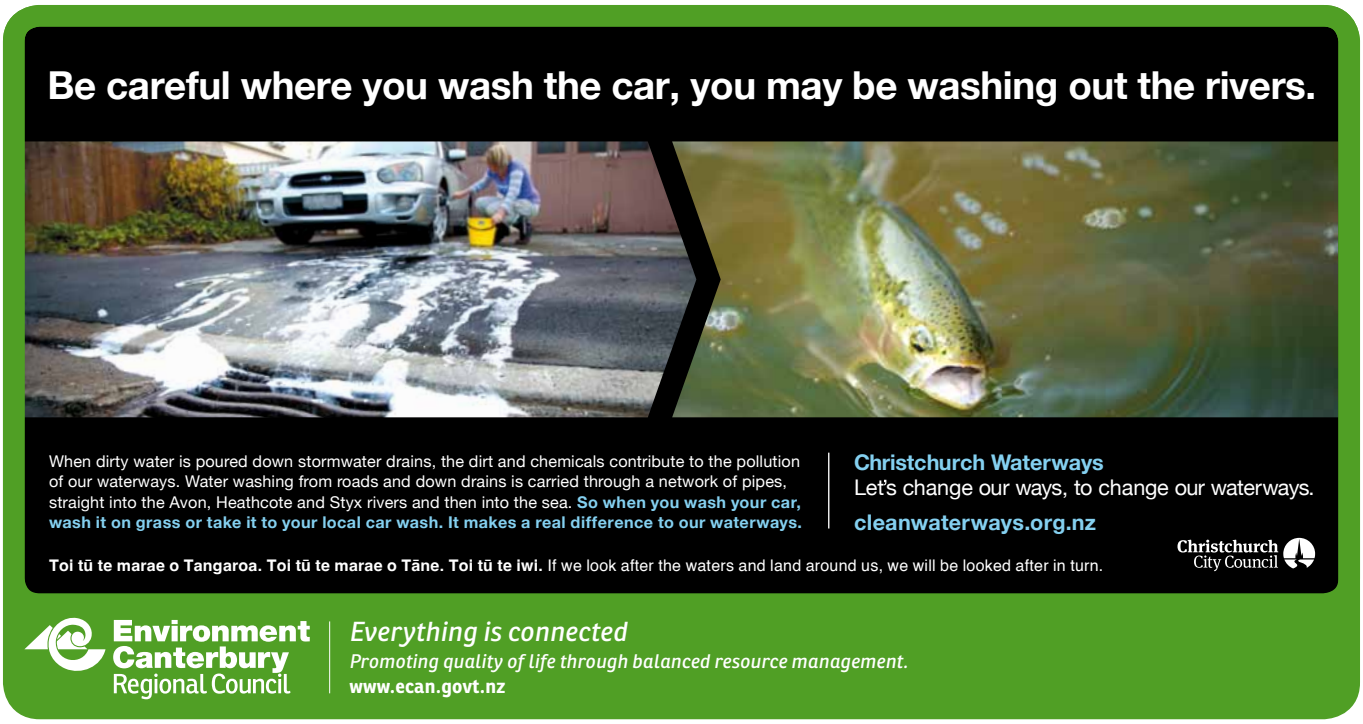
Okeover Stream has been chosen as a pilot engagement project at a sub-catchment level. Facilitated meetings will identify issues and help develop a series of tools to address waterway health issues for the Okeover Stream, in particular relating to stormwater quality and quantity. Tools may include reminders and encouragement for people to wash their cars on grassed areas away from gutters and drains, vouchers and rewards to encourage 'good' behaviour, front-of-mind slogans on stickers or fridge-magnets, etc. More information about Okeover Stream can be found on page 63 of this book.

The desired outcome is a self-managing community group committed to working on improving local waterways health, as well as engaging with Councils and other stakeholders. Environment Canterbury also hopes that this process will help develop and refine a template for improving urban waterway health by a process of community education and engagement which can be applied in other catchments in Christchurch.

Working with community groups

Both Councils work with local communities to improve local waterways. Projects include activities such as reshaping and replanting stream sides, or working with local people to improve water quality in their stream.

The Urban Water Health website www.cleanwaterways.org.nz can assist interested people in learning more about local waterways and how to clean them up.



Avon-Heathcote Estuary Ihutai Trust

An important community group is the Avon-Heathcote Estuary Ihutai Trust, which is concerned with the condition of the Estuary, including the rivers which flow into it (the Avon River/Ōtākaro and the Heathcote River/Ōpāwaho) and their catchments. The Trust was formed in 2002 and its vision is: "Communities working together for clean water, open space, safe recreation and healthy ecosystems that we can all enjoy and respect." It includes representatives from the Friends of the Estuary and the Christchurch Estuary Association, both of which have a long history of advocating for the Estuary. Other represented groups include Environment Canterbury, Christchurch City Council and Ngāi Tūahuriri (the rūnanga currently based at Tuahiwi).

The Trust works to protect and maintain the Estuary and has a management plan that identifies 76 actions needed to achieve their goal for the Estuary/Ihutai and its contributing rivers. This plan is based on the principles of integrated environmental management, so actions must occur across the Avon/Ōtākaro and Heathcote/Ōpāwaho catchments, as well as around the Estuary itself.

So far, much of the work of the Trust has focused on stopping the discharge of Christchurch's treated wastewater into the Estuary. However, now this is done, the Trust will focus more attention on the impact of contaminants coming from the City to the Estuary via the rivers. An important part of the Trust's work is monitoring changes in the Estuary.

Ngāi Tūahuriri

Ngāi Tūahuriri, who are part of Ngāi Tahu, claim mana whenua over the Christchurch area and as such they have a role as kaitiaki of the waterways in Christchurch.

The Treaty of Waitangi promised them that they would be able to maintain their relationships with their mahinga kai and other taonga. However as the City grew and developed, this promise was forgotten. For much of the nineteenth and twentieth centuries, Ngāi Tūahuriri and others who used the area were increasingly unable to look after their waterways and mahinga kai.

More recently, organisations such as the Christchurch City Council and Environment Canterbury have started to acknowledge this history. Ngāi Tūahuriri support work to improve the health of Christchurch's waterways and wetlands, and as kaitiaki, it is important that they are involved in looking after them. However, as a small group they do not always have the people or the resources to be involved in a way that is appropriate for the partnership that is needed. So, at the moment all parties agree that Ngāi Tūahuriri are important partners, but the exact ways in which this happens are evolving slowly over time.

Christchurch Estuary Association

This association is an amalgam of other organisations including Christchurch Residents' Associations, organisations such as the Royal Forest and Bird Society, and sports or recreational organisations that use the Estuary. The Association acts as a guardian and advocate for the Avon Heathcote Estuary/Ihutai. It promotes the protection and enhancement of the Estuary and surrounding area, so that people and natural biota can enjoy its full benefits in perpetuity. It also monitors the impact of human activity on the Estuary and its environment so as to eliminate or minimise any adverse impacts. It has been active politically in advocating activities to divert pollution from the Estuary.

Pleasant Point, Christchurch

Styx Living Laboratory

The Styx Living Laboratory Trust is working on fostering activities along the Styx River and has developed a Vision looking forward to the year 2040. It aims to encourage and develop initiatives that help establish the whole Styx River catchment as a 'Living Laboratory' and to share resulting information widely. As part of that goal it aims to develop, in partnership with other stakeholders, an Urban National Reserve that runs along the full length of the Styx to create a 'Source to Sea' experience. It runs community monitoring programmes, and has been involved in riparian planting. Learning is a central theme in the group's work and it supports Styx-based research by Summer Student Scholars from Lincoln University and Royal Society Teacher Fellows. They aim to learn and help other stakeholders learn about the river system and ways to manage the pressures caused by human activities in the catchment. The Living Laboratory is supported by Christchurch City Council, Environment Canterbury, NIWA, Landcare Research, Lincoln University and Willowbank Wildlife Reserve, and these organisations are represented by members on the Trust board of management.

Guardians of the Styx

The Guardians of the Styx Charitable Trust came into existence as a result of community interest in the Styx River. This group aims to promote the protection, restoration, and raise awareness of the values of the Styx River and its environs. The group formed largely after the Styx River Happening – a community event run at Spencer Park in 1999 to raise awareness about the Styx and to consult with people living in the catchment about future development.

A sub-group, called the Styx History Group, researches the local colonial history of the river and its surrounding area.

Other community groups

Other community groups involved in restoring and looking after the waterways in Christchurch include groups that look after specific rivers or river systems:

- The University of Canterbury Waterways project (restoration of Okeover Stream, Ilam Stream and the Avon/Ōtākaro River in the Campus area)
- St Albans Residents' Association (St Albans Stream)
- Addington Bush Society (Jacksons Creek, a tributary of the Heathcote River/Opawaho)
- Cashmere Stream Care Group (Cashmere Stream)
- Beckenham Residents' Association (Beckenham Loop, mid-Heathcote River/Opawaho)
- Friends of Ernle Reserve (mid-Heathcote River/Opawaho)
- Roimata Community (lower Heathcote River/Opawaho)

activities

Section 2:

Water in Canterbury & Christchurch

- **As a whole class activity**, create a large wall poster in the shape of Canterbury. On it, put the main geographical features, towns, large rivers, lakes, mountains, plains. Divide up the topics of information learned in this section between groups or pairs and add what you think is interesting or important about Canterbury's water to the poster. Can you name the rivers on the map?
- **Write** a story telling the life of a raindrop or snowflake. You might choose to begin the story hundreds of years ago or just last week. Describe the path it took and what it saw along the way from the sky to its final destination.
- **Make** a 3D model showing how the aquifers are placed underground. Use a square box and show the land on top and a cross-section of the ground with the layers of aquifers on the sides. You may have seen a similar model if you have been to the museum exhibit. You could also use pictures from Environment Canterbury publications to help you.
- **Learn** about the difference between the wastewater system and the stormwater system. Where does water from inside a house go and what happens to it? Where does water running off the roof, driveway or street go and what happens to it? Useful websites include: **www.ccc.govt.nz/homeliving/water/wastewater** or **www.cleanwaterways.org.nz/atSchool**
- **Write** a story or cartoon strip telling of the life of a local river becoming waimate (highly polluted) from being waiora (very clean). How did this happen? How could it be returned to its original state? How were the local people affected?
- **Invite** a speaker from a local streamcare group. Prepare some questions in advance or interview them for a newspaper article to be sent to a local newspaper.
- Using the Māori water classifications (i.e. waiora/waimate), divide the students into groups and do a 'living poster' using one of the water types as the theme. The poster can be tactile with pieces stuck on, such as rubbish to indicate sources of pollution. A tin can could indicate heavy metals, a plastic bottle could indicate human litter, ferns and leaves could indicate riparian vegetation, while sand glued on could indicate sediment.
- Remembering how the stormwater system works, have a **class discussion** about how your own actions or those of your family might affect the quality of water in our local rivers. Make a poster to illustrate how your activities affect water quality in your local creek.
- **Book** a Learning Through Action trip with the Christchurch City Council, or invite a water education speaker from Environment Canterbury, or another organisation or group to talk about how the water resources in your area are managed. Contact details are in Appendix 2 at the end of this book.

Word play

There are some important words you should know before continuing with this water programme. Choose the correct words from the list below to answer the following questions and circle the words in the wordfind.

You may need to use a dictionary to find out the meanings of some words.

irrigation	waterways
degraded	waiora
inaka	tuna
groundwater	wai
waterbodies	catchment
stormwater	waimate
polluted	quality
spring	puna
mahinga kai	

N	A	J	Q	A	Y	K	N	W	F	J	Y	K	C	D
S	C	N	S	J	S	S	C	N	A	M	D	A	E	Z
N	P	D	E	T	W	Q	U	A	L	I	T	Y	E	I
I	U	E	I	N	O	A	E	C	O	C	O	H	R	Z
A	N	D	D	E	H	R	I	Q	H	W	S	R	V	L
K	A	A	O	V	N	U	M	M	K	Y	I	D	A	B
A	Y	R	B	L	B	R	E	W	A	G	E	S	B	M
G	W	G	R	O	U	N	D	W	A	T	E	R	D	E
N	T	E	E	U	T	J	R	T	U	T	E	Y	Y	S
I	U	D	T	M	L	E	I	L	R	E	E	E	B	K
H	G	X	A	K	T	O	L	Q	Y	V	W	R	W	C
A	Z	H	W	A	N	O	F	B	E	X	W	A	I	C
M	T	H	W	Q	P	O	R	U	I	N	A	K	A	E
A	N	U	K	S	P	R	I	N	G	P	E	U	Y	A

1. When a river is contaminated with something that would not be there naturally, we say it is _____.
2. A river or stream, and even a ditch or drain that water flows through, are all called _____.
3. Permanent areas of water such as a river, stream, lake, pond, or wetland are all called _____.
4. When we talk about how clean or polluted a waterbody is, we are discussing the _____ of the water.
5. Much of the water in Canterbury that we use in our homes is pumped up from under the ground through wells. This water is called _____.
6. Water that is not used, such as rainwater, is collected from our roofs and footpaths and travels down our gutters to local rivers or the sea. This water is called _____.
7. When water is pumped from rivers or under the ground to supply farmland, it is called _____.
8. The Māori word for water is _____.
9. When water is considered highly polluted it is _____.
10. When water is in its purest form it is _____.
11. An area where the rainfall contributes to a particular river is called a _____ area.
12. A waterbody that is polluted or not considered to be in a healthy state is _____.
13. When water wells up from underground to the surface, it is called a _____. In Māori, the name is _____.
14. Two important native fish species are _____ and _____.
15. The gathering and management of traditional foods and materials is known as _____ _____.

Notes

Section 3:

Investigating a waterway

This section first identifies the healthy and not so healthy aspects of a stream before setting out to visit a local waterway to observe and monitor its quality. The stream-monitoring exercise offered here can be guided by the Environment Canterbury educator. At the end of this section, your students will have an understanding of the effects of contaminants and the overall human impact upon water.

Section 3: Investigating a waterway

What makes a healthy waterway?

Streams can become unhealthy in different ways. In times of drought, stream flow may decline, water temperatures rise, and oxygen levels in the water may diminish to levels that are harmful to aquatic life. When there are changes in land use that cause pollution, chemicals can change the nutrient balance or be toxic to fish and invertebrates, and increased sediment can reduce water clarity. Pollution and low flows reduce the biological diversity found in a stream because only some organisms can cope with these stressful changes. Reducing species diversity is never good as it prevents an adequate supply of food along the food chain. As the health of a stream declines, it also becomes unsuitable for human uses such as drinking, swimming, or fishing.

Water temperature

Dark colours absorb heat from sunlight, so murky water has a higher temperature than clear water. High water temperatures are great for swimming but are bad for native fish and invertebrates as they need to use more energy and the amount of oxygen in the water decreases, making it harder for them to breathe.

Native fish and invertebrates have adapted to New Zealand's naturally cool waters (12°C and below). When the water gets too warm (above about 16°C) and stays warm for a long period, most fish move to cooler waters. It is much harder for aquatic invertebrates to move far, so many die if the water gets too warm.

Habitat

Variety is the spice of life and a variety of different habitats in a waterway is very important. These habitats might be slower-flowing pools, faster-flowing riffles, overhanging plants, undercut banks, logs and debris, shady cool areas, and areas in the sun. The stream bottom might be stony, sandy, muddy or a mixture of these. If there is only one type of habitat, only a few species will be able to live there. Even in waterways that look like there is only one habitat, such as a braided river, if you look closely you will see that there are big stones and small ones, faster shallow water (called riffles) and slower deeper runs and pools.

A HEALTHY waterway has:

HEALTHY

- ✓ *An adequate flow with seasonal variation (freshes and floods).*
- ✓ *Cool, clear water with a balance of nutrients that allow a variety of plants and animals to co-exist.*
- ✓ *Many different species of plants, invertebrates, and fish. Scientists assess invertebrates to indicate the health of a waterway, as some species can only be found in high-quality water.*
- ✓ *Plants that provide suitable food and habitat for fish and invertebrates.*
- *Stream beds shaded with trees, shrubs, and grasses.*
- ✓ *Overhanging vegetation and natural debris on the stream bed for fish and invertebrates to hide in.*
- ✓ *A wide range of sediment sizes, from boulders to sand, to accommodate the different habitat needs of aquatic organisms.*
- ✓ *A mixture of shallow, fast-flowing water (riffles) and deeper, slower areas (pools).*
- ✓ *Good fish access both to and from the sea.*
- ✓ *A good-sized riparian zone planted with shrubs and grasses to filter the water running off land surfaces.*
- ✓ *Urban design mechanisms for filtering stormwater runoff, such as swales, rain gardens, soakage basins and specially-created wetlands.*

UNHEALTHY

An UNHEALTHY waterway could have:

- *No riparian vegetation (no plants along the river banks).*
- *Exotic and invasive pests, including weeds, fish and birds.*
- *Low water clarity (murky water).*
- *High water temperature.*
- *Low dissolved oxygen concentration.*
- *Fine sediment (mud) covering large areas of the stream bed.*
- *Low biodiversity.*
- *Low animal abundance.*
- *Excessive numbers of particular species, for example introduced waterfowl which can contaminate the water.*
- *Invertebrate species that are pollution tolerant, such as snails and worms.*
- *Restricted fish movement due to stagnant pools, channels with low water flow, poorly designed culverts, weirs, or dams.*
- *Dense mats of leathery or stringy algae.*
- *Erosion of stream banks (slips and scars).*
- *Dirty water being discharged into it.*

Riparian zone

The riparian zone runs along the edge of a waterway. This is an important area as it is the waterway's protective buffer zone. The riparian zone is the area approximately 30 metres either side of a waterway. Thick vegetation within this area provides the best protection from activities happening on the land. Ideally, it should include native plants such as tussocks, trees, shrubs, and ferns.

A well vegetated riparian zone serves a number of functions.

