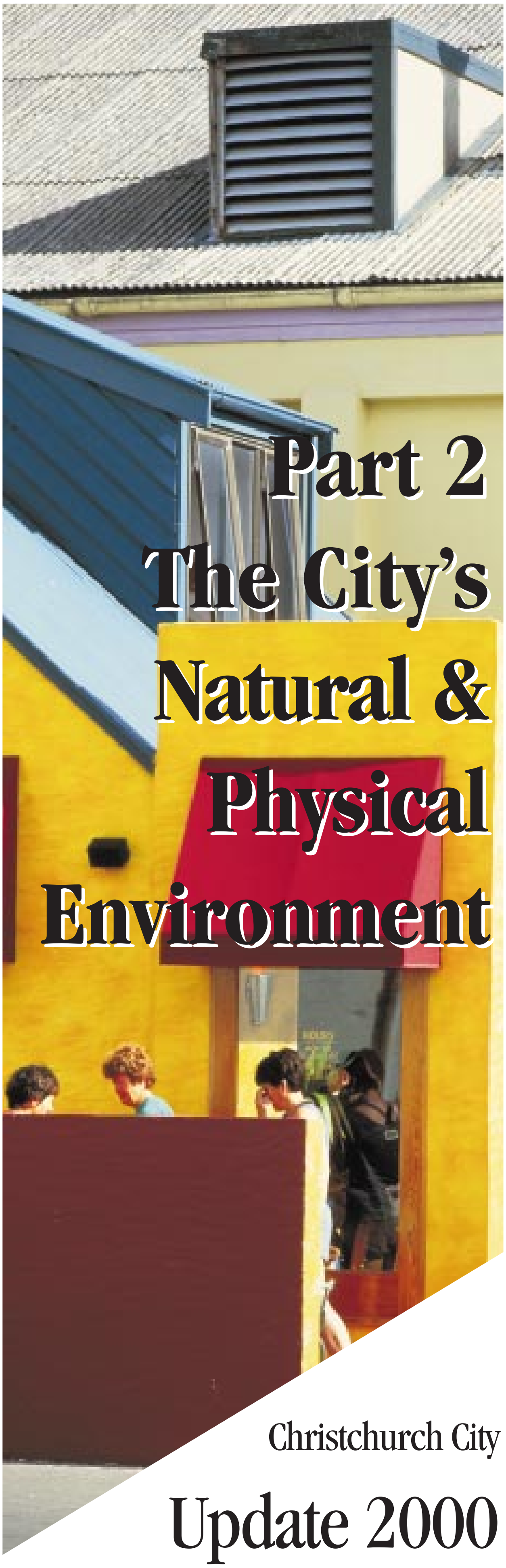
Part 2 The City's Natural & Physical Environment



Christchurch City

Update 2000

Introduction

Christchurch City covers a land area of 45,240 hectares. The City is bounded by the Waimakariri River to the north, the Pacific Ocean to the east and the Port Hills to the south (Figure 2.1).

Two distinct landforms define the topography of the City. The Port Hills, which extend for 16 kilometres and rise to a height of approximately 500 metres, dominate the landscape to the south. In contrast, the remainder of the City is characterised by relatively flat outwash plains derived from the Waimakariri River. Meandering across these outwash plains are several spring-fed waterways including the Avon, Heathcote and Styx Rivers. Much of the urban and agricultural activity occurs on the plains, while the Port Hills, coastline and waterways have high recreational, amenity and cultural value.

Approximately 17,000 hectares of the City are in some form of urban use. The built-up part of the City is the source of many pressures on the natural and physical environment. As described in Part 1: The City's People, continued population growth and changing life styles will increase these pressures.

Environmental impacts range from the detrimental effects of urban activities on the natural environment to changes in the built environment to meet the diverse needs of individuals and the community.

In addition to these urban pressures, the natural environment is not passive and can have a positive or negative impact on the state of natural resources. An example of this is the climatic phenomenon of the El Nino southern oscillation, which can cause increased demand for water or above average rainfall in the City. Natural phenomena such as severe storms and earthquakes can also affect the natural, physical and human environments in potentially catastrophic ways.

Air pollution is a factor in the degradation of the City's natural environment. Winter air contaminants regularly exceed local and international guidelines as a consequence of domestic fires used for heating.

While winter air pollution is a visible example of environmental degradation, other impacts are not as obvious until the level of contamination is extreme. The quality of the rivers, steams and other surface waterways for recreational activities, amenity and ecological values can only to be determined by scientific monitoring.

At present Christchurch is fortunate to have a large, very clean supply of groundwater to provide drinking water. It is important that the integrity of such supplies is retained for future generations and not degraded by overuse or contamination.

As in other large metropolitan areas, disposal of City waste can influence residents' quality of life and the environment in which they live. Solid waste in Christchurch is recycled, reused and composted where possible to reduce the amount of waste going to the landfill. Liquid waste is treated to a level that is safe to discharge into the Avon-Heathcote Estuary and on to land.

As the population increases the built environment will change to accommodate additional people. Changes include the development of previously rural land and increasing densities from infill development.

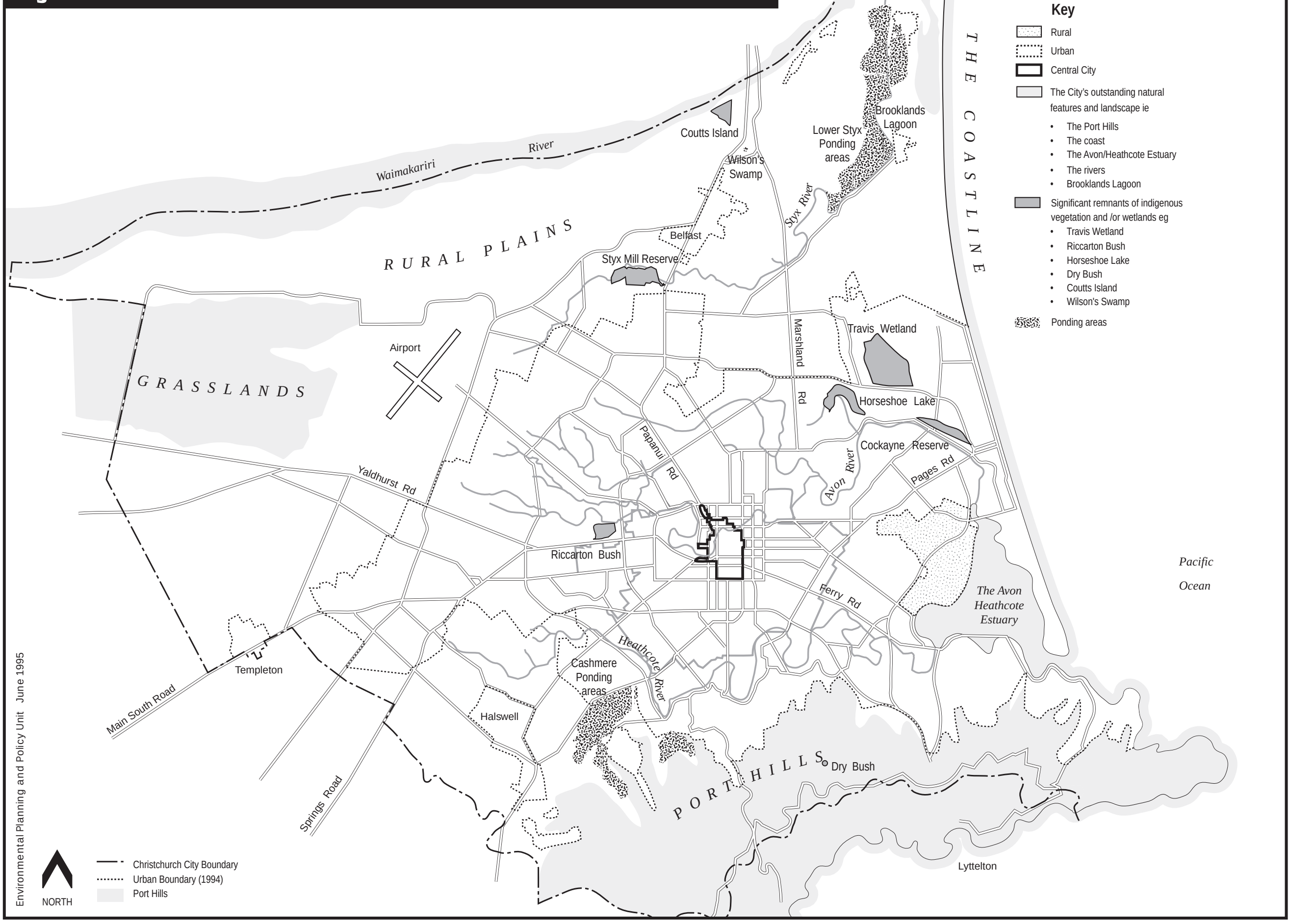
Changing lifestyles have made unit and apartment living more attractive. This has implications for quality of life, with increasing noise, traffic flows, and lack of privacy often the consequence of higher density living.

The trend towards building large houses on sections, traditionally regarded as small, has changed streetscapes and affects amenity values.

The following discussion on the City's natural and physical environment is divided into a number of sections. Firstly, environmental processes such as the weather and natural hazards are discussed. These combined with demographic information in The City's People provide the context for discussion.
Subsequent sections describe the state of the City's resources - land, air, and water - and its natural ecosystems. It concludes by considering the impacts of human activity on the environment: waste management, energy consumption and changes to the built environment, including amenity and heritage issues.

Note: Some information in this section has been sourced from the Canterbury Regional Council (CRC), at the time of publication the Canterbury Regional Council changed it's name to Environment Canterbury, This change has not been made in the text.

Fig 2.1 Natural environment



Weather and Climate

Key Information	Why is this Useful?	What is Happening?
Total annual rainfall.	Rainfall governs the amount of soil moisture available for plant growth. Periods of low rainfall result in increased water consumption and pressure on groundwater and surface water resources.	↓ Between July 1997 and June 1999 total rainfall was 75 per cent of the average annual rainfall.
Variation of monthly temperature from long-term averages.	Temperatures influence water availability and the rate of water consumption. Warm temperatures during winter also relate to lower levels of winter air pollution and demand for energy resources.	↑ Eighteen of the 24 months between July 1997 to June 1999 had warmer than normal temperatures.

Other Related Sections: Natural Hazards, Energy; Surface Water, Groundwater, Open Space and Natural Ecosystems, Part 2: The City's Economy

The weather affects much of the natural and physical environment. Extreme weather events result in stresses on the environment. For example, drought reduces groundwater and surface water quantities at times when consumption is also increased. The weather not only influences peoples' behaviour regarding resource use (especially water consumption), it also affects recreational resources and amenity values.

Two main climatic zones – the Port Hills and the Canterbury Plains – exist in the Christchurch area. The Port Hills have higher humidity and greater seasonal variability of rainfall than the plains, which are drier and have more evenly distributed rainfall. The plains are affected by north-westerly winds which dry out the soils, increasing their erosion potential and placing limits on forestry and agricultural productivity. In coastal areas the climate tends to be milder.

Table 2.1 shows some summary statistics for two climate stations in Christchurch; the Botanic Gardens in the centre of the urban area and Christchurch Airport, which is on the urban-rural boundary. This table illustrates that urban areas typically modify the climate in a number of ways. Trees and irrigated grass reduce summertime temperatures, whereas hard surfaces such as car parks and buildings increase temperatures. In winter, the urban night-time temperature is warmer than non-urban temperatures due to energy released from vehicles, buildings and other urban processes. This is evident in the lower mean annual minimum temperature and 11 more days of frost recorded at the Airport than the Botanic Gardens.

El Nino Southern Oscillation

Climatic influences on the environment can occur from either short-term, high-intensity local events or from long-term, large-scale events that are related to global circulation patterns such as the El Nino Southern Oscillation (ENSO). ENSO is controlled by surface water temperature patterns in the southern Pacific Ocean and is measured as an index of air pressure difference between Tahiti and Darwin (Figure 2.2).

The two years between July 1997 and June 1999 were characterised by a significant El Nino event for the first 12 months, followed by a La Nina event for the second 12 months (Figure 2.2).

The El Nino event between July 1997 and June 1998 produced the following weather in Christchurch:

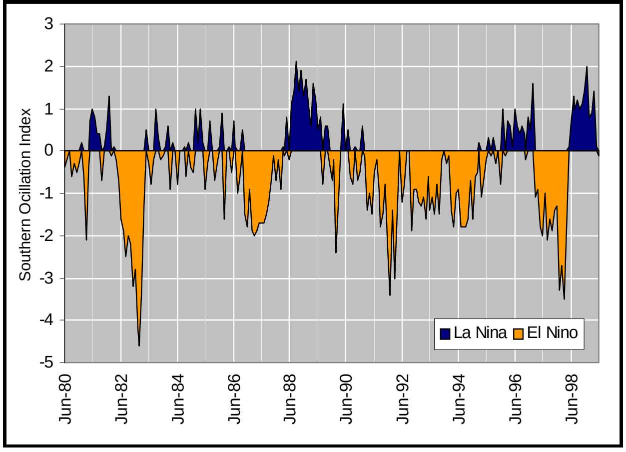
- Frequent westerly and south-westerly winds

Table 2.1 Summary of the City's Main Climatic Features

		Botanic Gardens	Airport
Temperature (°C)			
Mean daily maximum	January	21.7	22.4
	July	10.3	10.6
Mean daily minimum	January	11.8	12.0
	July	1.5	0.7
Mean annual maximum		32.0	33.4
Mean annual minimum		-3.9	-4.7
Sunshine			
Average sunshine hours (per annum)		1982	2049
Rainfall			
Average rain days 1mm or more		85	82
Average annual rainfall		644.6	621.4
Relative Humidity			
Average relative humidity (9am)	January	80.8	72.0
	July	91.9	87.6
Frost			
Average days of screen frost (minimum air temps. less than 0^{o}C)		34.7	45.9
Winds			
Average number of days with gusts reaching 63km/h or more (Gale force)			54.7
Average number of days with gusts reaching 96km/h or more (Storm force)			2.5

Source: National Institute of Water and Atmospheric Science.

Fig 2.2 El Nino Southern Oscillation 1980 – 1999



Source: National Oceanic and Atmospheric Administration (NOAA) world wide web site. http://nic.fb4.noaa.gov/data/cddb/cddb/soi.

- Lower than normal rainfall
- Higher than normal temperatures
- Increased sunshine.

The subsequent La Nina event (between July 1998 and June 1999) influenced the Christchurch climate in the following ways:

- Increased easterly and north-easterly winds
- Warmer temperatures
- Less than average rainfall
- Reduced snowfall during winter.

Temperature

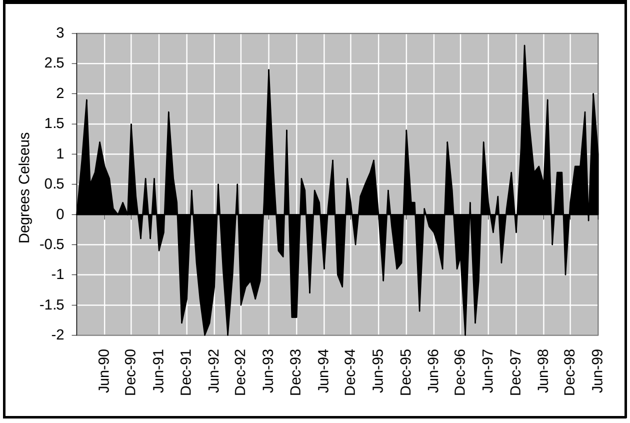
Changes in temperature often affect people's environmental behaviour. Periods with hot temperatures and reduced rainfall result in increased water loss from vegetation as a result of greater evapotranspiration. Consequently people water more, leading to increased water consumption. In addition, energy consumption increases with higher demand for air conditioning. Temperature can also affect the comfort of people and animals, with extreme temperatures impacting on normal behaviour.

In the two years from July 1997 to June 1999 the average temperature at the Botanic Gardens was 0.6° higher than normal. Eighteen of the 24 months had higher average monthly temperatures than normal (Figure 2.3).

Rainfall

During the two year period from July 1997 to June 1999, rainfall in Christchurch was 75 per cent of the normal level in the City. The beginning of this period corresponded with the beginning of the drought which affected much of the east coast of the South Island. During the first 12 months, only 63 per cent of the mean annual rainfall fell at the Botanic Gardens' site. The second 12 months had more rainfall, but it was still below 90 per cent of normal. Any potential relief that this could have produced was reduced by dry conditions from the previous year.

Fig 2.3 Variation between Actual and Normal Monthly Temperatures – Botanic Gardens



Source: National Institute of Water and Atmospheric Research.

Figure 2.4a shows the mean annual rainfall[1] for the Christchurch City Council's rain-gauge network. The general pattern of rainfall over the City shows a gradient from high rainfall on the Port Hills (due to orographic influences), to lower rainfall in north-eastern coastal areas. Much of the urban part of the City receives an average of 600 to 700 millimetres of rainfall a year, compared with between 550 and 850 millimetres for the whole territorial local authority.

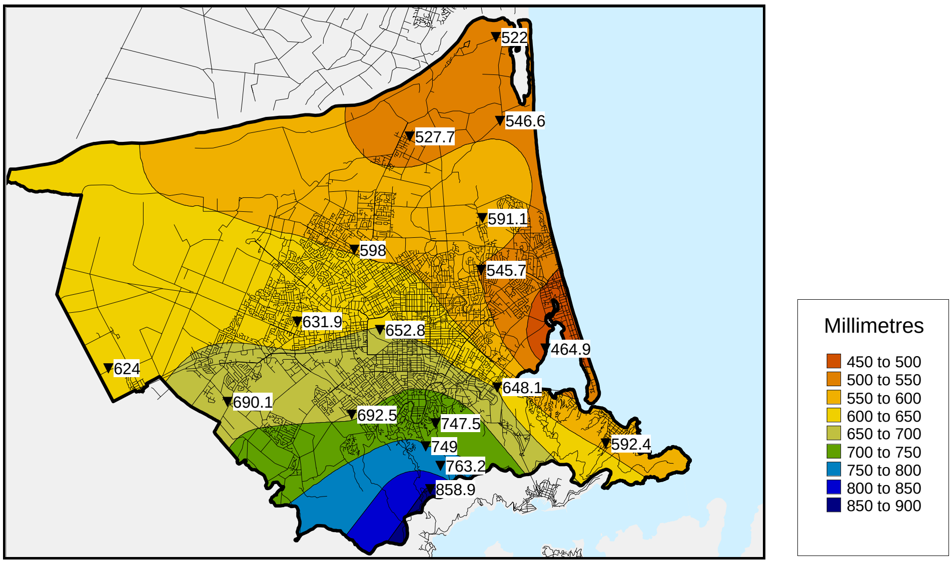
Figures 2.4b and c show the percentage difference between the annual rainfall for the 1998 and 1999 June years, and the mean annual rainfall (Figure 2.4a). Rainfall in Christchurch during the 1998 June year was below 75 per cent of the mean annual rainfall at all the sites. Some areas, especially near the coast, received just over half the mean annual rainfall. The distribution for this period is consistent with the prevailing El Nino conditions mentioned earlier.

Although all rainfall recording sites received more rain in the 1999 June year than the previous year, most of the City received less rainfall than the mean annual rainfall (Figure 2.4c). Areas in the north-east received up to 15 per cent more rainfall than normal. However, the Port Hills and areas to the south-west received the lowest proportion of annual rainfall. This distribution pattern was consistent with the increased north-easterly airflow that results from La Nina events. The cumulative result of the weather during the two year period between July 1997 to June 1999 was a rainfall deficit of between 150 millimetres near the coast to over 500 millimetres on the Port Hills.

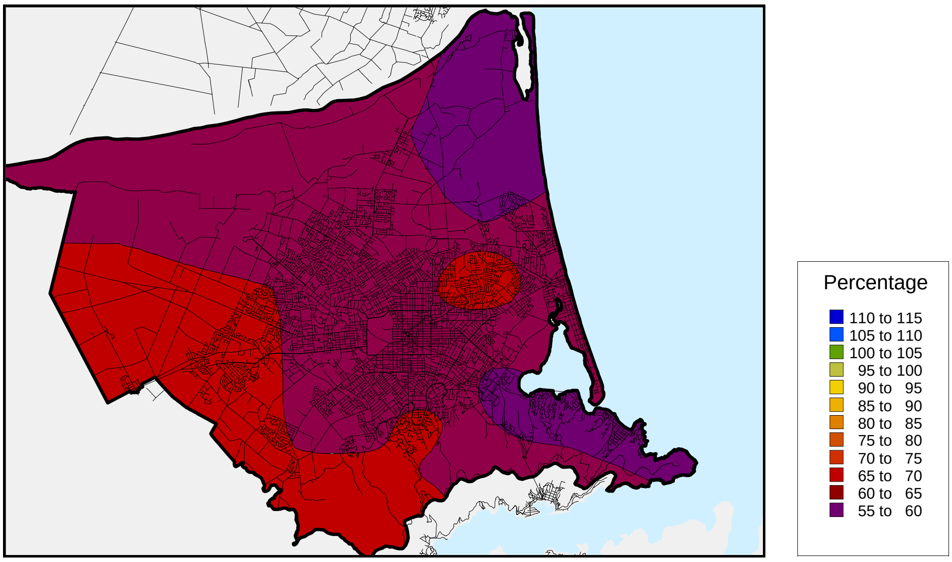
[1] Mean Annual Rainfall is the total amount of rainfall divided by the number of years records have been collected for a particular site.

Fig 2.4 Rainfall Distribution for Christchurch City

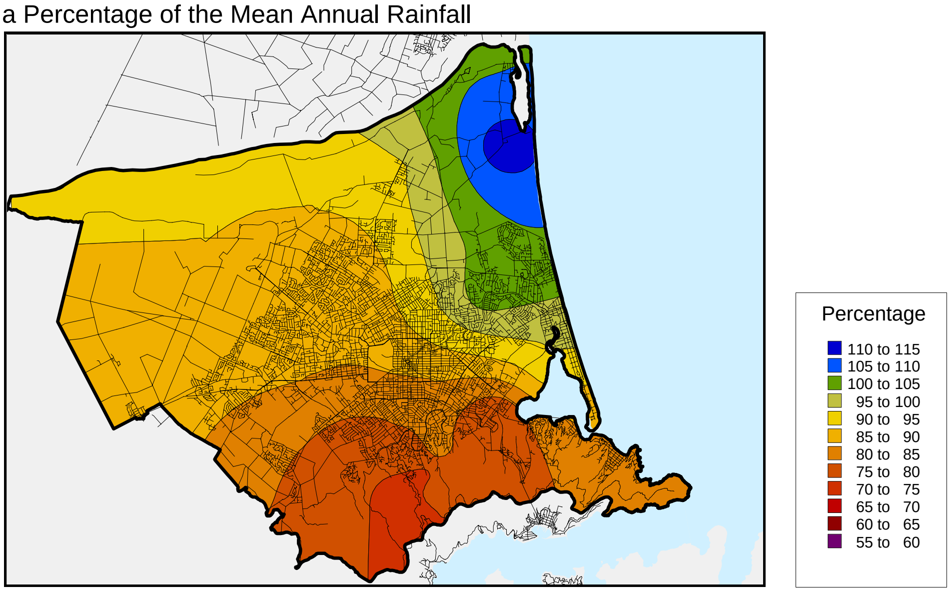
a. Mean Annual Rainfall Distribution



b. June 1998 Annual Rainfall as a Percentage of the Mean Annual Rainfall



c. June 1999 Annual Rainfall as a Percentage of the Mean Annual Rainfall



Source: Christchurch City Council.

Natural Hazards

Key Information	Why is this Useful?	What is Happening?
The impact of major natural hazard events.	Large natural events have a considerable impact on the regional and national economy. They result in use of resources that would not normally have been consumed. Some impacts of natural hazards cannot easily be quantified by economic measures and need to be considered in ecological terms.	● The drought which affected Canterbury between 1997 and 1999 resulted in an estimated $600 million loss in regional income and a potential loss of 1,950 jobs.
Number of natural hazard events that have had minor local effects.	Small-scale hazard events result in minor damage or inconvenience. However, the cumulative effect of several small scale events in a short time frame may be quite significant.	● There has been eight minor events over the last three years.

Other Related Sections: Population Growth, Weather and Climate, Land Use, Surface Water, The Coastal Environment, Open Space and Natural Ecosystems, The Built Environment, Part 3: The City's Economy.

This section summarises the natural hazards that affect Christchurch City. Most of the information is from the Canterbury Regional Council report *Natural Hazards in Canterbury*. Natural hazards which affect Christchurch are divided into the following types: meteorological hazards, flood hazards, coastal hazards, slope hazards and seismic hazards (Table 2.3).

Types of Natural Hazards

Meteorological Hazards

Table 2.2 lists the types of severe storms and environmental risk associated with each meteorological hazard. The greatest economic effects result from events that have a regional impact eg heavy snow storms, drought and wind storms.

Christchurch does not experience the intensity of rainfall that occurs in other parts of New Zealand. Generally, 24-hour rainfall with return periods of five years[2] produce 50 -100 millimetres on the plains and 100 - 150 millimetres on the Port Hills. The effect of heavy rainfall is covered in the flood hazard and slope hazard sections.

Significant snowstorms have occurred in Christchurch in 1895, 1896, 1901, 1918 1945 and 1992. Snow storms cause damage to buildings and power lines, disruption to traffic and communications within urban areas and stock losses in rural districts. A secondary effect is snowmelt flooding.

Table 2.2 Severe Storms and Effects

Storm Type	Indirect Natural Effects
Heavy rainfall	Flooding, landslips
Snowstorms	
Wind	Erosion of top soil, dust storms
Hail	
Electrical	Forest fires

Source: Canterbury Regional Council, Natural Hazards in

The 1992 snow storm killed over one million stock in Canterbury and damaged buildings in Christchurch and surrounding areas. Its overall economic impact was estimated to be $50 million to $100 million. The 1992 snowstorm had a recurrence interval of 50 to 100 years.

The most severe winds in Christchurch are associated with north-westerly airflow over the South Island. Severe events occurred in 1945, 1964, 1975 and 1988. The peak wind in 1975 was 193km/hr, which exceeded the 100-year return period. Extreme winds cause personal injury and death, and extensive damage to buildings, vegetation and infrastructure.

Three significant tornado events have been recorded in the Christchurch area in the last 36 years - in 1962 (Christchurch), 1975 (Governors Bay) and 1983 (Halswell).

Electrical storms tend to occur between September and March but are relatively infrequent with, on average, thunder five days a year on the Canterbury Plains.

Canterbury normally has one significant hail storm a year, usually occurring between October and March.

On average, the region has one significant drought about every six years. Since 1970 severe droughts have occurred in 1977-78, 1985, 1988-89, 1992 and 1997-99. Drought is generally considered a rural problem but there are also significant effects on the urban environment, such as increased water consumption and the economic impact of reduced cash flow from the rural sector. The 1992 drought also significantly affected hydro-electric power generation, resulting in power shortages in Christchurch.

Flood Hazards

Flooding is the most common and most significant natural hazard in Canterbury. Both urban and rural areas are affected.

