Waiora
(Healthy Water)

Waiora: A Teachers' Resource For Primary and Intermediate Classes

Environment Bay of Plenty
REGIONAL COUNCIL
Working with our communities for a better environment

Homai te waiora ki au

Give me life-giving water

Acknowledgements

This unit was compiled by Faye Wilson-Hill, Environment Waikato, and Sarah McCorkindale, Environment B·O·P with assistance from Alex Eagles, Environment B·O·P.

Environment B·O·P and Environment Waikato gratefully acknowledge the use of teaching resources from the following:

- Horizons MW — *'Waiora'*
- Environment Waikato - *Stream Sense*
- Taranaki Regional Council — *Living with the River*
- Wellington Regional Council —*Take Action*
- The Enviroschools Programme

Foreword

Welcome to 'Waiora' - healthy water.

Water is the basis of life, so healthy water is important for all living things.

Waiora will help you explore:

- the water around us
- the water cycle
- how we use water
- impacts of water and land use on water quality
- the health of your local stream

Environment B·O·P manages water resources in the Bay of Plenty. These include surface, geothermal and groundwater which are used for:

- domestic
- industry
- agriculture
- horticulture

A site visit to your local stream will help you assess how healthy it is and understand the impacts of land use around it.

Equipment for water monitoring can be borrowed from Environment B·O·P, phone 0800 368 267.

Jeff Jones
Chief Executive

Contents

Introduction

What is the Waiora Resource Unit?

The *Waiora* resource unit is designed for levels two to four (L2 - 4). It focuses on the relationship between people and water resources in the Bay of Plenty region. As an environmental education unit it seeks to encompass all the facets of environmental education as outlined in the "Guidelines for Environmental Education in New Zealand" (Ministry of Education, 1999).

This unit incorporates knowledge objectives from the seven essential learning areas and many of the essential skills, attitudes and values outlined in the *New Zealand Curriculum Framework*.

Key dimensions of environmental education are:

- Education ***in*** the environment - using field studies and other outdoor activities for increasing knowledge and skill development;
- Education ***about*** the environment - providing information about environmental phenomena and processes and;
- Education ***for*** the environment - activities directed at influencing environmental outcomes.

Five key aims of environmental education are:

- **Awareness and sensitivity** to the environment and related issues;
- **Knowledge and understanding** of the environment and the impact of people on it;
- **Attitudes and values** that reflect feelings of concern for the environment;
- **Skills** involved in identifying, investigating, and problem solving associated with environmental issues;
- A sense of responsibility through **participation and action** as individuals, or members of groups, whanau, or iwi, in addressing environmental issues.

Environmental education in New Zealand also examines the concepts of **interdependence, sustainability, biodiversity, and personal and social responsibility for action**. These concepts underpin many of the issues discussed in this unit and highlight how our actions often upset the natural balance in the environment.

Environmental education is an investment in our future. It is widely recognised that successful environmental education achieves long-term changes in knowledge and attitudes, develops strong environmental ethics, and encourages environmentally responsible behaviour.

The hands on action-oriented approach allows students to be involved in a style of learning that encourages creative and critical thinking, open questioning and long-term understanding of issues and concepts.

Why is Environment B·O·P involved in environmental education?

Environment B·O·P aims to manage the water resources in the Bay of Plenty in a sustainable way for the social, cultural and economic well-being of present and future generations. Environmental education is the principal non-regulatory means by which Council implements its policies to achieve these environmental aims. Environment B·O·P uses environmental education as a tool alongside other resource management tools, such as regulation and incentives, to help achieve sustainable resource management. The best means of achieving this is with the understanding, co-operation and partnership of the people who live in the Bay of Plenty.

Environment B·O·P's role in managing water resources relates to people's use of water and the impact of different land uses on water quality. Activities, such as farming, forestry, horticulture, industry and towns, can have adverse effects on water quality and the flow of water in our rivers, streams, lakes, aquifers (underground water sources) and estuaries. It is the long-term cumulative effects of these land uses that pose the biggest threat to our waterways.

As the population and development of the Bay of Plenty increases so too will the intensity of land use and its impact on the environment. Increased stocking rates, septic tank density, traffic density, proportion of sealed surfaces, use of herbicides and pesticides, and forest harvesting regimes may all contribute to increased future water quality and quantity problems in the Bay of Plenty.

How to use this unit

This unit is focused around a natural resource and therefore requires that students become familiar with the natural cycle of water - the *water cycle*.

All opportunities should be taken to refer students back to the impact that activities and land uses have on the water cycle.

The photocopy masters provide a visual version of the water cycle, but a large version of the water cycle can be helpful in teaching this unit.