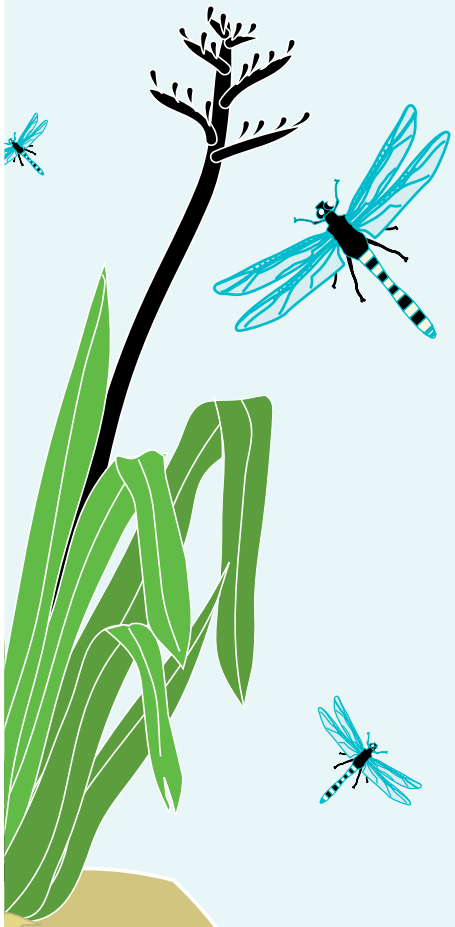
1. Good riparian vegetation slows down the rate at which water runs into the rivers and allows any particles and nutrients in the water to be filtered out as the water moves down through the soil.
2. Native plants provide food, shelter, and a breeding habitat for many birds, insects, fish and aquatic invertebrates along the stream edge. Removing plants reduces habitat for animals so they eventually leave or become prey for others.
3. Good planting stabilises stream banks and stops them being washed away.
4. Shade provided by the vegetation is important for keeping the water temperature cool. Removing plants from a riverbank allows the sun to shine directly onto the water, which heats it up.
5. The sunshine also stimulates photosynthesis and encourages excessive plant growth, which can clog waterways. In addition, excessive growth of plants increases decomposition, which uses up dissolved oxygen in the water, making it more difficult for fish and invertebrates to breathe.

The Christchurch City Council Streamside Planting Guide shows appropriate species for planting in riparian areas. This guide can be found by entering the following URL, or by visiting the Christchurch City Council website and typing 'streamside' into the search engine.

www.ccc.govt.nz/cityleisure/parkswalkways/environmentecology/streamsideplanting

What lives in a waterway?

Healthy waterways support a high diversity of life. They provide different habitats for different plants and animals. Each has its own place but they rely on each other to survive. This set of relationships is called an ecosystem. We know quite a lot about ecosystems on land but less about the ones underwater because they are harder to see and study. Like all ecosystems, underwater habitats are a finely-struck balance between micro-organisms, plants, animals, and the wider environment (including water quality).



Water plants

Aquatic plants are a vital part of the freshwater environment. They provide food and habitat for fish and invertebrates to live, breed, and hide from predators. They also play an important role in keeping a waterway clean and healthy. The plants improve water quality and clarity by slowing water movement during high flows, which stops mud and silt from getting stirred up and making the water murky. This is important as high levels of silt can clog the gills of fish and ruin the habitat of aquatic invertebrates. Aquatic plants also put oxygen into the water during the day, which help fish and invertebrates breathe. Plants overhanging the waterway help shade the water, keeping it cool and at the right temperature for fish and invertebrates. They also provide good habitat for fish and eels.

Aquatic invertebrates

These small water creatures are really amazing. Many aquatic invertebrates are the juveniles or young of flying insects that, as adults, live out of water. These quirky creatures spend the first part of their life underwater breathing through gills or siphons that are like small snorkels. When big enough, some change so they can breathe air and live out of water. Some are herbivores and eat algae and plant material; others are predators and eat other invertebrates. They can be food for fish and birds.

Aquatic invertebrates are considered to be indicators of waterway health. The different types of invertebrates and the relative abundance of each type in a waterway can indicate how healthy the waterway is. Some species are very sensitive to poor water quality and others are more tolerant. They are ranked in relation to their sensitivity (see the invertebrate study chart on pages 55-56).

Native fish

Taumutu tuna up close, © Craig Pauling, 2001

Eels/tuna

Photo courtesy of Angus McIntosh

Bully

Photo courtesy of Stephen Moore, © Doc

Whitebait

Photo courtesy of Angus McIntosh

Mudfish/kowaro

Christchurch waterways are home to a number of native fish which are a vital and special part of these ecosystems.

Longfin and shortfin eels/tuna can both be found in Canterbury and Christchurch waterways. They are endemic (they only occur in New Zealand) and can live for more than 60 years. They are mainly nocturnal, feeding at night on fish, koura (freshwater crayfish) and invertebrates, which they find with their keen sense of smell. Longfin eels can grow up to 2 metres long, although shortfin eels are shorter. They reach maturity on average between 15 and 35 years old.

There are also a number of different native **bullies** in Christchurch, but the most common are the common and upland bullies. They can live in a number of different habitats and eat bottom-dwelling invertebrates. They are an important part of the food-web and are the food of bigger fish and birds.

Whitebait is a prized catch by many but did you know that they are actually the juvenile or young fish of five different species? Most of the whitebait in a catch are young inanga but there could also be banded, shortjaw and giant kokopu, and koaro. Young smelt can also be caught in whitebait nets.

The **Canterbury mudfish/kowaro** is the second most endangered freshwater fish in New Zealand and it lives only in Canterbury. It needs good quality water to live in and is considered an 'umbrella species'. This means that by protecting their habitat we also protect other species, such as dragonflies, freshwater mussels, and koura. The mudfish is special as it has adapted to the dry conditions on the Canterbury Plains and, if its waterway temporarily dries up, it can survive for a couple of months buried in crevices in banks or in the mud. The kowaro has been found in Travis Wetland in Christchurch.

The population sizes of many native fish have decreased as waterways have been modified and polluted or exotic fish introduced. In some places, native fish numbers have become so small that they are almost never seen. In other places, they have disappeared altogether.

Exotic fish

Not everyone realises it but trout and salmon are not native to New Zealand. They were introduced as a sports fish by Europeans who settled in New Zealand in the 1800s. Trout and salmon need good quality water to survive. They are predators and feed on smaller fish and aquatic invertebrates, which they hunt by sight so they need clear, clean and cool water.
Trout and salmon lay their eggs among gravels on the bed of waterways, so to breed successfully they need the stream bed to be clean and without large deposits of fine sediment.

activities

Section 3:

Investigating a waterway

Design a story-book for a junior class at your school or for pre-schoolers about the animal life found in a local waterway. Make it tactile, using bark for trees, material for leaves, tin foil for water or bright coloured paper, and adding named characters, flaps to lift-up, different textures.

Arrange with a teacher of a junior class to organise a buddy system, where students from one class are paired or grouped with students from the other class. Students read their stories at story-telling sessions. These stories would make excellent display material.

Make 3-dimensional aquatic invertebrates using the pictures from this section. Make enlarged drawings using pastels or crayons, cut out 2 layers of the shape, staple round the edges, and stuff with newspaper. Hang the bugs from your classroom ceiling. Make sure you name the different bugs.

Use the line drawing provided on the next page of a cross-section of a stream. **Fill in the picture** with your own pictures and labels showing all the factors that make up a healthy stream. Add plants, fish, bugs, birds, and write explanations of how they contribute to a healthy stream. You will need to refer to the information at the beginning of this section. You could then do a second drawing showing all the bad factors that would make a stream unhealthy.

Make a poster informing people about the impact of pollution in waterways and how they can reduce it. See if you can put up your posters in strategic places around your local area, such as in shopping areas, community halls, on buses, and down the main street.

Invite a water scientist to be a guest speaker in your classroom. Prepare a set of questions to ask them. The water educator at Environment Canterbury will help you find the right contacts.

Experiment

This experiment is to simulate what occurs when a stream has substances and chemicals added. Each ingredient below acts like a contaminant.

a) You will need several jars. Have one jar with plain water as a control.
Mix different substances from the list below with water in a large screw-top jar to see what happens. Do several combinations of substances.

Test	Behaves like
Cooking oil	oil/petrol/paint spill
Sand/flour	eroded sediment
Garden soil (bugs and worms removed)	natural sediment
Sugar or salt	dissolvable chemicals/farm fertiliser

b) Record what happens to each substance. Leave the jar for a couple of days.

Discuss:

Do any of the pollutants disappear?

If so, where did they go?

Which substances would be visible if they were released into a river?

How would we know if a river has been polluted by an 'invisible' substance?

c) Put a flower in each of the jars, including the jar with plain water.
Check their survival after 1 or 2 hours. What happened?

Monitoring our water

At this stage you will be preparing to visit either your local waterway, or a waterway in another part of the city, for a water monitoring field trip.

There are three possible ways to do this:

1. Contact the water education officer at Environment Canterbury to arrange the field trip, which is usually preceded by a class visit. The field trip will be either to a local stream, or to a fairly healthy waterway just outside the city. The water education officer will give you guidance and bring all the materials needed. The 'Stream Monitoring Survey' on pages 51-53 is used as the basis for this trip. *Suitable for Years 1 – 10.*
2. Alternatively you can book one of the Christchurch City Council's Learning Through Action programmes. These include surface water programmes, based at the Groynes, Styx Mill stream, the Estuary or Travis Wetlands; and waste- water programmes where students can investigate the real-life workings of the Christchurch Wastewater Treatment Plant or Main Water Pumping Station. *Suitable for Years 1 – 10. See Appendix 1 on page 90 for more details about the Learning Through Action programmes.*
3. Waterwatch/Kaitiaki Wai works with Year 7 – 13 students, operating field studies to assess the biological and biochemical factors of stream health. The Waterwatch programme has a science focus, and is usually a one-off trip – although comparisons with other sites may also be done.

Contact details for the education teams at Environment Canterbury and the Christchurch City Council, and for Waterwatch, are in Appendix 2 on page 91 and 92 of this book.

It is important that you and your students understand why you need to monitor a waterway and what exactly you are looking for. There are several reasons to undertake water monitoring with your class.

- To begin an ongoing record of the health of your local stream, which can be read and added to by future students. In this case it will be important to record your monitoring techniques to ensure consistent results in the future.
- To make comparisons between different waterways, or different stretches of the same waterway. This will open up questions about the possible causes of the differences.
- Simply to expose your students to the river environment and what lives there, and to give them the basic skills of how to monitor water quality.

Why monitor?

Our water needs constant monitoring because water is continuously used and must be of a high quality. Contaminants in the rivers and streams are not always visible – they may dissolve into the water. Harmful bacteria and viruses are also invisible to the naked eye. Left unchecked, contaminants build up and affect the waterways further downstream.

If your students are contemplating a project to improve water quality, it is helpful to do "baseline monitoring". This will give you a record of the health of your stream before you begin the improvement project.

Monitoring and comparing two different waterways or the same waterway in different parts of the catchment (upstream and further downstream) will allow you to explore the impacts of surrounding land-use on water quality.

What to monitor?

Factors that need to be monitored and recorded include:

- Chemical composition (water quality)
- Clarity
- Physical appearance
- River flow (water quantity)
- Sediment type
- Species diversity, especially macro-invertebrates

You will also need to look at local land-use, recreation, and any other activities that may have an effect on what is in the water.

How to monitor?

Students can do some basic observations and, with a few tools, gain an understanding of the state of a stream.

Stream monitoring on-site includes investigating:

Clarity – by viewing a black disc through stream water using a perspex clarity tube. The more difficult it is to view the disc, the more sediment there is and the lower the water clarity.

Water flow – using a ruler, tape measure, calculator, and a tennis ball. The flow indicates the amount of water available in the stream.

Species diversity – by catching invertebrates in a net, placing them into a tray, and counting and sorting them into different species. Low abundance and low species diversity indicate the stream is polluted or habitat is of poor quality.

Stream bank and other activity observation – by identifying and recording riparian vegetation and the slope of banks. Also litter or unusual activities (such as new building going on near the stream) can be recorded.

Following your visit to the stream you may want to continue to monitor your waterway on a regular basis. The stream survey sheet provided will help you to do this.

Note: You will need to decide which aspects you will be able to monitor on a regular basis. Some aspects may not be possible, if you don't have the right equipment or if your local river does not have a safe area for students to visit. Other aspects may be able to be monitored in a simpler way, and some are observable from the riverbanks, such as litter, obvious pollution, and changes in vegetation or land use.

Decide on an appropriate way to record and/or publish your findings.

Some suggestions:

- You may want to link up with your local council, NIWA, or Environment Canterbury officers who also monitor the water in your area. Perhaps the speaker you invited to your classroom is interested in your findings on a regular basis.
- Arrange to publish your findings in the school newsletter or local newspaper.

Preparing for a stream monitoring trip

If you are working with the water education team at Environment Canterbury, they will be able to organise or advise on most aspects of the trip. The main points to consider are listed below.

1) Selecting a site

Distance from school: Whether chartering a bus or carpooling, keep travel time to a maximum of 30 minutes drive each way.

Accessibility:

- shallow water (below knee depth), ideally fast-flowing over gravels (riffle)
- gentle sloping banks
- flat area beside stream to work on
- space for bus or cars to park
- consider students' physical ability levels

Healthy waterway: You can study a degraded stream later for comparison but, ideally, the initial visit will be to a relatively healthy stream containing a variety of stream life.

Plan a postponement date, usually for a week later. Heavy rain on or just before the day will leave the stream unsuitable for monitoring.

2) Equipment

One of each of the following per group of four students:

- sample tray (white plastic, one open compartment).
- specimen tray (white plastic, 12 compartments).
- small net (for example, an aquarium net).
- plastic spoon and/or dropper.
- magnifying glass.
- Stream Monitoring Survey sheet (page 51-53).

- Clarity tube.
- Thermometer.
- Buckets (2 or 3).
- Large tarpaulin(s) in case ground is wet or grass is extra long.
- Didymo control kit (detergent, scrubbing brush, large plastic container).
- Tape measure, metre ruler, tennis ball, stopwatch, and calculator for stream flow activity.

Each student will need to bring:

- Suitable footwear (gumboots, river shoes or old trainers). No bare feet in the water!
- Suitable clothing, including warm jacket, sunhat, and preferably shorts.
- Drink bottle and food.

3) Safety/behaviour issues

At the beginning of your visit, remind students about:

- Walking carefully down to the stream and on slippery rocks in the stream.
- Danger/no-go areas.
- Respect for the environment – we are here to study creatures and their habitat, and will only disturb what we need to, leaving things as we found them.
- Check and leave the site clean (use plastic bags for rubbish).

A sample Risk Analysis and Management System form for your school to adapt and use is available on request from Environment Canterbury.

4) Activites

Three activities can be undertaken in rotation with a larger group (two or three stations, depending on how many trained adults are on hand) or undertaken consecutively with a smaller group.

- **Invertebrate monitoring:** led by Environment Canterbury educator (page 55-56).
- **Temperature, clarity, and habitat assessment:** can be led by class teacher with short briefing and instruction sheet (pages 41, 45-46).
- **Stream flow:** can be third station or whole-group activity at the end, if time (page 53).

Stream Monitoring Survey

Environment Canterbury Regional Council

Name of Waterway: .....

Date and Time of Survey: .....

Class / School: .....

Names of Group: .....

.....

(attach stream photo and map)

In-Stream and Riparian Habitat Survey

Walk along the stream banks and investigate the stream bed, answering these questions to describe the quality of the habitat.

Questions	Score 8	Score 6	Score 4	Score 2	Score
1. Stream flow	Variety of water depths, pools, and riffles	Some variety	Little variety	Stream flows straight and at one depth	
2. In-stream cover for fish	Over half the stream has logs, undercut banks, or plant cover	Up to half the stream has cover – may include in-stream plants	Less than a quarter of the stream has cover	Very little or no cover e.g. stream has artificial banks	
3. Sediment on stream bed	Rocks, stones and pebbles visible – little sediment cover	Up to 25% of the bed has fine sediment; tops of rocks clean	25% - 50% of bed is covered in sediment	Over 75% fine sediment cover; few stones visible	
4. Bank stability	No signs of erosion	Some erosion occurring - up to 25% of bank	25% - 50% of stream bank eroding	Very unstable – over half of bank eroding	
5. Riparian zone – width	Over 4 metres	2 - 4 metres	1 - 2 metres	Less than 1m	
6. Riparian zone – plant types	Native trees and shrubs including very tall trees and understory; grasses at water's edge	Non-native trees or shrubs; some grasses at water's edge	Mainly long grass; a few trees or shrubs	Mown grass or bare ground	
7. Riparian zone - extent of plant cover	75% - 100 % cover	50% - 75% cover	25% - 50% cover	Less than 25% cover	

overall rating

48 – 56 Excellent	36 – 46 Good
24 – 34 Fair	14 – 22 Poor

Total Score

Points for discussion

1. A variety of depths and flow rates provides a greater range of habitat types. Rapids and riffles help oxygenate the water and make good habitat for invertebrates and are good fish-spawning areas. In-stream plants (macrophytes) also perform these functions.

2. Plants, logs and stones in the stream provide hiding places for fish and invertebrates. The banks of urban waterways are often artificially reinforced to prevent erosion, but this reduces habitat for stream life.

3. Near the mouth of a river, it is natural for sediment or silt to occur on the stream bed. Further upstream the bed should be stony. If sediment covers the stones then habitat for fish and invertebrates is drastically reduced.

4. Unstable banks lead to poor water quality due to increased sediment entering the stream. Erosion is caused by wind, rain, and stream flow. It can be made worse by human activities such as building, farming, and clearing of trees and other plants.

5. **The riparian zone is the area immediately around the waterway** that provides a buffer from activities on the surrounding land. Plants up to 30 metres either side of the stream banks can reduce the impacts of flooding, erosion, and pollutants from run-off. The plants also shade the stream, keeping the water cool and providing habitat for birds and winged insects.

Calculating stream flow

Look at the stream and estimate:

How many litres of water are flowing past this point each second?

(It may help to know that a bucket holds 10 litres.)

Write your group's estimates here:

Equipment needed:

Tape measure, metre ruler, tennis ball, stopwatch, and calculator.