[2] Return period refers to the statistical likelihood of an event occurring eg an event with a five year return period will occur on average once every five years.

Table 2.3 Simplified Hazard Evaluation for Christchurch City

Hazard Category	Likely exceedence interval	
	Less than 100 years	Greater than 100 years
Meteorological	• Severe wind storm or intense rainfall • Major drought	• Extreme storm event (rain or wind) • Long-term climatic change
Flooding	• Severe flooding in any river system • Stopbank failure • Local flooding due to intense rainfall in low	• Breach in Waimakariri River stopbanks
Coastal	• Severe storm erosion of beaches • Continuing shoreline retreat • Rivermouth / spit changes • Possible sea level rise due to “Greenhouse” effect	• Major tsunami damage along coast • Long-term sea level and storm pattern changes
Landslide	• Severe rainstorm - generated landslides • Localised earthquake - generated slope failures and / or ground subsidence.	• Earthquake-generated rockfalls and liquefaction in metropolitan Christchurch
Seismic	• Ground shaking and local damage due to small magnitude event within region, or large magnitude event outside Canterbury.	• Ground rupture on Hope, Porters Pass or alpine faults with accompanying large magnitude effects earthquake in Canterbury.

Source: Canterbury Regional Council, Natural Hazards in Canterbury.

The most significant flooding threat to the Christchurch urban area is posed by the Waimakariri River, although this has been substantially mitigated by river control works. Breakouts of floodwaters from the Waimakariri River caused damage to urban Christchurch in December 1865, October 1866 and February 1868. The Waimakariri River still threatens more people and properties than any other New Zealand river.

The Halswell, Avon and Heathcote Rivers cause the most frequent flooding in Christchurch. Flooding from these rivers is usually the consequence of long-duration, moderate-intensity easterly storms.

Figure 2.5 shows the areas of the City which are prone to flooding. Areas of the Avon River most susceptible to flood damage are the lower Wairarapa Stream in the upper catchment and low-lying areas in New Brighton, Avondale, Horseshoe Lake, Hulverstone Drive and Bexley. Since 1883 over 30 different floods have caused damage due to ponding of stormwater and breakouts from tributary streams. Unusually high tides in July 1955, March 1957 and August 1992 also increased damage from flooding.

Flooding of property and roads occurs along much of the Heathcote River Channel between Woolston and Hoon Hay. Floodwaters have reached heights above house floor levels on four different occasions since the mid-1960s (1968, 1975, 1977 and 1980).

Coastal Hazards

The shoreline position of Pegasus Bay is generally stable or prograding[3]. However, sites such as South Brighton and Kairaki/Brooklands at the mouth of the Waimakariri River may be subject to rapid landform changes due to erosion or accretion.

Assessment of the tsunami hazard for Christchurch is subject to considerable uncertainty. A tsunami could be a serious hazard and damage a wide area, perhaps as much as 30 per cent of the urban area of the City. It is believed that during a tsunami all openings in the coastal dune system would become conduits and result in widespread inundation. There could also be large-scale flooding associated with extreme water levels entering the Avon-Heathcote Estuary.

The risk from coastal hazards is expected to increase in the future as the predicted sea level rise due to global warming will reduce the protective buffer from coastal processes.

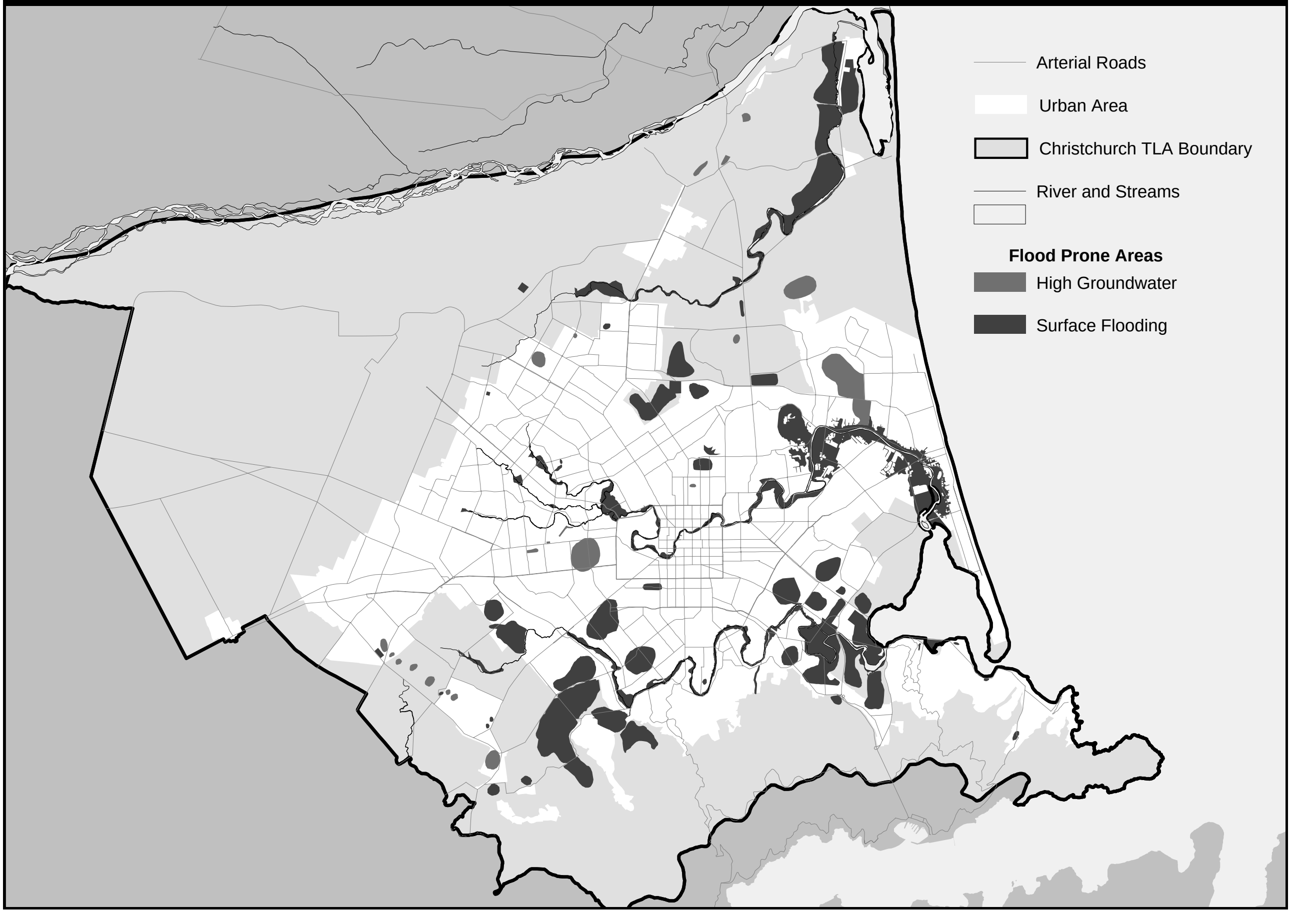
Slope Hazards

The Port Hills are at significant risk of landslides and rockfalls caused by earthquakes or severe rainstorms. Earthquakes can produce a rockfall hazard on the Port Hills or facilitate slope failure if they occur during mid-winter to early spring when soil moisture levels are high enough to reduce the cohesive strength of loess soils.

Rainstorm-induced landslides tend to be associated with prolonged wet periods, for example two or more consecutive wet winters, or after a major snowstorm when soil moisture levels are close to saturation. These conditions only require a minimal increase from

[3] A prograding coastline is one that is accumulating additional sediment and often growing seaward.

Fig 2.5 Land Area Prone to Flooding



Source: Christchurch City Council.

moderate frequency storms to initiate movement. There appears to be a frequency of 10-20 years between significant events.

Seismic Hazards

Since 1850 Christchurch has experienced three earthquakes that have generated effects such as difficulty in standing, furniture broken, weak chimneys broken at roof lines and the falling of plaster, loose bricks, stones and tiles. It is expected that a similar earthquake will occur again within the next 50 years.

The greatest impact from a major earthquake to the Christchurch area is widespread liquefaction, especially in the fine-grained loose sediments around the Avon-Heathcote Estuary. Liquefaction results from ground shaking which does not permit pore fluids to escape. As a consequence, loose saturated silts and sands lose strength and tend to become fluid, resulting in failure to support structures, soil movements, and the floating of buried structures such as pipelines.

Recent Impacts of Natural Hazards

Table 2.4 lists natural events that have caused damage in Christchurch City during the 1998 and 1999 June years. Eight events caused minor localised damage or inconvenience in Christchurch. Four minor earthquakes were felt in the City during this period but no damage was reported from them.

A prolonged drought affected most of Canterbury and Marlborough for both the summers of 1997/98 and 1998/99. This period of lower than normal rainfall and higher than normal temperatures had a major economic effect, both regionally and nationally. The Canterbury Development Corporation estimated that the impact of the drought during this period will lead to a decline in farm output over three years of $169 million, plus further losses in downstream processing (especially meat) of $426 million[4]. At present it is difficult to know what long-term effects the drought has had on the natural environment. However, mature trees died and groundwater levels and stream flows were reduced.

[4] Canterbury Development Corportation: The Leading Edge Newspaper, Issue 2, May 1999.

Table 2.4 Damage Caused by Natural Hazards Between July 1997 and June 1999

Event	Date	Location	Reported Damage to Assets
Wind and rain	6 May 1999	Christchurch	Minor wind damage and surface flooding.
Hail	11 Dec 1998	Halswell	Damage to fruit crops and orchards.
Hail, heavy rain and lightning	8 Dec 1998	Christchurch	Small fires, power disrupted, hail damaged orchards in Halswell. Surface flooding.
Wind	19 Oct 1998	Christchurch	Two light aeroplanes badly damaged at airport, trees blown over.
Wind	5 Oct 1998	Christchurch	Minor wind damage.
Lightning	21 Nov 1997	Christchurch	Power cuts - computers and security alarms damaged.
Wind	11 Nov 1997	Christchurch	Trees blown over, boats damaged.
Snow	22 Aug 1997	Christchurch and Banks Peninsula	Power cuts, difficult road conditions on the hills.
Drought	1997-1999	Canterbury	Sixteen consecutive months of drier than average weather up to June 1999. Extensive impact on regional and national economy.

Source: The Christchurch Press.

Land Use

Key Information	Why is this Useful?	What is Happening?
Total area of Christchurch City [5]	This provides contextual information for the rest of this report. The boundaries of the City are set by the Local Government Commission and only change after a formal review.	● The area of the City is 45,240 hectares.
Urban area within Christchurch City.	As the urban area of the City expands natural resources and non-urban landscapes are lost. Unrestricted urban growth can consume these resources in an unsustainable manner. The size of the urban area can also create pressure on other urban resources eg infrastructure.	↑ The urban area increased by 771 hectares (5 per cent) between 1995 and 1999.
Loss of versatile soils.	Versatile soils are valued for their food-producing potential. They are a limited resource regionally and need to be considered when land is rezoned.	● Five hundred and seventy four hectares of versatile soils were rezoned to urban use between 1995 and 1999.

Other Related Sections: Population Growth, Built Environment, Surface Water, Groundwater, Open Space and Natural Ecosystems, Urban Amenity, Residential and Commercial Property.

The area of Christchurch City[5] is 45,240 hectares. Of this area approximately 17,000 hectares are currently zoned urban. Just under 20,000 hectares are in some form of rural use, and the remaining 8,250 hectares are zoned for non-urban land uses such as conservation, open space and special purpose (Table 2.5).

Urban Land Use

The urban area of the City is diverse, with 72 per cent of the land area zoned for housing and residential land uses. Industrial and commercial land accounts for a further 13 per cent. The urban part of the City also includes cultural, conservation, open space and special purpose zones. Cultural zones include education facilities and heritage precincts such as the Arts Centre and the Nga Hau E Wha National Marae. Conservation zones include historic and garden parks and cemeteries in the urban area, plus ecological reserves on the Port Hills and along the coastal margins. Special purpose zones are areas in which specialist activities are carried out. They include hospitals within the urban area, and Christchurch Airport and the Burwood Landfill outside the urban area.

Table 2.5 Area of Christchurch by Zoned Land Use, 1995 and 1999

	1995 Proposed Plan		1999 City Plan Decisions	
Urban Areas	Area (ha)	Percentage	Area (ha)	Percentage
Suburban Residential	7,999	17.7	8,424	18.6
Inner Residential	2,119	4.7	2,112	4.7
Residential Hills	1,273	2.8	1,394	3.1
Rural Residential	212	0.5	256	0.6
Central City Commercial	127	0.3	126	0.3
Suburban Commercial	164	0.4	187	0.4
Industrial	1,864	4.1	1,917	4.2
Cultural	600	1.3	597	1.3
Conservation	377	0.8	387	0.9
Open Space	1,337	3.0	1,412	3.1
Special Purpose	80	0.2	110	0.2
Sub Total Urban	*16,151*	*35.7*	*16,922*	*37.4*
Non-Urban				
Rural	20,612	45.6	19,547	43.2
Rural Industrial	185	0.4	188	0.4
Open Space	1,491	2.2	1,464	3.2
Conservation	4,370	10.5	4,505	10.0
Special Purpose	1,345	3.2	1,531	3.4
Coastal Marine Area	1,086	2.4	1,083	2.4
Sub-Total Non-Urban	*29,089*	*64.3*	*28,318*	*62.6*
Total	**45,240**	**100**	**45,240**	**100.0**

Source: Christchurch City Council.

[5] Christchurch City is defined in this report as the Christchurch Territorial Local Authority area.

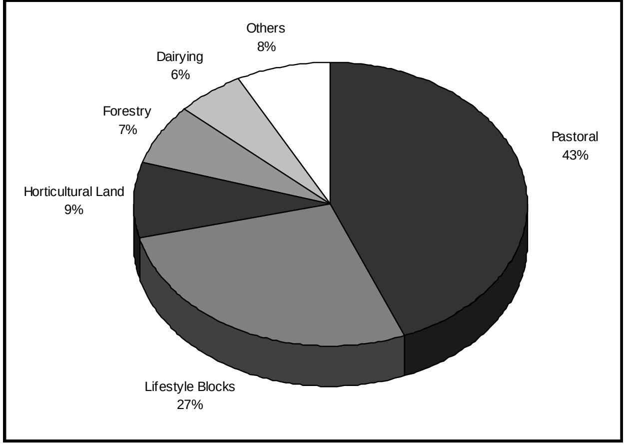
Rural Land Use

Figure 2.6 shows the breakdown of rural landuse for Christchurch City. Pastoral activities such as grazing occupy the largest area, approximately 9,500 hectares. Around 1,500 lifestyle blocks totalling 6,000 hectares make up the second largest rural land use in the City. The median size of these lifestyle blocks is 2.5 hectares. Horticulture, forestry, dairying and other rural activities each make up between 6 and 9 per cent of the remaining 29 per cent of rural land.

As the City's population grows, land is converted from rural to urban use. Between July 1990 and June 1998 the amount of land rezoned averaged 30 hectares each year. When the City Plan decisions were released in May 1999, an additional 665 hectares of land were rezoned to urban (Table 2.6). Potentially, an additional 465 hectares of rural land may be available for residential use where the Council's rezoning decisions are currently either under appeal or have been deferred.

Figure 2.7 shows the areas of the City which have been rezoned to urban as a result of City Plan decisions. Of this land, 32 hectares were earmarked for commercial use.

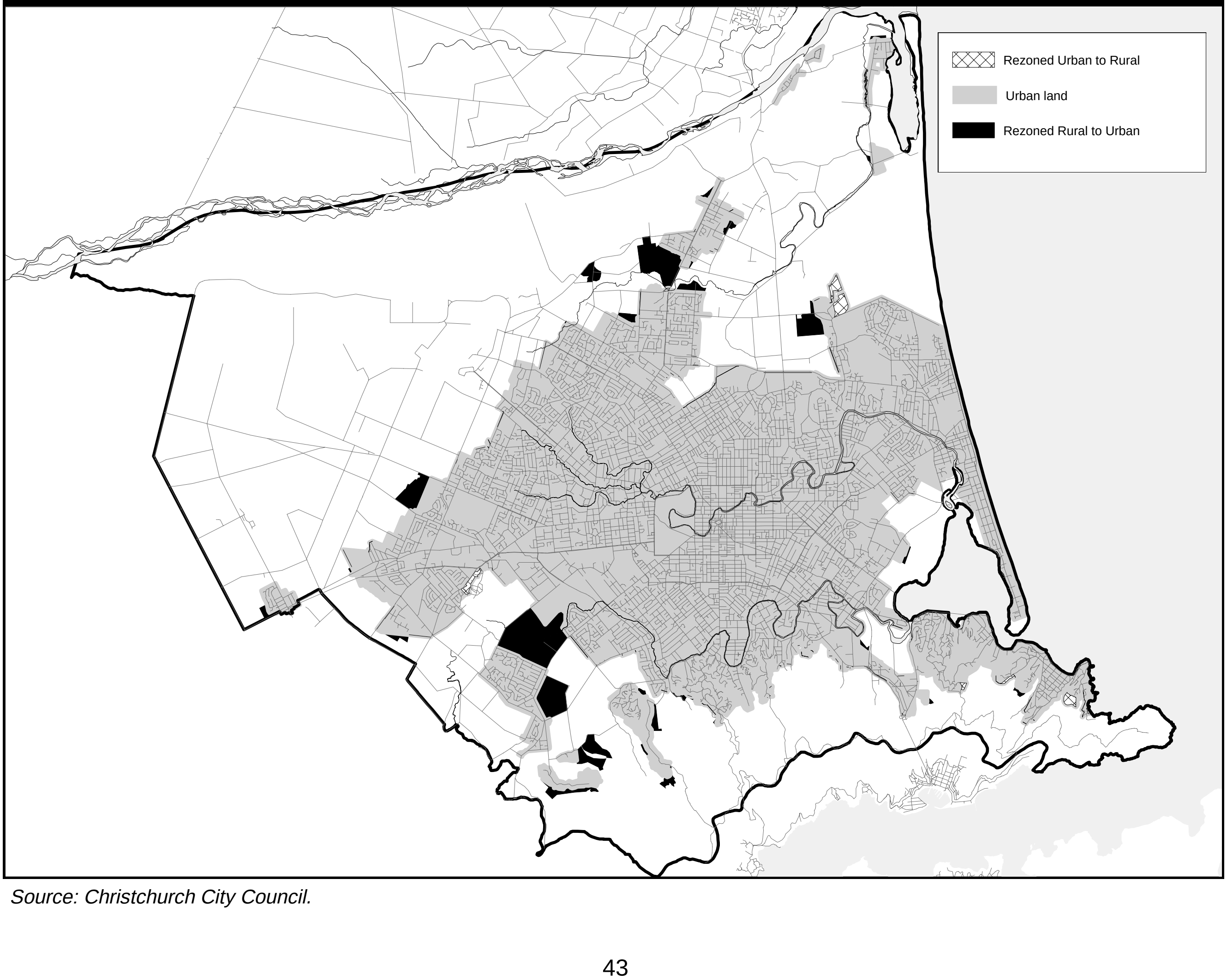
Fig 2.6 Rural Land Use – March 1999



Source: Quotable Value New Zealand.

The large amount of recently rezoned land resulted from increased development pressures during a period of rapid population growth in the mid-1990s and the City Council's desire to strategically plan for the next ten to 15 years of residential development.

Fig 2.7 Map showing Areas Rezoned from Rural to Urban Land Use Between the Proposed City Plan 1995 and the Decisions on the City Plan released in May 1999 (Includes Land rezoned but currently under appeal -Indicative only)



Source: Christchurch City Council.

Table 2.6 Land Rezoned to Urban use

Year to June	Area of Rezoned Land (hectares)
1991	16.7
1992	55.5
1993	12.0
1994	0.0
1995	9.1
1996	11.7
1997	56.9
1998	77.5
1999	664.7
Total	**904.3**

Source: Christchurch City Council.

Soils

Soils in Christchurch generally relate to the local topography. The soils on the Port Hills are derived from basalt (volcanic rock) and loess (a deposit of wind blown dust). Variations in Port Hills soils also result from local microclimates that influence soil formation processes. Most of the soils on the Port Hills are susceptible to erosion, particularly soil creep and gully erosion.

Soils on the Canterbury Plains are derived from outwash gravels and sand from the large braided rivers such as the Waimakariri, which traverse the Plains. They include fertile and versatile soils, soils which have natural drainage problems, and soils which are stony to very stony, poorly drained and susceptible to wind erosion.

The Horticultural Versatility System[6,7] has been used to assess the extent of high productivity soils in Christchurch City (Table 2.7). Versatility is mainly assessed in terms of the soil's physical characteristics and assumes that nutrient and soil moisture limitations are overcome by fertiliser application and irrigation.

Approximately 7,800 hectares (30 per cent of the non-urban land in the City) are highly versatile, that is Class 1 and 2 in the Horticultural Versatility System. Existing in limited quantities, both regionally and nationally, they are valued for their high productivity potential. Traditionally they have been used in Christchurch for market gardening, berry fruit production and town supply dairying. It should be noted, however, that the full productive potential of these soils is currently not being used. The lowest quality soils in the City tend to be on the Port Hills, in coastal areas or in areas associated with remnants of the Waimakariri River gravels.

Much of the City's versatile soils are in areas adjacent to the urban area. As a result of the 1999 City Plan decisions 574 hectares of Class 1 and 2 land were rezoned to urban use (Table 2.7). These versatile soils were converted to urban land use because the impact of other options, such as the loss of urban amenity values, restricted housing choice and adverse traffic effects, were seen as more significant.

Table 2.7 Soil Quality in Rural Christchurch[10]

Horticultural Versatility Classes	Area 1995 (ha)	Area 1999 (ha)	Change between 1995 and 1999 (ha)
Class 1	3,042	2,770	-271
Class 2	5,363	5,060	-303
Class 3	6,023	6,047	23
Class 4	1,491	1,468	-23
Class 5	4,028	3,998	-30
Class 6	6,288	6,184	-104
Areas not Classified	1,124	1,124	0
Total	**27,357**	**26,650**	**-708**

Source: Christchurch City Council, Landcare Research NZ Ltd.

[6] **Definitions and description of Horticultural Versatility Classes**

Class 1
: Very highly versatile with minimal limitations to horticultural crop production. Well suited to a wide range of crops with differing growth/soil management requirements with small management inputs.

Class 2
: Highly versatile with slight limitations to horticultural crop production. Such limitations may slightly constrain the range of crops that can be grown, or require slightly higher management inputs compared to Class 1 soils.

Class 3
: Moderately versatile and are usually capable of high production levels from a more limited range of crops than in Classes 1 and 2. Yields may be lower than for Classes 1 and 2 and management inputs higher.

Class 4
: Low Versatility. Land attributes impose significant limitations on the range of crops that can be grown successfully and/or crop production requires moderately high management inputs.

Class 5
: Very low versatility. Growth of a wide range of crops is likely to be severely limited and/or crop production requires high management inputs.

Class 6
: Least versatile soils. Soils can only be assigned to Class 6 on the basis of slope, poor aeration status, excessive stoniness, severe erosion or flooding risk or excessive salinity.

Source: Webb et al. 1993.

[7] Christchurch City Update '97 used the Landuse Capability Classification system to identify soil quality. The change to the Horticultural Versatility system is to be consistent with the versatile soils policy in the Christchurch City Plan.

Air Quality

Key Information	Why is this Useful?	What is Happening?
The number of days exceeding the PM_{10} guideline ($50\mu gm^{-3}$).	Particulate matter or smoke is the most significant element of winter air pollution in Christchurch. The number of days which exceed the guideline provides an indication of the impact ambient air quality has on amenity and residents' health.	● On average, PM_{10} has exceeded the guideline on 29 days each winter between 1988 and 1999.
Residents' problems with local air pollution.	This provides a measure of the impact of local sources of air emissions, and whether residents have problems with neighbourhood air quality.	↓ Generally the percentage of residents who had problems with air quality decreased from 1991 to 1999.

Other Related Sections: Population Growth, Health, Weather and Climate, Land Use, Built Environment, Urban Amenity, Energy, Transportation, Businesses, Employment and Unemployment.

Air pollution can have a major impact on people and the environment. Adverse effects of air pollution include health problems ranging from lung and eye irritations from short-term exposure, to permanent respiratory and nervous system damage from long-term exposure. In addition, air pollution can damage buildings and natural environments[8].

Christchurch City is particularly susceptible to winter air pollution due to its geographic location and calm winter weather. Under these weather conditions a temperature inversion develops. Consequently, cold air and emissions are trapped under the layer of warmer air and cannot disperse as there is no wind and the inversion stops vertical dispersion.

The main sources of air pollutants in Christchurch result from combustion processes, particularly emissions from industrial, commercial and domestic activities and motor vehicles. The most common air pollutants in Christchurch are suspended particulate matter (PM_{10}), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3) and lead. Of these PM_{10} (from smoke) is considered to be the biggest problem in Christchurch.

Residents rank air quality as one of the most important environmental issues in the City. The 1999 Annual Survey of Residents found that air quality was perceived to be the second most important environmental issue in the City. A self-completed survey in The Press newspaper conducted by Canterbury Dialogues[9] found that air quality was the number one issue in Canterbury.

Pressures on Air Quality

The Canterbury Regional Council (CRC) has carried out two recent investigations into factors that influence Christchurch's air quality. An air shed study examined the relationship between meteorological conditions and air quality. Secondly, an emissions inventory investigated the relative contribution various activities have on winter air quality.

Air Shed Study[10]
The Regional Council initiated an air shed study for Christchurch during 1994 and 1995. Analysis of data from the first phase of the study has identified the following meteorological conditions that influence the concentration and dispersion of air pollutants:

- Strong inversions are shown to develop overnight in the winter, trapping atmospheric pollutants in a shallow layer (typically less than 100 metres above the ground). During sunny mornings solar heating is able to destroy the inversion within a few hours, establish vertical mixing and decrease surface air pollution concentrations.
- Wind speed during the night often shows wave-like patterns, sometimes resulting in strong downward mixing of fresh air from aloft, and the decline of air pollution concentrations for short periods at ground level.
- Clean, cold air draining down the slopes of the Port Hills and from the Canterbury Plains has been observed to interact with air over Christchurch trapped by temperature inversions, to produce marked fluctuations in observed air pollution concentrations.

These localised phenomena have implications for both air quality in various areas and the movement of pollution from one part of the City to the other.

Christchurch Inventory of Total Emissions[11]
An emission inventory for urban Christchurch was undertaken by the Regional Council between June 1995 and June 1996. The objective was to identify and compare the relative contribution of emissions from industry, domestic fires and motor vehicles to the winter air quality. It also aimed to establish a baseline for emissions from different sectors for the purpose of monitoring future trends in emissions.

[8] More information on the health effects of air pollution can be found at http://www.crc.govt.nz/crchome/gis&database/airpol/guidelines.htm
[9] Canterbury Dialogues is an independent charitable trust. For more information see: http://www.canterburydialogues.org.nz/
[10] Canterbury Regional Council, Regional Environmental Report 1995/96.
[11] Canterbury Regional Council, Christchurch Inventory of Total Emissions Report R97/7.