Chapters One and Two explore the water cycle and how water flows.

Chapters Three and Four explore the issues that arise from people's use of water and land.

Information for teachers about these issues can be found on pages 18-26.

You can learn ***in*** the environment by investigating how water is used in your local area and investigating the water quality issues of a local waterway.

Students can then assess the water in their area (Chapter 5), plan and implement appropriate action to alleviate any problems with water resources.

Each chapter has a common approach:

- **Explore** - encourages thinking about the topic
- **Learn** - separate activities
- **Reflect** - encourages critical thinking about the activity, new concepts and issues.
- The tasks include:
  - » reading
  - » discussions
  - » role play
  - » debate
  - » design
  - » construction
- For further information check out the References and Resources section page 159.

The ultimate aim of this unit is to help teacher and students take action to improve or protect the environment.

Environment B·O·P would like to support you in your action to improve or protect the environment. Contact us for further assistance.

Water in the Bay of Plenty

For more detailed information refer to Bay Trends, the Bay of Plenty State of the Environment Report 2001.

The Bay of Plenty region

The Bay of Plenty is a myriad of streams, rivers, lakes and wetlands. Each district in the Bay of Plenty has at least one major river which the local people identify with while the Rotorua lakes district has one of the highest numbers of accessible lakes in a small area in the world.

Maori have strong cultural, traditional and historic links with our wetlands and inland waterways. There are many values Maori attribute to water. These are just a few examples. Freshwater resources are spiritually significant and closely linked to the identities of the tangata whenua (people of the land). Respecting our waterways is an important part of performing the guardianship or **kaitiakitanga** role for Maori. Rivers and streams contribute significantly to the diet of Maori people. Waterways also provide a place for aquatic plants and animals to live.

Yet there are many conflicting demands placed upon these waterways. Our rivers are used for

- hydro-electricity
- water supply
- waste treatment
- flood control
- recreation such as fishing, boating and swimming.

These activities take their toll on the environment and this is often reflected in decreasing water quality. This can have consequences for the health of people, and the plants and animals that rely on these areas for food and habitats.

The Bay of Plenty region has more than 16,000 km of rivers and streams, all of which have changed dramatically since European settlement.

Monitoring water quality in the Bay Of Plenty region

Environment B·O·P regularly measures water quality at over 40 sites along our rivers, harbours and streams, as well as at 32 lakes sites within the Bay of Plenty.

The basic ecology of 17 rivers and streams has been monitored over the last 10 years.

The factors monitored include the plants, insects, fish and other animals that make up stream life in the Bay of Plenty region, the velocity, the substrate and the plant life.

The stream habitat monitoring is to be expanded to include over 20 more sites.

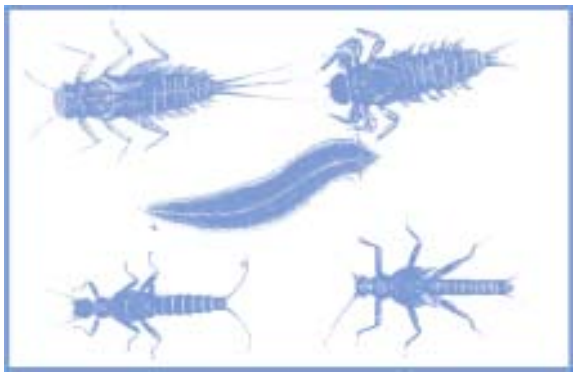
These surveys test the water for ecological health (the ability of the waterway to support plants and animals) and the suitability for human use such as swimming and general water supply.

Many factors affect water quality, including:

- **geology of a stream** - what the bottom or substrate of the stream is formed from
- **surrounding land cover**, soil types and activities carried out on the land
- **topography** - the steepness of surrounding land
- **source** - how much it is fed by overland flow, or water from springs and wetlands
- **flow** - affected by rainfall, catchment vegetation and soil, and by water removed
- **inputs** e.g. runoff from the land, stormwater or discharges from industry
- **plants and animals** that live in the stream (e.g. introduced koi carp stir up sediment

on the bed making water too muddy for native fish).

Indicators of water quality



Aquatic macro-invertebrates are the insects, snails, worms and crustaceans that live in water. Because some have a higher tolerance than others to pollution, invertebrates can be used to indicate the health of a waterway.

In general, mayfly, stonefly and caddisfly larvae are all associated with streams that have a high quality habitat, for example the headwaters of a cool, forested stream with a rocky bottom.

Snails, fly larvae and worms are found in more polluted, muddier and warmer streams, usually in the lower part of a catchment and often associated with urban areas or agricultural development.

Water quality testing also gathers information on the less visible sources of water pollution.