Step 1 — Measure stream width

Width ..... metres

Step 2 — Calculate average stream depth

Measure the depth at five points across the stream and take the average. Record the measurement in metres; for example 38 cm = 0.38 m

(1) ..... m (2) ..... m (3) ..... m (4) ..... m (5) ..... m

Total ..... m | **Average depth** (divide total by 5) ..... m

Step 3 — Calculate area of the cross-section

Width x Depth = Area | **Width** (from step 1) ..... m x **Depth** (from step 2) ..... m | = **Area** ..... m^2

Step 4 — Calculate the velocity (speed) of the water flow

Measure 10 metres along the stream bank, and mark the start and finish points. Use a stopwatch to measure how long a tennis ball takes to travel 10 metres down the stream. Repeat five times across the stream and calculate the average time in seconds.

(1) ..... seconds (2) ..... seconds (3) ..... seconds (4) ..... seconds (5) ..... seconds

Total ..... seconds | **Average time** (divide total by 5) ..... seconds

Distance ÷ Time = Velocity | 10 m ÷ ..... seconds = ... m/sec (metres per second)

Step 5 — Calculate the flow of the stream

Multiply the **area** by the **velocity**. | Area (from step 3) ..... m2 x Velocity (from step 4) ..... m/sec

= Flow ..... m3 / sec (cubic metres per second, or cumecs)

One cumec = 1000 litres so multiply by 1000 to convert the flow into litres: ..... litres

Whose estimate was closest?

Points for discussion

1. Stream flow varies throughout the seasons. In **surface-fed streams** and rivers, snow melt from the mountains increases the flow during springtime. These waterways have lower flows in summer, especially after prolonged periods of low rainfall (drought). **Spring-fed streams** are also affected by drought because of lower recharge of the aquifers and increased abstraction of groundwater for irrigation.
2. Low water flows can cause an increase in water temperature and concentration of nutrients and pollutants. In times of low flow, deep pools are important as they provide habitat for fish.
3. During high flows, sediment may be removed and pollutants diluted but strong floods can also wash invertebrates away.

Identifying different species

Look carefully at the samples you have found to see how many species you have. The greater variety of species, the healthier your stream, especially if you have a lot of sensitive species.

Many of the species shown here require a hard-bottomed, stony stream bed as suitable habitat. If the bed is covered with silt, there will be different invertebrates present, for example more worms and fly larvae.

Here are some clues to help you tell the difference between invertebrate species.

Mayfly larvae have three tails and gills on their abdomen that move to allow them to breathe better.

Dobsonfly larvae (toebiters) are distinctive, with six legs at the front and many sets of breathing tubes (gills) along their body. They will vary in size from 10 – 30 mm.

Caddis fly larvae have legs at the front of their bodies. There are over 160 species of caddis.

Fly larvae are a diverse group. Some types (e.g. Chironomids, the non-biting midges) can tolerate poor water quality, while others are less tolerant.

Cased, stick, and purse caddis carry their home around with them like a hermit crab.

Free-living caddis have a hook at the end of their bodies.

Beetle larvae have a thinner body than uncased caddis fly larvae, with fewer segments. Their tails are tufted rather than hooked.

Crustaceans include any invertebrates with more than six legs, including freshwater crayfish (koura), shrimps, and water fleas, which are tiny and move quickly.

Snails come in a variety of shell shapes and sizes from 3 – 12 mm.

The species you find will be smaller than the pictures. You may need a magnifying glass.

In spring, the larvae will be much smaller than in summer or autumn because cold water temperatures slow down growth.Mature larvae hatch into winged adult insects and fly away to find mates all through the year.

See if you can find any adult mayflies, caddisflies, or other species on the stones and plants beside the stream.

Invertebrate Survey

Transfer each invertebrate from the sample tray to the specimen tray, using the plastic spoon and/or dropper. Use the compartments of the specimen tray to separate different species for identification and counting.

Type of invertebrate		Number of specimens	Sensitivity Score (circle the ones you have)
Mayfly larvae – "flat"			3
Dobson fly larvae – "toe-biter"			3
Free-living caddisfly larvae			3
Smooth-cased caddisfly larvae			4
Stick-cased caddisfly larvae			3
Stony-cased caddisfly larvae			3
Beetle larvae			2
Cranefly larvae			2
Dragonfly larvae			2
Damselfly larvae			2
Crustaceans			2
Purse caddisfly larvae			1
Snails			1

Type of invertebrate		Number of specimens	Sensitivity Score (circle the ones you have)
Water boatmen			1
Worms			1
Non-biting midges			
BlackFly larvae (e.g Sandfly)			1
Other invertebrates	(name, describe, or draw)		
	(name, describe, or draw)		
	(name, describe, or draw)		
Fish	(name, describe, or draw)		
	(name, describe, or draw)		
	(name, describe, or draw)		
		Total Sensitivity Score (add up all circled numbers)	

overall rating		
	Over 20 – Excellent	15-20 – Good
	6-14 – Fair	5 or under – Poor

Water quality testing

Temperature

Use a thermometer to measure the water temperature. Fill a bucket with water and place the thermometer in the bucket. Take three readings from different parts of the stream and calculate the average.

Reading 1: _____ º C Reading 2: _____ º C Reading 3: _____ º C

Average temperature (total ÷ 3) = : _____ º C

Stream-dwelling invertebrates and fish have a specific range of temperatures they can live in. In New Zealand, aquatic invertebrates have adapted to cold water (below 12º Celsius), and start to struggle once the water gets over 16º Celsius. High water temperatures reduce the amount of oxygen in the water, which can affect the survival of aquatic insects and fish.

Rating	Excellent	Good	Fair	Poor
	below 15º C	15º C – 18º C	18º C – 20º C	above 20º C

Water Clarity

Use the clarity tube to measure how clear the water is:

- Fill a bucket with water and empty into the clarity tube. Make sure the tube is clean, and get rid of any air bubbles.
- Put the magnet with the black disc on the inside of the tube, the second magnet on the outside, and fit the rubber cap
- Hold and look through the clear end of the tube while a partner holds the other end and slides the magnet towards you.
- When you can see the black disc, slide it away from you until it disappears and then back towards you. When the black disc is just in view, take the reading from the side of the tube.

Reading 1: _____ cm Reading 2: _____ cm Reading 3: _____ cm

Average clarity (total ÷ 3) = : _____ cm

Clarity is an important aspect of stream health. A low reading on the clarity tube means there are a lot of suspended particles in the water. The particles may be sediment from erosion or run-off, or pieces of algae or decomposing plant matter. Sediment can smother the algae that invertebrates need for food, and can clog fish and insect gills, preventing them from breathing.

Rating	Excellent	Good	Fair	Poor
	80 – 100 cm	60 – 80 cm	40 – 60 cm	0 – 40 cm

Depth of sediment

Sometimes even though the water itself is clear, the stream bed may have a layer of fine silt deposited as sediment. This reduces the available habitat for fish and invertebrates. Use a metre ruler to measure the depth of sediment on the stream bed.

The velocity of the water will influence how much silt settles on the stream bed – at lower flow speeds the water will deposit more sediment.

Rating	Excellent	Good	Fair	Poor
	Less than 5 cm	5– 10 cm	10 – 30 cm	More than 30 cm

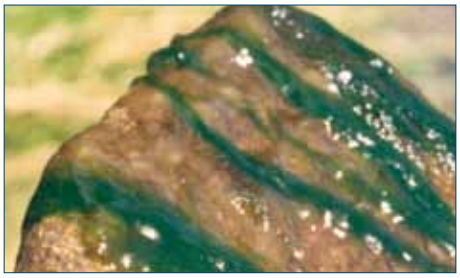
Algae

Pick up some stones from the bottom of the stream and look at the slimy layer on the surface. This is algae (tiny plants that live in the water). The amount of algae present in the water can indicate water quality. Look at stones from an unshaded area of the stream bed, as algae don't like the shade.

- A thin layer of algae on the surface of stones provides food for invertebrates.
- Algae can range in colour from dark brown, to brownish-green, to bright green, depending on which types of algae are present.
- The thickness of algal growth is affected by the frequency of flood flows, which clean out the waterway, how much sunlight reaches the stream bed, and the levels of nutrients in the water.
- Long strands (filaments) of algae can also indicate that too many nutrients have entered the water from the surrounding land.
- Too much algal growth (blooms) can clog waterways, depleting oxygen and smothering habitat.

Rating	Excellent	Good
	thin film	medium film

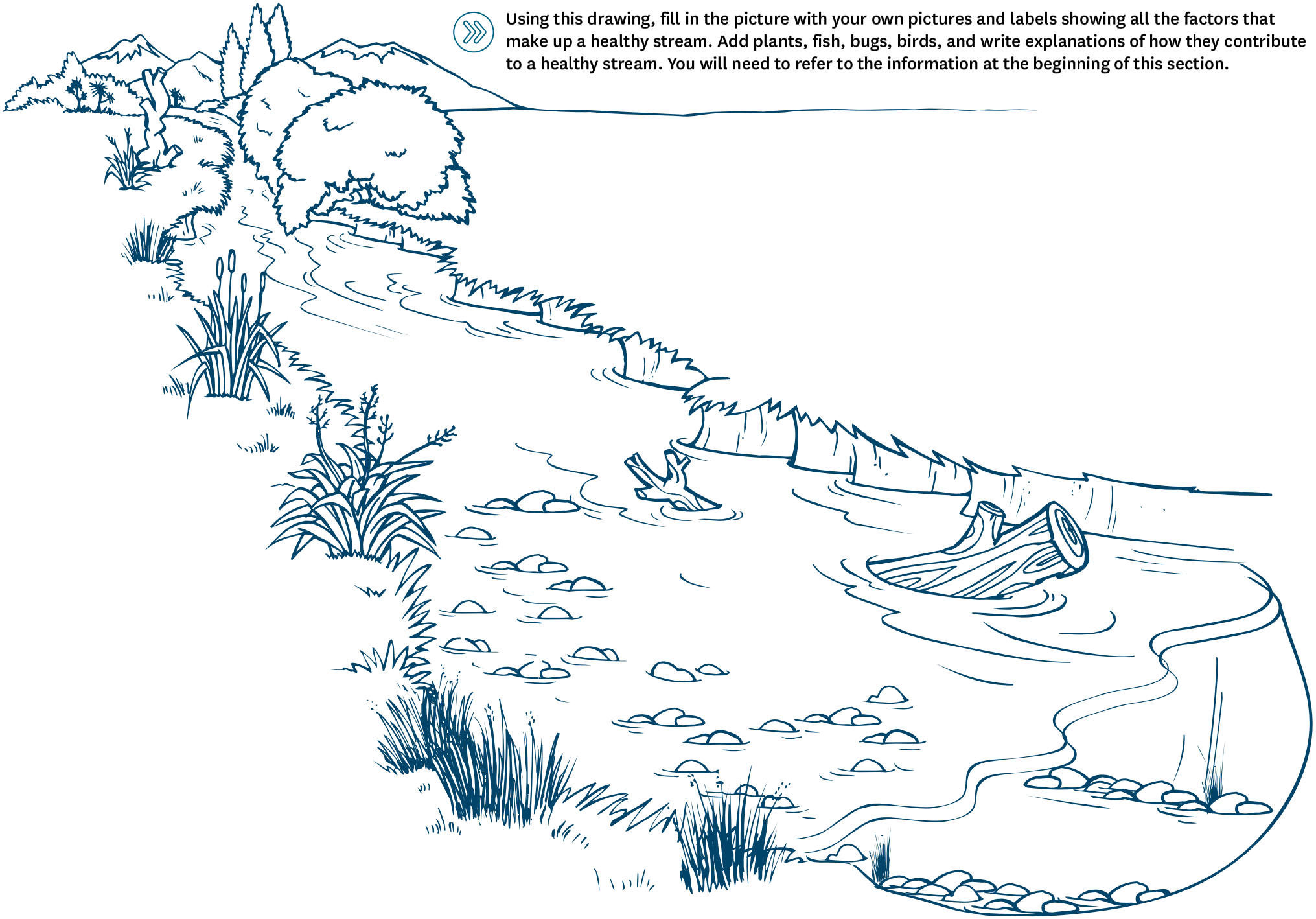
Fair	Poor
thick mat	long strands



Did you know?

Algae form the basis of all aquatic food-chains and make over three-quarters of the oxygen produced on Earth.

Using this drawing, fill in the picture with your own pictures and labels showing all the factors that make up a healthy stream. Add plants, fish, bugs, birds, and write explanations of how they contribute to a healthy stream. You will need to refer to the information at the beginning of this section.



Section 4:

Discovering your local waterway

If your school has been selected by Environment Canterbury as part of the Living Streams water education programme, you will receive a separate resource that identifies the river or stream catchment area near your school. It will outline the history of water quality in your waterways and the issues that currently face them. If you are not in an area that has been covered as part of the programme at this stage, you are encouraged to choose a local waterway and research its history to discover any issues it currently faces.

This stage of the programme is a good time to invite speakers who have knowledge of the local history and uses of the waterway. The water educator will help you here.

Section 4: Discovering your local waterway

Where to start, what to do?

Begin at your local library. Gather as much historical information about your area as you can and sift through the information to find references to your local river.

Contact any other organisations that might be able to provide information, for example, your local district or city council, DOC, NIWA, Fish and Game, local information centre, museums, local runanga, local people with an interest in their waterway.

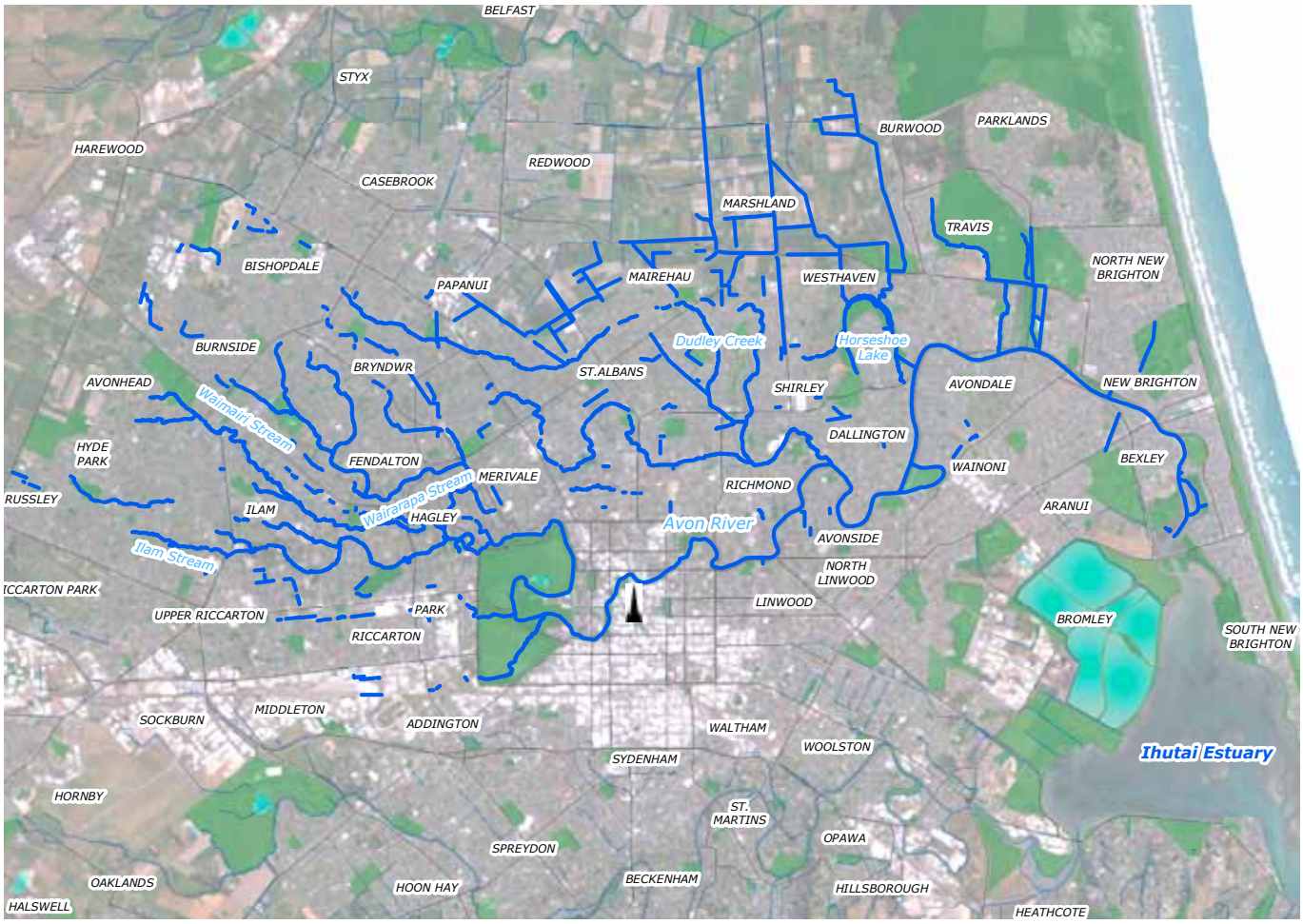
Invite guest speakers from your local community to your classroom, for example, people from your local council, Environment Canterbury, members of local care groups, local historians, people who live and work in the local area, such as business owners, farmers, members of the local runanga, parents of students, and anyone who has an opinion on the local waterway.

Present your findings in a way so that other groups interested in your local waterway can use them. You could make a large scrapbook and include pictures, anecdotes from guest speakers, maps and historical information, as well as thoughts from your own students, their families and friends.

What to find out

- What did it look like in the past?
- What was it once used for?
- Where does it begin and end?
- Try to locate a good map
- What river is it a tributary of?
- What streams are tributaries of your river?
- What type of river is it (spring-fed, rain-fed, braided, single channel)?
- What businesses or industries once operated alongside your river?
- Do they still operate now?
- How does industry use the river (water uptake, irrigation, as a waste outlet)?
- What do people use the river for today?
- What's the quality of the river like now?
- Do local people care about the river?
- What do they think of it?
- Do local people like, enjoy, or take pride in their river?
- Is it considered degraded, polluted, or contaminated?
- If so, what is causing the degradation?
- Who is responsible for managing the waterway?
- What is being done to improve or maintain the waterway?