The Christchurch inventory focused on emissions relating to a typical winter's day, reflecting the part of the year with significant air quality problems.

The emission inventory revealed that::

- Seventy eight per cent of Christchurch householders use electricity or gas (or both) as a method of home heating.
- Approximately 44 per cent of householders use a wood or coal burning appliance as their main method of home heating. Of these, approximately 62 per cent use woodburners, 30 per cent use open fires, and 8 per cent use enclosed coal-burning appliances or incinerators.
- Eighty two per cent of particulate emissions (PM_{10}) to the air on a typical winter's day result from domestic solid fuel heating.
- Motor vehicles are responsible for 90 per cent of nitrogen oxide (NO_x) emissions, 65 - 70 per cent of carbon monoxide (CO) and volatile organic compounds (VOC) emissions, and 60 per cent of carbon dioxide (CO_2) emissions.
- Fifty per cent of sulphur oxide (SO_x) emissions are from industry, compared with a third from home heating.
- Peak times for emissions over the study area were 4pm to 10pm for PM_{10}, CO, SO_x, VOC and CO_2 and 10am and 4pm for NO_x.
- Lowest emission times over the study area were 6am to 10am for PM_{10} and 10pm to 6am for CO, NO_x, SO_x, VOC and CO_2.

Air Quality Trends

The Canterbury Regional Council undertakes extensive air quality monitoring within Christchurch. Suspended particulate matter (PM_{10}), sulphur dioxide, nitrogen oxide, nitrogen dioxide and carbon monoxide have been monitored at a site in St Albans since 1988. Wind speed, wind direction and air temperature at ground level and at three metres are also measured. In addition, some monitoring of visibility and humidity has been carried out at this site.

In 1995 three additional monitoring sites were established in residential areas in Hornby and Beckenham, and in a residential area adjacent to a large industrial area in Opawa. The Beckenham site was discontinued in 1997. Not all pollutants are monitored at each site.

In general, air quality varies throughout the day. The lowest pollutant concentrations occur around midday, while peaks in pollutant concentrations generally occur in the evenings from 8pm to midnight. Concentrations reduce to low levels during the early morning and peak again with morning traffic. Most pollution peaks occur during the winter months. The exception is SO_2 concentrations at Hornby where effects of SO_2, influenced by industrial activity, can occur throughout the year.

Table 2.8 Summary of the Ministry for the Environment Guidelines for Ambient Air Quality

	Average Period	Concentration
Particulates* (PM_{10})	24 hours	120 $\mu g/m^3$
	24 hours	50$\mu g/m^3$
Sulphur dioxide	10 min	500 $\mu g/m^3$
	1 hour	350 $\mu g/m^3$
	24 hours	125 $\mu g/m^3$
	Annual	50 $\mu g/m^3$
Carbon monoxide	1 hour	30 mg/m^3
	8 hours	10 mg/m^3
Nitrogen dioxide	1 hour	300 $\mu g/m^3$
	24 hours	100 $\mu g/m^3$
Lead	3 months	0.5-1.0 $\mu g/m^3$
Ozone	1 hour	150 $\mu g/m^3$
	8 hour	100 $\mu g/m^3$

mg = milligrams, i.e grams/10^3
µg = micrograms, i.e grams/10^6

1. Ambient air quality is air quality in a general area, i.e away from the influence of a specific contaminant discharge.

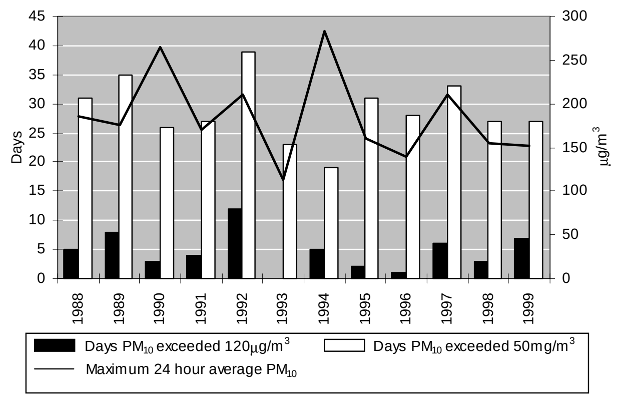
* In March 1996 the Canterbury Regional Council adopted a monitoring and reporting guideline for PM_{10} of 50$\mu g/m^3$.

Source: Ministry for the Environment and Canterbury Regional Council.

Suspended Particulate Matter (PM_{10})

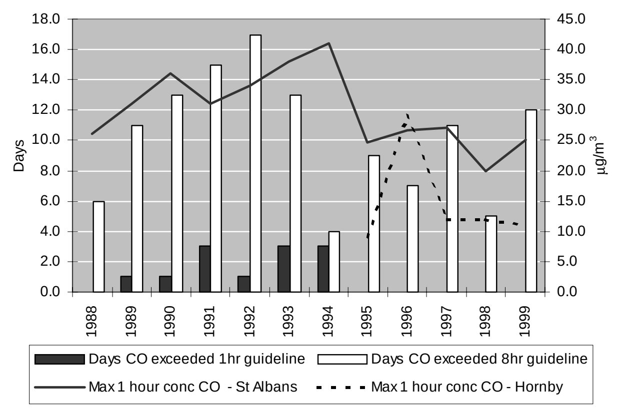
The Canterbury Regional Council 24-hour guideline for PM_{10} concentrations (50μgm^{-3}) has been exceeded every year since 1988 (Figure 2.8). The number of days which exceeded the guideline varied from 19 to 39 days per year for the period, with the average number of excessive concentrations being 29 days. This is equivalent to having one month a year with air quality that is hazardous to people's health. Maximum 24-hour concentrations of PM_{10} averaged 185 μgm^{-3} during the 1988 to 1999 period, which is three and a half times greater than the CRC guideline and well above the Ministry for the Environment's 120 μgm^{-3} guideline. As winter air quality is controlled by the weather, variation between years can be quite large, making it difficult to distinguish whether a trend exists or not.

Fig 2.8 Number of Days PM_{10} Guidelines are Exceeded – St Albans



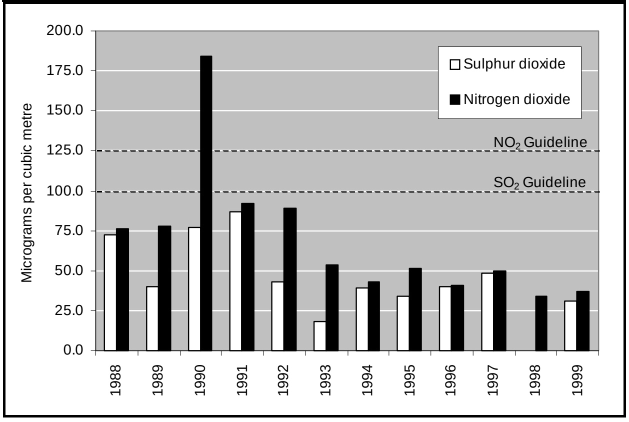
Source: Canterbury Regional Council.

Fig 2.9 CO Monitoring Results for St Albans, April to September 1988 to 1999



Source: Canterbury Regional Council.

Fig 2.10 Max 24 hr average SO_2 and NO_2 - St Albans, April to September 1988 to 1999



Source: Canterbury Regional Council.

On most high pollution nights, levels recorded at the St Albans monitoring site were higher than those recorded at other sites. Variations in emissions and proximity to sources could account for some of the differences between sites. The areas of non-residential open space near Hornby and to a lesser extent Opawa could also explain some of the variation between these sites and the residential site in St Albans[12].

Carbon Monoxide (CO)

Concentrations of carbon monoxide have exceeded the eight-hour guideline during each year since 1988. The St Albans site averages 10 days a year with CO concentrations greater than the 10 μgm^{-3} guideline (Figure 2.9). Between 1995 and 1999, one-hour concentrations of CO did not exceed the one-hour guideline of 30 μgm^{-3}.

Carbon monoxide is also monitored at Hornby. The maximum one-hour concentrations are shown on Figure 2.9. Generally, maximum concentrations of CO at Hornby were around half those recorded at St Albans. As a result CO concentrations at Hornby exceeded the guidelines on fewer days than at St Albans.

Sulphur Dioxide (SO_2)

The maximum annual 24-hour average concentration of sulphur dioxide at the St Albans monitoring site was consistently lower than the relevant guideline between 1988 and 1999 (Table 2.9 and Figure 2.10). Concentrations of SO_2 measured at the St Albans site show seasonal variations, with higher concentrations occurring during the winter period. Maximum concentrations at Hornby can occur throughout the year, with minimum concentrations during the period from early December to mid-February. This is likely to be due to the industrial nature of the area and the impact of SO_2 emissions from nearby industries.

Nitrogen Dioxide (NO_2)

Nitrogen dioxide levels showed a decreasing trend between 1988 and 1999 (Figure 2.10), except for a peak in 1990 when the 24-hour guideline of 100μgm^{-3} was exceeded with an annual 24 hour maximum of 184μgm^{-3}. This was over twice as high as any other record and is probably the result of a single one-off event.

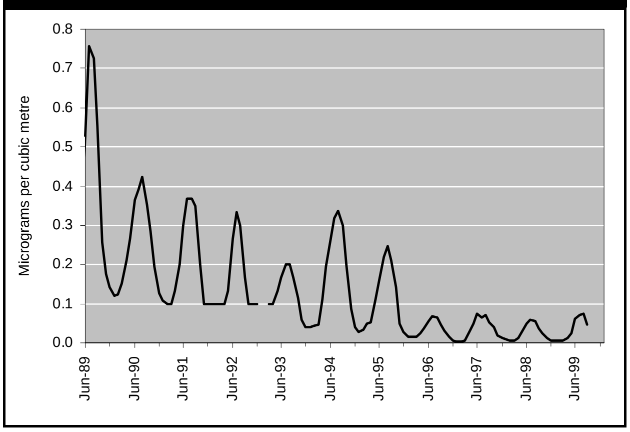
Lead Monitoring

Figure 2.11 shows the lead concentration for the period 1989 to 1999 at the St Albans site. There was a noticeable decrease in lead concentrations over this period, reflecting the change to unleaded fuel in motor vehicles. As a result, the lead guideline of 0.5-1.0μgm^{-3} (three-monthly average) was not been exceeded at the St Albans site after the winter of 1989. After January 1996 the lead concentrations remained below 0.1μgm^{-3} compared with the guideline of 0.5 to 1.0μgm^{-3}.

Carbon Monoxide Monitoring at Riccarton Road

Carbon monoxide monitoring was carried out by the Canterbury Regional Council on Riccarton Road during June and July of 1993 and from March to June in 1996. The purpose of this monitoring was to

Fig. 2.11 Lead Concentration at St Albans, 1988 – 1999 (3 month running mean)



Source: Canterbury Regional Council.

[12] Canterbury Regional Council, Annual Air Quality Monitoring Report 1998, U99/26.

Table 2.9 Summary of Winter 1999 Air Quality Monitoring at St Albans, Opawa and Hornby

Site		CO 8 hour	CO 1 hour	PM_{10} 24 hour (50 mg/m^3)	PM_{10} 24 hour (120mg/m^3)	NO_2 24 hour	SO_2 24 hour
St Albans	Days exceeding	12	0	27	7	0	0
	Max Conc.	21	25	152	152	37	31
Opawa	Days exceeding	-	-	13	1	-	0
	Max Conc.	-	-	168	168	-	47
Hornby	Days exceeding	0	0	-	-	-	0
	Max Conc.	7	11	-	-	-	67
Guidelines		10 mg/m^3	30 mg/m^3	50 mg/m^3	120 mg/m^3	100 mg/m^3	125 mg/m^3

Source: Canterbury Regional Council.

measure street level air quality that results from motor vehicle carbon monoxide emissions on a busy arterial road in urban Christchurch.

Measurements in 1996 were carried out at two monitoring sites. One was at street level on Riccarton Road, approximately 100 metres west of the Clarence Street/Riccarton Road intersection. The second site was 30 metres back from Riccarton Road and measured the impact vehicle emissions have on the surrounding area. (The 1993 site was situated close to the Clarence Street/Riccarton Road intersection.)

The eight-hour ambient air quality guideline (10mg/m^2) for carbon monoxide was exceeded at street level on 30 per cent of the 79 days monitored in 1996. The one hour ambient air quality guideline (30mg/m^2) was exceeded on 4 per cent of the days monitored. Fewer high readings were measured in 1996 than in 1993. Differences between the concentrations measured in 1996 and 1993 were likely to be due to lower wind speeds in 1993 and the different locations of the monitoring equipment. Concentrations of carbon monoxide at the site 30 metres from Riccarton Road did not exceed any of the ambient air quality guidelines.

The eight-hour guideline was more likely to be exceeded on days when vehicle numbers were greater than about 1,050 vehicles per hour and the maximum wind speed was less than 2 m/s. On days when the wind was primarily from the northerly quadrants, the minimum number of vehicles required to exceed the deadline decreased to about 900 per hour. This was due to the monitoring equipment being on the downwind side of the road.

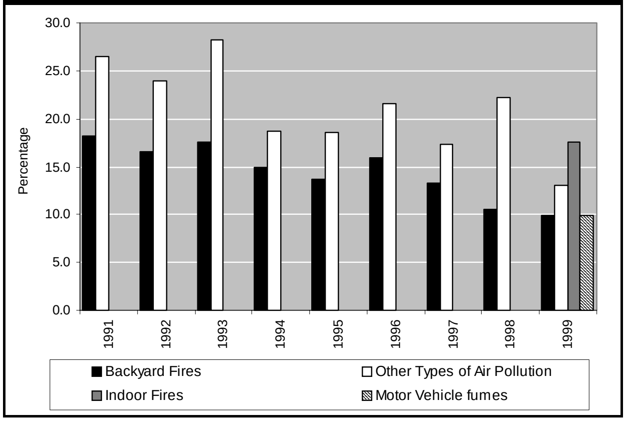
Air Pollution Complaints

The Christchurch City Council and the Canterbury Regional Council are jointly responsible for investigating complaints about the City's air quality arising from odours, fumes, dust, smoke and other problems. The City Council receives an average of 210 complaints a year.

The Regional Council's complaints register covers the whole of the Canterbury Region. However, the majority of air quality complaints are for the Christchurch City area. Between 1996 and 1998, complaints increased from 845 to 1,751 and then declined to 1,613 in 1999. Approximately 90 per cent of complaints received by the Regional Council were for odours, spray drift and industrial discharges, with the remaining complaints relating to domestic fires.

The Christchurch City Council's Annual Survey asked a representative group of residents whether they had experienced problems with air pollution. Figure 2.12 shows there has been a decrease in the percentage of those who had problems with air pollution, especially with regard to backyard fires. In 1999 the survey also asked whether indoor fires and motor vehicle fumes were a nuisance. Eighteen and 10 per cent of respondents respectively indicated these were a nuisance.

Fig 2.12 Percentage of Residents Who Have Had Problems with Air Pollution



Source: Christchurch City Council, Annual Survey of Residents.

Groundwater

Key Information	Why is this Useful?	What is Happening?
Total groundwater abstraction.	This measures the pressure the City Council places on groundwater resources through abstraction. This is also dependent on climate, with water consumption increasing in drier years.	↓ Generally, the City's groundwater abstraction decreased by 13 per cent between 1989 and 1999
Per capita groundwater abstraction.	This relates abstraction to population change. As residents are the greatest user group, this provides some insight into how efficiently residents use water.	↓ Per capita abstraction decreased by 15 per cent between 1991 and 1999.
Drinking water quality.	All of Christchurch's drinking water comes from groundwater. High quality groundwater reduces treatment costs needed to reduce potential health risks.	● Christchurch's drinking water supply meets New Zealand's drinking water standards without treatment.
Hydrocarbon contaminants in groundwater.	Hydrocarbons result from industrial and commercial activities and landfills. They pose a high risk to groundwater due to their persistence, toxicity, mobility and widespread use.	● Hydrocarbon contaminants were detected at approximately 50 per cent of wells monitored between 1988 and 1999.

Other Related Sections: Population Growth, Health, Weather and Climate, Land Use, Surface Water, Built Environment, Waste Management, Businesses, Employment and Unemployment.

In the 1999 Annual Survey of Residents, the long-term supply of clean drinking water was rated as the most important issue for Christchurch residents. Christchurch's drinking water is solely from a series of confined and unconfined aquifers which extend to a depth of 550 metres below the City and make up the Christchurch – West Melton aquifer system. The water in these aquifers comes from rainfall infiltration (26 per cent), seepage from the Waimakariri River (50 per cent), from stock races (1 per cent) and from deep groundwater flow from further inland (23 per cent). The Canterbury Regional Council estimates that 40 per cent of water discharged from the Christchurch-West Melton aquifer system is abstracted in wells, with another 40 per cent feeding streams in the City. The remainder flows to the east and south of the City, beyond the coastline or towards Lake Ellesmere (Te Waihora[13]).

Groundwater Abstraction

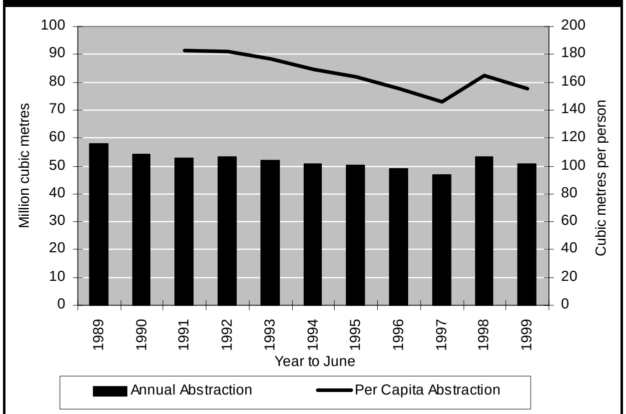
The groundwater resource beneath Christchurch is currently the sole source of drinking water for the City's residents. It is relied on to continuously provide high quality water without treatment from 150 bores which range in depth from 25 to 180 metres.

In the year to June 1999, 50.5 million cubic metres of water were drawn from the aquifer system by the Christchurch City Council and pumped through the City's reticulation system (Figure 2.13). The City Council's abstraction per capita for the year to June 1999 was 156 cubic metres per person. Both total abstraction and per capita abstraction declined between 1991 and 1997, then increased in 1998 and 1999 due to increased demand as a result of the drought during these years. This decline in abstraction before the 1998/99 drought can be attributed to the following:

- Increased use of private wells by industry;
- The discovery of unmetered commercial connections and other reductions in commercial water use due to changes in the water pricing structure;
- Urban consolidation;
- Leaks on private property discovered because of meter installation;
- A change in public awareness and attitudes.

Consequently, the municipal supply abstracted the same amount of groundwater in a high demand drought period (53.5 million cubic metres in the year to June 1998) as it did during the year to June 1991,

Fig 2.13 Christchurch City Council Groundwater Abstraction



Source: Christchurch City Council .

[13] Canterbury Regional Council, Groundwater – Christchurch-West Melton booklet 1997.

even though the population had increased by approximately 12 per cent in this period.

Municipal use accounts for approximately 50 per cent of total groundwater abstraction from the Christchurch-West Melton aquifer system. The Canterbury Regional Council estimated total groundwater abstraction from all sources to be 114 million cubic metres for the year to December 1998. Industrial sources used 14 million cubic metres of this total. This was 37 per cent of the total amount allocated through consents for industrial purposes. It is estimated that 20 per cent of the groundwater abstracted for industrial purposes was returned to groundwater after use (air conditioning and gravel washing). Other groundwater abstractions were for irrigation (an estimated 40 million cubic metres in 1998), and approximately 5 million cubic metres used for other public abstractions such as by Banks Peninsula District Council (1.5 million cubic metres), small community supplies and swimming pools.

Municipal Groundwater Use
The water abstracted by the Christchurch City Council is allocated approximately as follows:

Residential	57 per cent
Commercial	11 per cent
Industrial	10 per cent
Public and other	5 per cent
Unaccounted (leakage, illegal connections etc)	17 per cent

The figure of 17 per cent for unaccounted water compares reasonably well with typical figures world-wide of between 13 and 39 per cent.

Groundwater Quality

Water pumped from wells directly into the City Council's reticulation system complies with the *Drinking Water Standards for New Zealand 1995* without being treated. Water from several wells in the north-west is, however, dosed to increase pH levels to reduce the risk of corrosion of metal fittings. An additional 27 wells not owned by the City Council are used for community drinking water supplies and listed by the Ministry of Health[14] for Christchurch. Most of these wells are owned by primary schools in the City and the quality of the water is ungraded, therefore unknown.

Pressures on the long-term sustainability of Christchurch's groundwater resource come from current and historic land uses in the recharge area immediately west and north-west of Christchurch. This area is to the west of the three metre confining layer shown in Figure 2.14. Many disused landfill sites, 40 per cent of industrial zones (840 hectares) and the Christchurch International Airport (720 hectares) are in the recharge area. These pose a threat to groundwater quality through possible leachate and chemical contamination.

Groundwater Hydrocarbon Monitoring [15]
Since 1988 groundwater beneath Christchurch has been regularly monitored for hydrocarbon and other contaminants by the Canterbury Regional Council and its predecessor, the North Canterbury Catchment Board. Between April 1988 and June 1999, 19 different hydrocarbons were detected in monitoring wells in the Christchurch-West Melton aquifer system. Of these 19 hydrocarbons the chlorinated hydrocarbons were the most widespread and persistent, whereas aromatic hydrocarbons were detected less frequently at various sites throughout the City. Of the 101 monitoring sites in the City, 48 had one or more hydrocarbons detected between April 1988 and June 1999.

The chlorinated hydrocarbons (eg 1,1,1 trichloroethane, trichloroethane) pose a high risk to groundwater quality for a number of reasons including their persistence in groundwater, toxicity, mobility, and widespread use. In 1993 the City Council found 21 businesses in Christchurch used chlorinated hydrocarbon compounds. The location of these sites, along with business and industrial zoned areas of the City, are shown in Figure 2.14.

Aromatic hydrocarbons are found in petroleum products and are also used as solvents or chemical intermediates in a number of industries. Of the compounds in petroleum, the BTEX group (benzene, toluene, ethylbenzene, and the xylenes) poses the greatest threat to groundwater quality because it is very water soluble and the compounds are recognised carcinogens.

Generally, the concentrations of hydrocarbons detected were generally well below their relevant New Zealand drinking water standard[16]. Although there is little risk to groundwater users at present, it is a concern that persistent hydrocarbons are routinely found over an extensive area in the ambient groundwater.

Figure 2.14 shows three main areas where hydrocarbons have been found in Christchurch groundwater. These are:

1. Along Johns Road to the north-west of the urban area;
2. Along the old Waimakariri River paleochannel between Halswell Junction and Awatea Roads, Wigram; and
3. The southern part of the urban area between

[14] Ministry of Health, Register of Community Drinking Water Supplies in New Zealand, 1998.

[15] Information in this section from: Canterbury Regional Council: Groundwater contamination by hydrocarbons in Canterbury: A review of monitoring data from April 1988 to June 1999, August 1999. R99/11

[16] Ministry of Health: Drinking water standards for New Zealand, 1995.

Blenheim Road and the Heathcote River from Sockburn to Woolston.

In all three areas industrial activities landfills, created by infilling gravel pits with refuse, or leakage from underground storage tanks may be sources of hydrocarbon contaminants.

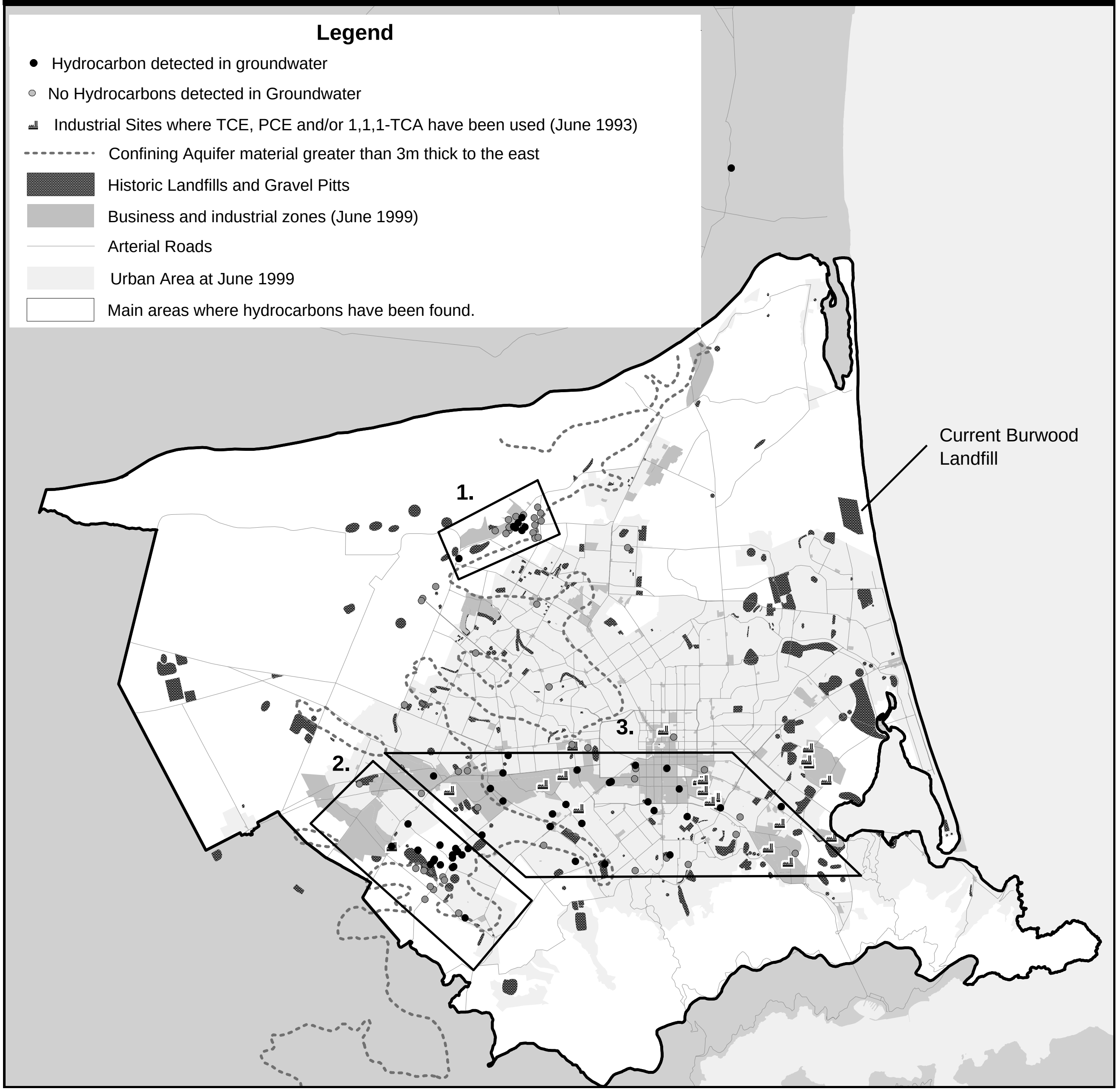
Leachate Monitoring at Burwood Landfill[17, 18]

Monitoring of leachate from the Burwood Landfill to the underlying groundwater is required as a condition of its resource consent. An assessment of the environmental effects of the landfill was carried out in 1995[17]. It was estimated that the leachate produced from the landfill, once the landfill reached a constant moisture level, would be in the order of 13 to 18 per cent of the site's rainfall. This equates to between 114 and 158 cubic metres of leachate per day from stages 1, 2A and 2 of the landfill.