These are known as **non-point sources** such as nutrients and sediment from farmland that is washed into waterways by rainfall or seeps through the soil into groundwater.

This is compared to **point sources** of water pollution such as a stormwater drain, which is very visible.

It is the **sources** of non-point pollution that this unit predominantly focuses on as the point sources of water pollution and water abstraction are regulated by the Resource Management Act (1991). This means that any discharge into or taking of water from a natural waterway (including groundwater) can only occur once a resource consent has been approved by Environment B·O·P, the Regional Council.

The Resource Management Act (1991) requires any user of a resource to maintain the quality of the resource. When industries and businesses use water they have strict conditions to which they must comply. Water that is used on site must be treated before being returned to a waterway.

Water quality issues in the Bay of Plenty

Water use

Drinking water

All water in the Bay of Plenty region has to be treated before it can be used for municipal supply. There are very few areas left where water is safe to drink directly from its source without first being treated.

Bottled water and water filters

Many people now choose to filter the water that comes into their homes or buy bottled water. This is a consumer choice possibly motivated by issues surrounding water quality and health.

There is also the convenience of having water that you know is safe to drink and that it is good for you.

With this though comes other social and economic issues such as what happens to the additional waste created from filters and bottles? Such businesses provide employment and income.

Considering a balance between all these issues is very important to our long-term survival.

Waste water disposal

All household waste from pipes connected to our homes and schools goes either to the waste water (sewage) treatment plant or in rural areas into septic tanks. A small percentage of people have composting toilets and alternative '**grey water**' systems.

Once we have used water it must be treated before being returned to the environment. Like water treatment for supply, this process has a cost, and the more water we use in our houses, the more water there is to treat.

Although the water is considered 'safe' as bacteria levels have been reduced, once it is returned to the environment it is usually considerably altered.

The additional nutrients that are not filtered out (such as phosphate in faeces and detergents, and nitrogen in urine) may increase the growth of plants in waterways and this can lead to **eutrophication**.

Eutrophication is where high nutrient levels in a water body cause rapid growth of plants (such as algae and water weeds). As these plants die, micro-organisms break the plant material down, using oxygen in the process. This can result in such low oxygen levels in the water that fish cannot survive.

Things we can do at school and at home to help reduce the amount of water that is treated:

- Fix leaky taps.
- Only run the water when necessary, e.g. turn the tap off while you brush your teeth or wash the vegetables.
- Wash full loads of washing and dishes.
- Water the garden in the mornings or the evenings when it is cool.
- Ensure that the water is going on the garden and not running down the driveway (drip systems are more efficient than sprinklers).
- Mulch the garden so less watering is required and plant plants that are suited to the habitat.

- Take a shower - it uses less water than a bath.
- Use the half-flush button on your toilet, or put a brick in the cistern so it takes less water to flush.
- Contact your district council for more water saving ideas.

Stormwater

Stormwater drains are designed to drain water away from buildings and sealed surfaces, such as roads, into natural waterways.

This water is not treated and any chemicals, dirt, oil, detergents, litter, and animal faeces that are on the surface can be washed down into the waterway.

All of these can have a significant impact on the quality of water.

Paint, left over chemicals, oil and other poisonous substances should never be emptied down the drain, they should be returned to the place they were purchased from or disposed of safely at a transfer station.

Vehicles should be washed on the grass, not on the road or in driveways, as grass helps to filter detergents and reduce the amount entering stormwater drains.

Hydro-electric power generation

We use electricity every day. We make choices about the amount of electricity that we use in our homes, schools and businesses and this drives the demand for electricity.

When the consumer demand for electricity rises, more water is used to generate electricity.

Water is also used as a coolant when fossil fuels like coal or gas are burnt to generate electricity.

One fifth of New Zealand's electricity is generated by burning fossil fuels and the rest is from hydro stations.

Fossil fuels are used to generate electricity during high use times like winter mornings and evenings. Warm water is released back into the river and can cause the water temperature to rise, affecting nearby river life.

When electricity is generated from hydro-dams, the level of the water in the hydro-lake decreases and the level of the water in the river increases. This fluctuation can create problems as the banks of the river may erode, animals living in the water can be stranded out of water and the look of the river can be affected.

Compared to other sources of electricity generation, hydro-power is relatively cheap and efficient and doesn't cause global warming through carbon dioxide release. But new hydro-development disrupts river systems, causing flooding upstream and blocking the migration of eels and fish which need to travel up and down to complete their life cycle.

What level of 'resource use' do we want to tolerate in order to have this access to electricity?

Are we prepared to reduce the amount of electricity we use in order to maintain water levels and temperature in the rivers, and prevent the need for new hydro-developments?