Avon/Ōtākaro



Avon/Ōtākaro

Where is it?

The Avon/Ōtākaro is one of two major rivers that flow into the Avon-Heathcote Estuary/Ihutai.
It winds 26 km from its source in Avonhead through Ilam, Riccarton, Fendalton, Hagley Park and the Central City. From here, it continues east through Avonside, Dallington and Aranui and into the Estuary near South Brighton. The entire Avon/Ōtākaro catchment covers about 84 square kilometres, nearly all of it urban in nature.

Major tributaries of the Avon/Ōtākaro include Wairarapa Stream, Waimairi Stream, and Dudley Creek, all of which are predominantly spring-fed streams. Water quality in the upper reaches of the Avon/Ōtākaro and its tributaries reflects the quality of water in the aquifers which feed the springs. However as the river flows on through the city, water quality is affected by the activities of people in the City.

History

Ngāi Tahu people had sites that they used for gathering food and a number of settlements sited along the banks of the Avon/Ōtākaro from Wairārapa (a site near Ilam) all the way through what is now the Central City, to Te Oranga, near Horseshoe Lake.

Māori had a number of different names for the Avon/Ōtākaro. In its lower reaches it was called Ōtākaro (a place to play) or Orotere (swamp) and Wainoni (winding water). Further up it was called Haere roa (long wanderer) and Rakipaoa (Smokey Sky). The Waimaero (now known as the Waimairi Stream) was named for its deep water. The springs in a reach of the Waimaero stream were highly valued for their good water which was used by Tohunga for ceremonies and healing purposes.

Christchurch was settled by the English and the names of many of our rivers, parks and even of the City itself come from places in England that the settlers wanted to commemorate. The settlers also brought many species of plants and trees (e.g. lawn grasses, oak trees) which have been used in Christchurch parks so that they look a bit like parks in England. The replacement of native plants such as harakeke and raupo with lawn grasses and European trees has also made our rivers look more like English rivers.

However, while English heritage is an important part of the City's history, Christchurch people are starting to recognise that New Zealand natural heritage is also important. As an international tourism destination, it is clear that international visitors want to see landscapes that make the City and New Zealand different to other places overseas as well as landscapes that are familiar. These shifts mean that native plants are now being planted on our stream banks and in our parks.

The shift towards naturalised waterways and greater use of native vegetation also reflects the "multi-value" approach that has developed in waterway management. A waterway's drainage function used to be the primary consideration. Nowadays ecology, landscape, heritage, culture and recreation are all managed for, as well as drainage.

Ecology

As an urban river, the Avon/Ōtākaro has been modified a lot as Christchurch City has developed on its banks and in its catchment. Many parks and private lawns line its banks, along with impervious paths and roads. In some places native vegetation has been planted.

The lower reaches of the Avon/Ōtākaro are affected by tidal action. In these parts of the river, water levels, the rate of water flow and salinity (saltiness) are all constantly changing.

Fish

The river, and its tributaries, are home to a number of fish species including three different species of bully (upland, common and bluegill), longfin and shortfin eels, inanga, yellow eyed mullet, brown trout and lamprey.

Many fish need places where they can take shelter under the banks or under vegetation on the banks. Long grasses and water weeds are ideal for this. Restoration work in the Avon/Ōtākaro is good for attracting fish. Where there is overhanging vegetation that provides shade and shelter, more fish are found.

Studies have shown that increasing amounts of fine sediment entering the Avon/Ōtākaro and settling on the river bed have reduced the number of places that are suitable for fish, such as brown trout, to lay their eggs. This fine sediment comes from dirt washed off roads and driveways as well as discharges of dirty water from construction sites and is likely to be causing a reduction in the number of fish seen in the Avon/Ōtākaro. Compared with sedimentation, chemical spills rarely occur in the Avon/Ōtākaro and therefore has relatively little effect on the lifecycles of fish.

Invertebrates include insects and other animals such as snails, worms and crustaceans. In the Avon/Ōtākaro, there are only a small number of species that are common. Overall, the diversity of invertebrates in the Avon/Ōtākaro river appears to be decreasing, despite the restoration work that has occurred. Research completed in Okeover Stream, a tributary of the Avon/Ōtākaro, indicates that culverts under roads stop insects flying along the river. The long distances that the stream runs through culverts, with no riparian zone, effectively stops insects returning to the newly-restored pieces of stream.

Fine sediment on the river bed also reduces the variety of habitats for invertebrates to live in and only those species that can tolerate fine sediment can survive.

Plants

The plants that grow in the water and on the banks of the Avon/Ōtākaro are gradually changing and in many cases are being replaced by introduced aquatic plants and weeds. In some places weeds such as the yellow flag iris are invading the river banks and making life difficult for other native plants. The best place for native aquatic plant communities in the Avon/Ōtākaro is between Salisbury St and the Antigua Boatsheds where the river is relatively fast-flowing with a gravel bottom.

Tributaries of the Avon/Otakaro:

Naturalising Frees Creek

A number of waterways are being naturalised into creeks with sloping banks and re-planted with native plants. One such restoration project is Frees Creek, a tributary of the Avon/Ōtākaro. Until about 1900, Frees Creek/Ōtautahi was a large stream with several branches. It was one of the creeks that drained a 2,000 acre swamp centred around what is now St. Albans. The Creek was important to Māori as a water collection area, and large springs bubbled up near what is now Rehua Marae in Springfield Rd.

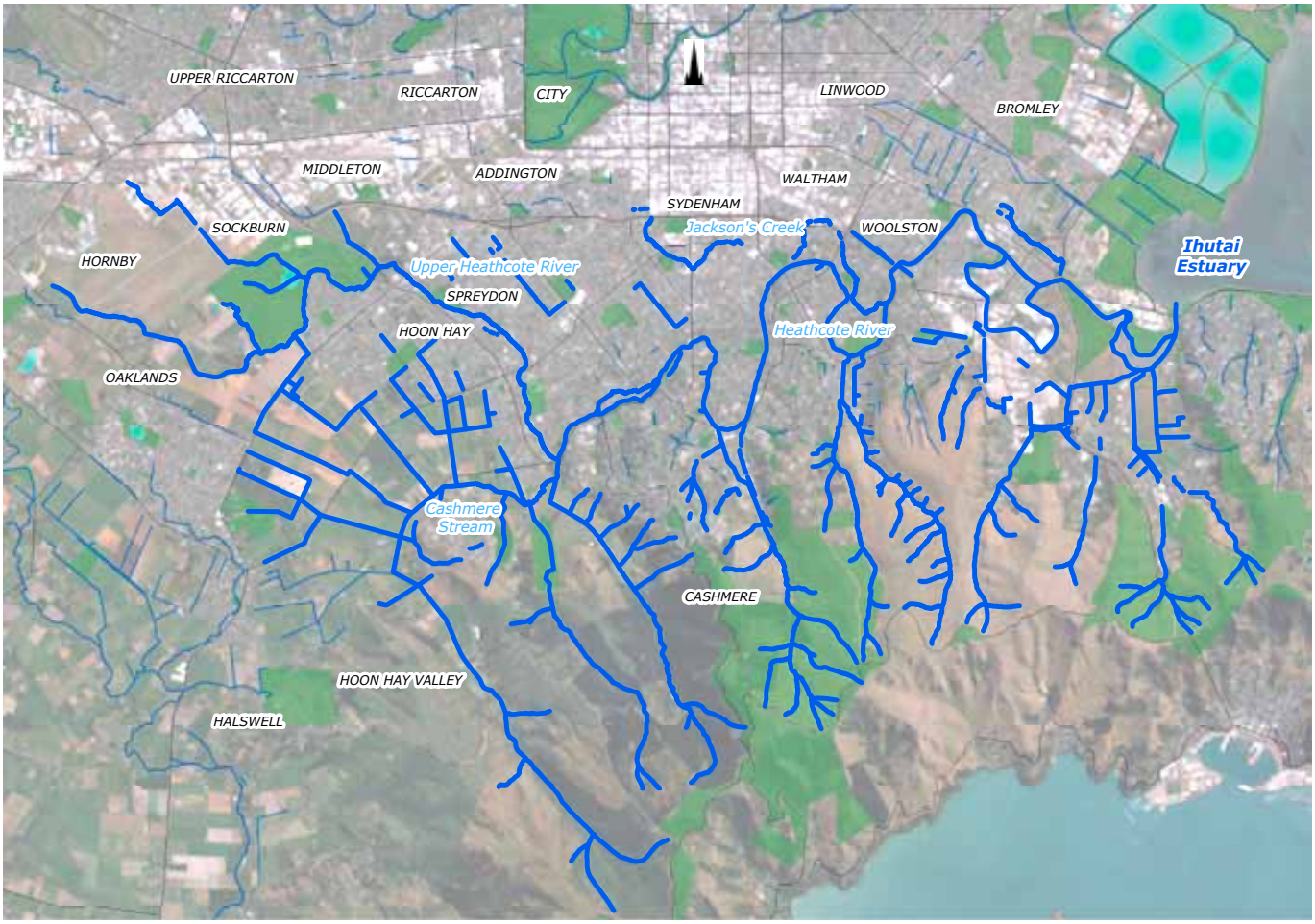
Drainage works over a century or so had turned the creek into a wooden box drain with very little water flowing in it. In 1996, the Council and the Marae took out the wooden boxing and dug the stream a winding channel through the grounds of the Marae. The stream sides were re-planted with a range of native wetland plants including harakeke and toetoe which can be used by Māori weavers. Stream flow was improved by tapping into an artesian bore found on the site. The river is now an important landscape feature that acknowledges the cultural and natural heritage of the creek. The plantings provide weaving resources for the Marae and an improved creek habitat for the plants and animals that live there.

Okeover Stream restoration project

Another tributary of the Avon/Ōtākaro is Okeover Stream. Over time, building developments in the vicinity of the creek have degraded the stream. Water flows have decreased as the water table has dropped and this in turn has increased the amount of sediment on the stream bed.

Interested people from the University and local residents have been carrying out a restoration programme that included riparian planting, habitat reconstruction and a programme to manage aquatic weeds. This has improved the stream habitat and the water flow. The creek is now seen as an attractive landscape feature, and has provided students with the opportunity to research the effects of the restoration process.

Heathcote/Ōpāwaho



Heathcote/Ōpāwaho

The Heathcote/Ōpāwaho is made up of water from springs and from creeks that run off the Port Hills. The river begins in the area of Templetons Road where there are some large springs, and it also receives wet weather flows from as far west as Pound Road. It flows through Hoon Hay and Spreydon, then it meets the sizeable Cashmere Stream before flowing through Cashmere, Beckenham, St Martins, Opawa and Woolston. It drains into the Avon-Heathcote Estuary/Ihutai at Ferrymead.

Haytons and Curletts Road streams feed into the upper reaches of the Heathcote/Ōpāwaho. For most of their length, they are straight, timber-lined drains vulnerable to industrial pollution.

History

Ō-pā-waho means Outpost pā. It refers to a pā sited just downstream of the present Opawa Road Bridge at what is now the intersection of Judges St and Vincent Place. The Ōpāwaho pā was used by Ngāi Tahu, who used the Heathcote/Ōpāwaho River to travel between Kaiapoi and Te Pātaka o Rakaihautu (Banks Peninsula).

The surrounding area was an important mahinga kai, a source of plentiful food, especially tuere (blind eel) and kanakana (lamprey). The swamp forest around the river provided gathering grounds for water fowl and forest birds. Traps were regularly set for inanga, pātiki and tuna.

In its upper reaches, near Wigram Airfield, the Heathcote Ōpāwaho is close to the headwaters of the Halswell River. Ngāi Tahu travellers used to drag their canoes across this gap, thus being able to travel by water from Waihora (Lake Ellesmere) to Otautahi (Christchurch).

The English name for the river comes from Sir William Heathcote, secretary of the Canterbury Association. The Heathcote/Ōpāwaho was important for shipping in the early days of settlement. It also presented a problem for early colonists who found that bringing goods to Christchurch from Lyttelton was difficult and expensive.

Ships came up the Heathcote/Ōpāwaho but first they had to make it through the mouth of the Estuary. The shape of the mouth changed constantly as sand shifted with the currents and tides, making it very dangerous. Many ships sank whilst trying to get in through the mouth.

Once they had made it into the Heathcote/Ōpāwaho, the sharp bends in the river and the wind from the hills and the swamp flats made navigating difficult. A towpath 25 feet wide was built on each side of the river so that bullocks and horses could pull the ships through the most difficult sections. Once the railway to Ferrymead was opened in 1863 and the Lyttelton Railway Tunnel was opened in 1867, the role of the Heathcote/Ōpāwaho in transport diminished greatly. The towpath has recently been restored as a walkway and native plants have been cultivated along it.

Early industry developed along the lower Heathcote Ōpāwaho and the Lyttelton railway line. Industrial waste was pumped into the river, making the water murky and unattractive. In 1970, the Christchurch Drainage Board (CDB) built a trade waste sewer which collected these wastes and pumped them to the Christchurch Wastewater Treatment Plant at Bromley.

Natural history

Before Christchurch developed, the Heathcote/Ōpāwaho wound through extensive wetlands full of flax (harakeke), toetoe, raupo, tutu and ferns and was dotted with ti kouka (cabbage trees) and tussock. The river corridor was low-lying and very wet. The only remnant of the marsh that remains today is the Beckenham Ponds, formed from natural springs in Beckenham Park.

The Heathcote/Ōpāwaho is fed by a number of springs, as well as streams that run off the Port Hills. This means that it currently has more sediment problems than does the Avon/Ōtākaro but it probably always carried a little more sediment due to the easily eroded soils on the hills. The wetlands and vegetation along the side of the Heathcote/Ōpāwaho and the forest growing on the hillsides would have ensured that this sediment loading was minimal. Removal of hill vegetation and construction on the hills has considerably increased the sediment load to the Heathcote/Ōpāwaho and its major tributary, Cashmere Stream.

Cashmere Stream

Cashmere Stream is an important tributary of the Heathcote/Ōpāwaho. It is a spring-fed waterway that also collects water from creeks running off the Port Hills. It flows into Heathcote/Ōpāwaho on the south-west edge of Christchurch. It runs along the base of the Hills, collecting water from its main hill tributaries Hoon Hay Valley, Worsleys Road and Cashmere Valley streams as well as from streams draining farmland in Hendersons Basin. At least 14 springs found in Hendersons Basin feed into Cashmere Stream. Altogether, its catchment has about 51 km of natural waterways and artificial drains.

The mid Heathcote/Ōpāwaho winds around the base of the Port Hills. Its route and character are influenced by the hill catchments. Tributaries that feed into the mid Heathcote/Ōpāwaho River include Couling Creek and Cashmere Brook. These creeks and Cashmere Stream contribute a lot of sediment to the Heathcote/Ōpāwaho. Sedimentation would occur even without help from humans but the rate of sedimentation increased significantly when people cleared the Port Hills of the natural vegetation and began farming activities. In recent years sedimentation has increased significantly yet again because of urban development in the catchment.

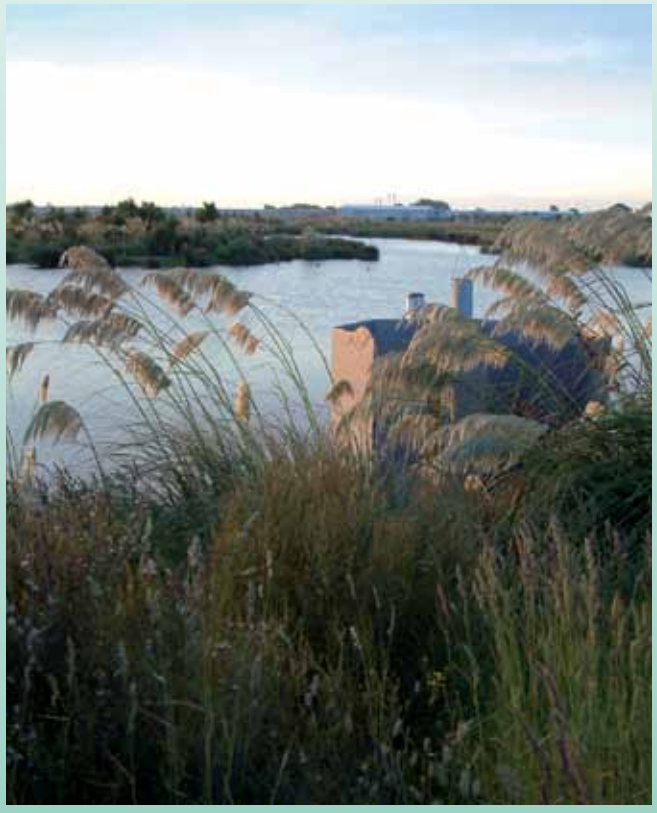
The Christchurch City Council has done a lot of work over recent years to replant native plants along the edges of the Port Hills creeks to slow erosion and filter runoff from the hills before it goes into the creeks. The Cashmere Stream Care group have also been involved in riparian planting and restoring the banks of the Cashmere and its tributaries to cut down the amount of sediment getting into the stream.

Further downstream, Wilderness and Jackson streams flow into the Heathcote/Ōpāwaho. These two tributaries collect stormwater from residential and commercial land in the flat areas of Sydenham and Opawa.

Hydrology

In the past few decades, the Heathcote/Ōpāwaho River has seen some significant changes in its flow regimes. Flooding has been a continuing problem in the lower reaches of the Heathcote River, so in 1986 the Woolston Cut was opened to allow water to bypass a big loop in the natural course of the river. This cut has changed the lower reaches of the river both in terms of the volume of water flowing in the natural channel, and in terms of the salinity of the water.

Flood retention basins have been constructed in the upper reaches of the river. Instead of immediately flowing into the river, water is instead held in ponds. As a result, floods in the Heathcote now have lower peaks. This is good for people living close to the river, and it means that there is less chance of unwanted sediment being flushed down the river in a flood.