Groundwater affected by leachate is in an unconfined aquifer that is approximately 30 metres deep. This aquifer discharges at the coast and there is no known use of this groundwater at or down gradient of the landfill site. It is estimated that groundwater takes 15 years to pass under stage one of the landfill. Results from the assessment of effects and the annual monitoring reports[17] conservatively estimate it will take 50 years for the ammoniacal nitrate plume from stage one of the landfill to reach the coast. Currently, leachate has not moved more than 50 metres down gradient from the landfill.

Leachate levels will decrease in the groundwater over time due to attenuation processes (dilution, dispersion, absorption, oxidation and biodegradation). As a result

Fig 2.14 Location of Wells where One or More Hydrocarbon Contaminants have been Detected between April 1988 and June 1999



Source: Canterbury Regional Council

of these processes it is estimated that the only leachates that will reach the coastline with levels above background levels are vinyl chloride, nickel and nitrate nitrogen. Predicted levels of nickel and vinyl chloride, when discharged, are not expected to be of environmental concern. The nature of the coastal environment is unlikely to result in undesirable biological growth from elevated nitrate levels. Once the groundwater discharges into the sea it will be diluted to such an extent by the coastal water that the potential for wider environmental effects are very limited.

Groundwater Monitoring of Closed Landfills[19]

The Christchurch City Council and the various local bodies which amalgamated to form the current City Council have operated a number of refuse disposal landfills over past years. The current register identifies 114 closed landfill sites within the City boundary (Figure 2.14). The City Council currently monitors groundwater quality at and down gradient of six old landfill sites in the City. The six chosen for monitoring were considered to present the greatest potential environmental risk.

The landfills monitored are:

- Sawyers Arms Landfill
- Bexley Landfill
- Ferry Road Tip
- Hansen Park Landfill
- Carrs Road Landfill
- West Truscotts Landfill

Results from the initial assessments of environmental effects and ongoing monitoring reports show that leachates from all these closed landfills currently appear to have no significant environmental effect on the groundwater beyond the sites. Due to the nature of these landfills it is predicted that the effects from leachate are expected to decrease over time. Current effects on groundwater appear to be confined to the uppermost unconfined aquifers and do not extend to the deeper confined aquifers from which the City's drinking water is abstracted. Landfills adjacent to waterways in the City (Hansen Park, Bexley and West Truscott) also appear to have no significant effect on these waterways due to the dilution of any leachate.

The remaining 108 landfill sites have been ranked according to their estimated environmental risk. Of these, 60 sites that were ranked as medium or high priority are currently being investigated to evaluate any environmental and public health effects.

[17] Burwood Landfill, Christchurch - Assessment of Environmental Effects, Report prepared by Woodward-Clyde for the Christchurch City Council 1995.

[18] Burwood Landfill - 1999 Groundwater Monitoring Report prepared for Christchurch City Council by Woodward-Clyde 1999.

[19] Draft Report: Christchurch Closed Landfills - Data Monitoring Reports. Prepared for Christchurch City Council by Woodward-Clyde, 1999.

Surface Water

Key Information	Why is this Useful?	What is Happening?
Microbiological water quality in waterways.	Faecal coliform concentrations are used to indicate whether waterways are safe to use for particular activities such as contact recreation eg swimming.	↑ The median faecal coliform values sampled in the City generally increased between 1995 and 1999.
Nutrient levels in waterways.	Large levels of nutrients such as nitrogen and phosphorus can lead to excessive growth of waterway plants and algae, which can produce undesirable aquatic conditions.	↓ Dissolved nitrogen levels have generally declined since 1991, however they are above the recommended guideline. ↑ Generally, median dissolved phorphorus levels increased between 1995 and 1999.
Biological oxygen demand (BOD) in waterways.	BOD is a measure of the potential for the chemical and organic contaminants in water to reduce the dissolved oxygen in the water body, which in turn could impact on aquatic organisms.	↓ Generally, BOD levels in the City's waterways decreased between 1996 and 1999.
Birdlife on the City's waterways.	Birdlife provides a indicator of the sustainablility of the City's waterways for natural communities. Birdlife relies on the presence of lesser fauna and vegetation to exist.	↑ Birdlife on the Avon River (the number of birds and bird species) increased between 1993/94 and 1998/99.

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

Waterway Characteristics

Christchurch's waterways, wetlands and drainage system is an important part of the City's environment. It is made up of natural assets such as:

- Rivers (90 kilometres)
- Environmental asset waterways (125 kilometres)
- Hill waterways (16 kilometres)
- Wetlands (69 hectares)

and man-made infrastructural assets such as:

- Stormwater pipes (504 kilometres)
- Utility waterways (130 kilometres)
- Drainage structures (stopbanks, stormwater retention and soakage basins and Woolston tidal barrage).

The main waterway catchments in the City are the Avon, Heathcote, Styx and Halswell Rivers, and Otukaikino Creek (south branch of the Waimakariri River). Both the Avon and Heathcote Rivers flow into the Avon-Heathcote Estuary. The Styx River and Halswell Rivers flow into Brooklands Lagoon and Lake Ellesmere respectively, while the Otukaikino flows into the Waimakariri River at the motorway bridge. The Waimakariri River forms the northern boundary of the City and is a large, braided river fed predominantly by rainfall in the Southern Alps.

Although the rivers that originate within the Christchurch City boundary are all spring-fed, there are distinct differences in the landuse of individual rivers. (The catchment land uses for the three main rivers are shown in Table 2.10.) Variation in catchment land use can have significant influences on the water quality in each catchment.

The Avon River originates from the spring-fed Avon, Waimairi and Wairarapa Streams in north-west Christchurch. It drains a highly modified urban

Table 2.10 Zoned Land Use for the Main River Catcments in Christchurch [20]

Landuse Zoning	Avon Catchment		Heathcote Catchment		Styx Catchment	
	ha	%	ha	%	ha	%
Living	5,465	63	3,816	39	983	20
Commercial	209	2	65	1	15	0
Cultural	353	4	151	1	52	1
Industrial	382	4	979	10	167	3
Rural	1,045	12	2,833	29	3,513	71
Conservation	335	4	1,013	10	89	2
Open Space	749	9	495	5	80	2
Special	192	2	532	5	19	0
Total	**8,730**	**100**	**9,884**	**100**	**4,918**	**100**

Source: Christchurch City Council.

[20] It should be noted these areas are based on the proposed zoning in the City of Christchurch City Plan. Because an area is in a particular zone the land use is not necessarily the same as the zoning.

catchment, with up to 73 per cent of its 8.730 hectare catchment zoned for urban land uses.

The Heathcote River drains a semi-urban catchment of around 10,000 hectares in area. Its catchment lies entirely within the City boundary and drains rural land on the Port Hills and the urban suburbs in southern Christchurch. Ten per cent of the Heathcote's catchment is zoned for industrial use.

As a result of City Plan decisions in June 1999, 550 hectares of rural land in the Heathcote catchment were rezoned. Of this, 380 hectares were rezoned residential, with the remaining 170 hectares going to conservation (76 hectares), open space (28 hectares) and special purpose zones (49 hectares).

The Styx River flows through a predominantly rural catchment. As a result of City Plan decisions in June 1999, an additional 150 hectares of rural land were rezoned residential. This represented a 18 per cent increase in residential-zoned land, bringing the proportion of urban-zoned land to 25 per cent of the catchment.

Both the Halswell River and the Otukaikino Creek have predominantly non-urban catchments.

Pressures on Surface Waters

The greatest impacts on surface water in the City come not from water use but from land use. Significant pressures on waterways are:

- Sedimentation and nutrient enrichment (eutrophication) of surface waters by agricultural run-off and urban stormwater; and
- Point source pollution in some lower reaches of streams and rivers.

Examples of agricultural pressures are land clearance, land drainage and channelling, draw off for irrigation and stock watering, and run-off and waste discharges from farms and agricultural processing facilities.

Urban pressures on waterways result from sewage and industrial waste, stormwater run-off, water being drawn off for household and industrial uses, and urban expansion into wetlands and estuaries. Urban pressures tend to fall into two main types: point source discharge of sewage and non-point source discharge of stormwater run-off.

Stormwater run-off pollution comes from substances that are washed off the street and adjacent surfaces, and also from accidental mixing of stormwater and sewage. Contaminants include sediments, organic matter, nutrients, disease-causing organisms and toxic substances ranging from oil products and contaminated dust from vehicle exhausts to industrial chemicals.

Stormwater run-off is also a major source of marine debris, such as floating plastic, which is both unsightly and hazardous to marine mammals and birds.

Urban stormwater is often similar in quality to secondary-treated sewage. Stormwater that runs off construction sites can carry very high levels of sediment, particularly where the vegetation and topsoil are stripped beforehand. Sediment loss from catchments undergoing urban development is up to 15 times greater than the sediment loss from equivalent non-urban catchments.

Water Quality

Water quality is generally defined by various parameters which measure the microbiological, physical and chemical nature of a waterway. Each of these parameters can impact on the waterway or its use in different ways. Impact of water quality parameters are outlined with the recommended guidelines in Table 2.11.

Spatial Variation in Water Quality Parameters

Monitoring results show water quality in Christchurch rivers appears to be dependent on the nature of surrounding land use, the flow regime and the influence tributary streams have on the main rivers.

Microbiological water quality is measured by the median concentration of faecal coliforms[21] in the water. This gives an indication of the safety of water used for recreational activities such as swimming. It also provides a measure of the contamination of waterways from agricultural land uses or sewage discharge.

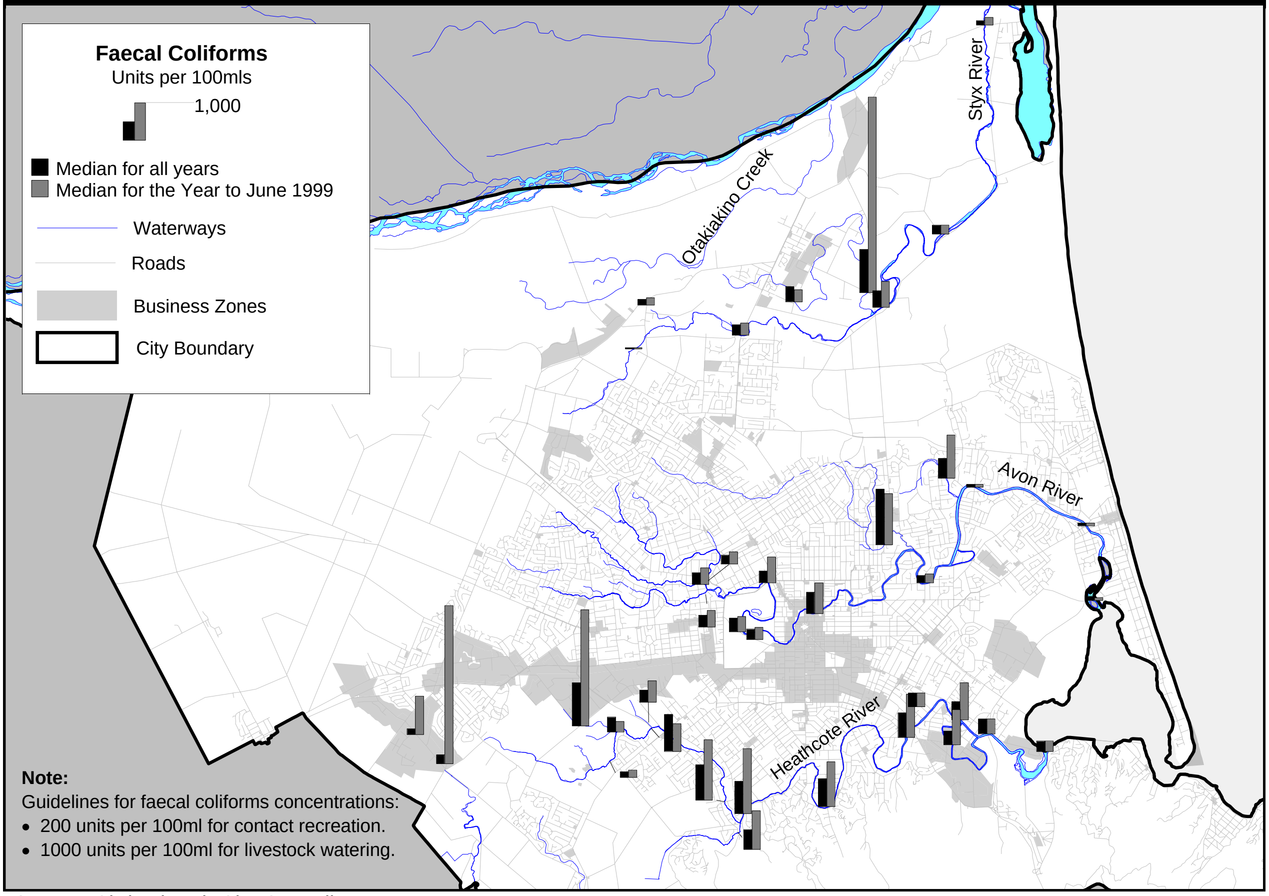
Faecal coliform concentrations were sampled at 42 river and stream sites in the City. The drains which flow directly into the Estuary were also sampled but the results are not presented in this report. Coastal bathing information is in the Coastal section of this report.

River sites in Christchurch City which met the guidelines for swimming (200 faecal coliforms per 100 millilitres) during the year to June 1999 were in the upper Styx River, the Otukaikino Creek above the outlet of the Belfast waste water treatment plant, the source of Cashmere Stream, and lower tidal reaches of the Avon River (Figure 2.15).

Seven sites have long-term medians which exceed the livestock watering guideline of 1,000 faecal coliforms per 100 millilitres. They are in the upper Heathcote from Haytons Drain down to below the confluence with

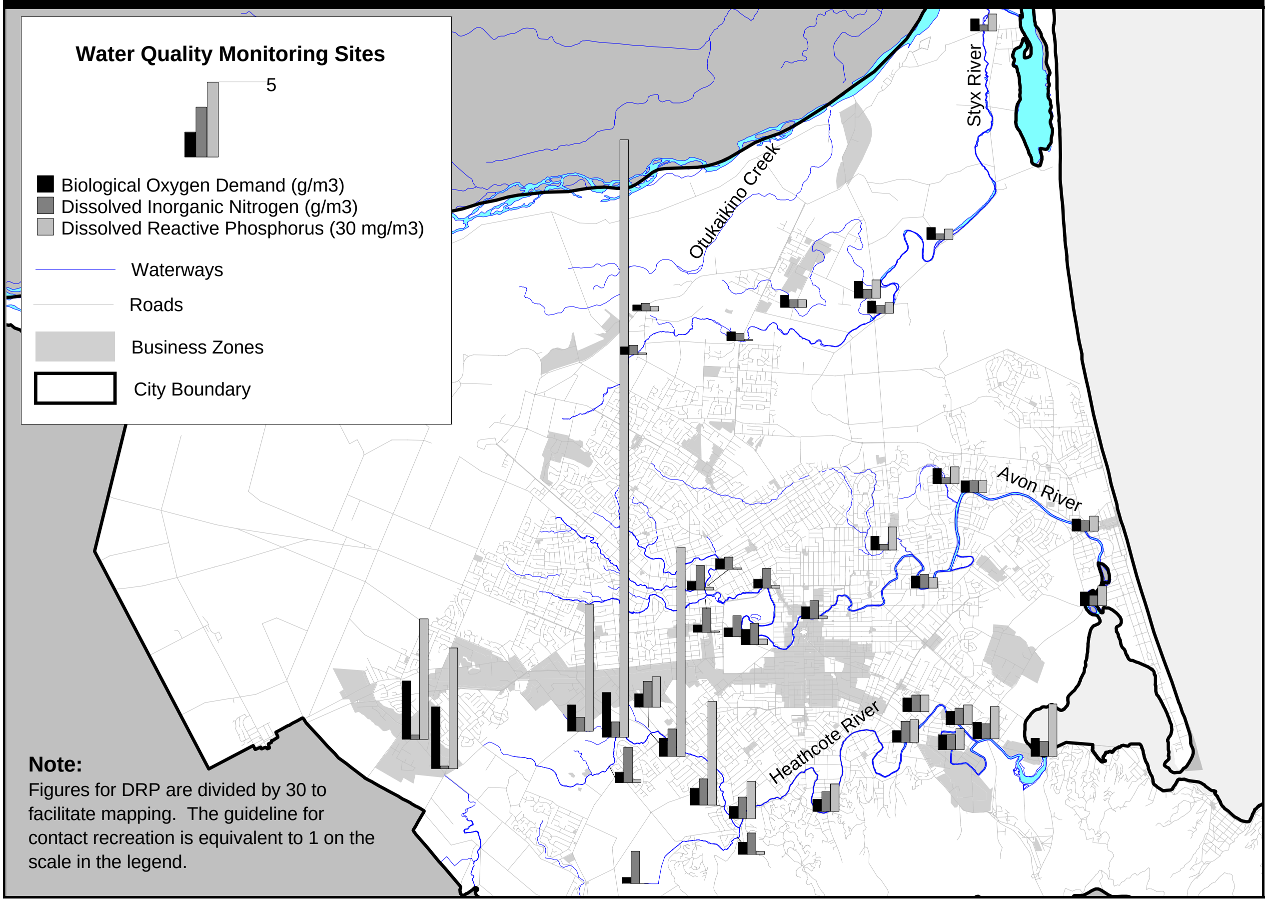
[21] It is not practical to monitor water for all harmful micro-organisms. Instead the common bacteria faecal coliforms have been monitored on the assumption that were there are high concentrations of these, there is the possibility of more harmful micro-organisms. If these bacteria are present at all, water is classified as unfit for human consumption. As bacterial density increases, water is progressively classed as unfit for shellfish harvesting, contact recreation and livestock consumption.

Fig 2.15 Median Faecal Coliforms Concentrations



Source: Christchurch City Council.

Fig 2.16 Median Values of Selected Water Quality Parameters for the Period from 1989 to 1999.



Source: Christchurch City Council.

Table 2.11 Physio - Chemical Water Quality Guidelines

Parameter	Suitability Thresholds for Particular Uses	
Biochemical oxygen demand (BOD_5)	1-2gm^{-3}	Contact recreation Aesthetics
Dissolved reactive phosphorus (DRP)	no more than 15 - 30mgm^{-3}	Contact recreation Aesthetics Preventing algal growth
Dissolved inorganic nitrogen (DIN)	No more than 40 - 100 mgm^{-3}	Contact recreation Aesthetics Preventing algal growth
Ammonia	Suitability varies with temperature and pH	Aquatic ecosystems
Dissolved oxygen (DO)	No less than 80 per cent	Aquatic ecosystems

Source: Ministry for the Environment, The State of New Zealand's Environment 1997.

Cashmere Stream at Fernihurst Street, Dudley Stream which flows into the Avon River, and Kaputone Stream in the Styx catchment. During the year to June 1999, 14 sites exceeded this guideline. The high faecal coliform levels of the Heathcote River extended downstream to Garlands Road, excluding the Mackenzie Street site which had levels below the guideline. The Avon at Manchester St, Horseshoe Lake, Dudley Stream, Kaputone Stream and the outlet to the Halswell retention basin also exceeded the guideline.

Higher concentrations of faecal coliforms during the year to June 1999 may have been partially caused by lower flows in the waterways as a consequence of the drought during 1998 and 1999. Lower flows can reduce the dispersion or dilution of micro-organisms, especially if the source is in-stream wildlife.

The same river and stream sites tested for microbiological indicators were sampled for physical and chemical water quality parameters. Physical and chemical water quality indicators include dissolved oxygen, pH, turbidity, biological oxygen demand (BOD_5), ammonia, temperature, nutrients including, dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP)) and suspended solids.

Nutrients levels are important as they influence the level of eutrophication and growth of slimes and water weeds. Ammonia can be very toxic to aquatic life depending on the pH and temperature of the water body. Turbidity and suspended solids provide a measure of the clarity of a water body, which effects recreational and aesthetic values more than biological ones. Biological oxygen demand provides a measure of the potential for chemical and organic contaminants in water to reduce the level of dissolved oxygen available in the water body.

Nutrient concentrations in the tributaries were generally higher than in the main rivers. Figure 2.16 shows results of BOD and nutrients measured as dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) at most of the monitoring sites in the City. Median values for the year to June 1999 were similar to long-term medians and did not vary as much as the faecal coliform values.

Generally, Christchurch waterways show spring sources have dissolved reactive phosphorus (DRP) levels well below guidelines. Tributary streams are the main contributors of phosphorus; subsequently concentrations increase with distance downstream. Haytons Drain had high median DRP values of around 900 micrograms per cubic metre for the whole monitoring period and 1500 micrograms per cubic metre during the year to June 1999. This is between 30 to 50 times the recommended guideline. The main source of the phosphorus is the fertiliser industry in Hornby[22]. The nutrient-rich environment of Haytons Drain appears to have a detrimental impact on the water quality of the Heathcote River down to its confluence with Cashmere Stream. Nutrient levels remain relatively constant from this point before increasing again as the Heathcote comes under tidal influences.

Dissolved inorganic nitrogen at all sites in the City was higher than the Ministry for the Environment guidelines. The spring sources of Cashmere Stream, Avonhead, Waimairi and Wairarapa Streams have DIN levels greater than the guideline. Generally, DIN concentrations decrease with distance downstream, with most tributaries having little effect on the main rivers.

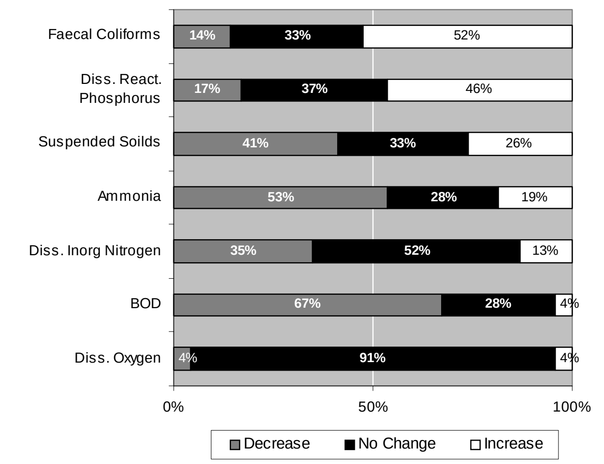
Biological oxygen demand (BOD_5) guidelines were exceeded at sites close to the industrial areas of Haytons Drain and Curletts Drain, and the Halswell Retention Basin. Although sites in the main rivers downstream of the confluences of these tributaries showed high BOD_5 concentrations, only the Heathcote River below the confluence with Haytons Drain approached the guideline.

Trends in surface water quality parameters

Trends in individual water quality parameters aggregated for all the water quality monitoring sites in Christchurch are shown in Figures 2.17 to 2.21. Figure 2.17 shows the difference between the median value for the year to June 1999 and the long-term median for selected parameters for all monitoring sites. The upward trend indicates an increase in the median concentration of a particular parameter compared with its long-term median concentration, while a downward

[22] Christchurch City Surface Water Quality Data 1995 – 97, Water Quality Trends 1986 – 97, Christchurch City Council, Waste Management Unit Laboratory, 1999.

Fig 2.17 Trends in Surface Water Quality by Indicator



Note: The presence of an upward trend indicates an increase in the median concentration of a particular constituent while a downward trend indicates a decrease in the median concentration. No trend was defined as plus or minus 20% from the median long term value for each indicator.

Source: Christchurch City Council.

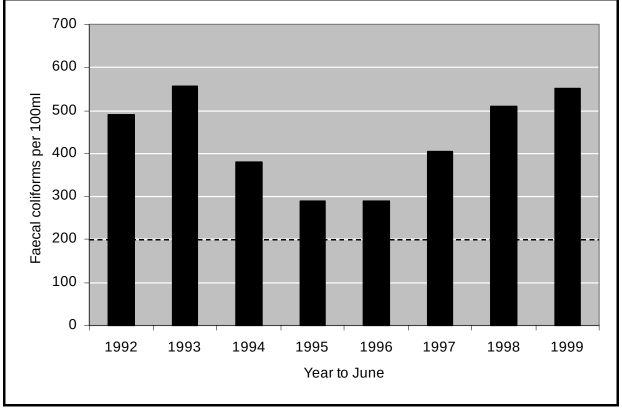
trend indicates a decrease in the median concentration. It should be noted that, for dissolved oxygen, a decrease in concentration results in reduced water quality as opposed to increased water quality for other indicators.

Trends in water quality parameters show most of the median concentrations for the year to June 1999 remained unchanged or decreased for the majority of sites compared with the long-term median concentration. Only faecal coliforms at more than half the monitoring sites have increasing concentrations. This means that increasing faecal coliforms is a widespread occurrence throughout most of the waterways in the Christchurch rather than a local or site-specific problem. This is confirmed by Figure 2.18 which shows the annual median values of faecal coliforms for all sites monitored. The annual trend shows that since 1995 faecal coliform levels in the City's waterways have been increasing. This may be related to changes in rainfall during these periods or the increase in birdlife which is a main source of faecal coliforms in waterways.

Just under half the sites in Figure 2.17 also show an increasing trend in dissolved reactive phosphorus. Figure 2.19 shows median values from all sites have more than doubled since 1992. In 1998 and 1999 the median for all sites was above the Ministry for the Environment guideline of 30 micrograms per cubic metre. This means that over half the sites monitored in the City exceeded the guideline.

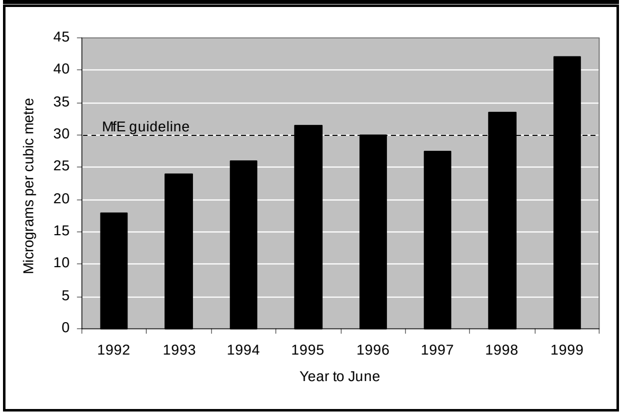
Figure 2.20 shows a 33 per cent decrease in the levels of dissolved inorganic nitrogen (DIN) between 1991 and 1999. However all sites in the City were still well above the guideline. Dissolved organic nitrogen measures the combined effect of nitrate and ammonia

Fig 2.18 Median Faecal Coliform Conc for all Sites



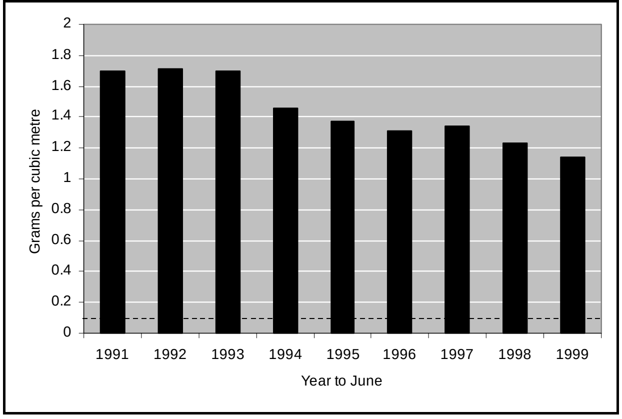
Source: Christchurch City Council.