How much electricity we use and the times that we create the demand are issues to think about.

Recreation

We love to live beside and have access to water. We swim, fish, boat and enjoy many other water sports. Once again these activities can have impacts on water.

Litter, boat fuel pollution, and introduction of exotic plants and animals have contributed to the decreasing number of places that we can safely enjoy these activities.

Individuals can take responsibility for ensuring that boats are well maintained, litter is disposed of appropriately and plant and animal pests are not transferred on propellers between waterways. By doing this, we can help to ensure that waterways continue to be our playgrounds into the future.

Many land use activities can result in negative impacts on waterways when the activity continues over time. See summary chart pages 24-26.

Significance of water to Maori

Waiora A Tane

Water is a very significant resource to Maori, and plays a central role in both the spiritual and secular worlds.

The origins of water from a Maori viewpoint are central to Maori culture. In order to understand how water is an agent of bondage between the physical and spiritual worlds of the Maori, we need to understand the origins of water. Maori mythology gives voice to this. The creation myths tell Maori of the lineage of his or her unique relationship with the environment, and how the environment is perceived as the living, breathing, delicate source of life. Maori mythology also explains the connection that Maori have with the divine forces present in the environment, such as mauri.

Mauri in relation to water means life and the living. It has the capacity to generate, regenerate and uphold creation. Because of this, all living things in the water and its environs (which include people), are dependent on its mauri for their well-being and sustenance. Hence, each water type is seen as a taonga (a highly prized possession) and is sacred due to the potential prosperity it can give to Maori associated with it. The mauri of each water-way is a separate entity and cannot be mixed with the mauri of another. There are clearly impacts of this within water pollution, agricultural spray, fertilizer run off and effluent discharge, as expressed by Ngai Tamarawaho and other iwi/hapu of the horticultural area of Tauranga Moana.

(Source: Ngaa Tikanga Tiaki I Te Taiao. Issues of significance to Maori for inclusion in the Bay of Plenty Regional Policy Statement.)

Land use activities and their impact on waterways

Removal of natural land cover

It is helpful to retain or restore tree cover to stream banks and headwaters to protect soil, regulate water flow, provide good habitat and buffer run-off from the land. Stands of native trees can have a covenant placed on them to protect them from ever being felled. Over 46% of the Bay of Plenty remains in native forest vegetation cover. This is generally found in the steeper headwaters and steep river margins.

Native forest allows water to infiltrate naturally.

Water is taken up by the trees and then released slowly reducing the risk of flooding.

Shade from the trees provides good habitat for animals in the stream, and the insects, leaves and logs falling into the water provide food and homes for stream life.

Clean cool water is safe for swimming, and provides good feeding and spawning habitat for fish.

The water that enters streams from native forests generally requires less treatment for drinking.

Dairy shed effluent

In the past, effluent from dairy sheds was discharged straight into waterways. Through the Resource Management Act (1991) this no longer occurs as effluent must be either treated in ponds or irrigated back onto the land.

Landowners are now encouraged to irrigate effluent onto land, as this uses the soil to filter the bacteria and also allows the pasture to benefit from the nutrients.

However, there is potential for bacterial and nutrient runoff into streams, especially during heavy rain or when the ground becomes saturated.

Runoff can also occur from effluent ponds that are too small. This runoff can make waterways unsafe for swimming and drinking.

Waterways can be protected by using sufficient sized effluent ponds and by shifting effluent irrigators regularly. If the ground is saturated an alternative form of disposal is needed such as temporary ponds.

Stock access to waterways

There are a number of issues surrounding stock having access to waterways:

- Trampling and erosion of the banks and removal of bank vegetation.
- Stirring up of the stream bed and loss of habitat for stream animals.
- Bacteria entering streams directly through faeces and dead animals.

This can make streams unsafe for swimming and drinking, increase the amount of sediment entering the stream and decrease the water clarity.

Alternatives are to provide stock with drinking troughs and to fence off the stream.

Planting the banks will help restore the stream habitat for water life and create **wildlife corridors** for **terrestrial** life.

Erosion

Erosion has a number of causes but the impact is the same - soil enters a waterway and is eventually washed out to sea.

Bare soil exposed by cultivation, overgrazing, slips on steep land, or streambank trampling is particularly susceptible to being washed into streams and rivers during rain. This reduces the clarity of waterways, impacting on the plants and fish.

Sediment settles on the streambed between rocks and reduces the number of different places in which **invertebrates** can live.

High sediment levels also increase the amount of treatment required for drinking supply.

Stream banks and steep slopes should be well vegetated to prevent erosion. Some steep areas may be better retired from grazing and planted in a timber crop or left to regenerate into native bush.

