The Coastal Environment

Key Information	Why is this Useful?	What is Happening?
Length of coastline in Christchurch.	This provides contextual information about the extent of the coastal environment in the City.	● There are approximately 65 kilometres of coastline in the City including the Avon-Heathcote Estuary and Brooklands Lagoon.
Coastal recreational water quality.	Microbiological organisms such as viruses, bacteria and protozoa may pose a health hazard when water is used for high contact recreation such as swimming.	● During the 1998/99 summer the guidelines were exceeded twice.
Nutrient inputs to the Avon-Heathcote Estuary.	Nutrients are important for sustaining Estuary life. However, excessive nutrients can lead to unwanted algal growths which can reduce amenity and sometimes produce toxic conditions.	● Around 7,150 kilograms per day of dissolved nitrogen and phosphorus are discharged into the Estuary. Ninety seven per cent of this is from the oxidation ponds.

Other Related Sections: Population Growth, Health, Weather and Climate, Land Use, Surface Water, Open Space and Natural Ecosystems, Built Environment, Urban Amenity, Waste Management, Businesses, Employment and Unemployment.

The City's coastal area is of significant ecological, conservation and recreational value to both metropolitan residents and the region as a whole.

Forming Christchurch's eastern boundary, the coastline extends from the Waimakariri River in the north to inside Lyttelton Harbour. Its diverse features include:

- The man-made mouth to the Waimakariri River;
- Salt marsh areas in estuaries;
- Long sandy beaches backed with high dunes;
- Man-made shorelines, eg sea walls, piers;
- Rocky headlands.

Including the Avon-Heathcote Estuary and Brooklands Lagoon, around 65 kilometres of coastline border the Christchurch territorial local authority area[25]. Table 2.12 shows the extent of each type of coast within the City at high tide. Two thirds of this length is made up of open coast, with the remaining third bounding the Avon-Heathcote Estuary and Brooklands Lagoon.

Approximately 80 per cent of the coast can be described as being in some form of natural condition. However, these areas have been extensively modified since the first European records described the coastline. Approximately 50 per cent of Christchurch's coastline has some form of urban development within 250 metres. This varies from residential and commercial development to the City's landfill.

The Avon-Heathcote Estuary is almost completely surrounded by urban development within 250 metres of the high tide line, if the Bromley wastewater treatment plant's oxidation ponds are included. However, if we exclude these, the extent of urban development around the Estuary is reduced to two thirds of the shoreline.

[25] These figures were calculated using digital orthophotographs flown in 1996, with a ground resolution of 0.5 metres.

Christchurch's Beaches

Christchurch has 22 kilometres of sandy beaches. Most of these are backed by sand dunes which are more than eight metres high in some places. Sea walls or other built structures back sections of beaches, such as at Brighton and Clifton. Sumner-Scarborough beach only has sand at low tide. At high tide, water washes against the sea wall.

Since European settlement began the Christchurch beaches have been in a long-term equilibrium condition; that is, over a period of several years the loss of sand from erosional processes equals the gain of sand from accretion. It is anticipated that this condition of long-term stability or minor growth, with shorter-term fluctuations, will be characteristic of Christchurch beaches in the foreseeable future. Generally, the natural cycle of sand movement on Christchurch beaches involves sand being removed over winter months and then replenished over the summer.

Table 2.12 Length of Christchurch's Coastline[25]

	Coastal Type	Km
Open Coast	Beach with dunes	20.2
	Rock foreshore or cliffs	14.2
	Beach in front of built structure	1.7
	Sea wall	1.6
	Total	***37.8***
Estuaries	Sea walls - Avon-Heathcote	6.9
	Salt marsh - Avon-Heathcote	6.0
	Residential sea wall - Avon-Heathcote	2.1
	Stopbank - Avon-Heathcote	1.8
	Saltmarsh - McCormacks	1.1
	Avon - Heathcote Total	***18.0***
	Brooklands - salt marsh	9.8
Total		**65.6**

Source: Christchurch City Council.

The mechanisms affecting the addition and loss of sand in the beach system can occur very rapidly. For example, during the storm on 28 August 1992, five metres of the dune face were removed. However, in the next five months approximately one metre of sand had built up again along the shore.