Fig 2.19 Median DRP Concentrations for all Sites



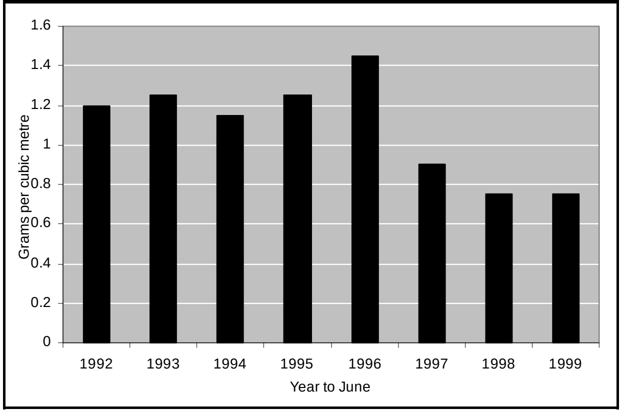
Source: Christchurch City Council.

Fig 2.20 Median DIN Concentrations for all Sites



Source: Christchurch City Council.

Fig 2.21 Median BOD Concentrations for all Sites



Source: Christchurch City Council.

levels in a waterway. Christchurch waterway DIN levels are dominated by nitrates. Fifty three per cent of sites showed decreasing ammonia levels in the year to June 1999, which is consistent with decreasing DIN values.

Sixty seven per cent of sites showed a decrease in BOD levels in the year to June 1999. The median value for all sites (Figure 2.21) shows decreasing levels of BOD since 1996.

Waterway Management

In the past waterway management in Christchurch aimed to create fast draining water channels, which were straight and had few obstructions. This type of management affected natural ecosystems in and along Christchurch's streams, often transferring pressures on the waterway network to different parts of the system.

Waterway management has changed to a more integrated approach which focuses on a range of values including ecology, landscape, recreation, cultural, heritage, drainage and flood control. Outcomes of this change in management are to:

- Protect and improve the natural character of waterways;
- Restore natural waterway function;
- Restore habitat for birds, fish and insects;
- Create green linkages and corridors;
- Restore waterways for their value to local communities; and
- Retain a natural buffer between waterways and development.

By June 1999 waterway enhancement projects had resulted in 1,700 metres of waterway margin being planted. Waterway views were enhanced at Jacksons Creek, Bells Creek at Mary Dixon Park, Dudley Creek at McFaddens Road and Halswell Junction Road wetland.

Eleven hundred metres of waterway or wetland margin was protected through the use of covenants, road stopping, reserve acquisition or land purchase. This included reserve creation on Marshland Road, road stopping by Thorrington School and the purchase of river bank on Nottingham Stream and Smacks Creek.

Birdlife on the City's Waterways[23]

The state of the City's waterways can be assessed using the number, diversity and distribution of natural wildlife, such as waterway birdlife. Birds are high up the food chain and therefore dependent on the condition of lesser fauna and vegetation of a waterway to sustain them.

In 1993/4 a series of bird surveys was carried out for the City Council on a number of Christchurch waterways. The aim of these surveys was to provide some baseline information about the wetland bird populations in the City. These surveys were repeated five years later in 1998/99 and the results for the Avon River are presented below.

Initial conclusions show an increase in bird numbers between 1993/4 and 1998/9. The number of native birds more than doubled from an average of 174 birds in 1993/4 to an average of 380 in 1998/9. The number of native wetland bird species also increased from 11 to 15. This increase in native birds was spearheaded by the New Zealand scaup. Seen only seen once in 1993/4, the New Zealand scaup was recorded on all counts in the 1998/99 survey, with a maximum of 172 birds in July.

These increases in bird numbers on the Avon River have taken place across the range of guilds and feeding groups. This suggests that the cause of the change lies within rather than outside the Avon River ecosystem. A tentative but logical conclusion is that bird numbers and species richness increased partly in response to habitat enhancement and improved feeding, roosting and nesting opportunities.

Birdlife of Natural Waterways[24]

An investigation of birdlife along small natural waterways (streams) was carried out in July and August 1997. The following eleven streams were surveyed:

- Nottingham Stream, Halswell
- Hoon Hay Valley Stream, Port Hills
- Jacksons Stream, Sydenham
- Steamwharf Stream, Woolston
- Avoca Valley Stream, Port Hills
- Old Lake Outlet, Horseshoe Lake
- Upper tributaries, Horseshoe Lake
- Wairarapa Stream, Fendalton
- Papanui Stream, Papanui
- Kaputone Stream, Belfast
- Smacks Stream, Belfast

Twenty two species of wetland bird probably inhabited Christchurch streams when European settlement began in the 1850s. Of these, at least six subsequently became extinct locally (brown teal, buff weka, banded rail, spotless crake, black stilt and South Island fernbird) and most of the others are now seldom recorded on streams.

Despite this decrease in native species, the actual number of wetland bird species that could potentially occur on Christchurch streams is 28 on coastal and peri-urban streams, and 21 on urban streams. The

[23] Information in this section is based on the report for the Water Services Unit, CCC, by Andrew Crossland: The Avon River – Wetland Birdlife Monitoring the first five years: 1993/94 – 1998/99. Preliminary Update February 1999.

[24] Information in this section is based on the report for the Water Services Unit, CCC, by Andrew Crossland: The Birdlife of Christchurch's Natural Waterways.

potential species diversity has probably decreased due to many of the new birds having similar or overlapping niches, while the diverse niches of extinct species are no longer occupied.

Linwood Avenue Canal has the greatest species diversity supporting up to 20 wetland birds, including eight which regularly nest there. However, most City streams currently attract less than 10 species, and some less than five.

Approximately six species of native bush bird may occur in wooded stream-side habitats along Christchurch waterways. These include the common silvereye, grey warbler and South Island fantail, as well as the less common bellbird, kereru (NZ pigeon) and shining cuckoo. In addition, streams which pass through native bush remnants on the Port Hills may also occasionally be visited by vagrant tomtits, tuis and long-tailed cuckoos.

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.

Open Space and Natural Ecosystems

Key Information	Why is this Useful?	What is Happening?
Area of public open space per 1,000 residents.	This measures whether the ratio of public open space (neighbourhood, district and metropolitan parks) to population is at a level which meets the recreational and amenity needs of the community.	- In 1996 and 1999 there were 4.5 hectares of zoned public open space per 1,000 residents in Christchurch.
Area of conservation land in Christchurch.	This measures the amount of land in the City protected for its significant scenic, ecological and heritage values.	↑ This increased by 218 hectares between 1995 and 1999 to 4,892 hectares.
Number and area of Ecological Heritage Sites.	Ecological Heritage Sites are those areas in the City which have high levels of indigenous natural value. The number and area of these sites provides a measure of whether new sites are being identified or being degraded.	● The City has 49 Ecological Heritage Sites with an area of 3,117 hectares.
Number of protected trees in the City.	This measures the number of trees which have sufficient heritage and/ or amenity value within Christchurch and warrant some level of protection.	● There were 19 heritage and 2,567 notable trees listed in May 1999.

Other Related Sections: Population Growth, Land Use, Surface Water, Coastal Environment, Built Environment, Urban Amenity, Heritage, Transportation.

Christchurch City has the following outstanding natural features and landscapes:

- The Port Hills
- Coast
- The Avon-Heathcote Estuary
- Rivers
- Brooklands Lagoons

In addition to these large-scale features many areas of the City are valued for public recreation, open space, conservation values and having significant indigenous vegetation. A balance needs to be found between pressure from development, population growth and lifestyle changes, and the need to provide adequate levels of open space for recreation, without adversely impacting on important landscapes and indigenous habitats.

Public Open Space

In a growing city such as Christchurch the role of public recreational open space is of vital importance. These areas make the City a more attractive place to live and visit. They contribute to Christchurch's 'Garden City image' and are important areas for all types of recreation.

In May 1999 the Christchurch City had 2,872 hectares of zoned open space (Table 2.16). The area zoned as open space increased by 44 hectares between the notification of the City Plan in 1995 and when Council decisions were released in 1999. Areas zoned as open space are the parks and reserves in the City that are primarily for public use or organised recreation. Conservation zones occur in areas where natural and heritage values are predominant.

Open space is divided into the following categories:

- Neighbourhood parks, which comprise small areas of open space. Generally between 0.1 and two hectares in size, they are of value to local neighbourhoods and communities.

- District parks which are primarily large areas of public open space serving a suburban or district-wide function. These are generally greater than two hectares in size.

Table 2.16 Open Space and Conservation Zones

	Area (hectares)	
	1995	1999
Open Space		
Neighbourhood Parks	124	137
District Parks	1,053	1,068
Metropolitan Parks	249	254
McLeans Island	802	802
Private Recreation Facilities	316	317
Agribusiness Centre	103	106
Clearwater resort and Rosebank	181	188
Total Open Space	**2,828**	**2,872**
Conservation		
Natural, Ecological and Scenic Parks	1,545	1,608
Coastal Margins	471	514
Bromley	473	467
Historic and Garden City Parks	87	133
Waterway Conservation	54	48
Waterway Conservation - Waimakariri	2,044	2,044
Cemeteries	72	77
Total Conservation	**4,674**	**4,892**

Source: Christchurch City Council.

- Metropolitan Parks comprise large publicly-owned stadiums and other public recreation areas which include large built structures or single use developments.

- Other areas in the City which are zoned for open space and recreational activities include McLeans Island, private recreational facilities such as golf courses and the Clearwater Resort, and the agribusiness centre incorporating the new A & P showgrounds and saleyards.

It is intended that the amount of public open space in Christchurch should remain consistent with the population of the City. This means that as the population increases, more open space needs to be zoned. At June 1999 the area of neighbourhood, district and metropolitan parks per 1,000 residents was 4.5 hectares. This level has remained around the same since 1996. The proportion of City parks which meet local needs (ie neighbourhood and district parks) to residents is around 3.7 hectares per 1,000 people.

The proportion of open space at local or neighbourhood level within the urban area is quite variable, with areas in the outer suburbs having higher levels of open space than areas in the older central parts of the City.

In addition to the areas zoned in the City Plan as open space, other areas such as the Bottle Lake Forest Park provide a recreation function as well as being a production forest. Small amounts of land are constantly being rezoned as a result of subdivisions, through Council purchases or being gifted to the Council. They are not included in these totals.

Conservation Zones

Table 2.16 shows the breakdown of conservation zones in the City. There were 4,892 hectares of land zoned conservation in the City at June 1999. The majority was in natural, ecological and heritage parks, or the bed and surface of the Waimakariri River. Conservation zones are more sensitive to modification or intensive public use than open space zones. However, areas of these conservation zones are used for public use and recreation purposes, with some land areas, such as the Botanic Gardens, being subject to intense public use.

Natural Areas and Ecological Heritage Sites

Five hundred and one sites within the City were identified by the Lincoln Centre for Resource Management in 1993 as having some natural value. These included wetlands, woodlands, saline habitats, forests, grassland and shrublands found within the Port Hills, low plains and the coastal environment (Table 2.17). The top 49 sites were selected as

Table 2.17 Types of Natural Area Sites

Vegetation Type	Number
Exotic conifer forest (with indigenous elements in the understorey)	44
Grass - shrubland	114
Hedgerows, shelter belts and other fence line communities	16
Maritime or coastal dunes and saline wetlands	33
Open woodland-scrub or planted gardens and continuous shrubland	150
Predominantly indigenous (podocarp)/ hardwood forest	16
Swamp and riparian sedge rush wetland (including water races)	82
Willow forest (with regenerating elements beneath)	46
Total	**501**

Source: Christchurch City Council.

Ecological Heritage Sites, because of their high values based on the following five criteria:

- Biodiversity (number of indigenous species);
- Representativeness (of the original soil - vegetation system);
- Unusualness (the number of rare or uncommon species);
- Naturalness (the percentage cover of indigenous species, with a reduced value where there are problem weeds on the site);
- Area.

Ecological Heritage Sites comprise an area approximately 3,120 hectares in size (excluding the Avon-Heathcote Estuary, which is controlled by the Canterbury Regional Council), and are classified into the groups shown in Table 2.18. A proportion of the sites are in public ownership.

Many of the Ecological Heritage Sites are in conservation zones or public ownership, including the Christchurch City Council, the Canterbury Regional Council and the Department of Conservation. Others are in private ownership and are protected by rules in the Proposed City Plan, with a few sites having special rules.

Although there are many natural areas and Ecological Heritage Sites within the City, their highly fragmented nature and often small size means they are vulnerable to threats including development, cultivation, forestry, fire and weeds. If the small sites can be linked to other sites by “green corridors or linkages”, this would allow the natural spread of plants and animals between the sites.

Table 2.18 Ecological Heritage Sites

Category	Number of Sites	Area of Sites (ha)
Coastal dunes	1	353
Native shrubland	7	184
Grassland / shrubland	32	2,021
Wetlands and riparian areas	9	559
Total	**49**	**3117**

Source: Christchurch City Council.

The location of Ecological Heritage Sites includes the following:

- Rocky outcrops, patches of native forest and silver tussock grassland on the Port Hills eg areas such as Dry Bush in Bowenvale Valley, Mount Vernon Park, Castle Rock reserve and Godley Head reserve.
- Remaining wetlands such as Travis Wetland, Styx Mill reserve, Coutts Island reserve, and Horseshoe Lake. Historically, Christchurch vegetation was dominated by wetland vegetation.
- Riccarton Bush, which is a rare remnant of floodplain forest in the City.
- A nationally significant area of dry grassland on the plains in the north-west part of the City. This area includes a rare type of native grassland with scattered shrubs and kowhai trees.
- The coastline from the Waimakariri River to South Shore Spit supports a diverse range of native plants and animals.
- The rocky coastline around Godley Head.

Protected Trees

Tree cover and vegetation make an important contribution to amenity values in the City. Existing vegetation is often lost and not replaced when sites are redeveloped. The City Plan has identified and listed 19 trees of heritage status and 2,567 notable trees. The notable trees listed include 19 groups comprising an unspecified number of trees.

Protected trees are considered worthy of recognition based on a number of criteria which may include:

- Historic significance to the community
- Scientific or botanical significance
- Cultural or spiritual significance
- Recreational significance
- Landscape significance
- Functional value
- Size or age.

A tree may be protected because of a combination of factors, or because it is outstanding in one respect. Heritage trees have at least one or more factors which give them metropolitan or wider significance and which makes them outstanding or unique. Notable trees are identified as important in neighbourhood landscapes. They may be large, old, have a high visual profile or other character, which individually or in combination, make them worthy of listing.

Street trees

In addition to heritage and notable trees, many other trees and types of vegetation enhance the amenity of the City. Street trees are a source of vegetation within public spaces. Currently there are well over 42,000 street trees on more than 1,400 of the approximately 3,300 roads in Christchurch.

The first large-scale street tree planting took place in the Four Avenues of Christchurch in the late 1860s. Now, an average of 30 additional streets are planted by the Council each year, mostly at the request of residents. Neighborhood improvement schemes and road reconstruction works have also created new opportunities for planting in areas previously without street trees.

Indigenous Urban Vegetation[31]

The urban environment is often overlooked as a source of indigenous vegetation. Historically in New Zealand much of the focus on indigenous vegetation is often directed at those areas of pristine natural vegetation. The only alternative to this has frequently been purely utilitarian, maximising production or beautifying gardens and using monocultures or formal exotic systems. However, in the context of reversing the decline in New Zealand's biodiversity, the urban environment may be a significant resource, especially where there are receptive sites, economic resources and fewer exotic browsing and predatory animals. In some cases urban areas may even provide a more hospitable habitat for sensitive indigenous species than non-urban areas.

Until recently little was known about which indigenous plants have naturalised[32] in the urban environment. The Christchurch City Council, in partnership with Lincoln University and Landcare Research, has been involved in a project to list native species in natural and semi-natural areas of Christchurch City. Part of this project identified which indigenous and exotic plant species were found at various natural and semi-natural areas in the city such as wasteland, lawns, herb borders, shrubbery, parkland and hard surface cracks.

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[31] Based on work carried out by Maria Ignativa, Lincoln University, Colin Meurk, Landcare Research, and Kate McCombs, Christchurch City Council.

[32] Naturalised plants are those plants that live and reproduce in the urban environment without human intervention, so this excludes gardens.

Table 2.19 Species diversity of naturalised urban plant communities in Christchurch

Biotope	Number of sites recorded	Species		
		Exotic	Indigenous	Total
Wasteland	3	69	7	76
Shrubbery	3	45	6	51
Hard surfaces	10	43	6	49
Lawn	7	36	8	44
Herb Border	2	26	0	26
Parkland (woodland)	1	12	1	13

Source: Landcare Research and Christchurch City Council.

Table 2.19 shows the number of individual plant species in the various natural and semi-natural areas of the urban environment. Of the total number of species identified in the Christchurch study, 159 were naturalised exotics and 18 were indigenous. Wasteland areas had the greatest species diversity, while the parkland area had the lowest number of species. It is interesting to note that hard surfaces such as walls, cracks and graves have a level of species diversity comparable to shrubbery and lawn. Nearly 400 indigenous species grow wild in Christchurch City, indicating that an untapped potential exists for greater incorporation into cultural landscapes.

The study also compared the composition of the naturalised Christchurch urban plant communities with similar urban plant communities in Europe. It was found that the Christchurch urban plant communities were poor in indigenous species compared with a similar European study in St Petersburg, Russia.

Many of the naturalised plant species found in Christchurch are actually the same as in other cities of the world. For example, over 90 per cent of the naturalised species of European or other origin found in Christchurch are also found in similar European cities.

Birdlife in the Port Hills[33]

During 1996 Port Hills birdlife was examined to identify changes in species composition from the 1850s to the present day. An overview of habitat requirements was also undertaken and recommendations made to enhance native forest in order to increase birdlife.

Thirteen native bird species and 18 introduced bird species were known to occur in the Port Hills in 1966 compared with 31 species of native birds known to have lived there during the 1850s.

The cause of this decline is attributed to the destruction of forest cover through bush fires, land clearance and timber milling, combined with the impact of predators and introduced bird diseases.

Of the native species, the following eight are generally found in bush habitats: New Zealand pigeon (kereru), shining cuckoo, brown creeper, grey warbler, fantail, tomtit, silver eye and bell bird. Although there are larger numbers of introduced birds in the Port Hills, competition between the introduced and native birds is probably minimal. In general the introduced species occupy empty niches, including those left abandoned after the extinction of earlier native species. Some introduced species (particularly blackbirds) play an important role in native seed dispersal and subsequent forest regeneration.

Forest Size

Forest on the Port Hills is characterised by small, fragmented bush remnants. Much of this native forest is presently highly degraded by browsing animals such as cattle, sheep, goats, pigs, possums and deer. Even reserves such as Kennedy's Bush and QEII Trust-covenanted areas like Prendergast's and Ahuriri Valley have not escaped. Outwardly these areas have the appearance of healthy stands of bush; inwardly some of them could be described as 'skeleton forests' so complete is the destruction of understorey vegetation.

This means opportunities for many native bird species on the Port Hills are limited due to lack of space and an insufficient food resource. All of those species presently established in good numbers (bell bird, grey warbler, fantail and silvereye) are birds that can utilise a variety of habitats and are capable of crossing open country between pockets of bush. In autumn and winter, a proportion of these birds leave and take advantage of food sources in farmland and City gardens during a time of scarcity within the bush remnants. Other native bird species with more restricted habitat requirements (eg tomtit and brown creeper) do not leave the Port Hills, so the size of their populations is governed by the number that can survive there through winter.

[33] Information in this section is based on the report for the Parks Unit, Christchurch City Council, by Andrew Crossland: Port Hills Birdlife: Inventory, Analysis and Restoration Potential, August 1996.

The Built Environment

Key Information	Why is this Useful?	What is Happening?
Residential density.	This provides a measure of how closely people live together. This provides contextual information as both increased and decreased densities have environmental costs and benefits in relation to resource use and amenity values.	↑ Overall, densities within the City increased from 20.3 to 20.9 people per hectare between 1996 and 1999.
Total number of building consents issued for units and dwellings.	New dwellings and units put pressure on the natural and physical resources in the City, for example non-urban land and urban amenity.	↓ Consents increased to a peak of 2,532 in 1995. They have since declined to 1,868 in 1999.
Consents for new units as a proportion of total consents.	This provides an indication of the type of residential development currently being undertaken in the City. Unit development tends to occur as higher density infill, whereas dwellings tend to be built at lower densities on greenfield sites.	↓ Between 1995 and 1999, unit developments decreased from 72 per cent to 56 per cent of all consents.
Inner city residential development.	Inner city living is associated with higher densities, which are more energy and resource efficient due to reduced travel distances and dependency on cars, increasing the feasibility of public transport services.	↑ The number of new units in the inner City increased by 864 between July 1990 and June 1999.

Other Related Sections: Population Growth, Profile of Christchurch Residents, Land Use, Open Space and Natural Ecosystems, Urban Amenity, Heritage, Energy, Transportation, Residential and Commercial Properties, Central City.

The urban environment in Christchurch is influenced by changes in the size, composition and lifestyle of its resident population. These factors not only influence current development patterns, they also influence the nature of future development through the formation of City Plan objectives and policies, as well as individual decision making by residents. These variations in the demographic make-up of the population and changing housing preferences will influence the type of housing construction and the location of new developments within the City.

Residential Dwellings

Dwelling Type

The March 1996 Census of Population and Dwellings recorded 116,619 occupied dwellings in Christchurch. This was an increase of 8,922 or 8.3 per cent between 1991 and 1996, compared with an increase of 5.9 per cent for the five years prior. It is estimated that by 2016 the number of dwellings in the City will have increased to around 140,000.

In 1996, 75 per cent of total dwellings (including private and non-private) were separate houses, while 24 per cent of dwellings comprised two or more flats or houses joined together (Table 2.20). Christchurch had a greater proportion of units compared with the total for New Zealand. Cities have greater constraints on living space than rural areas and smaller towns, increasing the desirability of apartment and unit development.

Dwelling Density

Figure 2.25 shows the distribution of occupied dwellings within Christchurch. Generally, areas close to the Central City or around some suburban commercial centres such as New Brighton and Riccarton have high dwelling densities. Whereas the rest of the City tends to have moderate to lower densities.

Overall, dwelling densities in the City increased in the five years between 1991 and 1996 by approximately 8 per cent. Inner City net densities[34] averaged 15 dwellings per hectare in 1999. Some meshblocks with apartment blocks or unit developments had densities of up to 45 dwellings per hectare. In contrast, the net densities of suburban parts of the City were lower and averaged 10 dwellings per hectare.

Population Density

Dwelling density is a key component of population density in the City. Urban population densities in Christchurch increased over the last decade. During the last four years, population density for the urban area[35] of the City increased from 20.3 to 20.9 persons per hectare. Population density distributions within Christchurch mirror the dwelling density pattern shown in Figure 2.25, with high population densities around the Central City of 35 persons per hectare (corresponding to the high dwelling densities), and suburban population densities of 26 persons per hectare.

Policies in the Christchurch City Plan are designed to reinforce this distribution by trying to restrict high density living to those suburbs close to or within the Central City and the suburban focal points (such as

[34] Net densities are calculated from the area of the residential zoned land only, these areas include the area of the road in the residential zoned areas, but not open space, parks and business zones in residential areas.

[35] Urban population density is calculated from the estimated population within the urban area of the City and the total urban area of the City, including industrial, commercial, parks and open spaces within the urban area as well as residential land.

Table 2.20 Type of Dwelling (Private and Non Private)

	Christchurch City	%	New Zealand	%
Separate House	87,549	75.1	1,050,114	81.8
Two Flats or Houses Joined Together	15,414	13.2	115,812	9.0
Three or More Flats or Houses Joined Together	12,528	10.7	93,351	7.3
Flat or House Joined to a Business or Shop	438	0.4	7,122	0.5
Bach, Crib or other Holiday Home	18	0.0	2,565	0.2
Caravan, Cabin or Tent in a Motor Camp	159	0.1	3,414	0.3
Mobile or Temporary Dwelling (not in Motor Camp)	60	0.1	3,927	0.3
Hotel, Motel, Guest or Boarding House	204	0.2	3,519	0.3
Home for the Elderly	99	0.1	801	0.1
Other (non-private)	150	0.1	3,342	0.3
Total	**116,619**	**100**	**1,283,967**	**100**

Source: Statistics New Zealand, Census of Populations and Dwellings, 1996.

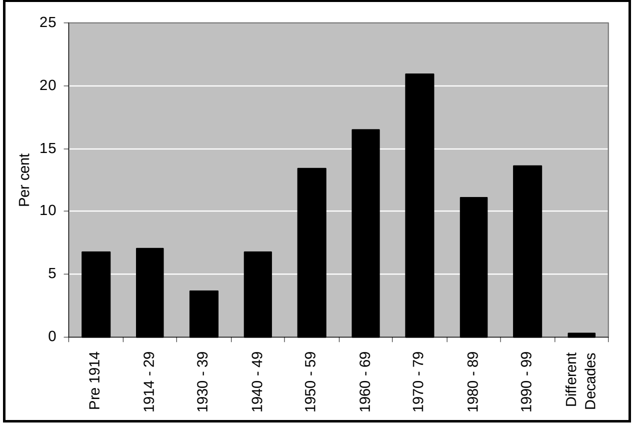
shopping centres), while maintaining moderate densities in suburban residential areas. This will increase the overall density of the City, creating environmental benefits and retaining an urban environment in which residents enjoy living.

Age of Housing

Although Christchurch was settled in 1850, much of the current housing stock in Christchurch was built after 1914, with only 7.5 per cent erected before this time. The age structure of Christchurch's current residential properties is shown in Figure 2.22. Three quarters of the residential properties have been built since 1950, with almost 45 per cent of properties built since 1970. The 1990s contributed 14 per cent of the housing stock in the City, with around 16,300 residential properties.

The 1970s were characterised by the construction of a large proportion of units. The 13,500 units built during that decade comprise over 50 per cent of units in the present housing stock.

Fig 2.22 Age of Residential Properties in Christchurch, 1998



Source: Quotable Value New Zealand.

Residential Development

Building consent records provide insight into how the City's residential environment is developing. The most significant housing trend to emerge last decade was the rapid growth in the construction of units or apartments within the City[36]. Overall, growth in the number of units in recent years reflects the general trend towards smaller households, an ageing population and changing lifestyles.

Between July 1991 and June 1999 building consents issued for units accounted for two thirds of all residential construction within the City. During this time 11,198 building consents were issued for units compared with 5,326 for separate dwellings.