Planting crops in rows across a slope rather than down, leaving crop stubble on the paddock, cultivating as little as possible and maintaining a healthy soil with lots of organic matter will help to prevent erosion in a cropping situation.

Continuous cropping

Continuous cropping of land for food production can have negative impacts on waterways:

- Erosion of soil from bare land reduces water clarity/quality.
- If applied too heavily, fertiliser can run off or drift into waterways.
- Lack of organic matter in the soil.
- Water shortages in summer because of water used for irrigation. Water temperature can also increase when too much water is taken from waterways.

Some of these impacts can be reduced by keeping a planted buffer on the edges of the paddock to help filter the soil and fertiliser running downhill into gullies where waterways are.

Planting with the contour of the land will help stop water that is channelled down into the gully, taking soil and nutrients into the stream at the bottom of the gully.

Too much fertiliser can leach nitrogen into groundwater systems making them unsuitable for humans to drink.

When the soil is used over and over again organic matter is depleted making the soil more prone to erosion.

Ploughing back in some organic matter like crop stubble at the end of each harvest will add organic matter to the soil.

Sealed Surfaces

Sealed surfaces such as roads, buildings and carparks prevent water from filtering into the ground naturally during rain. More water flows to rivers and streams through stormwater systems during rainfall, sometimes causing flooding.

These 'flash floods' can change small trickling streams into dangerous waterways with water moving at high velocity and stripping all life out of the stream.

The stormwater systems will pick up any pollutants and litter on the streets and carry them into waterways.

We can reduce the sealed surfaces around us by using materials that will allow water to filter naturally, such as gravel and shells, or by maintaining grassy or treed areas.

Road works and subdivisions

Road works and the creation of subdivisions expose soil and make it susceptible to runoff and erosion.

Sediment, oil and grease can all run off into waterways, reducing the clarity of the water and habitats for streamlife to live in.

Heavy machinery compacts the soil, preventing water from infiltrating naturally during rain.

All of these activities need careful management to create minimum impacts.

Sometimes sediment traps can be used to stop the soil from entering the waterway and replanting quickly helps restore the balance. However both roadworks and subdivisions will result in more sealed surfaces.

Other issues

The issues outlined here have arisen through our choices and demands to make our lives more comfortable.

We can blame others for polluting waterways, yet we often rely on the products that come from the businesses we consider to be the cause of pollution.

We all have opportunities to think about the resources we use daily, like water, so we can be responsibile resource users.

For example, most people in the Bay of Plenty enjoy high quality dairy products, are able to drive to work/school each day on well sealed roads, wash clothes and water gardens.

Environmental education is about exploring issues from many points of view and recognising that people must learn to live in balance with the environment.

There are many other issues that have not been specifically outlined in this unit of work. You can investigate the issues for waterways in your area and determine what impacts activities might be having on the environment.

For more information check out Environment B·O·P's website www.envbop.govt.nz and Bay Trends the Bay of Plenty State of the Environment Report 2001.

When the well is dry, we know the worth of water.

Benjamin Franklin (1706-1790)

Effects of land use on stream and catchment health

Land use	Associated activities	Potential pollutants	Potential effects of landuse on stream health
Dairy Farming	Fertiliser use	Nutrients such as Nitrogen and Phosphorous	Increases nutrient status of waterway – can lead to eutrophication Growth of aquatic plants which can strangle stream
	Chemical use	Pesticides and herbicides e.g. Organophosphates	Poisonous to stream life (especially pesticides)
	Effluent spray irrigation Dairy shed effluent oxidation ponds	Leachate of faecal bacteria e.g E.Coli (& Nitrogen)	Can make humans and other animals sick
	Streambank damage from stock Removal of native & riparian vegetation.	} Sediment & faecal bacteria	(1) Sediment infills or smothers habitats and prevents feeding by some species. Sediment can reduce light levels on the streambed. Stock damage can cause steeper streamsides & faster water flow = Channelisation. Fewer habitats for stream life and breeding Streamside vegetation destroyed so no vegetation buffer to stop sediment, fertiliser and chemicals entering water Less shade in stream (Increased stream water temp so less dissolved O_2) All of the above can contribute to increased algal growth.
	Wetland drainage/flow change:	Sediment Nutrients	Fewer habitats for aquatic life and breeding Less flood retention ability in waterways without wetlands
Dry Stock farming -Beef & sheep	Chemical use	Pesticides, herbicides & animal health remedies	Poisonous to stream life (especially pesticides)
	Streambank damage Removal of native & riparian vegetation	} Sediment & faecal bacteria	See above
	Soil compaction by animals		Less water infiltration therefore more run off
Horticulture	Implement/tractor use	Compaction	Less water infiltration therefore more run off
	Irrigation	Water removed from stream	Reduced water flow for stream life Increased stream water temp so less dissolved O_2
	Vegetation removal	Sediment and increased runoff of chemicals	See above (1).
	Fertiliser use	Nutrients such as Nitrogen and Phosphorous	Increases nutrient status of waterway – can lead to eutrophication Growth of aquatic plants which can strangle stream
	Chemical use	Pesticides & herbicides e.g. Organophosphates	Poisonous to stream life (especially pesticides)
Forestry	Native vegetation removal beside streams Creation of tracks and creation of bare land post harvest and pre-planting.	} Sediment	See above (1)