The Avon-Heathcote Estuary[26]

The Avon-Heathcote Estuary is one of the key landscape elements of Christchurch City. It is valued for its ecological and amenity values by both local Maori and Pakeha residents. However, it has been significantly modified in post-European times through direct processes such as the outfall of the City's sewage treatment plant, and indirectly through changing landuse and development in the catchments of the Avon and Heathcote Rivers. The net result has been changes to the hydrological and nutrient conditions of the Estuary through increased water, sediment and nutrients entering from the rivers and oxidation ponds.

The Avon-Heathcote Estuary is approximately eight square kilometres in area, and has around 11 million cubic metres of water flowing in then out with each tidal cycle. The Avon and Heathcote Rivers and the Christchurch wastewater treatment plant oxidation pond outfall add fresh water to the Estuary, which mixes with the saline water and is discharged on the out-going tide.

Studies of the Avon-Heathcote Estuary note that there was a large influx of muddy sediment into the Estuary associated with the development of Christchurch. It is thought that there was a phase of high sediment input that probably began in the late 1800s and extended through until the 1950s. Over the last 30 years the bed of the Estuary has become less muddy overall and is currently composed of muddy sand. Muddier patches occur off the mouths of the Avon and Heathcote rivers and the City outfall drain.

Rapid sedimentation of the Estuary, as interpreted for the early part of this century, is no longer an issue. Current sedimentation is relatively minor and local in its effects. Sediment from the Avon and Heathcote Rivers is typical of mature urban catchments, amounting to 35 and 43 tonnes per kilometre per year, respectively. This equates to 2,600 tonnes per year from the Avon and 4,500 tonnes per year from the Heathcote. Ninety nine per cent of this sediment is carried in suspension and consists of clay and silt particles.

The Avon-Heathcote Estuary is unparalleled among New Zealand estuaries in supporting such a large and varied wildlife population within such a heavily urbanised area[27]. In the last 150 years at least 113 species of bird have been recorded in the Estuary, including 102 species between 1980 and 1992. Between 15,000 and 32,000 wetland birds use the Estuary and oxidation ponds or their margins, with numbers peaking in late summer and autumn.

The Estuary is of international importance. A wetland is internationally important if it regularly supports either 20,000 wetland birds or 1 per cent or more of the total world population of a species or sub-species. The Avon-Heathcote Estuary and oxidation ponds regularly support 5-6 per cent of the world populations of South Island pied oystercatcher and New Zealand shoveler, about 3 per cent of New Zealand scaup, close to 1 per cent of Black Cormorant and Little Cormorant and over 1 per cent of the New Zealand populations of at least 13 other species.

The Avon-Heathcote Estuary is an important link in a chain of wetlands along the central Canterbury coast between the Waipara River mouth in the north and the Rakaia River mouth in the south. At peak times, this wetland system supports a combined population of over 150,000 wetland birds. Few of the birds now found on the Estuary actually nest there. The area's real importance is as a post-breeding habitat in autumn and winter. Consequently, many of the birds make some sort of annual migration. The Estuary and the Bromley oxidation ponds may be either a destination or simply a transit stop for birds moving between the high country and the coast, from the South Island to the North Island or even between the high Arctic to Australasia and the south-west Pacific.

Coastal Water Quality

Recreational Water Quality

The Canterbury Regional Council monitors the quality of most of the recreational swimming areas in the City over the summer months for levels of microbiological organisms such as viruses, bacteria and protozoa. These organisms may pose a health hazard when the water is used for recreational activities such as swimming and other 'high contact' water sports.

The Ministries of Health and the Environment[28] recently revised guidelines for monitoring contact recreational water quality in marine waters. The revised guidelines changed the indicator species from faecal coliforms to enterococci (Table 2.14). The Regional Council monitoring programme changed to using enterococci during the summer of 1998/99. Results for Christchurch beaches and the Avon-Heathcote Estuary are shown in Table 2.13.

[26] Information from: Sedimentation and Erosion in the Avon Heathcote Catchment and Estuary, D Murray Hicks, March 1993, NIWA. And The Estuary, Where our rivers meet the sea; edited S-J Owen, CCC 1992.