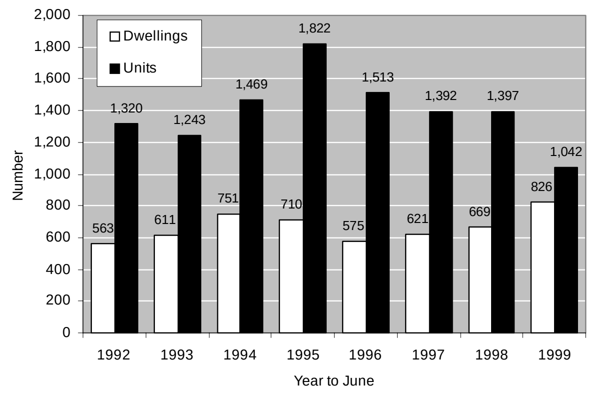
The trend in building consents issued for the 1991 to 1999 period shows a peak in the 1995 year, with around 2,500 consents. Since then, the trend has returned to around 2,000 building consents issued for residential properties each year (Figure 2.23). The increase during 1995 appears to be partially attributable to public uncertainty prior to notification of the proposed City Plan[37] for Christchurch. This may have resulted in some developers and homebuilders obtaining building consents in advance of any possible City Plan rule changes.

Since 1995 there has been an increase in the number of building consents issued for dwellings, while the number of consents for units has decreased. By 1999 the number of consents for dwellings was around 44 per cent of the total. This may reflect a trend away from infill housing, which could have resulted from a decrease in easily subdividable properties and/or changing attitudes to infill development. It is anticipated that the number of building consents for

[36] Unit development falls into three major categories: 2 or more units built on new site, two or more units built on a site where a house may have been demolished or removed (ie. redevelopment) and units added to a section with an existing house (ie. infill).

[37] The Proposed City of Christchurch City Plan was notified on June 24 1995, it was then amended by Council decisions and publicly notified on the May 8 1999.

Fig 2.23 Building Consents Issued for Units and Dwellings



Source: Christchurch City Council.

dwellings will continue to increase as a result of the increasing availability of land due to amendments to the City Plan.

For the period between July 1991 and June 1999, development was evenly distributed between new and redeveloped sites. At the beginning of last decade 60 per cent of building consents issued were for development on new sites. This proportion decreased to around 40 per cent between 1994 to 1997 (when infill development dominated) and then increased to 57 per cent in 1999.

Location of Residential Building Activity

The location of new development within the City is dependent on whether it is for units or dwellings. As Figure 2.26 shows, the majority of new dwellings in the City have been located around the perimeter, where there are still greenfield[38] sites available (Figure 2.28). The main areas where building consents have been issued for dwellings are the north-eastern areas of Parklands, Travis, Marshlands and Burwood, Avonhead in the west, Halswell in the south, and the Port Hills.

In contrast, unit development has occurred over much of the City, with one third of the area units in the City having more than 100 building consents issued for new units in the period between July 1991 and June 1999 (Figure 2.27). Two area units, Avon Loop and Riccarton, had over 400 building consents issued for units. Much of the unit development has taken place in the residential area immediately surrounding the Central City and in the north-western suburbs. Development has also occurred in the outer suburbs of Sumner, North Beach and Belfast.

Vacant Residential Land

Vacant Residental land are those areas of the City zoned for residential development that are not currently built on. These areas are where future development is likely to occur. The location of vacant residential land at June 1999 is shown in Figure 2.28.

About 1,500 hectares of vacant residential land were available in the City. Of this, the greatest amount was in undeveloped sites. Table 2.21 shows the breakdown of vacant residential land for the City. The greatest proportion was in the north-east and west of the City. Although the Port Hills still has a reasonable amount of vacant residential land, lower densities and other building constraints mean fewer houses can be built on the hills than a comparable area of land on the flat.

In May 1999 the City Plan decisions rezoned an additional 1,130 hectares of non-urban land to residential, effectively joining Belfast and Halswell to the rest of the City. However, 465 hectares of the rezoned land is currently either under appeal or has had the Council decision deferred.

The rate at which vacant residential land was used last decade averaged 85 hectares per year. Assuming current rates of uptake of vacant residential land, enough land should be available for approximately 20

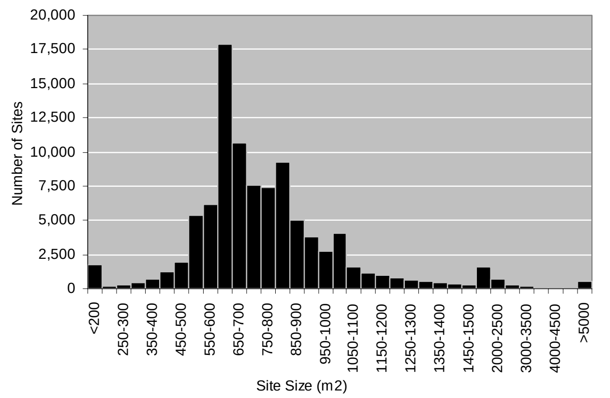
Table 2.21 Vacant Residential Land, June 1999

	Vacant Lots		Potential for Development	Undeveloped Land	Total	Under Appeal and deferred
	Number	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)
North-East	773	63.8	13.3	334.38	411.5	81.2
South-East	346	26.6	8.4	66.51	101.5	0.0
Hills	757	83.3	38.8	316.67	438.7	194.1
South-West	202	14.6	5.9	285.53	306.0	91.0
North-West	433	38.2	12.4	168.58	219.2	98.5
Inner City	173	11.2	0.0	6.45	17.7	0.3
Total	**2,684**	**237.7**	**78.8**	**1,178.13**	**1,494.7**	**465.1**

Source: Christchurch City Council.

[38] Greenfield sites are areas that were previously non-urban, typically rural areas which have been rezoned to urban uses.

Fig. 2.24 Distribution of Site Sizes, 1998



Source: Christchurch City Council.

years of future residential development.

Residential Site Size

Figure 2.24 shows the distribution of residential property sizes in Christchurch. The greatest number of sites are between 600 and 650 square metres. The median site size is 713 square metres.

Using the critical standard for site size (420 square metres) in the Living One (outer suburban) zoned area in the Proposed Christchurch City Plan, only 24 per cent or 16,700 sites within the Living One zone can potentially be subdivided, assuming all other constraints are overcome. Another 6,900 sites in areas zoned Living Two can be subdivided using a critical standard of 330 square metres. This is a very crude estimate of the potential infill in residential zones. It does not allow for sites already with more than one house due to cross lease subdivisions, or any other constraint, especially economic, which are possibly a greater restriction.

Central City Living

Townhouses and apartments are increasingly becoming a standard feature of the inner City environment. This development is similar to trends experienced internationally and in other large New Zealand cities. Since 1991, 864 units have been built in the residential zones within the 'four belts' of central Christchurch[39] (Table 2.22). An additional 201 units have been constructed in the Central City business zone. This growth was particularly pronounced between July 1996 and June 1999, and accounts for over half the units built in the inner City.

Although the majority of this development occurred in the second part of the decade, the population within the four avenues had already grown by 924 people between 1991 and 1996, with a total of 6,954 people within the Central City. This was a 16 per cent increase compared with 7 per cent for Christchurch City.

New Rural Dwellings

The number of houses built in rural zones is very low compared with other parts of the City. Between 1991 and 1999 a total of 231 consents were issued for residential housing in rural zones. This was less than 2 per cent of total building activity for the City during this period. Since 1991 the number of residential building consents issued for rural zones has ranged from 18 to 37 per year, with an average of 29 dwellings per year (Table 2.23).

Although the non-urban part of the City has over 60 per cent of the land area it had only around 8,850 people, or 3 per cent of the City's population, in 1996. The population in the rural area grew at a slower rate between 1991 and 1996 than the rest of the City, with only 248 additional people or a 3 per cent increase. This is consistent with City Plan objectives which are designed to accommodate population growth within the urban area of the City, with the rural area remaining primarily for rural use.

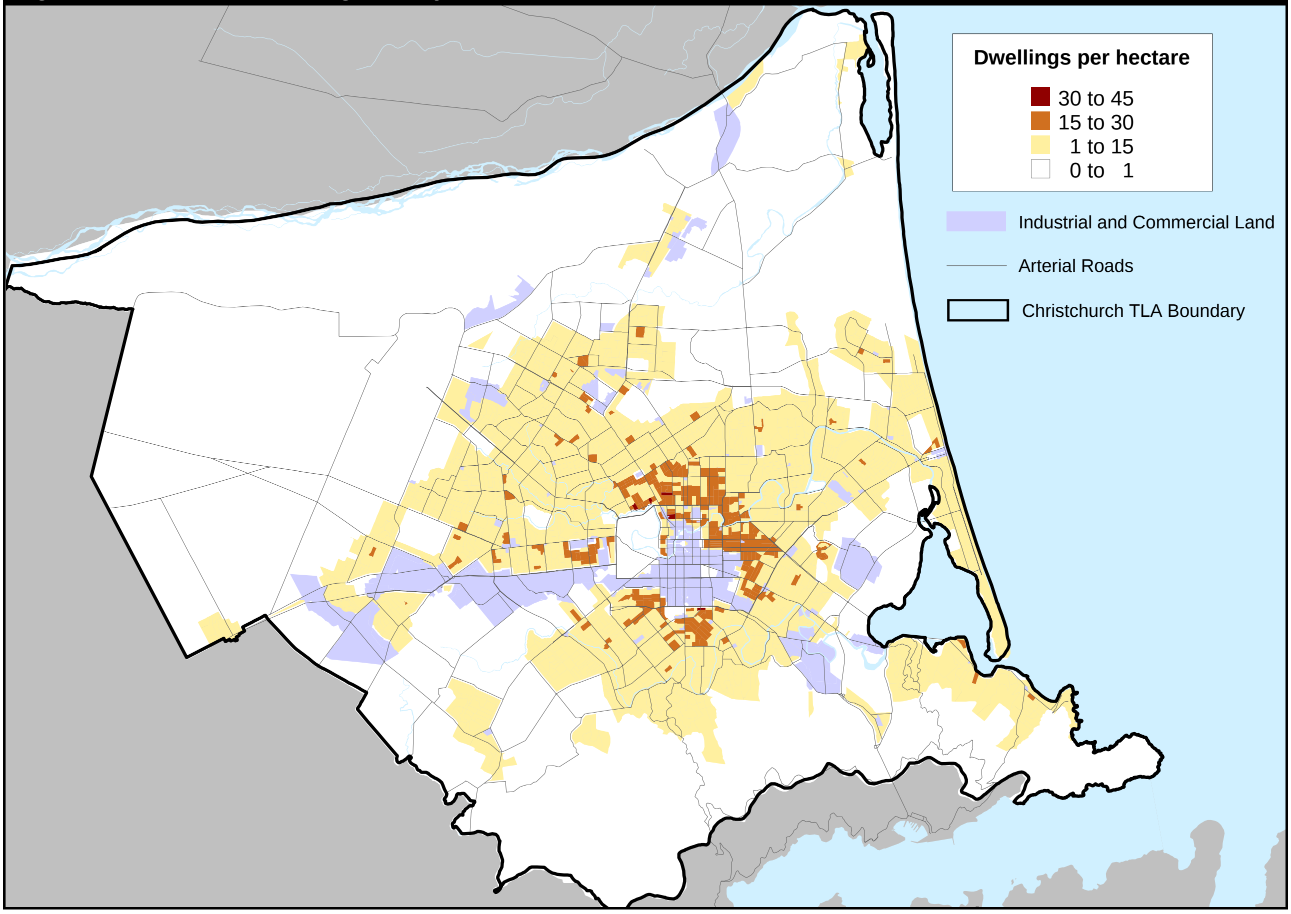
Table 2.22 Growth in New Residential Units within the Inner City

Year to June	Residential Zones within Four Belts			Central City Commercial Business Zones		
	Developments	Units	Units added since 1990	Developments	Units	Units added since 1990
1991	12	75	75	-	-	0
1992	18	69	144	1	8	8
1993	8	39	183	5	41	49
1994	15	77	260	3	38	87
1995	11	54	314	1	3	90
1996	14	95	409	1	5	95
1997	21	130	539	3	29	124
1998	13	180	719	2	76	200
1999	8	145	864	1	1	201

Source: Christchurch City Council.

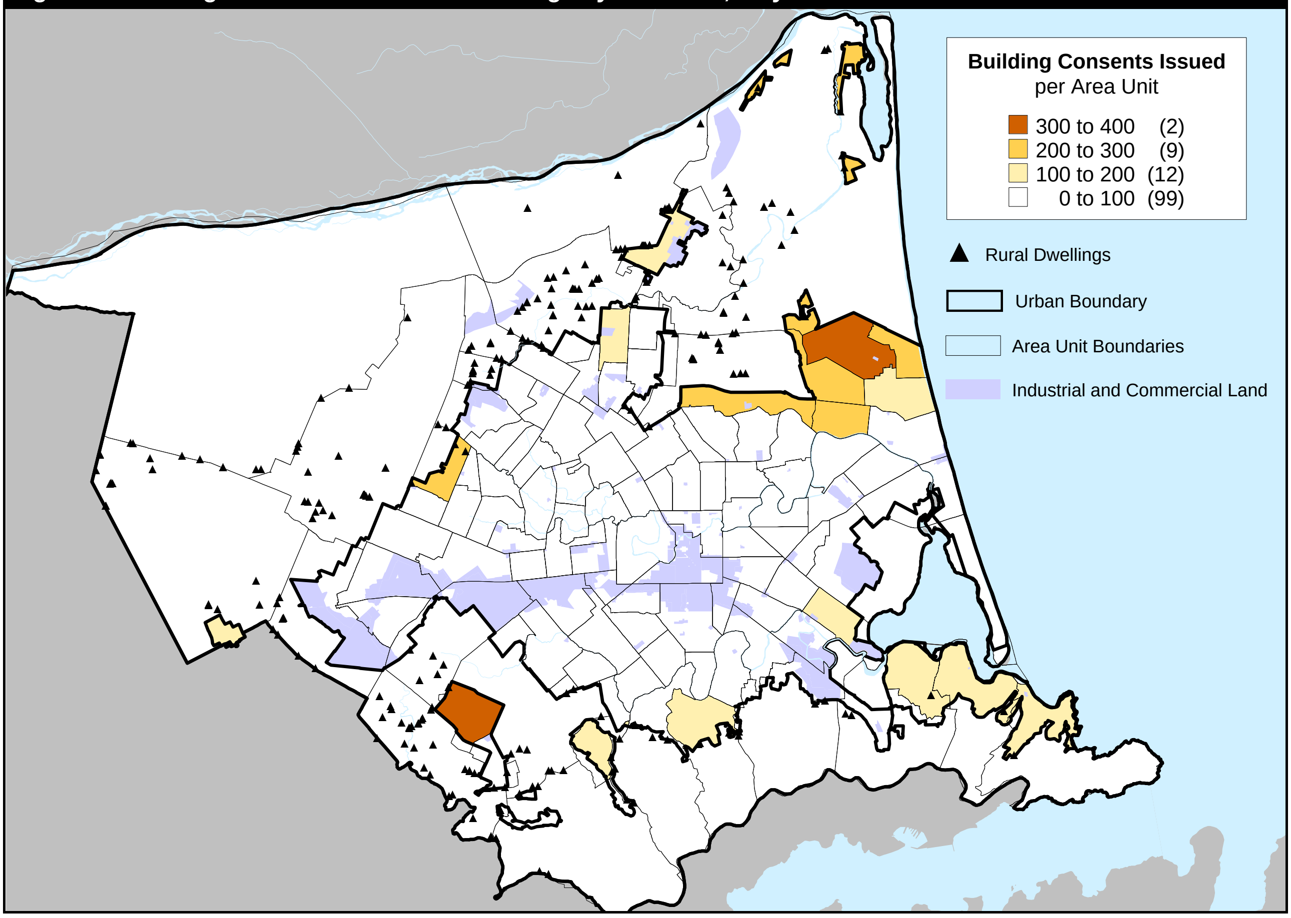
[39] The four belts refers to the area bounded by Bealy Ave, Fitzgerald Ave, Lichfield St – Cambridge Tce, and Rolleston Ave – Park Terrace.

Fig. 2.25 Meshblock Dwelling Density for Christchurch, 1996



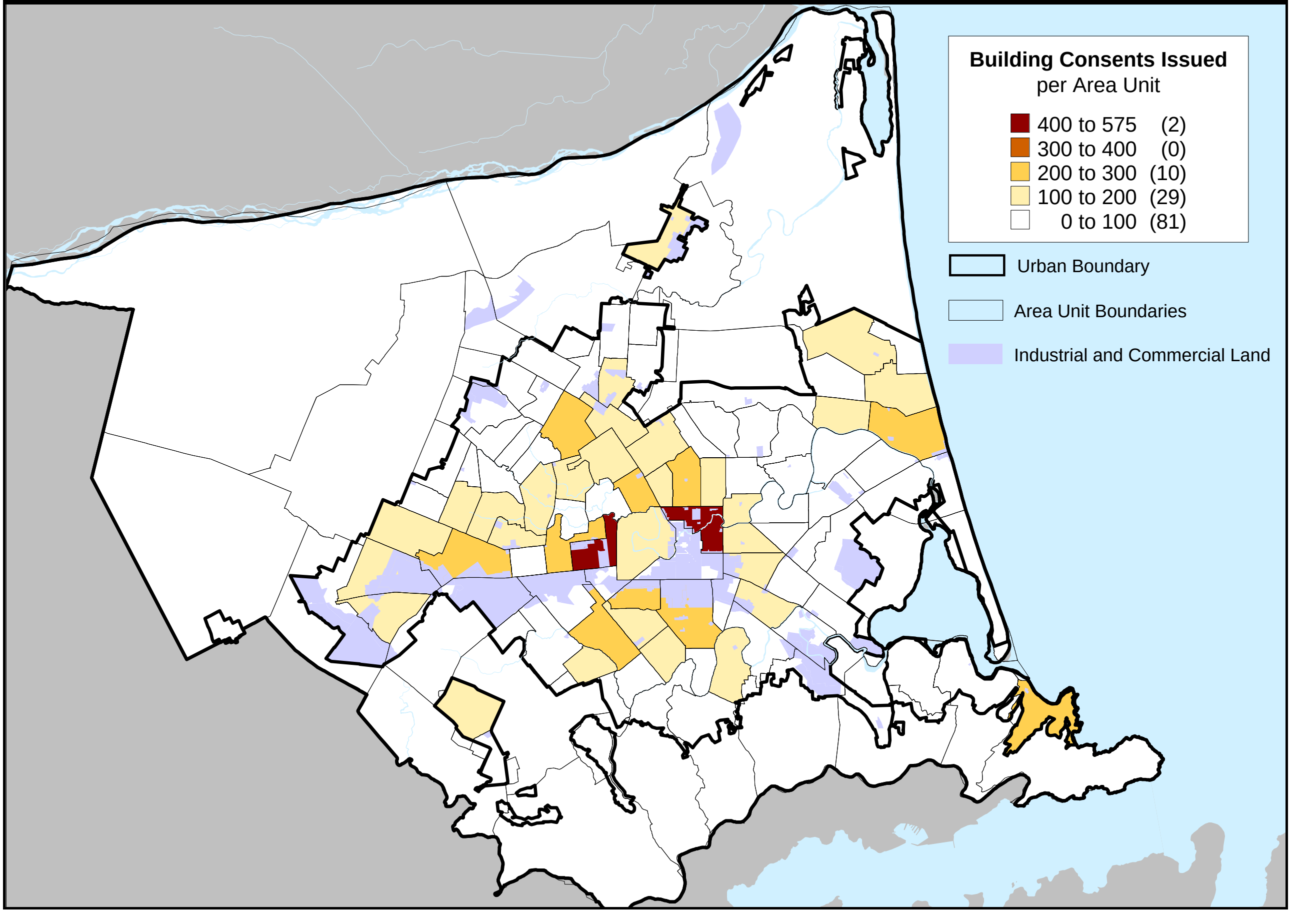
Source: Statistics New Zealand, Census of Population and Dwellings 1996.

Fig. 2.26 Building Consents Issued for Dwellings by Area Unit, July 1991 to June 1999



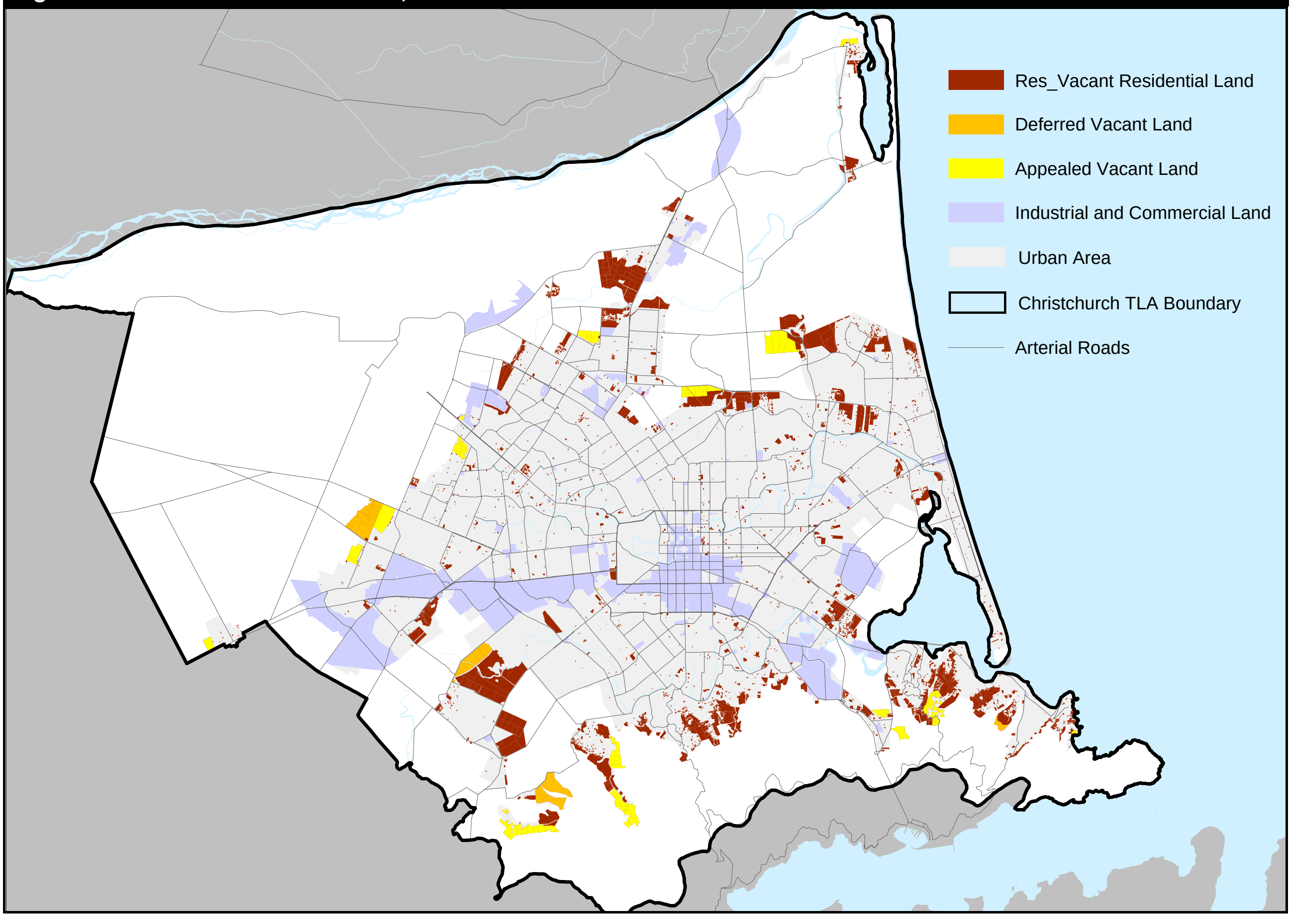
Source: Christchurch City Council.

Fig. 2.27 Building Consents Issued for Units by Area Unit, July 1991 to June 1999



Source: Christchurch City Council.

Fig. 2.28 Vacant Residential Land, June 1999



Source: Christchurch City Council.

Table 2.23 Number of Building Consents Issued for Dwellings and Units in Rural Zones

Year to June	Total New Housing in Rural Zones
1992	36
1993	37
1994	31
1995	31
1996	21
1997	18
1998	22
1999	35
Total	**231**

Source: Christchurch City Council.

Industrial Activity

Most industrial activity in the City is confined to areas zoned for industrial purposes. Christchurch has around 2,050 hectares of industrial land, with some additional land used for industrial activity in the airport special purpose zone. Businesses adjacent to the airport tend to undertake activities which benefit from their proximity to the airport.

The distribution of industrial zones and activity in the City corresponds to major transportation networks. Most industrial land in the City tends to be in a corridor along the railway line and Blenheim Road/Main South Road, which run parallel from the centre of the City to Hornby in the south, thus enabling local distribution as well as efficient access to the rest of the South Island. Other industrial areas are adjacent to State Highway I or close to the tunnel through to the Port of Lyttelton.

About 510 hectares of vacant industrial land was available in Christchurch in June 1999. This was equivalent to 25 per cent of the total area zoned industrial. Seventy five per cent of this land was in Hornby, Islington, Wigram and Bromley. Annual uptake of vacant industrial land averaged 22 hectares for the last decade. Based on this rate of take up, there appears to be enough vacant industrial land available to meet current demand for the next 20 years. However, some of these areas of vacant industrial land are constrained for particular uses by factors such as being over aquifers, and/or infrastructure, especially water supply and waste disposal.

Infrastructure

Growth in population and dwellings puts pressure on the infrastructure of the City. This section describes the City's infrastructure and recent changes that meet the needs of new urban development, or which increase the efficiency of services provided to the community.

Solid Waste

Currently there are three refuse stations in the City - Metro Place in Bromley, Parkhouse Road in Sockburn, and Styx Mill Road in Redwood. The transfer stations also collect recyclable and compostable material. Domestic and commercial refuse from these stations is dumped at the City's only landfill site at Burwood. The resource consent for the Burwood Landfill is due to expire in 2002 and it is anticipated that solid waste will then go to a new regional landfill.

The Garden City Compost Plant was opened at Bromley in 1994 for large-scale composting of garden waste. Clean, separated garden waste dropped off at all three transfer stations is composted at the compost plant into 'Envy' garden products. These are then available for sale at Metro Place Transfer Station and garden centres throughout the city.

Sewage

Ninety nine per cent of Christchurch sewage is treated at the plant in Bromley. Small plants at Belfast and Templeton provide local sewage treatment for these areas.

The City has 1,408 kilometres of sewers and 1,165 kilometres of lateral pipes which connect 125,158 customers to the sewage treatment plant. Approximately 70 pumping stations pump the sewage from low areas, particularly near the Avon and Heathcote Rivers. Five terminal pumping stations then pump all the flow to the Bromley treatment plant. The sewage undergoes full primary and secondary processes then passes through oxidation ponds before being discharged into the Avon-Heathcote Estuary.