Effects of land use on stream and catchment health

Lifestyle Farming	Fertiliser use	Nutrients such as Nitrogen and Phosphorous	See above
	Pesticides & herbicides		See above
	Land development	Sediment	
	Septic tanks	Faecal bacteria	
	Stormwater	Small amounts of heavy metals	Can accumulate in the food chain, can become toxic in stream, coastal and estuarine ecosystems.
Urban	Removal of riparian vegetation Channelling of streams	Sediment	Removal or change of habitats (due to widening or concreting of streams for stormwater management).
	Roading Stormwater Commercial activities	Heavy metals (greater in stormwater from commercial areas)	Can accumulate in the food chain & become toxic in stream, coastal and estuarine ecosystems. Results in a decline in diversity and density of stream life sensitive to pollution and an increase in pollution tolerant species.
	Water supply	Water taken for drinking, washing etc.	Reduced water flow for stream life Increased stream water temp so less dissolved O_2
	Waste disposal	Litter Organic waste Domestic animal waste Human waste	Increased Biochemical Oxygen Demand (BOD) for bugs to break down waste therefore less oxygen for stream life.
	Chemical use	Detergents Solvents Paints	Poisonous to stream life. Can accumulate in the food chain & become toxic in stream, coastal and estuarine ecosystems.
	Fertiliser use	Nutrients such as Nitrogen and Phosphorous	Increases nutrient status of waterway – can lead to eutrophication Growth of aquatic plants which can strangle stream
Industrial	Oil use	Oil	Toxic to stream & bird life. Also destroys waterproofing of birds, smothers gills of fish and blocks filter feeders.
	Chemical use	Paint Solvents Detergent	Poisonous to stream life. Can accumulate in the food chain & become toxic in stream, coastal and estuarine ecosystems.
	Human, plant and animal waste	Food processing waste Faecal bacteria	Increased Biochemical Oxygen Demand (BOD) for bugs to break down waste therefore less oxygen for stream life. Can make humans and other animals sick
	Water used for cooling industrial processes and machinery	Heated water	Increased water temperature reduces amount of dissolved oxygen and makes stream too warm for stream life.
	Miscellaneous industrial processes	Many other contaminants	Poisonous to stream life. Can accumulate in the food chain & become toxic in stream, coastal and estuarine ecosystems.
Parks/Reserves	Grounds maintenance	Fertiliser	See above
	Public use	Litter	Threat to stream and bird life
	Illegally dumped rubbish	Cars - Oil, battery acid, heavy metals from fuels Fridges – CFC's	Poisonous to stream life. Can accumulate in the food chain & become toxic in stream, coastal and estuarine ecosystems.
	Irrigation	Water taken to irrigate lawns and gardens	Reduced water flow for stream life Increased stream water temp so less dissolved O_2

Effects of land use on stream and catchment health

Roads (& other hard surfaces)		Heavy metals from fuels Oil	Poisonous to stream life. Can accumulate in the food chain & become toxic in stream, coastal and estuarine ecosystems. Toxic to stream & bird life. Also destroys waterproofing of birds, smothers gills of fish and blocks filter feeders.
Tourism	Waste disposal	Litter Human waste	Threat to stream and bird life Increased Biochemical Oxygen Demand (BOD) for bugs to break down waste therefore less oxygen for stream life.
River flood management	Gravel extraction	Sediment	As above Gravel extraction changes habitat type
Mining	Water abstraction Processing ore Waste treatment Extraction of minerals	Sediment Iron floc Heavy metals PH changes (acidification)	} Poisonous to in stream invertebrates Can accumulate in the food chain & become toxic in stream, coastal and estuarine ecosystems.
Dams	Flooding of land above dam Reduced water flow in river below dam		Flooding land changes habitats Dam stops young fish and eels from migrating up stream or river so populations decline.