In-stream plants

The Heathcote/Ōpāwaho catchment's aquatic plant life has changed significantly since 1980. The plants have changed from mainly filamentous green algae that floated in or on the water, to being mainly larger, leafy, introduced plants like the curly leaved pondweed or pond water starwort. These are attached to the bottom and tend to clog up the river, slowing down the water flow and holding sediment in place so that it is no longer flushed out when there is a flood.

The sedimentation of the river from the many building development projects over the past few years has been an important part of this change. The algae found in the river in 1980 grow best where the river bottom is gravel. Now that the gravel has been covered in sediment, and that sediment is held in place by the plants, the river is unlikely to return to its former state naturally.

Invertebrates

The invertebrate fauna of the Heathcote/Ōpāwaho River appears typical to that found in other urban streams. It is dominated by worms, two species of snails, two kinds of crustaceans, and midges.

Fish

The fish found in the Heathcote/Ōpāwaho are similar to those found in the Avon. Different species of bullies, trout, eels and whitebait have all been observed in the Heathcote/Ōpāwaho over the last 5 years. The amount of sediment entering the Heathcote/Ōpāwaho and settling on the river bed have reduced the number of places that are suitable for fish to lay their eggs.

Freshwater mussels have been found in Cashmere Stream, although it appears that there are very few young mussels. The larvae of these New Zealand natives depend on native fish such as bullies for part of their life cycle. The larvae hitch a ride on the fish, eventually dropping off to burrow into the streambed and grow.

Koura (freshwater crayfish) are also found in Cashmere Stream, which is unusual for a waterway in an urban area. These koura are therefore of high ecological and local conservation interest. Koura play an important role in ecosystems where they are present by increasing organic matter processing, reducing fine sediment cover through moving and mixing sediments on the stream bed (known as bioturbation), and therefore influencing the habitat and food sources for other invertebrate species. Native riparian planting appears to be an important factor in maintaining populations of this important and rare species.

Avon-Heathcote Estuary/Ihutai

What is an estuary?

An estuary is a coastal body of water with one or more rivers or streams flowing into it, and with a free connection to the open sea Many estuaries are protected from the sea by sand banks or sand spits. The water in an estuary is a mix of seawater and fresh water. Estuaries typically trap nutrients, sediments and other contaminants that enter the estuary, both from their rivers and the sea.

The Avon-Heathcote Estuary/Ihutai is at the mouth of the Avon/Ōtākaro and Heathcote/Ōpāwaho rivers. It opens to the sea near Sumner, where sea water flows in and out of the estuary with the tide. It is about 700 hectares in size and is highly valued for its variety of bird life, as a source of mahinga kai, as a recreational playground for sailors, kayakers, fishers, walkers and cyclists, and as an educational resource.

The Estuary is surrounded by the suburbs of Redcliffs, Monks Bay, Ferrymead, Bromley, New Brighton and South Shore. South Brighton is built on the sand spit that encloses the estuary.

Who looks after the estuary?

The estuary is looked after by a number of organisations including the Avon-Heathcote Estuary Ihutai Trust, the Christchurch City Council, Environment Canterbury, the Christchurch Estuary Association and in the past the Friends of the Estuary.

Natural history of the estuary

Estuaries are places of great change – change that happens over a range of time scales. The coastline associated with the Avon-Heathcote Estuary/Ihutai has shifted and changed over the past 8000 years. Sea level has risen and fallen as a result of a series of mini ice ages, and the build up of sand and gravel from the Waimakariri and Ashley/Rakahuri Rivers has contributed to these changes.

Only 1000 years ago, the sand spit did not exist and the Avon/Ōtākaro ran into the northern end of Travis Wetland, which was a shallow protected bay. At this time, the Heathcote/Ōpāwaho flowed directly into the sea.

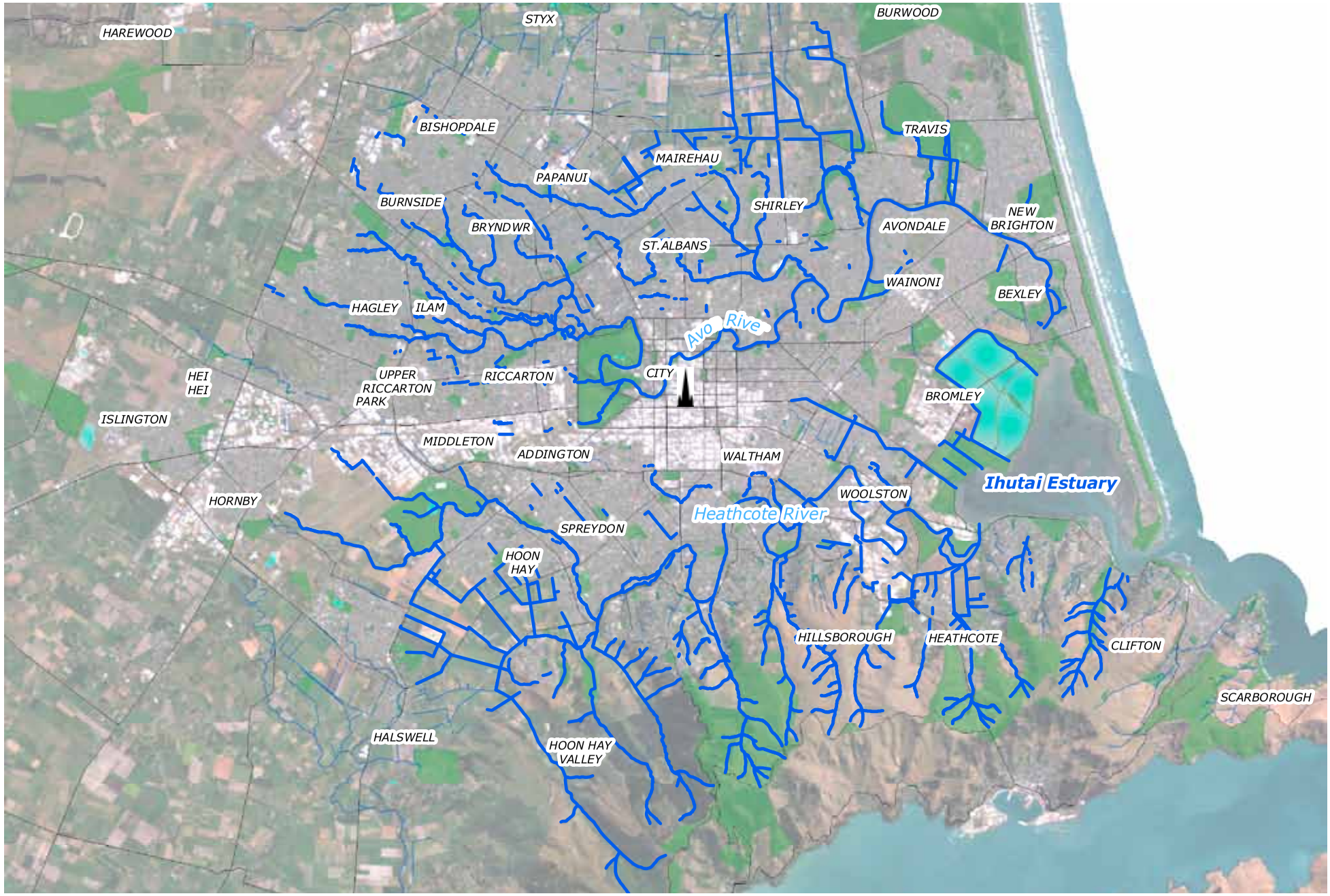
Now, of course, there is a sand spit which contains the Avon-Heathcote Estuary/Ihutai, and both the Avon/Ōtākaro and Heathcote/Ōpāwaho rivers flow into the estuary.

Change also occurs on smaller scales. The estuary is affected by human activity such as drainage and changing sediment loads that come from building sites in the City. Pollution and contaminants from human activities during the past 150 years have also affected the estuary. Seasonally, the Avon/Ōtākaro and the Heathcote/Ōpāwaho bring down differing amounts of fresh water, pollutants and sediment. On each tidal cycle, that is about twice each day, 11 million cubic metres of salt water flow in and out of the Avon-Heathcote Estuary/Ihutai.

The ecology of the estuary

Like other estuaries, the Avon-Heathcote Estuary/Ihutai is a highly productive ecosystem. Estuaries produce about four times as much biomass per square metre as good New Zealand pasture.

A wide range of different plants and animals live in the estuary and a wide range of environmental conditions are found around it. The tides, salt concentrations, different kinds of sediments and the speed of currents all affect the plants and animals living in the estuary.



Greater Ihutai Estuary

Human settlement

Archaeological evidence suggests that Māori settled the South Island at least seven centuries ago. Māori whakapapa suggests that it was 44 generations ago –considerably longer than 700 years. For those who settled in the Canterbury area, the Avon-Heathcote Estuary/Ihutai was a rich source of tuna (eel), kanakana (lamprey), inaka, pātiki (flounder) and pipi. Kōmara and aruhe (edible fern root) were grown in the sandy soils at the mouth of the Avon/Ōtākaro. The estuary also provided access to all the rivers and waterways, an important means of transport to the various settlements and mahinga kai in the wider Christchurch area.

For Europeans too, the estuary was an important transport link. Fishing vessels, schooners, steamers, paddle steamers and whaleboats all used for trade and shelter even though the sand

Tides

Anything living between high and low tide mark must cope with very big changes in environmental conditions on a daily and seasonal basis. Plants growing in tidal areas on the edge of the estuary are submerged for some of the time, and exposed to the air for some of the time. The plants growing in this zone, in fine mud or clay, may also have to put up with a decreasing amount of oxygen getting to their roots as the tide recedes and the clay forms an airtight seal as it dries out. Although the tidal water movement creates challenges for the plants and animals living in the estuary, it also brings in a wide range of food and oxygen which contributes the high levels of productivity mentioned above.

Saltiness of the water

Water saltiness or salinity affects what lives in the water and what lives and grows on the mudflats and at the water's edge around the estuary. Understanding how the salinity changes with the tides is an important part of understanding the ecology of the estuary and the lower reaches of the two rivers. Salinity influences the ecology of the rivers as far up as Kerrs Reach on the Avon/Ōtākaro and as far as Tennyson St up the Heathcote/Ōpāwaho.

Over the course of a tidal cycle the freshwater mixes with salt water as the tide moves in and out of the estuary. Wind also affects the way that the waters mix: on a windy day the salt and fresh water are well mixed, whereas on a calm day the waters tend to stay separate, with the heavier salt water lying below the fresh water in what is known as a "saltwater wedge".

Salinity also differs considerably between the high and low tide marks. Evaporation when a mudflat is exposed to air can increase the salinity of the mud, so that in some places salt concentrations in the mud can be greater than those found in seawater. Any plants growing where the evaporation is greatest must be very salt-tolerant.

Animals that live in the water or the sediments of the salty estuary mouth are also able to live on the open seashore. In comparison, the animals found further into the estuary, such as mudflat snails and tunnelling mud crabs, have to be more tolerant of the constantly changing salinity.

Sediments

Another important aspect of the ecology of the estuary is the distribution of different sediments around the estuary. Fine sediment, such as mud and clay, tends to occur around near the mouths of the two rivers and along the western side of the estuary. The mudflats around the mouth of the Heathcote/Ōpāwaho tend to be more silty than those around the Avon/Ōtākaro River mouth (and have been since before European settlers arrived). Sand predominates around the mouth of the estuary and along the sand spit.

Glasswort

Vegetation

There are a range of vegetation types around the estuary. Salt marsh is an important plant community found above mid-tide and up to about high tide mark. The plants growing here can cope with a wide salinity range and with being exposed to the air for considerable periods each day. The plants that grow here are small things like glasswort, sea blite, cord grass and sea rush. Further up the shore the vegetation changes to include larger plants. As water salinity decreases with distance up each river, the vegetation changes to comprise much taller rushes, sedges and grasses that grow in fresher water.

Below mid-tide

Although seaweeds can tolerate a lot of salt, most of them cannot tolerate being dried out, so few seaweeds grow above the mid-tide level. Eelgrass (or Zostera) is the only flowering plant in New Zealand that lives below the mid-tide mark and to do this it has evolved to behave more like a seaweed. Eelgrass absorbs nutrients through its leaves rather than through its roots like other flowering plants. Its roots are mostly there to hold it in place. Eelgrass was once common in the estuary but over the years the eelgrass beds have gradually diminished in size.

Animals

Crabs: About 10 species of crab can be found in the Avon-Heathcote Estuary/Ihutai. Perhaps the easiest to find are the tunnelling mud crabs which dig holes down into the mud between mid and high tide levels. These holes are like little wells that are a water-filled refuge for the crab to descend into when the tide goes out.

Molluscs: About 50 species of molluscs live in the Avon-Heathcote Estuary/Ihutai. These include a group called the gastropods. These are animals like limpets, snails, sea slugs, periwinkles and whelks. This group can live on the rocks or on the mud. The mudflat snail is found only in New Zealand. These snails are very unusual because they can absorb oxygen from the air, whereas other sea snails absorb it from the water through their gills. Mudflat snails feed on tiny organisms – single celled algae, bacteria and small animals that they pick up as they chew their way across the surface of the mud.

The other group of molluscs in the Estuary are the bivalves – animals that have two hinged shells, such as cockles or pipi. These animals are filter feeders, filtering food out of the water.

There are huge numbers of cockles in the estuary and they are important members of the estuarine community, providing food for many animals and also providing something for barnacles and mudflat sea anemones to grow on. Pied oystercatchers eat about 76,000 cockles per year each, which adds up to an estimated 214 million cockles per year for the whole flock – and this is only pied oystercatchers! There are many other bird species also feeding in the Avon-Heathcote Estuary/Ihutai, which shows just how productive this estuary is.

Fish: 28 species of fish have been noted in the Avon-Heathcote Estuary/Ihutai but only a few are common. These include sand flounder, yellow bellied flounder, herrings, kahawai, globefish, common sole, common bullies and cockabullies. Estuaries are important for the breeding of many fish species because they provide both shelter and a rich source of food. The Avon-Heathcote Estuary/Ihutai is no exception. Sand flounder, yellow bellied flounder and herrings use the shelter of the estuary as a nursery – living and feeding inside it until they are mature.

Other fish, including inanga, brown trout and short-finned eels, pass through the estuary on their way to and from the rivers and wetlands in which they live.

Marine mammals: Although not common, seals and dolphins have both been recorded in the estuary. For example, a group of Hector's dolphins came into the estuary and swam some distance up the Avon/Ōtākaro River in late 2000.

Birds

The Estuary/Ihutai is an internationally important wetland for birds, despite the fact that by international and even national standards, it is not very big. This is because it supports 5-6% of the world populations of South Island pied oystercatchers/torea and New Zealand shovelers/hono. It also supports more than 1% of the world populations of 14 other bird species.

113 bird species have been recorded in the estuary, many of them wetland and wading birds and gulls and terns. Geese, ducks, swans, grey teal/tete, godwits/kuaka, dotterels/tuturiwhatu, plovers, pied stilts/poaka, blue herons, royal spoonbills/kotuku-ngutupapa, and many other birds can be found in the estuary during late summer-autumn.

Few of the birds found in the estuary are there permanently and few birds even nest there. Instead they use the estuary as a place to feed and recover in the autumn and to winter after breeding, as a place to moult, as a gathering point, as a winter quarters or perhaps for shelter during storms.

Many birds use the estuary along with other Canterbury wetland sites between the Waipara river mouth and the Rakaia river mouth. This includes Te Waihora/Lake Ellesmere, Brooklands Lagoon, the Ashley/Rakahuri Lagoon, Lyttelton and Akaroa Harbours, and Lake Forsyth/Wairewa.

Birds often visit the area as part of an annual migration. For some, such as the godwits/kuaka, this means travelling huge distances across the world. For others it means local travel either around Canterbury or the South Island. Migratory patterns can include sites in the North Island, Australia, and the Pacific.

Godwits

Godwits are perhaps the best known of our migrating birds. The most common godwit is the Eastern Bar-tailed Godwit which nests in the Arctic on the Northern coast of Eastern Siberia across to the northern coast of Western Alaska. In 2007, a small number of bar-tailed godwits were tracked by satellite trackers. Their path went from New Zealand to the coast of the Yellow Sea in China where the birds stopped for 5 weeks to eat before flying on to their breeding grounds in Western Alaska. On the way back they flew direct from Alaska to New Zealand – a non-stop journey of 12,000 km. All up, over less than a year, the godwits had flown nearly 30,000 km in a round trip from New Zealand!

Godwits start to arrive in the Avon Heathcote Estuary/Ihutai in late September with more arriving through until November. They spend the summer in the estuary before leaving again in March and April for the trip back to their Arctic breeding grounds. Some of the younger birds, which are not ready to breed, stay in the estuary for the winter months.

Because many godwits in the estuary breed in northeastern Siberia, the conditions there affect how many birds arrive at the estuary each year. In good years, up to 2200 godwits arrive, whereas in bad years only about 1700 arrive. This is linked to the success of the breeding season in Siberia, which depends on the breeding success of lemmings.

When lemmings have a good breeding year in Siberia, foxes and skuas leave the godwits alone because lemmings are better food. However, in years when the lemmings are few in number, the foxes and skuas are hungrier and prey on the godwits. In those years, fewer godwits leave Siberia and arrive in New Zealand. Fewer godwits in the estuary means fewer shellfish and worms get eaten, so there are more there for other species that also eat shellfish and worms.

It is easy to see how the estuary ecosystem here in Christchurch can be affected by an ecosystem far, far away! Similarly, if the estuary ecosystem here deteriorates and becomes less productive, it will support fewer birds which in turn will mean fewer birds making it back to the ecosystems in Siberia to breed.

The state of the Avon-Heathcote Estuary/Ihutai and its tributaries

The estuary is affected by all the activities going on within the wider catchments of the Avon/Ōtākaro and the Heathcote/Ōpāwaho. Any contaminants in either river eventually make their way into the Estuary which can affect the animals and plants living there.

Both catchments are almost completely urban, so a range of litter, chemicals, heavy metals, hydrocarbons and sediments wash down the rivers and into the estuary. These can collect in the estuary and enter the food web via shellfish and fish that feed by filtering the water for plankton and other micro-organisms. Any pollutants and bacteria in the water also get filtered out and consumed. Therefore, studying the sediments in the estuary, and the fish and shellfish living there, can give us information about pollution levels in the water.