Water

Christchurch's water supply is an integrated City-wide scheme sourcing high quality groundwater from confined aquifers and pumping this water into 1,300 kilometres of water mains and 2,000 kilometres of sub-mains throughout the City. The water is supplied to consumers from 150 wells at 53 sites, eight main storage reservoirs, 37 service reservoirs and 26 pump stations. Christchurch's drinking water complies with New Zealand drinking water standards without needing to be treated.

Roading

The Christchurch roading network comprises 1,533.5 kilometres of roads, 25.9 kilometres of which are unsealed. Roads within the City are classified in Table 2.24. In the year to June 1999, 12.2 kilometres of road were added to the road network. The transport network also includes 2,191 kilometres of footpaths and 2,298 kilometres of kerb and channelling, with 2.6 kilometres and 14 kilometres added to each respectively during the year to June 1999. There are also 139 bridges within the City, of which 21 are for pedestrian use only.

Table 2.24 Road Type by Kilometre

	Km	Per cent
Major arterials	87.1	5.7
Minor arterials	234.1	15.5
Collectors	222.5	14.7
Local	968.3	63.9
Other	3.5	0.2
Total	**1,515.5**	**100.0**

(Excludes state highways & boundary roads not maintained by the Christchurch City Council.)
Source: Christchurch City Council.

Power

Christchurch City receives electricity from the national grid at four exit points; Bromley, Papanui, Addington and Islington. Electricity is then distributed throughout the City through 1,794 kilometres of high and low voltage overhead line and 3,162 kilometres of high and low voltage underground cable. During the year to March 1999 there was a decrease of 10 kilometres of overhead line and a increase of 57 kilometres of underground cable within the Orion distribution network.

Urban Amenity

Key Information	Why is this Useful?	What is Happening?
Residents' perceptions of local development.	Development in local neighbourhoods can impact on residents non-work and leisure-time quality of life.	↓ The proportion of residents who perceive their local area to be worse as a result of new development has declined by 25 per cent between 1996 and 1999.
Problems with noise.	Changing urban densities and lifestyles can affect the level of noise in the local environment. Noise can have an impact on people's health and quality of life.	● Around twenty per cent of residents found neighbourhood and traffic noise a problem in 1999.
Noise complaints.	Complaints not only provide a measure of increased noise problems, but also of residents' tolerance to local noise.	↑ Residential noise complaints have increased by 170 per cent since 1991.
Residents' perceptions of City-wide development.	Changes to the City as a result of new development can impact on the feeling residents have about the City as a whole.	~ The proportion of residents who believe new development had made the City worse has averaged 10 per cent since 1992.
Popularity of the Central City.	Christchurch needs a diverse, vibrant and attractive City Centre that will provide a social and commercial focus for the City. This provides a measure of how attractive the Central City is to Christchurch residents.	↑ Between 1991 and 1999 the number of residents who made one or more non- work trips each week to the Central City increased by 72 per cent.
Residents' concern about litter.	Litter has an impact on visual amenity in an area. Large quantities of litter can also be a health risk depending on the content.	● Eighteen per cent of residents were concerned or very concerned about neighbourhood litter in 1999.

Other Related Sections: Population Growth, Profile of Christchurch Residents, Personal Safety, Land Use, Air Quality, Built Environment, Surface Water, Heritage, Transportation, Waste Management, Businesses, Employment and Unemployment, Central City.

Amenity values are defined in the Resource Management Act as *those natural and physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes.* Many of the physical aspects of the City are described in other sections of this report. Amenity values, however, relate to the quality and grouping of these elements. Individuals and the community assign values to these elements. Changes to the environment and community values may influence amenity.

The Christchurch City Council has used questions in its Annual Survey of Residents to find out residents' perceptions of various aspects of amenity in the City and associated pressures. Other information in this section also comes from surveys conducted to measure specific amenity issues relating to the urban environment, for example noise and litter.

New development is responsible for much of the pressure on amenity in Christchurch. New buildings replace older ones or they are built on previously undeveloped sites. Some development contrasts with the existing character of an area. This is especially the case where infill development results in increased residential densities and reduced outdoor living space around dwellings.

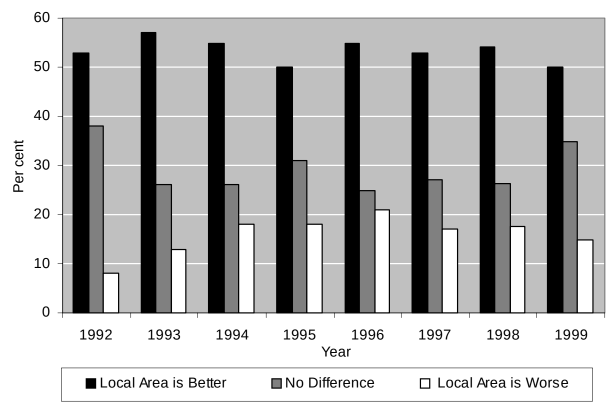
Generally, Christchurch rates highly as a place to live and work. The 1999 Annual Survey of Residents found 93 per cent of Christchurch residents were satisfied or very satisfied with the City as a place to live, work and spend their spare time. This percentage has remained the same since the question was first asked in the 1995 Annual Survey of Residents.

Local Neighbourhood Amenity

Residents invest a large portion of time and money in their local neighbourhoods. They choose to live in a particular part of the City due to a set of personal and environmental criteria. Many of these relate to the amenity value of an area. New development at this local scale can have a significant impact on residents' quality of life.

According to the 1999 Annual Survey of Residents, 54 per cent of respondents were aware of new residential building alterations, extensions or developments in their local area during the past 12 months. Of this group 50 per cent felt these changes had made their area *better* or *much better*. This level of satisfaction has fluctuated between 50 and 57 per cent since 1992 (Figure 2.29). The trend in residents who considered development had made their area *worse* or *much worse* increased from 1992 to peak at 20 per cent in 1996. After 1996 the proportion of residents who

Fig 2.29 Residents Views on Development in their Area



Source: Christchurch City Council.

disapproved of developments slowly decreased to 15 per cent in 1999.

Twenty two per cent of residents who were aware of local development felt there were examples of activity in their area which should not have been allowed. Most of these related to infill development, particularly the physical effects of increasing density such as small section sizes, building heights and the loss of gardens and trees. There were also a number of criticisms regarding design issues and the changing character of some streets and neighbourhoods.

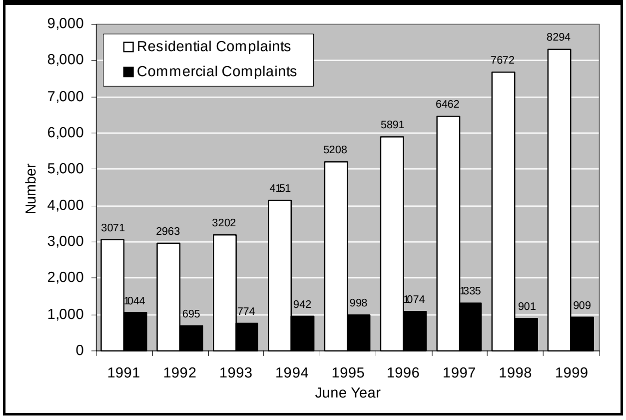
In September and October 1999 the City Council carried out a survey of residents living in townhouses built since the notification of the City Plan in 1995[40]. Preliminary results show that 95 per cent of residents living in recently-built townhouses were satisfied with this form of dwelling, and 83 per cent of respondents were satisfied with the outdoor area. The most popular reasons for choosing to live in townhouses relate to the ease of living in a modern house on a low maintenance section. However, the survey also found a number of common concerns such as small sections, a lack of privacy, shared driveways and noise.

Noise

Increasing population, higher density living in many residential areas, changing lifestyles and new technology all influence the level of noise within the City. Controlling noise is an important aspect of environmental management in the urban area because of the major impact noise can have on public health and well-being. High levels of noise over prolonged periods can damage hearing, while low levels of environmental noise affect well-being by interfering with activities such as sleep and communication. Noise control is the responsibility of the City Council. As part of its function the Council receives and investigates noise pollution complaints.

As Figure 2.30 shows, residential complaints make up the largest number of noise complaints. In 1999

Fig 2.30 Noise Complaints



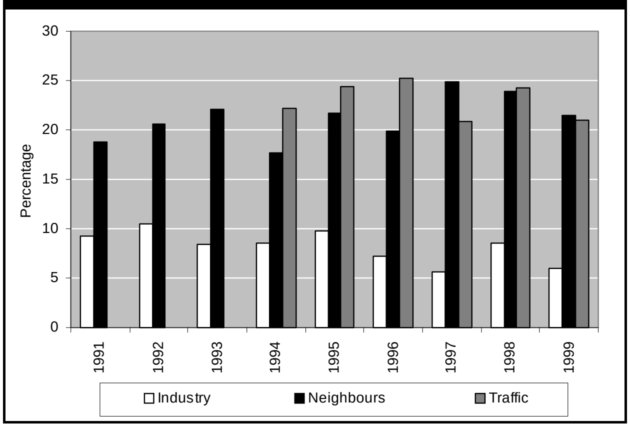
Source: Christchurch City Council.

residential complaints accounted for 90 per cent of all complaints, compared with 75 per cent in 1991. Throughout the 1990s commercial complaints averaged 960 per year. Although there was an increasing trend between 1992 and 1997, these complaints reduced to around 900 in 1998 and 1999. After 1993 residential complaints increased at a constant rate of around 850 new complaints each year. Between 1991 and 1999, the number of residential complaints increased by 170 per cent.

Music and music-related activities continue to be the major source of annoyance in both residential and commercial premises. In 1999 this source accounted for 72 per cent (5,957) of residential noise complaints and 50 per cent of industrial/commercial noise complaints (492). Music-related activities dominated complaints but seizures of musical equipment occurred in less than 1 per cent of cases in the 1999 year. A total of 65 seizures were carried out where amicable compliance could not be achieved.

Although the number of recorded noise complaints has increased, most residents do not find noise from neighbours, industry/commerce or traffic a problem, according to the Annual Survey of Residents. Figure 2.31 shows that the proportion of residents who experienced problems with various types of noise remained relatively low between 1994 and 1999. Just

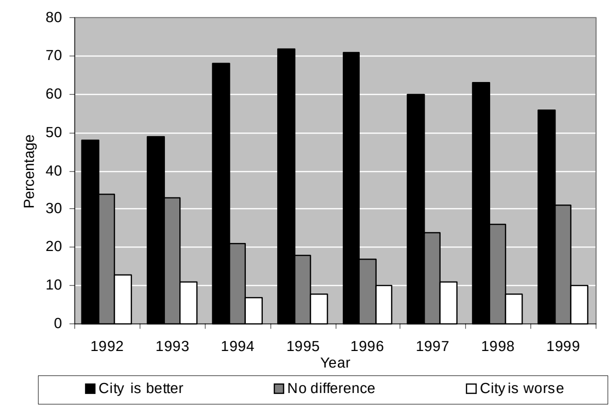
Fig 2.31 Percentages of Residents Who Have Had Problems with Noise



Source: Christchurch City Council.

[40] Christchurch City Council, Townhouse Survey 1999. http://www.ccc.govt.nz/reports/2000/townhousesurvey

Fig. 2.32 Residents Views on the Effects New Developments have on Christchurch City



Source: Christchurch City Council.

over 20 per cent of residents had a problem with either neighbourhood or traffic noise.

The percentage of residents experiencing problems with industrial and commercial noise has been slowly decreasing since 1991. However, the trends for traffic and neighbourhood noise showed an apparent increase to 1996 and 1997 respectively, before starting to decrease again.

City-Wide Amenity

The Annual Survey of Residents asked citizens about the impact new development had on the wider City. Most respondents (56 per cent) thought that new developments during the 12 months to April 1999 had made Christchurch a *better* or *much better* place to live. Only 10 per cent believed new developments had made living in the City *worse* or *much worse*.

Figure 2.32 shows that the level of approval has been declining since a peak in 1995. However, this has been offset by an increase in those who believe that new development has made no difference to the City. The proportion of residents who disapproved of City-wide development remained around 10 per cent between 1992 and 1999. Of the 10 per cent of residents who believed in 1999 that the City looked worse as a result of new developments, many were concerned with the demolition of historic buildings, and the impact this had had on the character of the City. Cathedral Square was a concern for many residents. However, at the time of the survey the Square was still being redeveloped.

Location of Shops

Respondents were asked in the Annual Survey of Residents whether there had been any improvement in the location of shops during the year to April 1999. Most believed the location of shops were *more or much more convenient* (40 per cent) or that it was *unchanged* (54 per cent). Only 6 per cent indicated that shops had become less convenient.

Respondents who believed that shops were more convenient cited the improvement or upgrading of shopping malls, the handy location of shops, the number of shops and malls and access to parking as the main reasons.

Litter

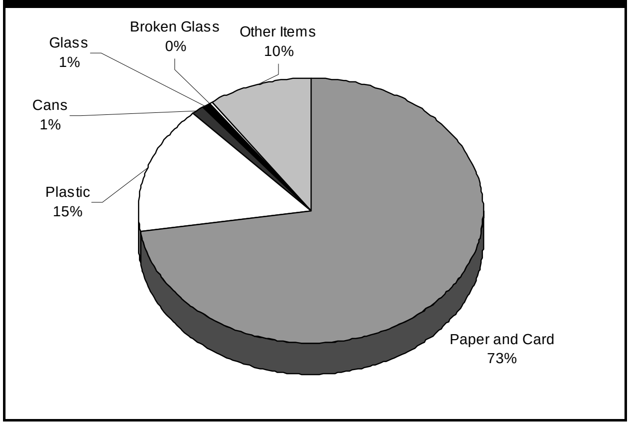
The Keep Christchurch Beautiful campaign counts litter at 111 sites throughout the City. This has normally been carried out twice yearly, in the summer and the winter. Between December 1990 (when counting began) and July 1997, the total amount of litter recorded decreased by 66 per cent. Unfortunately recent staff changes since July 1997, has resulted in information that cannot be compared with these earlier surveys. Figure 2.33 shows the breakdown of litter by type from the January 2000 survey. Seventy three per cent of the litter counted was paper and cardboard, with plastic contributing 15 per cent of the total. Glass and cans each contributed only 1 per cent of the total.

The Annual Survey of Residents asks whether litter in neighbourhood streets has been a concern to residents during the previous 12 months. The 1999 results show 55 per cent of respondents were *not at all concerned* or stated *there is no problem*; 27 per cent were *a little concerned*; while 18 per cent were *concerned* or *very concerned* about neighbourhood litter. These proportions have not changed significantly since this question was first asked in 1994.

Amenity of Rivers and Streams

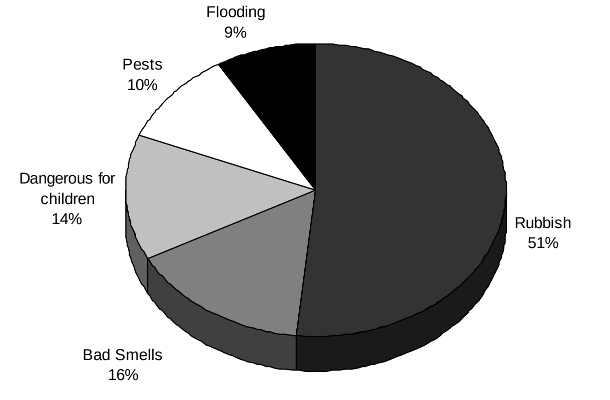
In 1999 the Annual Survey of Residents asked whether residents had noticed any problems of flooding, rubbish, bad smells, pests, or dangers to children near streams, rivers or open waterways during the previous 12 months. Of the respondents who had been near the City's waterways, 45 per cent had not noticed any problems. Figure 2.34 shows the proportion of problems observed in waterways in the 12 months to April 1999. Of these, rubbish accounted for 51 per cent of the total sightings. Overall, observations of each problem have not changed significantly over recent years, but rubbish in or near waterways has remained comparatively high[41].

Fig 2.33 Proportion of Litter by Type, 2000



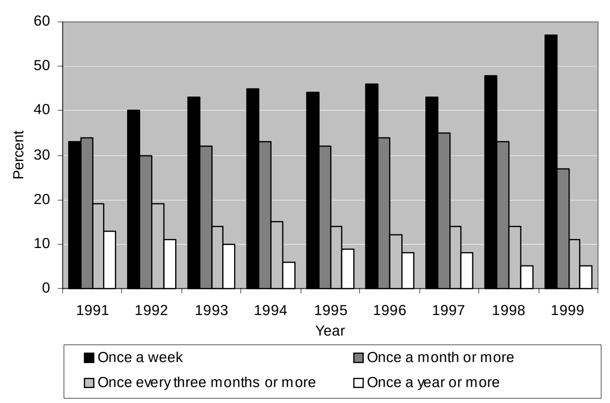
Source: Keep Christchurch Beautiful.

Fig 2.34 Observed Problems Near Streams, Rivers and Open Waterways, 1999



Source: Christchurch City Council.

Fig 2.35 Frequency of Non-Work Visits to the Central City



Source: Christchurch City Council

Overhead Power Lines

Throughout the City, visual amenity is continually being improved through converting infrastructure such as overhead power lines to underground cables. Currently in the City 64 per cent of power cables are buried underground. This has been increasing at a rate of 0.5 per cent or 25 kilometres per year during the last four years.

Central City Amenity

According to the 1999 Annual Survey of Residents, the Central City remains a popular place for residents to visit. Nearly all residents (96 per cent) had visited the Central City some time during the year. Ninety seven per cent of those working in the Central City had visited for non-work purposes. Ninety three per cent of residents who did not work in the Central City had also visited the City Centre.

The frequency of non-work visits to the City Centre was also high with 57 per cent visiting *once a week or more* and a further 27 per cent visiting *once a month or more*. Between 1991 and 1999 there was a 72 per cent increase in the number of respondents who come to the Central City once or more a week for non-work reasons (Figure 2.35).

Two thirds of respondents (65 per cent) were *satisfied* or *very satisfied* with the range of things to do in the Central City during the previous 12 months. Only 11 per cent expressed any level of dissatisfaction with the range of opportunities available. In 1998 residents were asked the main reasons for visiting the Central City. Responses were shopping (40 per cent), then socialising or meeting friends (21 per cent).

Central City Parking

Respondents who travelled to the Central City for work purposes by car were asked about ease of parking in the Central City. Responses to this question were evenly split with 40 per cent of respondents finding parking *easy or very easy* on work trips and the same proportion finding it *hard or very hard*. This may highlight the difference between workers who are either supplied with or are willing to pay for car parking, and those looking for free car parking. It may also indicate a lack of car parking in some areas of the City.

[41] More information on water quality of the City's waterways is in the Surface Water section.

Heritage

Key Information	Why is this Useful?	What is Happening?
Total number of heritage buildings, places and objects in the City.	This measures the number of buildings, places and objects in the City which are considered to have heritage value worth protecting through the City Plan process.	↑ As a result of City Plan decisions the number of heritage items listed increased to 594 in May 1999.
Number of heritage buildings, places or objects at risk of loss of heritage value or demolition.	Heritage buildings are at risk from development which may impact on them in a number of ways, from alterations and additions to total demolition.	● Currently 32 heritage items are classified as being at risk of losing heritage value or demolition.

Other Related Sections: Population Growth, Open Space and Natural Ecosystems**,** Built Environment, Urban Amenity, Part 3: The City's Economy,

The Christchurch City Plan lists 594 buildings, places or objects as having heritage value worth protecting. In some cases individual items may be listed separately as one site, while other items may include the surroundings of the building, or a site without a building. Listed heritage items have been classified into the following four heritage groupings:

- Group 1: Includes 69 heritage buildings, places and objects of international or national significance. Their protection is considered essential.
- Group 2: Includes 124 heritage items of national or regional importance. The protection of these is seen as very important where this can reasonably be achieved.
- Group 3: Includes 195 heritage items that are of regional or metropolitan significance. The protection of these is seen as important where this can reasonably be achieved.
- Group 4: Includes 206 heritage items which are of metropolitan significance and/or involve a contribution to the heritage of the City. The protection of these is seen as desirable by the Council.

Within the Central City 34 groups of buildings that contribute significantly to the streetscape have been identified in the City Plan as character groups. The architectural character and heritage qualities are an important part of these character groups. However, not all buildings in character groups are necessarily listed heritage buildings, although such buildings may be an important component of the group.

Pressures on Heritage Items

Increasing business development in the City and the trend toward Central City living has placed many older buildings at risk. Since the year ending June 1990, 14 historic items listed in the six transitional district schemes and the proposed Christchurch City Plan have been demolished or partially demolished.

Table 2.25 shows the number of buildings in each heritage group that have been identified as being at risk of losing some of their heritage value or are at risk of being demolished. Risk to heritage items does not only come from demolition. Heritage items can lose value from not being maintained or from alterations and additions. The sale of a heritage building is potentially a risk as it may result in a change of use. At present, heritage items under threat of demolition or modification include:

- Lyttelton Times building - Cathedral Square
- Lyttelton Times/Star building - Gloucester Street
- Warner's Hotel - Cathedral Square
- McKellar House and Fleming House (Wesley Lodge/ Eventide Home Site) - Park Terrace
- Canterbury Club – Cambridge Terrace
- Mountfort buildings at Sunnyside Hospital
- Crown Tavern – Moorhouse Avenue
- Harley Building – Cambridge Terrace
- Old Saddlery – Riccarton Road
- Wigram Air Base Workshop – Main South Road
- Former Sydenham Council Building – Colombo Street
- Former Dwelling – 137 Victoria Street

Fig 2.25 Number of Heritage Items at Risk of Losing Heritage Value or Demolition at March 2000

Risk Factor (Decreasing Risk)	Heritage Group				Total
	1	2	3	4	
Imminent demolition	-	-	-	-	-
Consent approved for demolition	-	2	1	-	3
Environmental Court appeal	1	2	1	-	5
Application for demolition consent	-	-	3	2	5
Application for significant alteration or alternative site use	1	4	3	2	10
Deterioration or earthquake prone	2	1	1	-	4
Sale	-	3	1	1	5

Source: Christchurch City Council.

Energy

Key Information	Why is this Useful?	What is Happening?
Total energy consumption for Christchurch.	This measures the total amount of energy used by the City.	↑ Total energy consumption increased by 17 per cent between 1990 and 1997 to 24,669 tera joules.
Per capita energy consumption.	This takes into account the effect population change has on energy consumption. Population growth results in an increase in total energy use. Decreasing per capita consumption reflects increases in efficiency and energy conservation.	↑ Per capita consumption increased by 5 per cent to 77 giga joules between 1990 and 1997
Renewable versus non-renewable energy consumption.	This measures the proportion of the City's energy consumption that comes from renewable sources, and how reliant the City is on fossil fuels.	- The proportion of renewable to non-renewable energy consumption did not change between 1990 and 1997.
Energy use by the transportation sector.	Transportation accounts for 50 per cent of the total energy consumed in Christchurch. Almost all modes of transport in the City use fossil fuels, which contribute to greenhouse gas emissions and reduced street level air quality.	↑ Transportation energy consumption increased by 29 per cent between 1990 and 1997.
Commercial/industrial energy consumption.	This measures the amount of energy used in production and provision of goods and services. This would be more meaningful if it could be related the City's economic output, as it would measure the efficiency in the production of goods and services.	↑ Energy consumption in the industrial and commercial sector increased by 7 per cent between 1990 and 1997.
Domestic energy consumption per capita.	This measures the effectiveness of residential energy conservation and efficiency, and changing individual behaviour towards energy use.	↓ Per capita energy consumption decreased by 8 per cent between 1990 and 1997.
Expenditure on domestic energy.	This shows the proportion of household expenditure on energy and gives a general measure of the affordability of domestic energy. This excludes transportation.	● Average household expenditure on energy was approximately $1,200 per year in 1997.

Other Related Sections: Population Growth, Air Quality, Health, Built Environment, Urban Amenity, Transportation, Businesses, Employment and Unemployment.

Energy is used whenever we undertake an activity. However, it is the services we obtain from energy, such as heat, light and motive power, which are important rather than the energy itself. Energy resources, whether renewable, such as hydro-electricity and wood, or non-renewable such as oil, gas or coal, are limited at any point in time. Non-renewable resources are finite and cannot be replaced, whereas renewable resources such as hydro-electricity are limited by the amount of water storage available for generation.

Present rates of consumption of non-renewable energy sources cannot be sustained indefinitely. In addition, some forms of energy have adverse effects on the environment. Fossil fuels produce greenhouse gases which are linked to global climate change. Some fuels also produce emissions which have adverse effects on human health and the environment, and contribute to Christchurch's air quality problems.

Recognition of the future costs and availability of energy, and of the adverse effects of energy use on the environment, has increased the need for energy conservation and efficiency and a change to more environmentally-friendly energy sources.

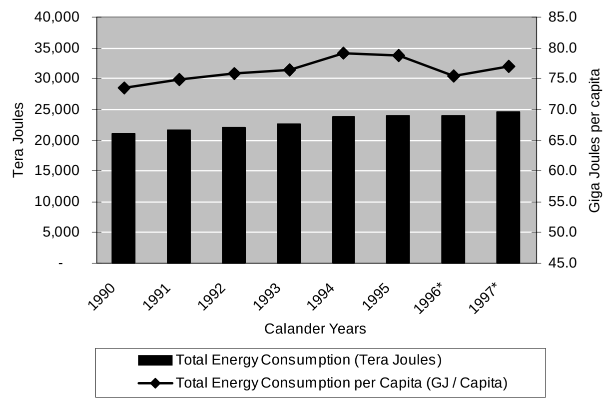
Total Energy Consumption

Energy consumption within Christchurch City was estimated to be 24,669 tera joules[42] for the 1997 year[43]. On a per capita basis this was around 77 giga joules (GJ) per person, considerably lower than the 108 GJ/capita and 113 GJ/capita[44] for Canterbury and New Zealand respectively. Higher per capita energy consumption in Canterbury and nationally can possibly be explained by the higher energy use in rural areas, and the fact that Christchurch has few heavy industries that are energy intensive. In general, urban areas are also relatively energy efficient due to shorter travel distances.

Total energy consumption in the City grew by 17 per cent between 1990 and 1997. Growth in population could account for 12 per cent of this growth, with increasing energy consumption responsible for the remaining five per cent or 1,050 tera joules (Figure 2.36).

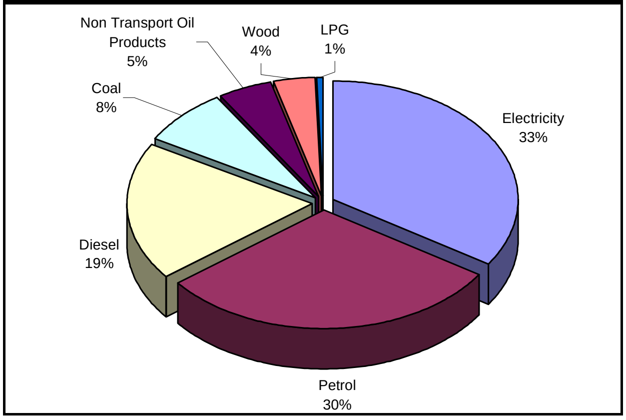
[42] A Joule is a unit of energy. Mega Joule(MJ) is one million joules($1x 10^6$); Giga Joules (GJ) is one thousand million joules ($1x10^9$), Tera joule(TJ) is one million, million joules ($1x10^{12}$).
[43] This was the most recent period with complete records for all energy sources. Energy consumption information provided by Canterbury Regional Council.
[44] Ministry of Commerce, Energy Modelling and Statistics Unit, Energy Data Figures 1999.