Major Catchments of the Bay of Plenty Region

Tauranga Harbour Catchment

43% native forest, 43% pasture, 6.5% forestry, and 6% horticulture

Te Puna Stream Catchment

This catchment begins on the north eastern slopes of Otawa. The topography in the upper catchment is steep with a native forest cover. This develops into strongly rolling to rolling hill country through the mid catchment.

From here down to the estuary the stream flows on a hard rock base losing altitude over waterfalls and through steep sided gorges. The catchment is subject to strong winds and high levels of rainfall.

Nearly 30% of the land cover in the catchment is native forest, 66% is pasture, 2% is horticulture and just over 2% is forestry. The stream discharges in Tauranga Harbour.

The catchment is prone to erosion particularly along the streambanks and in the steep upper part of the catchment. This is accentuated by the fact that the natural vegetation and waterways have little or no protection from grazing stock.

Waitao Stream Catchment

The catchment begins on the native covered slopes in the north eastern part of the Otawa volcanic range. The topography is steep in the upper catchment but becomes strongly rolling to rolling hill country through the mid catchment.

From the mid catchment to where it discharges into the Tauranga Harbour estuary the stream follows an alluvial flood plain with rolling hills and terraces on either side.

Rainfall in the catchment ranges from 2400mm/year in the upper ranges to 1400mm/year at the coast.

Strong winds are a feature of the catchment climate in addition to the high rainfall.

Over 46% of the native vegetation remains in the catchment. Pasture accounts for 39% of the land cover in the catchment, forestry is nearly 14% while horticulture is less than 1%.

The steep areas and stream banks in the catchment are subject to erosion which is accentuated by grazing stock.

Te Mania Stream Catchment

The catchment begins at around 400m on the lower slopes of the Kaimai Range within the Department of Conservation forest park. The topography here is steep but develops into strongly rolling to rolling hill country through the mid catchment and then to undulating to flat country from there to where the stream discharges into Tauranga Harbour.

The catchment is subject to strong winds and a high rainfall of 2000mm/year in the ranges.

There is active erosion in the catchment particularly in the farming regions which account for 57% of the catchment.

Native vegetation remains on around 30% of the area while horticulture covers 11% and forestry less than 1%.

Kaituna Catchment

The Kaituna catchment covers 122,000 hectares. Half of the catchment area flows directly into Lake Rotorua or Lake Rotoiti. Water levels in these lakes combined with the two lake level control structures moderate the peak flood flows down the Kaituna river. The Kaituna river flows from

Lake Rotoiti at Okere Falls, reaching the Bay of Plenty coast at Maketu. Around 30% of the catchment area is in indigenous forest, and around 50% is in pasture.

The Waihi Estuary Catchment runs from Paengaroa in the west to Otamarakau in the east and extends south from the estuary almost to Lake Rotoiti. The western side of the catchment is drained by the Pokopoko Stream, which has a number of major tributaries. These are the Oeuteheuheu and Waiari Streams in the mid to upper catchment, and the Pekahinemata and Mangatoetoe Streams in the lower catchment. All of these streams eventually converge into a single waterway down stream of State Highway 2 and is known as the Kaikokopu Canal. This is a manmade canal.

The central catchment is drained by the Wharere Stream while the eastern side of the catchment is drained by the Pongakawa River. Coastal terraces and flats to the east of the estuary are drained by the Pukehina Canal. The lower reaches of the Wharere Stream and Pongakawa River have also been channelled to assist drainage of the flats bordering the estuary.

Characteristic of the upper catchment are extensive dry wash sub-catchments formed by broad gullies running to the north. These sub-catchments carry surface flow in heavy storms and have potential to form major erosion features known as gully heads. The underlying geology of the catchment is composed of Rotoiti Breccia, a pumiceous pyroclastic flow originating from the Okataina volcanic centre. This is covered with deep layers of **tephra** and present day soils are derived from a layer of Kaharoa ash. This lies over most of the catchment, forming coarsely textured soils with limited water holding capacity. These soils are susceptible to surface erosion processes, which can be initiated by removal of vegetation cover or by excessive livestock treading.

About 45% of the catchment is classified as Land Use Capability (LUC) Class VI meaning it is moderately steep land with a medium to high erosion potential if not managed correctly.

About 10% of the catchment is Class VII, being steeper terrain with higher erosion potential. Around 2% of the catchment area is classified as Class VIII, and is too steep and erosion prone to be used for agriculture or forestry.

Tarawera Catchment

Tarawera Falls to Matata Lagoon
Lake Tarawera lies at the headwaters of this catchment which consists predominately of steep hills covered with indigenous and exotic forest. The lower reaches of the catchment flow through fertile dairy farming land and the town of Kawerau. The Tarawera River reaches the Pacific Ocean near the township of Matata.