From the late 1800s onwards the Woolston Loop in the lower Heathcote/Ōpāwaho was used as a drain for industries including tanneries, wool scourers, a flax mill, a glue works, soap and candle works, an abattoir, a leather-goods manufacturer and a carpet factory. The river was used as a drain until 1971, when the Woolston industrial sewer was completed. After this, industrial wastewater was sent to the Christchurch wastewater treatment plant in Bromley instead of running into the river. This has improved the health of the lower reaches of the River and the Estuary.

The good news

The restoration work described earlier, in which stream sides are being planted with natives, and the fact that the water quality is better now than it was 30-40 years ago has helped some species.

There are now more birds and more kinds of birds in the lower Heathcote/Ōpāwaho than there were in the mid-1980s. Scaup, pukeko, native ducks, cormorants and gulls are now often seen in places around the City that they were not seen in 15 years ago. The native plantings have also helped birds such as shags and kingfishers.

The restoration work has also benefited eels and other species of fish. These fish tend to be found mostly in those stretches of the river where plants overhang the water, providing shade and hiding places.

Scaup

Scaup

Scaup

A particular success story is the return of the native scaup. In the mid-1980s there were only about 200 scaup in Christchurch. Their numbers had been dropping for 130 years because of the effects of hunting by duck shooters, habitat loss and predation. At the time scientists thought that they would never recover their population in Christchurch, but in 1991, the first pair of scaup was seen nesting in the ponds at the Christchurch Wastewater Treatment Plant in Bromley. By 2002 there were more than 200 pairs breeding there.

Now Christchurch has 20% of the estimated world population of scaup. Their numbers are increasing and they are spreading over the Canterbury Plains. Winter flocks have recently returned to Te Waihora/Lake Ellesmere and Te Roto o Wairewa/Lake Forsyth, where they hadn't been seen for many decades.

But there are still some things to do …

However, industrial development in the upper reaches of the Heathcote/Ōpāwaho has seriously affected the River over the past 15 years. For example, a diesel spill in 2005 heavily polluted a tributary in the upper reaches.

In 2008, journalist David Williams wrote a series of articles for The Press about the state of the City's rivers. He pulled a variety of rubbish out of the Heathcote/Ōpāwaho, from old microwave ovens and computers to lounge suites and used tyres. The stories were written in response to an Environment Canterbury report released that year, which showed that both river systems were badly polluted. However it appeared that the Heathcote/Ōpāwaho was in slightly worse condition than the Avon/Ōtākaro.

Both river systems have a high number of E.coli bacteria in them (which show there are a lot of faeces in the water), high levels of heavy metals such as zinc and copper at times, and high levels of nitrogen and phosphorus.

The Heathcote/Ōpāwaho showed much higher levels of ammonia, a form of nitrogen, which appears to come mainly from the tributaries draining the industrial area in the upper reaches of the river. High ammonia levels kill fish living in the water. Ammonia levels high enough to do this have been recorded at one site in Addington Brook (a drain that is also affected by an industrial area) in the Avon/Ōtākaro catchment and at six sites in the Heathcote/Ōpāwaho catchment.

Phosphorus levels are also high in both rivers. Phosphorus can come from industrial processes but can also come from the fertiliser people use in their gardens and from detergents used to wash cars. Both phosphorus and nitrogen can increase plant growth. When this happens, waterways can become clogged and the water flow decreases, which makes it even less likely that the nutrients and other contaminants will be flushed out. The risk of flooding also increases.

Both rivers also have a lot of suspended solids, i.e. particles of sediment in the water. The Heathcote/Ōpāwaho has the most sediment, which comes from a range of sources – e.g. developments such as Aidanfield and the Port Hills Streams where the soils are easily eroded and where there has been new housing development on steep slopes over recent years.

Metals such as zinc, copper and lead are all found in large amounts in the upper reaches of the Heathcote/Ōpāwaho. They may be in the lower reaches too, and in the Avon/Ōtākaro but they have not been tested there.

Faeces are a major problem in Christchurch rivers, particularly after rainfall. A lot of dog poo is washed off the streets and grassed areas of the city when it rains. In a recent study, the highest number of E. coli found at a site in the Avon/Ōtākaro before rain was 540 E.coli per 100 ml of water. Most of these bacteria came from birds – probably birds like ducks who defecate in the water. When it rained, E. coli counts in the Avon/Ōtākaro River went up to as much as 3600 E.coli per 100 ml of water, with much of the increase resulting from dog faeces washing into the river. When it rains very heavily, human waste contamination can also occur when the sewer system overflows.

The Ministry for the Environment and Ministry of Health say that freshwater recreation areas should have less than 260 E. coli per 100 ml of water. The numbers of E.coli in the Avon/Ōtākaro River are much higher than this, so our rivers are usually too dirty to use for swimming. Events that may involve people getting wet, such as raft races on the Heathcote/Ōpāwaho, have been cancelled because of high E.coli levels.

There have been changes in the plant life in the catchments of the Avon/Ōtākaro and the Heathcote/Ōpāwaho. In particular, there has been a big increase in the growth of curly leaved pondweed, especially in the lower parts of the Heathcote/Ōpāwaho. This has been blamed on increased sedimentation in the waterways, because change has been greatest in rivers downstream of major subdivisions on the Port Hills, for example.

Invertebrate species have not really recovered, despite the restoration projects. Many of our smaller streams now have fewer invertebrates in them than they used to have 20-30 years ago.

There may be a number of reasons for this.

1. The water quality may not have improved enough in our streams to allow them to survive there.
2. Most restoration work only involves short stretches of a river or creek. Insects and other missing invertebrates may need more continuous stretches of good conditions.
3. Pipes may make it difficult for flying insects to move along a stream to recolonise an improved area.
4. Sediments, introduced plants and heavy metals in the stream may have changed the habitat so much that invertebrates that need stony-bottomed streams still cannot find suitable habitat.

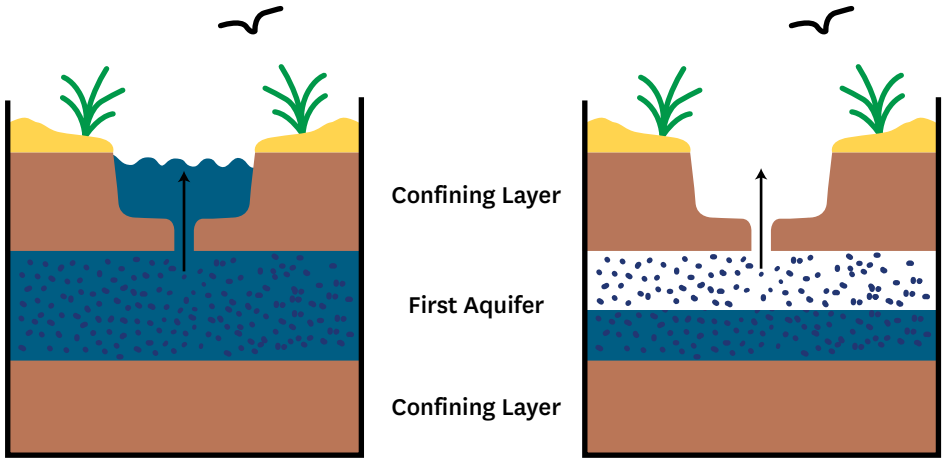
So what can we do?

Remember that much of what is on our roads and streets ends up in our waterways so anything that we can do to keep those roads free of chemicals, sediments and faeces is good. As has been mentioned, always pick up dog faeces when out walking your dog and dispose of them carefully. Wash your car on the lawn so the detergent does not get onto the road. Use cars as little as possible. Avoid spilling oil or other chemicals on tarmacked surfaces.

Water flow

While most of this discussion has been about water quality, an important issue in Christchurch centres on water quantity. The rivers in Christchurch were much deeper and faster flowing in the early days of the City than they are now. The Avon/Ōtākaro was once considered a fast and dangerous river. A number of people drowned trying to cross the River during the late 1800s. One story tells of an unfortunate young man crossing the river on horseback between the Armagh and Victoria St bridges, who was swept away by the current and drowned.

Now, the amount of water flowing in all of our rivers has decreased as the City has developed and many springs have stopped flowing. This is happening for a number of reasons.



1. The water table can drop so that there is less water to come up through the springs.
2. Springs can be destroyed by earthworks.
3. Creeks or springs can sometimes be blocked off by people who take the water for their own use.

This is of concern to many because the wildlife in the creeks requires flowing water. Also, less water flowing in the rivers means that it is less likely that any contaminants or sediments in the water will get flushed out. When creeks dry out, the aquatic species living in them die and may not come back again when the water starts flowing.

What is happening in the estuary?

As the rivers flow into the estuary, all of the problems that affect the rivers will also affect the estuary. This means that we can expect to see increased sediment, the presence of heavy metals, excess nutrients and bacteria that indicate the presence of animal faeces of various kinds.

Heavy metals

A range of fish and shellfish from the estuary have been tested for contamination by heavy metals. In 2008, heavy metals such as mercury, cadmium, lead and arsenic were found in the fish. The good news is that the levels of these metals were well below those recommended by the New Zealand Food Safety Authority. Scientists also found that the levels of arsenic, cadmium, chromium, copper, lead, nickel and zinc in sediments around the estuary in 2007 were well below amounts that are likely have any effect on plants and animals living there.

Human and animal waste

The Christchurch Wastewater Treatment Plant outfall has been an important factor in the pollution of the estuary. Treated wastewater is released into the estuary by a pipe called an 'outfall'. Completed in 2010, a new ocean outfall is taking highly treated wastewater 3 kilometres out to sea, rather than discharging it into the estuary. Currently shellfish have levels of E. coli that make them unsuitable for eating, and it is hoped that this will change with the new outfall. However the shellfish will still absorb faecal matter that comes into the estuary via the rivers and the stormwater network, and the focus of attention will need to shift to developing social norms and systems that reduce the amount of faeces from animals, especially dogs and ducks, that can get into the estuary.

Travis Wetland

Travis Wetland Nature Heritage Park is 56.5 hectares in size, and is the only major remnant of the swamp landscape that was once common in the Christchurch area. Now the site provides opportunities for groups and individuals to learn about the wetland environment. 1600 years ago it was an estuary similar to the Avon/Heathcote Estuary/Ihutai of today.

After the estuary, Travis Wetland holds the second largest concentration of birds in Christchurch. 55 species of birds, including 35 natives, have been recorded at the wetland. Other animals that live there include an indigenous skink, the native short-finned eel, inanga (adult whitebait) and the Canterbury Mudfish.

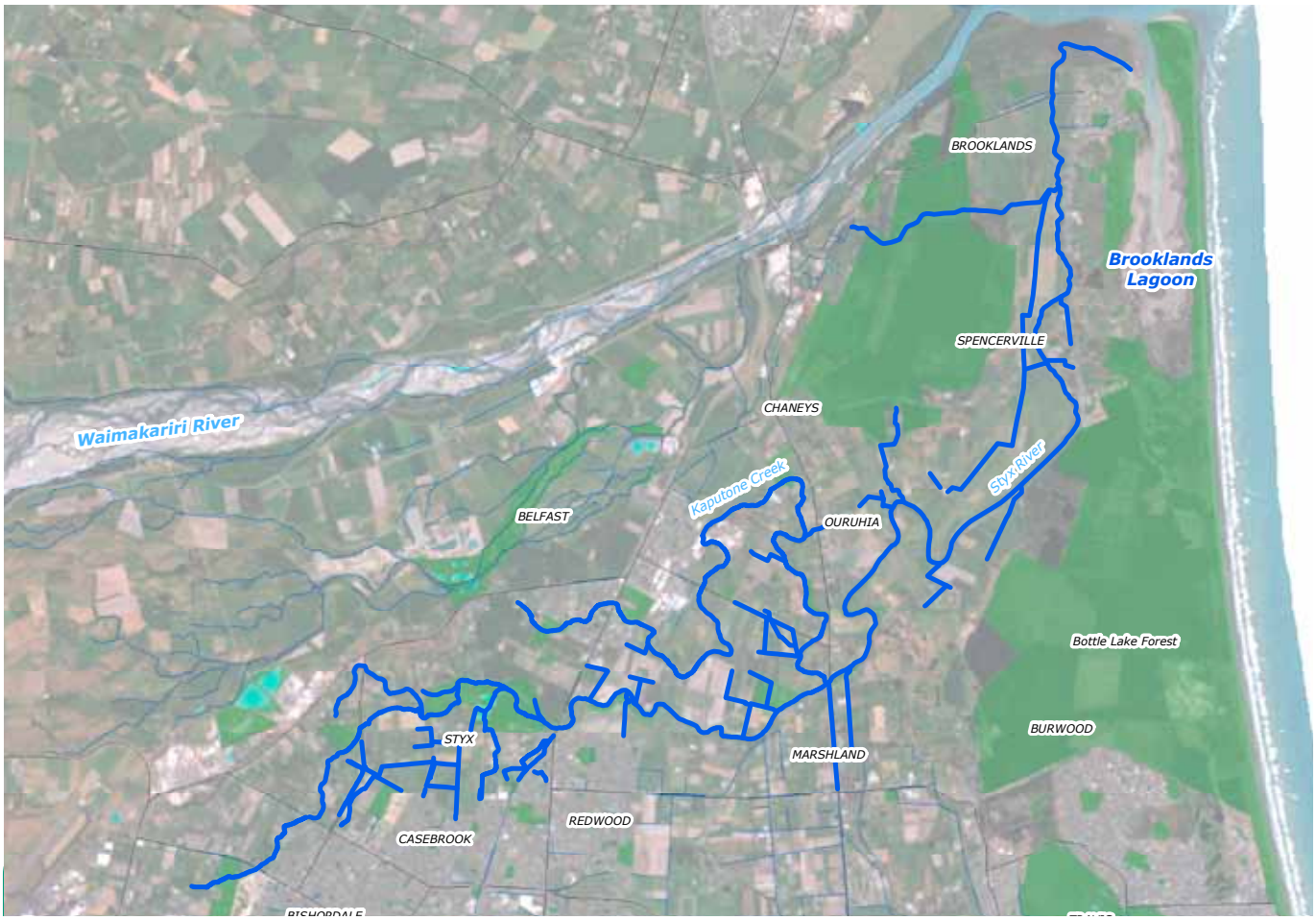
More than 600 insect species have been found in the wetland, most of which are found only in New Zealand. Over 50 other invertebrate species (spiders, snails, worms, etc) have been identified, with about half of them being aquatic invertebrates.

Native plant species are present in the wetland, including a number of species now rare on the Canterbury Plains. A species of spider orchid and a native sundew are found at the site and both of these are regionally vulnerable. There is also a large stand of manuka in the wetland.

Restoring the environment

Restoration is an important activity at Travis Wetland. It takes a lot of work to plant natives and clear away pest plants such as grey willow, blackberry, gorse and grass. Animal pests such as rudd, cats, rats, stoats, ferrets and hedgehogs are also controlled as part of the restoration programme. These animals prey on, or compete with our native fish, birds, lizards and invertebrates, so it is important to control their numbers.

Styx/Purakaunui River



Styx/Purakaunui River

The Styx/Pūrākaunui, like most of the rivers in Christchurch, is a spring-fed river. It flows in a channel that is cut into sediments laid down by the Waimakariri River. From its source in Harewood, it flows 24.8 km north-east through Belfast, Marshlands and Spencerville, and into Brooklands Lagoon near the mouth of the Waimakariri River. Smacks Creek and Kaputone Stream are its two biggest tributaries.

Unlike the other rivers in Christchurch, the Styx/Pūrākaunui is controlled by tide gates which have been built just below Harbour Road/Kainga Road. These were erected in the 1980s to stop flooding when there are leap tides or when the Waimakariri River floods. The surrounding farmland and residential areas are very low lying and highly susceptible to flooding.

Each tide, these gates close to prevent sea water from getting up the river. They also prevent the river water from flowing into the sea so the river backs up behind the gates, causing the water levels to rise. This means that the plants and animals upstream of the gates have to tolerate fluctuating water levels but they do not have to be salt-tolerant. As a result the change in riparian vegetation and aquatic plants at the saltwater interface is more dramatic than it is for the Avon/Ōtākaro and Heathcote/Ōpāwaho rivers. Raupo grows down as far as the gates, as do freshwater plants like the introduced curly pondweed. On the seaward side of the gates the riparian plants are mainly salt-tolerant wetland species such as three-square and sea rush.

Natural history

Before humans arrived in the area, the Styx/Pūrākaunui catchment was covered in totara, matai and kahikatea forest. Big floods in the Waimakariri River buried some of these forests in mud and sand. Some forest areas were uncovered by earthworks in recent years. By the time Māori reached the area, the forest was patchy and interspersed with scrubby species such as manuka and wetland areas. Māori people modified this environment with fires, and European settlers cleared the native vegetation, draining many of the wetlands and turning the land into farmland.

Since European settlement, the area has been highly modified through farming and drainage practices, and in some cases, by housing developments. The landscape around the Styx/Pūrākaunui has been subject to earthworks, cutting and burning of vegetation, cultivation and grazing. Today the area is used for agriculture, horticulture, reserves, and housing.

Māori history

When Māori lived in this area the extensive wetlands and easy access to the sea made the Styx/Pūrākaunui an important area for mahinga kai (food gathering) and for the cultivation and harvesting of flax, something that continues today in the Janet Stewart Reserve.

European history

European settlers used the area for a number of purposes. Sheep farming was popular, and the river was also used to drive waterwheels that helped to power sawmills, flax mills and flourmills.

There are a number of ways that the river may have got this name:

In Greek mythology the river Styx is one of the seven rivers of the underworld and flows into a great marsh.

However, the name Styx appears to have been changed from the word “sticks”, because:

1. European settlers crossed the river on flax-stick rafts.
2. Bundles of flax sticks were laid in the bed of the river.
3. Sticks were stuck in the ground to guide travellers to where the river was bridged by logs.