[27] Information from: Birds of the Estuary, by Andrew Crossland. In Estuary – Where our rivers meet the Sea edited S J Owen, CCC 1992.

[28] Bacteriological Water Quality Guidelines for Marine and Fresh Water: Guidelines for the Management of Recreational and Marine Shellfish gathering Waters. MfE and MoH 1998. http://mfe.govt.nz/about/publications/water_quality/

Table 2.13 Contact Recreational Water Quality Monitoring Results – Summer 1998-99

Site	Enterococci/100ml					number of samples
	No. of 5 day medians greater than 35	No. of single samples between 136 and 277	No. of single samples above 277	Maximum sample	Seasonal Median	
Beach Sites:						
Spencerville Beach	0	0	0	23	4	14
Waimari Beach - Surf Club	0	0	0	37	2.5	14
New Brighton - Surf Club	0	0	0	28	2.5	14
Scarborough Beach	**1**	0	0	60	28	14
Sumner Beach - surf club	0	0	**1**	410	15	14
Taylors Mistake	0	0	0	8	2.5	14
Estuary Sites:						
Pleasant Point Yacht Club	0	0	0	50	14	14
Moncks Bay	0	0	0	48	8.5	14
Beachville Road	0	0	0	35	4	14
Humphries Drive	0	0	0	130	16.5	14

Source: Canterbury Regional Council.

Monitoring was carried out approximately weekly between the beginning of November 1998 and the beginning of February 1999. Of the 140 samples taken, the guidelines were exceeded twice. These samples were from Sumner and Scarborough beaches, but at different times. For much of the time microbiological water quality levels, including those in the Estuary near to the sewage treatment, were well below the recommended guidelines.

Nutrient Inputs to the Avon-Heathcote Estuary.

There are three main sources of nutrients into the Estuary: the Avon and Heathcote Rivers and water discharged from the wastewater treatment plant's oxidation ponds. The average amount of water discharged from the oxidation ponds for the year to June 1999 was 131,000 cubic metres per day while the daily discharges of the Avon and Heathcote Rivers are 207,000 and 108,000 cubic metres per day respectively. A number of small drains flow into the Estuary from farmland adjacent to the treatment plant. Although some of these have high nutrient levels, the limited flow from these drains means they have very little effect. Combined, these drains discharge 15,085 cubic metres of water per day, which is about 3 per cent of the total fresh water input to the Estuary.

Table 2.14 Marine Bathing Guidelines

SURVEILLANCE – GREEN MODE:	Running median less than 35 enterococci/100 mL,
ALERT – AMBER MODE I.	Running median greater than 35 enterococci/100 mL and no single sample greater than 136 enterococci/100 mL,
ALERT – AMBER MODE II:	Single sample between 136 and 277 enterococci/100 mL (irrespective of running median),
ACTION – RED MODE	Two consecutive single samples (within 24 hours) greater than 277 enterococci/100 mL (irrespective of running median),

Source: Ministry for the Environment and Ministry of Health.

Table 2.15 shows the contribution of nutrients to the Estuary from the three main sources. The oxidation ponds contribute the greatest amount of nutrients with approximately 90 per cent of dissolved inorganic nitrogen (DIN) and approximately 98 per cent of dissolved reactive phosphorus (DRP). Generally, the annual median values for nutrients from the Avon and Heathcote Rivers into the Estuary have been decreasing over time, except for DRP in the Avon which appears to be increasing. None of these trends are statistically significant.

Heavy Metals in the Estuary

Effluent discharged from the oxidation ponds also contributes heavy metals, such as copper and cadmium, to the Estuary. The total metal content of the effluent, based on mean daily flows and mean metal content, is as follows[22]:

- Copper 2.7 kg/day
- Chromium 5.7 kg/day
- Nickel 4.2 kg/day
- Zinc 6.3 kg/day
- Cadmium 30 g/day
- Lead 1.0 kg/day

The total heavy metal of 20 kilograms per day is twice the estimate for the Avon River of 10 kilograms per day, with the Heathcote River contributing 8 kilograms per day, using dry weather flows and mean metal concentration values for the period 1989 to 1999.