Rangitaiki Catchment

Napier-Taupo Highway to Thornton
The undulating pumiceland formed during the Taupo volcanic eruption in AD186 comprises the upper half of the catchment dominated by exotic forestry. At the Matahina Dam the land use changes from forestry to intensive farming. Several small towns including Te Teko and Edgecumbe are situated along the river with the outfall into the Pacific Ocean adjacent to the small settlement of Thornton.

Whakatane Catchment

Ruatahuna to Whakatane township
This catchment begins in steep country clad in indigenous forest, the traditional home of the Tuhoe people. The steep land gives way to undulating, highly productive farming land with the Waimana River joining the Whakatane River at Taneatua. The river reaches the Pacific Ocean at the township of Whakatane.

Ohiwa Harbour

Nukuhou North to Ohiwa Harbour river bar
The Ohiwa catchment is comprised of a number of small waterways, the most significant of these being the Nukuhou River. The catchment is made up of undulating to moderately steep land, most of which is farmland. The Ohiwa Harbour drains into the Pacific Ocean across the river bar.

Waioeka/Otara Catchment

Urewera to Opotiki wharf
Steep indigenous bush clad hills dominate two thirds of this catchment. The area is renowned for the high and intense rainfall events which can cause flooding in the Opotiki hinterland and township. The Waioeka and Otara Rivers unite near the township of Opotiki before reaching the Pacific Ocean just over a kilometre away.

Motu Catchment

Matawai township to Motu River mouth
The Motu Catchment is largely extremely steep land covered in indigenous forest with very little human habitation. The river drains to the Pacific Ocean around five kilometres west of the settlement of Te Kaha.

Raukokore Catchment

This catchment is comprised of very steep land dominated by a bush covering. There is little development or human habitation in the area. The region is prone to high intensity cyclonic storms which arrive from the north east. The Raukokore River flows into the Pacific Ocean some five kilometres west of Waihau Bay settlement.

Catchment facts for the Bay of Plenty

	Tauranga Harbour	Kaituna	Waihi Estuary	Tarawera	Rangitaiki	Whakatane	Ohiwa Harbour	Waioeka/Otara	Motu	Raukokere
Catchment facts for the Bay of Plenty										
Catchment size km^2	1240	1218	697	990	3005	1784	186	1228	1427	408
Mean river flow		39,300		30,700	71,000	57,100		31,800	91,900	31,000
Maximum river flow		376,800		92,400	637,200	2,313,800		1,493,900	2,988,000	1,500,000
Low flow		22,000		15,200	32,800	5,800		1,200	6,700	1,700
Main discharges and water takes										
Dairy sheds	76	83	112	121	174	111	25	53	2	3
Discharges for stormwater	153	83	4	14	11	15	1	1	0	0
Water takes for irrigation	355	154	86	60	78	27	2	14	0	0
Water takes for domestic water supplies	52	31	1	5	4	3	0	2	0	0
Dams/electricity consents	13	0	0	3	8	0	0	0	0	0
Geothermal takes	79	120	1	5	0	0	0	0	0	0

Data Source: Environment B·O·P Consents 2002

Note that the catchment boundaries used to generate these results are indicative only.
For example, the catchment for Little Waihi Estuary is the area left over between the Kaituna and Tarawera river catchments – some of which may not flow in to the Little Waihi Estuary including lakes Rotoma and Rotoehu.

71% of the earth is covered in water, 97% of that water is salty, 3% is fresh. Of the fresh water, about 2% is locked in polar ice-caps.

"Filthy water cannot be washed." West African Proverb

Only 0.45% of the earth's water blanket is freely available at or near the earth's surface, and circulates in what is know as the water cycle.

About 50,000 litres of water is used in making a car.

When Maori people ask your name they say 'Ko wai to ingoa'. 'Wai' is the Maori word for water.

61% of the human body is water.

97% of the world's water is in the sea (2% of this is ice).

The average New Zealand household uses 200,000 litres of water a year. Half of this is in the bath, shower and toilet.

80% of human skin is made up of water.

Water is also a key component in many industrial processes - as an ingredient in the brewing industry, as a coolant in the steel making process, or as a power source in the generation of hydro-electricity.

Water is important because it supports life on the planet, as almost all the significant reactions at cellular level depend on aqueous solutions.

It takes about 4 litres of water to make a small can of coke.

Adults need 2.5 litres of water a day. This can be in food and drink.

It takes about 200 litres of water to make one newspaper.

'Wairua' is the Maori word for 'spiritual things'. It literally means two waters the physical and the spiritual.

90% of the human brain is water.

The average person uses at least 150 litres of water a day for washing and cleaning, with almost half this amount being used to flush the toilet.