Ecology

Much of the Styx/Pūrākaunui remains essentially rural in character, although this is changing as Christchurch spreads further north and the Belfast area is being further developed. The rural nature of the river means that it is in relatively good health compared with the urban streams in Christchurch. Despite this, the river is rated fair to poor in terms of the invertebrate species found in it.

A 2007 plant survey found that there had been big changes in the aquatic plants found in the Styx/Pūrākaunui since 1980. It appears that the smaller native plants are becoming less common, whilst a number of introduced plants are moving in and becoming more common.

The observations of relatively poor aquatic invertebrate life and the changes in plant communities may be due to the large amount of sediment that has got into the river as a result of some large developments in the Styx/Pūrākaunui catchment. To make matters worse, at the same time as the sediments were put into the river, the developments destroyed many of the springs in the headwaters of the river. River flows are now lower, so sediments are not flushed out and instead have settled on the bottom, changing the river habitat. This has allowed the new plants to replace the natives that used to live there and has meant there are fewer places where there are stony-bottomed riffles that many clean-water invertebrates need for habitat.

A number of wetlands in the Styx Mill basin are in relatively healthy condition, and the salt marsh at the mouth of the Styx/Pūrākaunui provides an excellent example of what was once present along much of the Canterbury coastline.

The Styx/Pūrākaunui has ten species of freshwater fish, of which only the brown trout has been introduced. Eight of the nine native fish species require sea access, so clear passage down the

river is essential for their survival. Styx Mill Conservation Reserve is an important fish spawning ground. Tuna, brown trout and yellow-eyed mullet can be found around the mouth of the Styx/Pūrākaunui at Brooklands Lagoon. The Styx/Pūrākaunui River mouth is an important location for whitebaiting, and inanga also spawn there.

A survey undertaken in December 2002 established that 46 bird species can be found within the Styx Mill Reserve. Half of these are wetland birds. Loss of habitat caused by urban encroachment is a threat to this but there are a number of reserves such as the Styx Mill Reserve (a large 57 ha reserve) that provide a haven for wildlife. The Australasian bittern and marsh crake can be found in the dense Raupo at the mouth of the Styx/Pūrākaunui River, although they are difficult to see because they are well camouflaged.

Restoration work along the Styx/Pūrākaunui, supported by the Styx Vision 2000-2040 and the Styx Living Laboratory Trust, means that one day there may be a reserve walkway in the riparian zones all the way down the river. Native sedges and ferns are regenerating under the tall willow canopy along the river margins.

Janet Stewart Reserve is an interesting reserve that already exists alongside the River. The Reserve was initially a paddock that was given to the Christchurch City Council by Edmond Stewart. The boxed waterway was released to form a large pond that was surrounded by native riparian planting. Part of this planting was a large Pā Harakeke (harakeke garden) which is used by local weavers. Harakeke and whaririki (another species of flax) varieties were planted at Janet Stewart Reserve in 1998 with the assistance of local weavers and Landcare Research.

Brooklands Lagoon

Brooklands Lagoon covers 270 hectares and is just north of Spencer Park at the mouth of the Waimakariri and the Styx/Pūrākaunui rivers. It is protected from the sea by Brooklands Spit and coastal sand dunes. The lagoon is slowly filling up with sand and silt which enters the lagoon when the Waimakariri floods. Sand is also blown into the lagoon from the sand dunes. As the lagoon becomes shallower, rushes start to grow. The rushes trap the sediment and spread outward, allowing salt-tolerant plants to establish, which reduces the amount of open water.

Brooklands Lagoon is one of a few coastal wetlands that are used by migrating birds. Like the Avon-Heathcote Estuary/Ihutai and Te Waihora/Lake Ellesmere, the lagoon provides a breeding habitat, wintering site and a feeding stop for birds migrating between the North and South Islands. Seventy-four species of bird have been recorded on the lagoon and at the height of the season there can be more than 3000 birds there.

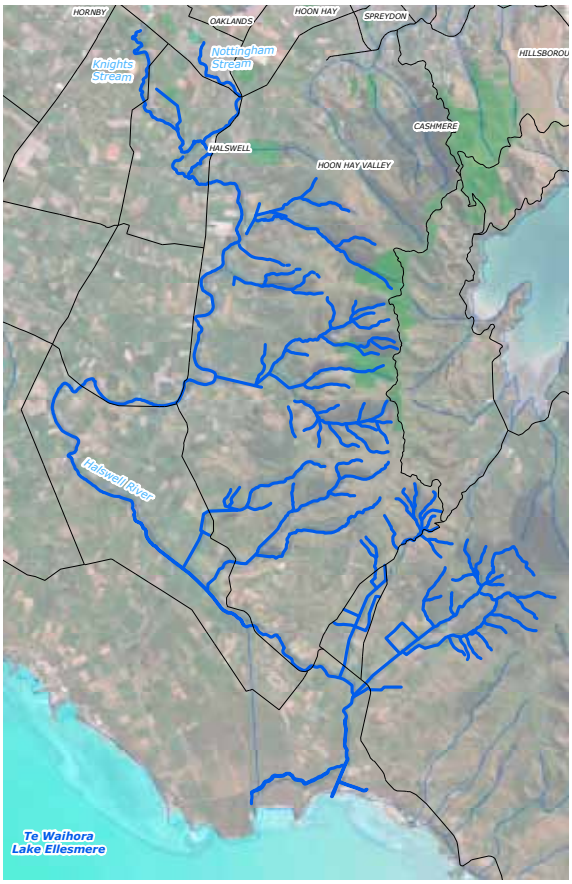
As with the estuary, Brooklands Lagoon also provides sheltered habitat for a range of aquatic animals. Pipi and cockles can be found in sandy patches close to the lagoon mouth. Tunnelling mud crabs, mudflat snails and ragworms are common on the mudflats. The Waimakariri River mouth is popular for salmon fishing, and both the Styx/Pūrākaunui and the Waimakariri river mouths are important whitebaiting areas.

Many native plants grow around the margins of the lagoon. The mudflats support various native sedges, rushes, grasses, salt-tolerant herbs and occasional shrubs, such as the saltmarsh ribbonwood. The sand spit provides habitat for natural dune-land plants such as flax, cottonwood, manuka and sand convolvulus. There are also some very big akeake and ngaio trees.

Brooklands Lagoon - Looking out to the river mouth

Halswell River/Huritini

The Halswell/Huritini starts where Nottingham Stream meets Knights Stream, near the city boundaries. Nottingham Stream begins at Westlake, runs through Oaklands and Halswell, and then runs parallel with Halswell Road before meeting Knights Stream in open farmland. Most of the rest of the length of the Halswell/Huritini is largely rural in character.



The Halswell/Huritini is mainly spring-fed from Marshs Rd Drain, Quaifes Road Drain, Knights Stream and Nottingham Stream in its upper reaches. Nine springs occur in paddocks east of Knights Stream near Quaifes Road and Murphys Road. Seven more springs are recorded in or to the west of the headwaters of the Halswell River. The river is also fed by creeks from the Port Hills valleys, from Tai Tapu south towards Te Waihora/Lake Ellesmere. The Halswell River/Huritini flows into Te Waihora and has no direct outlet to the sea.

Originally the Halswell ran through extensive wetlands, which since European settlement have been drained. Like other catchments in Christchurch, the drainage network in this catchment has been highly modified. Riparian vegetation has been removed, streams have been straightened and widened, water has been contaminated with stormwater run-off, surrounding wetlands have been drained and springs have been filled in.

The name Huritini means “many turns” and comes from the meandering path that the river takes, particularly in its upper reaches. Māori used to bring their canoes up the Huritini from Te Waihora/Lake Ellesmere and carry them over into the Heathcote/Ōpāwaho catchment.

It is possible to catch trout and eels in the lower reaches of the Halswell River/Huritini. Short-finned and long-finned eels as well as upland bullies are common in the upper parts of the river and brown trout can be found but are less common. Koura (freshwater crayfish) have been found in quite large numbers in the Quaifes Road spring-fed drain network.

Nottingham Stream

Nottingham Stream is the most urbanised of all the tributaries of the Halswell River/Huritini. It runs from Westlake Park in Halswell down to meet Knights Stream, where it becomes the Halswell just outside the city boundaries.

Nottingham Stream is mostly contained in a boxed drain, but some parts of it have been restored and the banks planted. Some years after this restoration work, the number of short-finned eels in the stream rose 1.6 times and long-finned eels were found only in the restored sections.

A useful resource: Restoring Nottingham Stream by the CCC and the Residents of Halswell June 1997

Otukaikino Stream/South Branch

The Otukaikino Stream was once the south branch of the Waimakariri River but was cut off from it in the 1930s by some major river control works. Now it is a spring-fed stream arising on farmland and running through the Groynes. It is a relatively stable, unpolluted waterway that contains good populations of smaller trout. Trout also spawn there in winter. There are a good range of invertebrates including some of those not found in city waterways because of the pollution and sediment problems. It is possible to see mayfly and caddisfly species at this site, along with damselflies and dragonflies. Stoneflies have also been seen in this creek.

There has been a lot of restoration and planting work done at the Groynes aimed at replacing the willows. Water is unsafe for swimming at the Groynes because of the high numbers of water birds found there that pollute the water with their poo.

Have a class discussion to consider these things:

Imagine being an early settler from a city in England with no way to easily get back home or even to talk to people at home – no telephones, no planes, no internet or email and letters that take months to arrive, if they arrive at all. Imagine arriving in a wild landscape with very few people, lots of strange plants and lots of swamp.

How do you think the settlers might have felt? How would you feel if you had been one of them? How could you make the place feel less strange and more like home?

Imagine being a Māori person living in the Christchurch area. This is the place that you get food, play, and find resources such as trees, flax, raupo etc for building houses, rafts and tools (a bit like today's shops!).

How might you feel when strangers come in and clear away your best resources, and favourite toys, so they could use them. What of them draining the pools and creeks where you get your favourite foods?

Write a story in which you are either a settler or a Māori person living in Christchurch when European settlers arrived, describing what it is like, and what you see and feel.

Role-play: Have some of the class role-play European settlers and some role-play Māori locals.

Imagine being a fish that lives in the estuary. Write a story or develop an artwork that shows the different conditions that you find as you swim around the estuary.

Where are your favourite places? How does it feel to move around? How do your surroundings change over the course of a day?

Section 5:

Making a Difference

By now, your students will have gained an understanding of their local waterway and listened to various people talk about its values and issues. They will now be ready to undertake a project that will make a difference to their local waterway. This section helps you to think through possible courses of action. It suggests some activities and encourages you to show off the great work you have done.

Section 5: Making a difference

In this section, students will consider solutions for improving the quality of water in their local waterway. They will decide on and carry out a project that will make a difference by improving or enhancing the stream or river.

It's your turn to take action

Everything that happens in a catchment (on the edges of a river and further back on the land) can have downstream effects. All the communities in a catchment must work together to protect and restore waterway health.

In this section, everything you have done and learned so far can go towards making a real difference to the quality of your river. It is the most important part of the programme. All of your work up to now may have highlighted important problems that you and your community feel need to be sorted out, and now is the time to take action!

This section will help you to decide on some activities or a working project that will physically improve the state of your local waterway.

Getting started

Reviewing what you know

You need to have a clear idea of what is wrong with your river or stream and what is needed to improve it. The first thing to do is to review some of the things you have learned in previous sections, in particular, what you have found out about your local waterway. At this point, it is also a good idea to visit either a local wetland or waterway that is healthy so you can get an idea of what it should look like. Make a note of the plants, birds, and insects. Your river would have looked similar. You can then discuss and agree on what you believe needs to change or be improved in your waterway.

Talking with people in your community

Armed with this knowledge, your next step is to get support from your local community. You need to make sure that what you want to change is also what other people want to change. You may have already had some contact with people or interest groups in your community at this point. If you haven't, now is the time to do this.

First, complete the Stream Users' Survey on the following page to find out what people in the area think. Then, if you haven't already done this in previous sections, and if you can find someone with an interest in the local waterway, invite them to speak to your class. Talk with people in your community to find out who would be willing and valuable guests in your classroom.

Examples might include:

- Members of water or stream care groups.
- People from residents' associations.
- People from recreational groups (for example, fishing or boating) who use your waterway.
- Other classes in your school that are also learning about your river.
- Other schools in your area that are also learning about your river.
- People from local businesses.
- Friends, family, and whanau.
- The Environment Canterbury education officer will help you locate some of the relevant groups that exist in your community and may have some good contact people.

Choosing the project

Now, it's time to decide what to do. You will need to consider your time constraints, other school commitments, and the age or level of your students.

Your project does not have to be time-consuming or necessarily an activity at the river, such as planting or monitoring. You may prefer to raise people's awareness by letting everyone know what your class has been doing. It can be a publicity campaign or event to highlight the community's impact on the quality of water in the river and what they can do to minimise it. This is just as important as any practical task. If people don't know the problems, how can we expect them to help us solve them?

On page 87 are some examples of activities that you could consider, including a selection of activities at the river and alternative projects. There may be other ideas more appropriate to your area that you could discuss or come up with as a class. Add them to this list.

Stream Users' Survey

Group name

Questions	Name	Name	Name	Name
How long have you lived in the area?				
0-1 year				
2-5 years				
5-20 years				
All my life (over 20 years)				
Do you visit the river?				
Yes				
No				
What do you use the river for?				
Commercial activities				
Fishing				
Recreation				
Other-please state				
Do you think the river is healthy?				
Yes				
No				
What makes you say that it is healthy or unhealthy?				
Is the river important to you?				
Yes				
No				
Would you help with a project to restore the river plant and animals life?				
Absolutely				
Maybe, if it wasn't for too long				
No				

Project options

1. Organise litter clean-up days

Ask your school principal for a half-day off to have a river clean-up, and invite parents and local people. Ask local businesses to sponsor your project and provide waste bags and gloves or hot and cold drinks. Start the day in school with presentations of what you have been doing, why you have done it, and the importance of today's clean-up.

Organise a list of things you will need, including rubber gloves, gumboots, sticks with points on the end (to pick up paper and plastic bags), buckets, and rubbish bags. Elect to have a couple of students look over the rubbish that is collected to sort it into recycling bins and to determine where the majority of the rubbish comes from. Then you might be able to find the source.

Make sure everyone is aware of safety issues. Your river might be swift and deep in some places so choose a region that is safe for a large group of busy people.

2. Look out for opportunities for riparian (streamside) planting

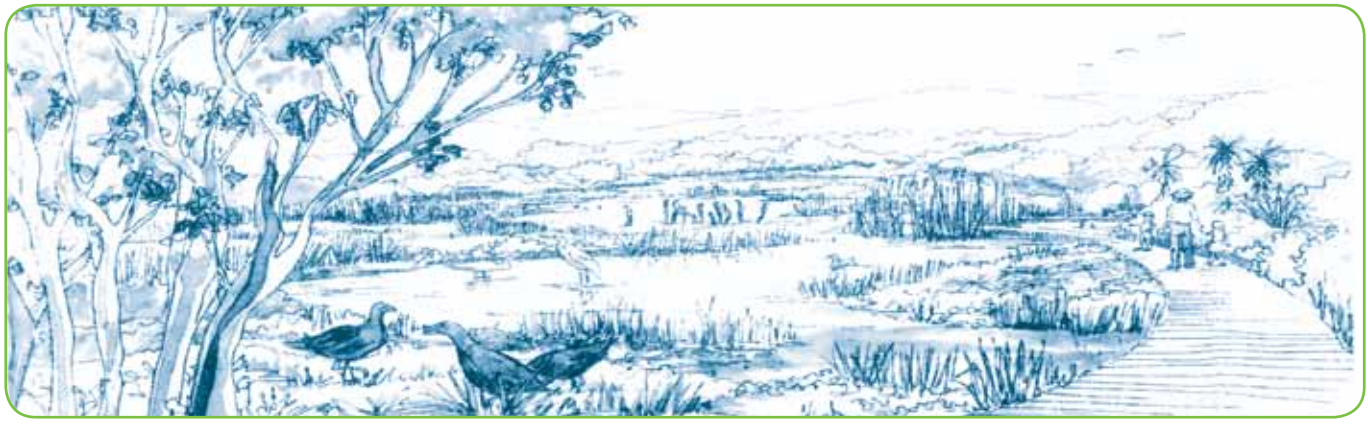
Plants are important to the health of a river. They provide shade and protection from predators, create microclimates, absorb pollutants, and beautify. Look out for community groups or council-organised days where planting is happening. Ask the Environment Canterbury or Christchurch City Council educators to put you in touch with the right people to do this.

Another important part of revegetating stream banks is maintaining plantings. Your students may be able to get involved in weed removal and mulching plants.

You may be interested in a long-term planting programme under which students can grow their own plants for future planting

3. Design a public walkway

There may be an area of your river that is suitable for people to walk alongside or an area that is used as a pathway but may be disturbing plants or animals. As a project, the class could design a walkway with interpretation panels. You could call in a landscape architect to give you ideas, consult the public and the local council for advice, work with a local community group, gain funding, and possibly follow through with the project to its end.



4. Water monitoring

Set up a water monitoring group that can test the water on a regular basis. Graph the results and publish them at the end of each month in the school, local fishing magazine, or local paper. Get in contact with other schools and compare results.

Invite parents and community members to attend water quality sampling sessions on the river. Students can show adults how and what to sample so they can see for themselves what is going on.

This type of project will probably require support and advice from the Environment Canterbury water educator, so feel free to contact them and discuss your plans.

5. Get involved with the media

Invite the local media (newspapers, radio, and television) to interview you, take photos, or film your work. Prepare a media release and offer to visit media offices or studios to show off your work or give the public any important messages you have.

6. School clubs

Start a school group or club whose main focus is to get involved in cleaning and monitoring the river on a regular basis. Give the group a title, such as the "River Protection Gang" or "Soldiers of the Riverlution"!

7. Public display

Throughout this programme, you will have completed a lot of work that would make excellent display material. Ask the local library or community hall if you can put up displays of your work providing information posters and the results of your stream sampling.

Have the water educator at Environment Canterbury arrange an award for the best display.

Invite the local media to take a picture of your displays and write an article about your work and why it is so important.