Estimates of both nutrients and heavy metals for the rivers are probably conservative, considering

maximum levels are likely to occur during heavy rainfall events when contaminants are washed into the stormwater system and then into the waterways. It is unlikely that the monitoring coincides with these events, and the river flows during these events would be much greater than the dry weather flows used here.

Table 2.15 Nutrient Inputs to the Avon Heathcote Estuary

Site	Parameter	Nutrient Loadings (kg/day)	
		Long term Median (1989-1999)	1998/99 Median
Avon at Seaview Road	DIN	178	104
	DRP	7	8
Heathcote At Garlands and Tunnel Rds	DIN	142	126
	DRP	8	7
WTP Oxidation Ponds	DIN	3080	3420
	DRP	760	740
Total	**DIN**	**3400**	**3650**
	DRP	**775**	**755**

Source: Christchurch City Council.

Implications of Sea Level Rise on the Christchurch Coast[29]

The coastal environment is a dynamic environment which responds quickly to pressures exerted on it. These pressures can result from the direct impact of people, from other aspects of the natural environment such as the weather and climate, or indirect human pressures such as sea level rise. Greenhouse gas emissions (such as the combustion of fossil fuels) contribute to global warming, which in turn results in sea level rise.

It is anticipated that the effects of sea level rise will be significant in the next 50 to 100 years. Over the last 100 years the sea level around New Zealand has risen by 1.8 millimetres per year. By the year 2050 the best estimate of sea level rise in New Zealand is 0.2 metres ±.0.15 metres to the year 2050 and 0.5m ± 0.3m by 2100[30]. More important than sea level rise will be the potential increased annual variation in sea level, which can result from events such as El Nino and La Nina, and the potential changes in storm frequencies, tropical cyclone occurrences and sediment supply to the coastal regions from changing climatic conditions that may result from increased global temperatures impacting on other aspects of the climate.

The potential impacts of sea level rise on the Christchurch coastline are as follows:

- Brooklands Lagoon will increase in size, and Brooklands township will be at an increased risk of inundation.
- The Christchurch dune system will have a reduced rate of shoreline advance and dune growth, with more frequent damaging storms.
- The Avon-Heathcote Estuary mouth will increase in width to accommodate the increased water flowing in and out of the Estuary. An increase in the Estuary water level will result in increased risk of flooding and the loss of wildlife habitat around its margins.
- In the Avon and Heathcote Rivers, the tidal influence will move upstream by one and 1.5 kilometres respectively. A 1:100 year event would affect an additional 55 hectares in the Heathcote River and 180 hectares in the Avon River by 2100. The saline water boundary will also move upstream, resulting in the introduction of saltwater species such as crabs and eventually bank collapse.
- Reduced sediment will be available at Clifton beach, and there will be increased scouring of sediment in front of the Sumner sea wall and increased erosion at Taylors Mistake.

Coastal Wave Climate

Waves are the driving force behind most near-shore processes affecting sandy beaches. Until now, very little has been known about the wave climate of the Christchurch's coast. The Christchurch City Council, Canterbury Regional Council and NIWA (National Institute of Water and Atmospheric Research Ltd) have recently deployed a directional wave-rider buoy, which is located approximately 17 kilometres east of Banks Peninsula, off Le Bons Bay, in approximately 90 metres of water.

The data collected from this buoy will be useful for beach and dune management, maintenance and operation of stormwater outfalls (and possibly an ocean sewer outfall) and coastal roads, and in dealing with coastal flooding and hazard management. Initial data from the buoy for the period from February to May 1999 revealed that:

- The majority of waves originated from the north through to the south, with most of the high-energy waves coming from the south-east to southerly direction.
- The mean wave height was 1.64 metres, with a range from 0.73 to 4.06 metres.
- The time between waves was, on average, 6.7 seconds, with a range from 4.5 to 10.5 seconds.

[29] Based on report: Impacts of Sea Level Rise on the Coast of Christchurch. Prepared by Tonkin and Taylor for the Christchurch City Council 1999.

[30] Based on the Inter-Governmental Panel of Climate Change (IPCC) 1995 estimate for sea level rise.