8. Theatre production

Put on a play for the school assembly and/or the community about the history of the river, from when it was crystal clear with loads of plants and fish life to today, where it is not used for much except commercial activities. Arrange a school assembly for parents, Environment Canterbury staff and councillors, local community group members, and interested public to attend.

9. River week

Organise a River Week at school. This would be an ideal time to put out displays, hold competitions, give talks at assembly, invite parents, friends and relatives to events, organise some riparian planting on your school grounds (if you have a stream on the school property), or promote water conservation in the school. Environment Canterbury can help with events like this and has resources that you might find useful. Check with ???? for further information

What about if there is a school fair, suggesting having a tent which the class can set up to raise awareness about water?

10. Design information brochures/pamphlets

The students can become the teachers by designing information material to be distributed to parents and the local community, illustrating ten ways they can help the river. The information could also be conveyed through a PowerPoint presentation, a website, or a video to upload to YouTube. These ways of spreading information can reach people without creating large amounts of printed material.

11. Posters, paintings, murals in public places

Design posters or have an art exhibition or organise a mural (with a river theme) to be displayed in the local community, illustrating different ways to help improve water quality in the rivers. You will need to check with appropriate people that it's alright to display your work in some places (shop windows). If you choose to do a mural, it would be a good idea to ask people in the community to contribute to the work. You could perhaps work in with other local schools or artists.

Making a plan

Now you've chosen which option or combination of options is best for you, you need to plan it. One of your first tasks will probably be to call the Environment Canterbury water educator but before that, plan what you want to do. Complete the action planner so that you know what you are doing, what you are trying to achieve, and where you need help.

Action planner

Your name

What is your vision for the stream? How would you like it to look?

What skills and experience will we need?

Who could influence the decision?

What action project could you do to achieve your vision for the stream?

What information will we need and where will we find it?

Is there any way your project could damage the stream?

How could you tell others about what you are doing, so they can help?

Get going!

Now you have an action plan you can begin to make a difference.

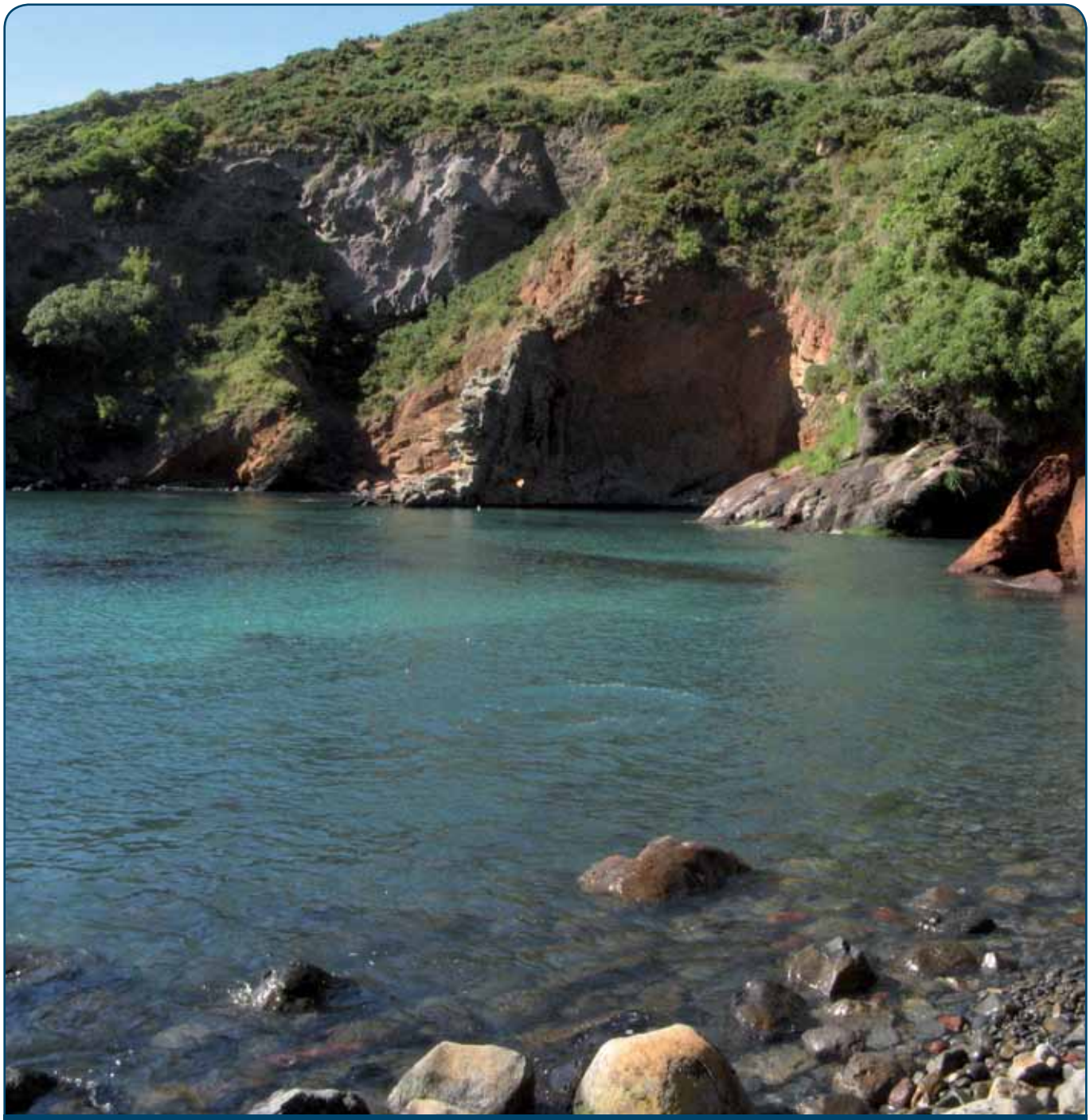
We hope we have given you some good suggestions. Don't take on something that is too difficult to manage. Be realistic, and get help from wherever you can. The water educator at Environment Canterbury is there to help at all stages of the programme.

Don't forget to show off! You will have done a lot of hard work during the programme and that needs to be recognised.

Appendix 1 Learning Through Action – programmes at a glance

For bookings, visit www.ccc.govt.nz/learningthroughaction - see page 91 for full contact details.

Programme	Duration and timings Add 15 mins for AM prog. - Morning tea		Suitable Year Levels	Site	Description
Estuarine Encounters	**2 hrs**	9.30-11.45 or 12.30-2.30	**3-8**	South Brighton Estuary McCormack's Bay	Your students will explore what lives in, on and under the mud or rocks at an estuary. They will be able to observe the estuary animals and their special adaptations for this environment. Students will consider effects on the water quality at the estuary and explore simple actions they can take to help protect the estuary environment. This programme can be run at two sites: studying creatures living in the mud at South Brighton, or creatures in rock and water at McCormack's Bay.
Freshwater Frolicking @ Styx Mill	**2 ¼ hrs**	9.30- 12.00 or 12.15-2.30	**3-8**	Styx Mill	Students will investigate what lives in and around the streams in these areas, particularly looking at what factors affect water quality. They'll get up close and personal to examine freshwater invertebrates, and will find out what's in the water that affects them. Students will have a personal empathy for these creatures as they participate in a role play game. This is serious hands-on action for students!
@ The Groynes	**2 hrs**	9.30- 11.45 or 12.30-2.30		The Groynes	
Wetlands, Waders and Water Boatmen	**2 ¼ hrs**	9.30-12 or 12.15-2.30	**3-8**	Travis Wetlands	Students will go pond-dipping to find out what lives in the water at Travis Wetlands, identifying the water invertebrates through a hands-on approach. They will be able to observe animal life in the bird hide using binoculars, and will be involved in practical rehabilitation of the wetland. At the information kiosk students will be able to read and hear about the past, present and future directions for Travis Wetland.
All Flushed Out	**2 hrs**	9.30-12 or 12.30-2.30	**5-13**	Christchurch Wastewater Treatment Plant	Our wastewater is carried through a network of underground pipes and pumps to the Christchurch Wastewater Treatment Plant. At this facility, students will discover what happens to anything that goes down the drain. Be prepared for a revival of your senses – this is a smelly one. For once, hands-on is not the first choice of learning. Students are able to get up close to the working systems and processes that take place to treat what we flush away in the bathroom, kitchen and laundry. Closed-in shoes are required for entry to this working site.
Water for Life	**2 ½ hrs**	9.30- 12 or 12-2.30	**5-13**	Main Water Pumping Station (Colombo Street)	From the aquifers through to our taps, students will discover how Christchurch residents access some of the world's best water. During a visit to the water pumping station, students will compare Christchurch's water usage with the rest of the world to see how much we waste. They will tour the pumping station to see the big water tank, water pumps, the control room and a retired World War II submarine engine. The programme winds up with a twist on a game of Snakes and Ladders. A large-scale board game is played using students as board pieces. Student groups can advance their human markers by correctly answering questions about water consumption and conservation.



Appendix 2: Useful organisations' contacts and websites

Both Environment Canterbury's and the Christchurch City Council's educators are available to assist and guide you through the programme.

Environment Canterbury
58 Kilmore St
PO Box 345
Christchurch 8140

Phone: (03) 365 3828
Fax: (03) 365 3194
Email: education@ecan.govt.nz

www.ecan.govt.nz/education

Christchurch City Council
(for Learning Through Action programmes)
PO Box 237
Christchurch 8140

Phone: (03) 941 8298
Fax: (03) 941 8384
Email: learningthroughaction@ccc.govt.nz

www.ccc.govt.nz/learningthroughaction

Other organisations you might find useful:

Waterwatch

Waterwatch works with Year 7-13 students, operating field studies to assess the biological and biochemical factors of stream health. Their programme is aligned with the New Zealand Curriculum, works within NCEA objectives and accommodates the Achievement Standards.
Lincoln University
Lincoln
Ph: 325 2811 ext. 8795
www.lincoln.ac.nz/story10334.html

Department of Conservation

Doc has information on native aquatic flora and fauna, threatened species and pest fish and plants in waterways.
195 Hereford Street
Private Bag 4715
Christchurch
Ph: 371 9758
www.doc.govt.nz

Canterbury Museum

Rolleston Avenue
Christchurch
Ph: 03 366 5000
www.canterburymuseum.com

Te Runanga O Ngai Tahu

158 Hereford St
Christchurch
Ph: 03 366 4344
www.ngaitahu.iwi.nz

NIWA – National Institute of Water and Atmospheric Research

10 Kyle St
Christchurch
Ph: 03 348 8987
www.niwa.co.nz

Landcare Research

Gerald St
Lincoln
Ph: 03 325 6700
www.landcareresearch.co.nz

Environmental Science and Research Ltd (ESR)

Christchurch Science Centre
27 Creyke Rd
Christchurch
Ph: 03 351 6019
www.esr.cri.nz

Southern Encounter Aquarium and Kiwi House

Regent Building
Cathedral Sq
Christchurch
Ph: 03 377 9196
www.southernencounter.co.nz

Useful websites:

The Avon-Heathcote Estuary/Ihutai Trust
www.estuary.org.nz

The Styx/Pūrākanui Website
www.thestyx.org.nz

Travis Wetland Trust
www.traviswetland.org.nz

Waterlink – a Christchurch City Council site
www.enviroschools.org.nz

Clean Waterway
www.cleanwaterways.org.nz

Urban Waterways
www.urbanwaterways.info

Water Wisdom
www.waterwisdom.org.nz

Environmental Monitoring and Action Project (RSNZ)
www.emap.rsnz.org

Whitebait Connection
www.whitebaitconnection.co.nz

Up The Creek: How fresh water supports life
www.biodiversity.govt.nz/kids

Enviroschools
www.enviroschools.org.nz

Irrigation NZ
www.irrigationnz.co.nz

Water Rights Trust
www.waterrightstrust.org.nz

National Wetland Trust
www.wetlandtrust.org.nz

Glossary

Aquatic invertebrate
Animals with no backbone, including insect larvae, crustaceans, worms and snails, that live in water.

Aquifer
A layer of sand and gravel below ground that holds water. A confined aquifer has a layer of very fine sediment above and below it, confining the water. Unconfined aquifers allow water to sit and move slowly towards the sea.

Biodiversity
Plants, animals and other living things

Catchment
The area of land that contributes its runoff from rainfall to a river. The use of land surrounding the river influences the quality of the water.

Clarity
How clear the water is. The more sediment there is in the water, the lower its clarity. A black disc inside a perspex clarity tube is used to measure clarity.

Contaminant
A substance in the water that reduces its purity or quality. See also pollutant.

Dissolve
When you put a packet of jelly crystals into a bowl and tip in the water, the crystals all seem to disappear. They are still there but they have melted into the water to make a solution. Chemicals can do the same thing in the river and sometimes can be poisonous to animals and plants.

Ecosystem
All the plants, animals, rocks, soil, and water that together make up a biological community in a particular environment. There are many different types of ecosystems, including rocky shores, estuaries, streams, deserts, and forests.

Ecology
The study of ecosystems. The study of interactions between plants and animals and their environment.

Effluent
All the stuff that you and your family flush down the toilet, and down the pipes from the shower and sink, is called effluent. The effluent travels down sewage pipes to the treatment station where it gets sorted. All the solids are taken out and the waste liquid is piped into oxidation ponds where the sunshine kills most of the germs. Later, water from the oxidation pond is piped into a river or the ocean.

Endemic
Something is endemic to New Zealand if is found here and nowhere else in the world.

Exotic/introduced
A plant or animal that was not found in a country or area until it was introduced, usually by humans.

Faecal coliforms
A group of bacteria that comes from the effluent of people and animals. If we find them in a river or stream then we know the water is being polluted from too much effluent. They indicate that other bacteria, viruses and protozoa are likely to be present that can cause very bad stomach pains and can be dangerous to people who are old or not very well.

Faeces
Poo

Fertiliser
Chemicals put on soil to make crops grow faster and bigger.

First-flush basin
A type of pond which catches the first few millimetres of water that runs off land in a rainstorm. The water is held in the basin so that particles of pollution can settle out before the water either soaks into the ground or enters the stormwater system.

Fresh
An inflow of water to a stream or river caused by rain or melting snow.

Groundwater
Water that is below the ground. It comes from water seeping out of rivers into the gravel and from rainwater soaking down through the ground.

Habitat
The place people live in is usually called their home, but for animals and plants their home is called a habitat. A habitat is the place the animal or plant lives, eats, and breeds.

Harakeke
New Zealand flax.

Herbicide
Chemicals that kill weeds. Sometimes they can kill other plants too if they are not used carefully.

Impervious
Not allowing fluid to pass through, e.g. a hard ground surface such as concrete.

Inaka/inanga
One of the adult species whose young are known as whitebait.

Invertebrate
An animal without a backbone or spine – e.g. snails, worms and insects.

Kaitiaki
Guardians.

Mauri
Life force.

Mahinga kai
Refers to natural resources and the area in which they are found. It includes the way resources are gathered, the places they are gathered from, and the resources themselves, such as tuna, or harakeke and paru, which are used for dyes.

Native
(as in vegetation, animals) Naturally occurring in a particular area or country, not brought in by humans (see also Exotic).

Nutrient
A substance that provides nourishment essential for life and growth. Plant nutrients that can find their way into waterways include nitrogen and phosphorus. Too many of these nutrients can upset the balance of life in the waterway.

Papatipu rūnanga
The collective rūnanga of a region.

Paru
Soils.

Pathogen
Any organism that causes disease, especially micro-organisms such as bacteria, viruses or parasites.

Pesticide
A chemical added to crops to kill the bugs. Like a giant fly spray!

Poha
Kelp bag.

Pollutant
A substance contaminating the water, which reduces its quality and/or harms or poisons plants or animals that live there.

Puna
Springs.

Rahui
A system of rules that protects a mahinga kai.

Residue
Substances or chemicals that are left over. Fertilisers, herbicides, and pesticides are chemical powders or liquids. Sometimes they are not completely used up by the plants so they collect in the soil and leak into streams, which can kill the animals and plants.

Renewable
Describes a resource that can be used again, such as water or energy from the sun.

Rūnanga
Local representative Māori groups. A Māori equivalent of local government.

Sediment
Particles of rock that are deposited into a river by wind, water, or ice.

Solute
A solute (for example, coffee, soap powder) dissolves in a solvent (water) to form a solution.

Species
An animal or plant with distinctive characteristics, that can only breed with others of the same species.

Sterile
Something that has no bugs and germs.

Tangata whenua
People of the land. The original (Māori) inhabitants of Aotearoa/New Zealand.

Taonga
Treasure or treasures.

Tohunga
An expert practitioner of any skill or art, religious or otherwise.

Treated water
Water that has had any bad microscopic bacteria removed.

Tributary
A smaller stream that runs into a bigger stream or river. For example Nottingham Stream is a tributary of the Halswell River/ Huritini.

Tuna
Eel or eels.

Turbidity
The measure of how much light gets through the water. Aquatic plants need light to photosynthesise, just like land plants. When the water is murky and dark, the plants in the water can't survive. This then reduces the amount of food for the animals that feed on the plants.

Urban
Towns or city areas, where there are lots of buildings, roads, and houses.

Waikino
Polluted water with the potential to harm all life forms. The mauri of such water is damaged.

Waimataitai
Water that is a mixture of saltwater and fresh water, such as in estuaries and marshes. A source of mahinga kai.

Waimate
Water so polluted that its life force has expired. It has no power to regenerate itself or living things. Its mauri is lost.

Waimāori
Fresh water.

Waiora
The purest form of water. It has the potential to give life, sustain well-being, and counteract evil. Waiora is used by priests (tohunga) in sacred rituals to purify and sanctify.

Waitai
Saltwater.

Waitohi
Water used for religious purposes such as baptism, initiation ceremonies, and to remove a tapu. This water must remain pure.

Wai ngawha
Hot springs or geothermal water.

Water table
The height of water in the ground, which can in places be above the ground as in ditches or ponds. The water table in Christchurch rises in the winter when there is more water in the ground and lowers over the summer as the land dries out.

Waterway
River, stream, or drain. An area that water flows through.

Water body
A permanent body of water such as a river, stream, lake, pond, wetland, or area of groundwater.

Notes

Notes

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