Fig 2.36 Estimated Total Energy Consumption for Christchurch



Source: Canterbury Regional Council.

Fig 2.37 Energy Consumption by Type, 1997



Source: Canterbury Regional Council.

Energy by Type

Figure 2.37 shows the proportion of each type of fuel used in Christchurch in 1997. Petrol and electricity dominated energy consumption. Combined, they provided around two thirds of the energy used in the City. Diesel use increased by 83 per cent between 1990 and 1997 and accounted for almost 20 per cent of total energy consumption in 1997. Part of this increase can be attributed to the increase in diesel-powered motor vehicles imported into New Zealand since 1990. The number of new diesel vehicles registered during this period increased by 125 per cent in the Christchurch postal area.

Almost two thirds of Christchurch's energy consumption (61.3 per cent) was from non-renewable energy sources, with 38.3 per cent from renewable sources such as electricity and wood. This proportion remained stable for much of the 1990s and is comparable to the national proportion of renewable energy of 33.1 per cent. However, growth in non-renewable energy consumption increased in real terms by 16 per cent from 1990.

Preferences for individual energy sources have changed. For example, domestic coal use declined by 25 per cent between 1990 and 1997. However, this only represents a real decrease from 1.6 to 0.9 per cent of the total energy consumed. The change in the consumption pattern has not resulted in increased use of renewable energy sources but has been offset by the growth in other non-renewable energy sources such as diesel.

Energy by Sector

Figure 2.38 shows energy consumption by sector. The transport sector, which used the highest proportion of energy, accounted for around 50 per cent of the total energy consumed. Between 1990 and 1997 consumption in this sector increased from 9,425 to 12,194 tera joules, or 76 per cent of the total growth in energy consumption for this period. (Unfortunately the transportation sector cannot be separated into commercial and private energy consumption.) The commercial and industrial sector and domestic sector used 30 and 21 per cent of the City's total energy respectively.

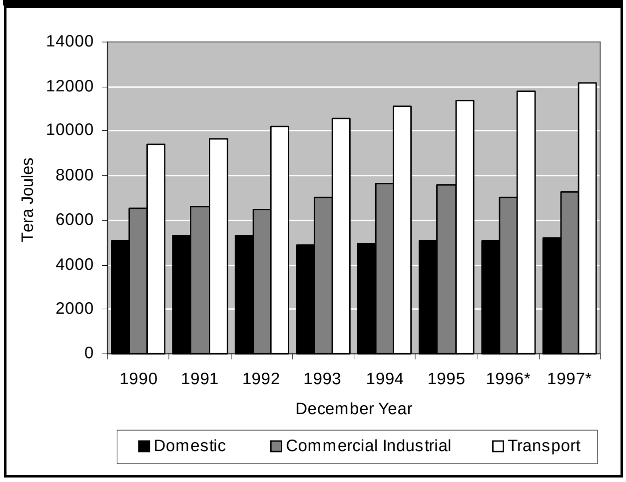
Transportation energy consumption was dominated by the use of petrol, which made up 61 per cent of total transportation consumption (Figure 2.39). Diesel contributed 38 per cent and LPG comprised the remaining 1 per cent. Petrol consumption has steadily increased.

The trend in diesel consumption showed no change up to 1991. However, between 1991 and 1997, diesel use increased by 73 per cent. This change in trend can be explained by changes in road transport policy and purchasing behaviour by motorists.

Commercial and industrial consumption remained at around 30 per cent of total energy consumption. In real terms there was a 7 per cent increase in energy consumption between 1990 and 1997.

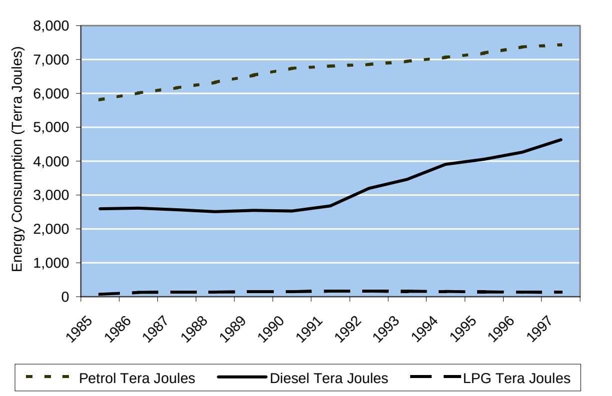
Total domestic energy consumption increased by 2 per cent over this period. The rise is encouraging considering the population grew by 7 per cent between the 1991 and 1996 census periods. Consequently, per capita domestic consumption decreased from 18

Fig 2.38 Energy Consumption by Sector



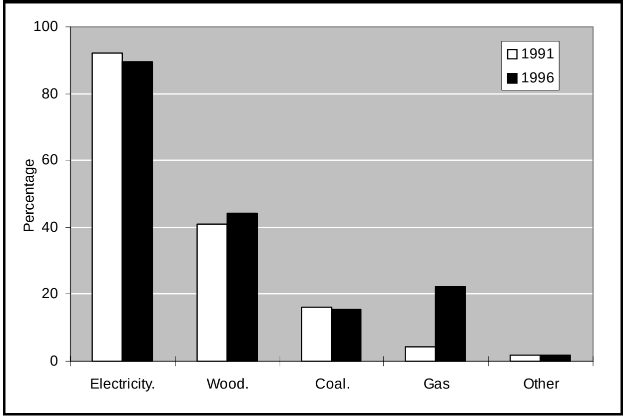
Source: Canterbury Regional Council.

Fig 2.39 Estimated Christchurch Vehicle Energy Consumption



Source: Canterbury Regional Council.

Fig 2.40 Means of Heating in Private Dwellings



Source: Statistics New Zealand, Census of Population and Dwellings.

GJ/person to 16 GJ/person between 1990 and 1997. This trend reflects improvements in house construction and insulation, and increased energy conservation.

The types of fuel used for domestic heating in Christchurch were surveyed by Statistics New Zealand in the 1996 Census of Population and Dwellings. Figure 2.40 shows that electricity continued to be the most common form of energy used to provide heating[45]. Ninety per cent of householders used electricity to heat their house, with wood being used in 45 per cent of homes. The most notable change in heating behaviour was the increase in gas heating from 4.5 per cent in 1991 to over 20 per cent in 1996. This can be partially attributed to the increased use of portable gas heaters during this period.

Statistics New Zealand also collects information on the average household expenditure on domestic energy as part of its Household Economic Survey. For the years to March 1997 and March 1998, the average annual household expenditure on domestic power and fuel, excluding transportation fuels, was $1,239 and $1,201 respectively. Of this, electricity made up about 90 per cent of the expenditure, firewood 5 per cent, and other fuels such as CNG and LPG the remainder.

[45] Dwellings may use more than one form of heating, therefore the percentages will not add to 100.

Transportation

Key Information	Why is this Useful?	What is Happening?
Number of registered motor vehicles.	Higher levels of car ownership are generally associated with lower levels of public transport use and greater pressures on the transport infrastructure and the environment.	↑ Between 1997 and 1999 the number of registered vehicles in the Christchurch postal area increased by around 10 per cent to 336,296.
Traffic volumes.	Changes in the volume of traffic in the City can highlight pressures on the transport infrastructure and the impact of other transport-related environmental effects, such as air quality.	↑ Average annual traffic volumes on selected radial and orbital arterial roads in 1999 increased by 1.8 and 3.7 per cent respectively.
Number of people cycling to work.	Cycling is a form of personal transport which has fewer adverse environmental effects than motor vehicles.	↓ The number of people travelling to work by bicycle declined by 1,050 between 1991 and 1996 to 9,633.
Bus patronage.	Public bus networks provide a means of moving people with less environmental effects than low occupancy private motor vehicles. They also provide transportation for residents who do not have access to other forms of transport.	↑ The number of bus trips per year in the City has been increasing since 1992.
Ease of travel in the City.	This provides a measure of people's perceptions of the congestion and functionality of the road network in the City.	● Sixty per cent of residents found the City easy or very easy to travel around in 1999.

Other Related Sections: Population Growth, Personal Safety, Air Quality, Land Use, Built Environment, Urban Amenity, Energy, Part 3: The City's Economy.

Christchurch is accessible by all conventional means of transport. Road and rail networks link Christchurch to the rest of the South Island, while the airport and Port of Lyttelton link the City with the rest of New Zealand and the world. Within Christchurch, the main modes of transport are road-based through the use of motor vehicles, bicycles or walking. Public transport in the City is provided by a bus network, covering much of the City, and taxis and shuttles.

A survey[46] carried out in June 1999 by the Christchurch City Council's City Streets Unit found the percentage of people who used the following types of transport:

- 92 per cent used cars
- 52 per cent walked
- 22 per cent used buses
- 20 per cent cycled
- 20 per cent used taxis.

The road network of Christchurch is generally radial with orbital roads connecting the radial branches, forming a strong grid pattern. The road network at June 1999 consisted of 1,533.5 kilometres of roads and 2,191 kilometres of footpaths. There were also 161 kilometres of cycleways, made up of designated (quiet) streets (81 kilometres), on-road cycle lanes (29 kilometres), and off-road paths (51 kilometres).

Other transportation infrastructure in the City includes 40 kilometres of railway corridors and 720 hectares of land zoned for domestic and international airport activities. Although around 230 hectares are zoned at Wigram for aviation purposes, this does not provide a significant transportation function.

[46] Measuring and Monitoring the City Streets Performance Outcomes. Prepared for City Streets Unit, Christchurch City Council by Opinions Market Research, June 1999. Survey sample 301 residents.

Motor Vehicles

There were 336,296 motor vehicles registered in the Christchurch postal area at June 1999 (Table 2.26). Cars made up the majority of registered vehicles (70 per cent), with trucks accounting for 12 per cent (around 40,000 vehicles). Since 1971 the number of cars registered in the Christchurch postal area has almost doubled (95 per cent), while the number of

Table 2.26 Registered Vehicles in Christchurch Postal District at June 1999

	Number	Percentage
Cars	234,576	69.7
Trucks	39,665	11.8
Motorcycles and mopeds	6,130	1.8
Buses and Coaches	3,536	1.0
Rental Cars	1,356	0.5
Taxis	858	0.3
Tractors	2,674	0.8
Trailers and Caravans	44,658	13.0
Others	2,748	0.8
Total	**336,296**	**100**

Source: Land Transport Safety Authority.

registered trucks increased by 80 per cent during the same period.

The growth in car numbers has been greater than population growth since 1971. Generally, the number of people per registered car in Christchurch has decreased by around 60 per cent since 1971, from 2.2 people per car to 1.4 people per car in 1999. Over half of this growth in car numbers relative to population occurred during the 1970s. Twenty per cent of the increase occurred between 1997 and 1999 as a result of population growth starting to slow and the rate of vehicle registration remaining relatively constant.

Table 2.27 Number of Vehicles per Household

	1986		1991		1996	
	No.	%	No.	%	No.	%
No Motor Vehicles	14,634	14	14,022	13	14,448	12
One Motor Vehicle	47,262	47	46,923	44	47,049	40
Two Motor	27,837	28	32,613	30	36,993	32
Three or More	9,192	9	11,640	11	13,818	12
Not Specified	2,316	2	2,028	2	3,861	3
Total Households	101,241		107,226		116,169	
Average Household Size (people per	*2.66*		*2.58*		*2.57*	

Source: Statistics New Zealand.

Motor Vehicles per Household

The 1996 Census of Population and Dwellings found that 84 per cent of households had at least one car (Table 2.27). This was only one per cent more than in 1986 (83 per cent). However, the proportion of households which had two or more cars increased by seven per cent from 37 per cent to 44 per cent between 1986 and 1999. This could reflect the increased affordability of motor vehicles as a result of the importation of used Japanese cars since the mid-1980s.

Although the proportion of households without cars has been decreasing, the actual number of households without cars did not change significantly in the 10 years between 1986 and 1996. The distribution of vehicles per household in Christchurch was very similar to figures for New Zealand.

Traffic Volumes

Traffic counts are taken on a number of roads throughout the City on a regular or semi-regular basis. Table 2.28 shows traffic volumes for a selection of radial and orbital arterial roads in the City. Average daily traffic volumes on selected two lane arterial roads in 1999 ranged from 11,000 vehicles per day on Rutherford Street to 26,000 vehicles per day on Papanui Road. Four lane roads with median strips, such as Blenheim Rd and Johns Road, had on average 27,000 and 31,000 vehicles per day, respectively.

Figures 2.41a to 2.42c show the change in traffic volumes on the selected radial and orbital roads between 1985 and 1999, and forecast volumes for 2000. All these sites have shown increases in traffic volumes over this 14 year period. On the radial roads increases in traffic volumes ranged from 15 per cent on Colombo Street to 120 per cent on Ferry Road.

Orbital roads show a much larger increase in traffic volumes over this period. Much of this can be

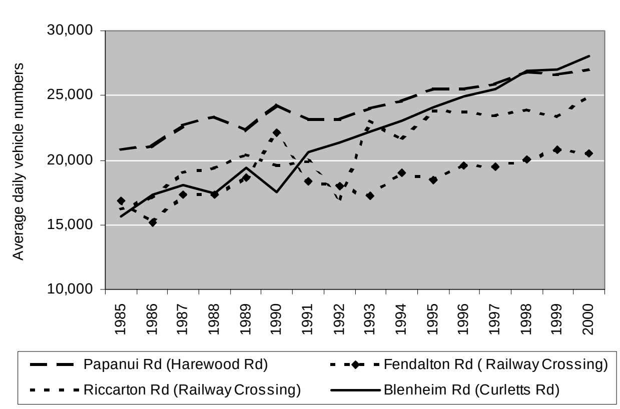
Table 2.28 Traffic Volumes at Selected Arterial Roads in the City

	Average Daily Traffic Volumes in 1999	Annual Percentage Increase at 1999
Radial Arterial Roads		
Papanui Rd (Harewood Rd)	26,603*	1.3%
Fendalton Rd (Railway Crossing)	20,776	2.0%
Riccarton Rd (Railway Crossing)	23,342	0.6%
Blenheim Rd (Curletts Rd)	26,967	2.8%
Lincoln Rd (Railway Crossing)	18,078*	2.0%
Colombo St (Hastings St / Brougham St)	19,726*	0.9%
Ferry Rd (Humpreys Drive)	16,176*	3.1%
Marshland Rd (Mitre Pl)	14,992*	2.1%
Orbital Arterial Roads		
Carmen Road (Waterloo Rd)	21,788*	5.2%
Russley Rd (Ryans Rd)	20,430*	4.8%
Johns Rd (Groynes)	13,108*	4.2%
Main North Rd (Johns Rd)	31,087*	3.1%
Northcote Road (Railway Crossing)	21,031	3.9%
Northcote Expressway (Grimseys Rd)	18,074	4.9%
QEII Drive (Marshlands Road)	17,268	3.3%
Travis Road (Burwood Rd)	18,626	3.3%
Dyers Road (Breezes Rd)	11,048	2.6%
Rutherford Street (Ferry Rd)	12,901	3.5%
Curletts Road (Nth Blenheim Rd)	19,671*	3.6

* Estimated for 1999 based on analysis of previous traffic volume trends.

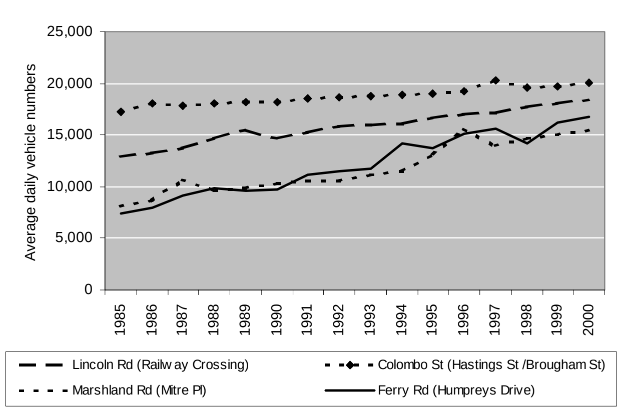
Source: Christchurch City Council.

Fig 2.41a Radial Road Traffic Volumes



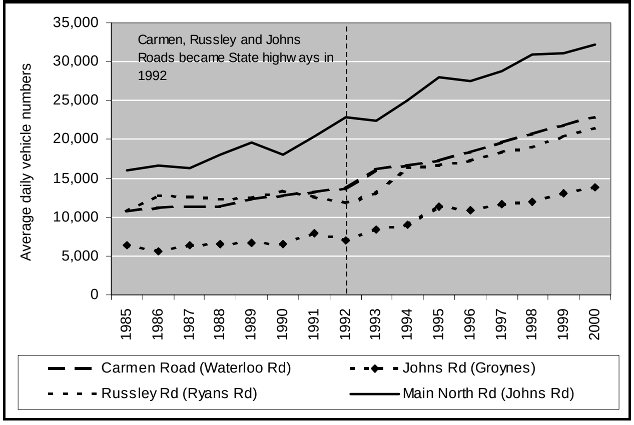
Source: Christchurch City Council.

Fig 2.41b Radial Road Traffic Volumes



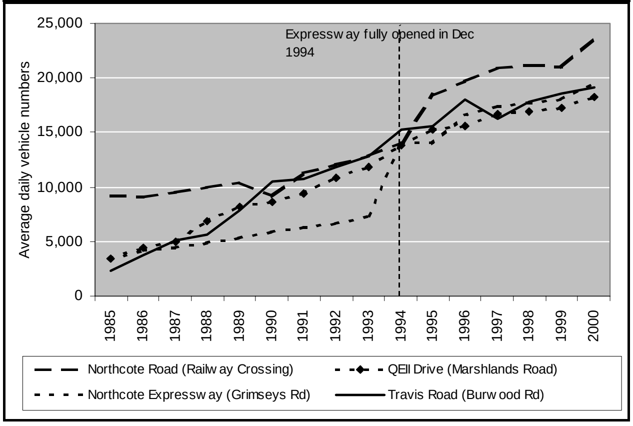
Source: Christchurch City Council.

Fig 2.42a Orbital Road Traffic Volumes



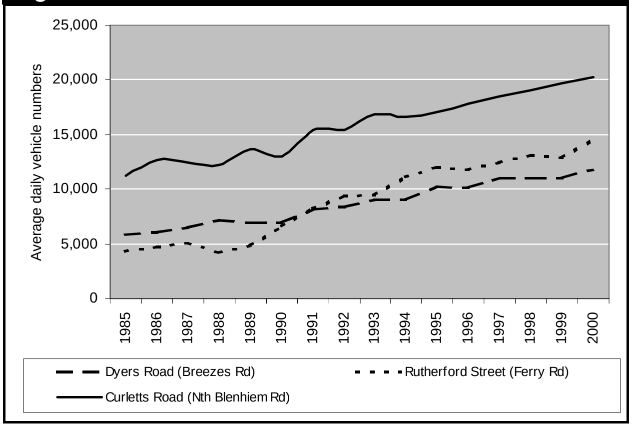
Source: Christchurch City Council.

Fig 2.42b Orbital Road Traffic Volumes



Source: Christchurch City Council.

Fig 2.42c Orbital Road Traffic Volumes



Source: Christchurch City Council.

explained by the linking of orbital routes and the creation of expressways to remove through traffic from local roads. Increases in traffic volumes on the orbital roads ranged from 76 per cent on Curletts Road to 700 per cent on Travis Road. The large increase in traffic on Travis Road is the result of it being converted from a local road to part of an expressway in 1994.

The annual percentage increase in traffic volumes at 1999 are shown in Table 2.28. Generally on the radial routes traffic volumes increased by an average of 1.8 per cent per year. On orbital routes the annual growth in traffic volumes in 1999 was on average 3.7 per cent.

Population growth was in the order of 15 per cent between 1986 and 1999. The most recent annual rate of population growth for the City was 0.5 per cent for the year June 1998 to June 1999. Both long-term and short-term rates of population growth were considerably less than increases in traffic volumes on the selected arterial roads. The increase in traffic volumes in the City can only partially be explained by changes in the resident population. For many of the arterial roads the rate of increased volume is significantly greater than the growth in population.

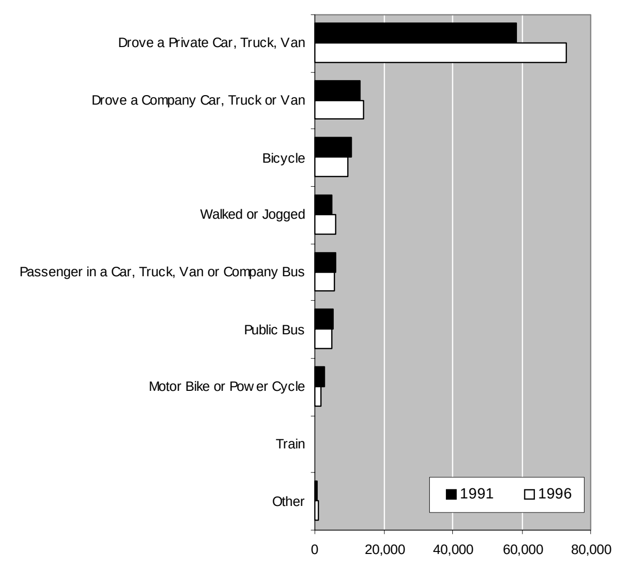
Journey to Work[47]

Figure 2.43 shows how people travelled to work on the day of the 1991 and 1996 Censuses of Population and Dwellings. People who drove private cars, trucks or vans dominated, with 56 and 60 per cent of the total respectively. If company vehicles are included, 15,600 more people drove vehicles to work in 1996 than 1991.

The number of people using more environmentally sustainable forms of transport to travel to work, such as cycling, public transport and walking, declined between the census periods. Cycling was the third most popular mode of travel to work behind driving private and company vehicles, with 8 per cent of

[47] Jouney to work information is based on a question in the Census of Population and Dwellings asking how people travelled to work on the day the census was carried out (ie. Tuesday 5 March 1996).

Fig 2.43 Journey to Work



Source: Statistics New Zealand.

people travelling to work on a bicycle in 1996. The number of cyclists declined by 1,050 people from 10,863 to 9,633 between 1991 and 1996.

Between 1991 and 1996 the number of people who walked or jogged to work increased by 840, to make up five per cent of the total number of people travelling to work. The number of people working at home increased by approximately 80 per cent to a total of 7,200 people between the two censuses.

Public Transport

Public buses, taxis and shuttles are the main forms of public transport in Christchurch. Between 1991 and 1996 the proportion of workers who used the bus to travel to work declined from 5 to 4 per cent (Figure 2.43). However, annual bus patronage trends shown in Figure 2.44 have been increasing from a low point in 1992, even though the number of trips was less in the year to June 1996 compared with the year to June 1991. By the year ending June 1999 the number of passenger trips had still not recovered to the June 1991 level. Trips per capita have also been increasing, but at a slower rate than total trips. In the year to June 1999, trips per capita were approximately 28 trips per person per year.

The bus network provides a good coverage of the City's residents. Up to 90 per cent of the resident population in the City lived within 400 metres of a bus stop into the City (as the crow flies) at September 1998.

Eight hundred and fifty taxis were registered in the Christchurch postal area in June 1999. This number had increased from just over 300 at June 1986 as a result of the taxi industry being deregulated in 1989. The Canterbury regional office of the New Zealand Taxi Federation estimates that around 5.5 million person trips are made by taxis each year in Christchurch.

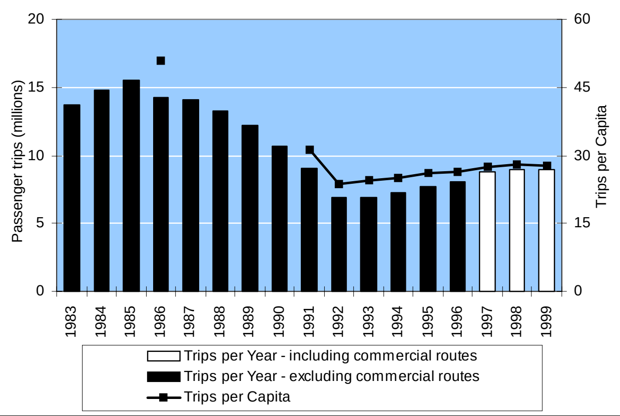
Ease of Travel within Christchurch

The 1999 Annual Survey of Residents asked how easy or difficult residents found travelling in Christchurch by car or bicycle (Figure 2.45). Generally, 60 per cent of residents found Christchurch easy or very easy to get around by car, with less than 20 per cent of residents finding the City hard or very hard to get around by car. These percentages remained at these levels between 1995 and 1999.

Residents were also asked whether they had ridden a bicycle in the last 12 months. In 1995, 41 per cent of respondents had used a bicycle in the previous 12 months, whereas in 1999 this percentage dropped to 32 per cent of total respondents. Of the residents who cycled in 1999, 65 per cent found Christchurch easy or very easy to travel around. This was a small increase compared with 1995 when 59 per cent of cyclists found the City easy or very easy to travel around. Between the 1995 and 1999 surveys the percentage of cyclists who found the City hard or very hard to travel around declined from 25 to 13 per cent. This may indicate that some people who found it difficult to cycle in the City in 1995 may have stopped cycling.

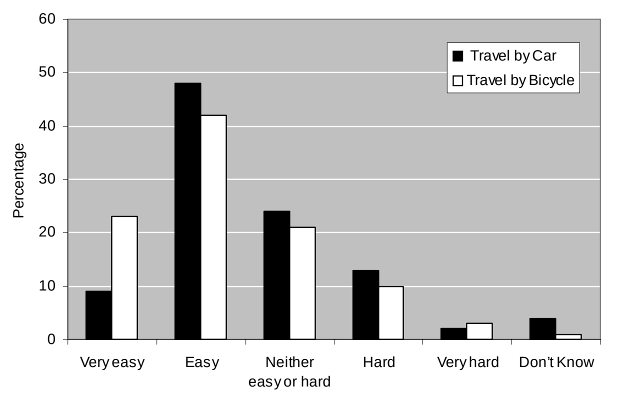
The Annual Survey of Residents also asked questions

Fig 2.44 Bus Patronage



Source: Canterbury Regional Council.

Fig 2.45 Ease of Travel in Christchurch, 1999



Source: Christchurch City Council.

on how safe residents felt travelling around the City by car, bicycle or walking. These results are reported in the Safety section of this report.

Airport Noise

Airports can generate a considerable amount of noise as a result of aircraft taking off and landing, and other activities such as aircraft engine testing. For this reason airports tend to be located away from residential areas. As the urban area of Christchurch has grown, the rural buffer between residential properties and the airport has been gradually reducing. During this time, the size and power of aircraft, as well as the frequency of flights, have also contributed to adverse effects from the airport.

The number of people who live in areas directly affected by airport noise can be estimated using the 55 decibel (dba) noise contour around the airport. At the 1996 Census of Population and Dwellings approximately 5,100 residents lived within the 55 dba noise contour. This was an increase of around 300 people since the 1991 census.

Waste Management

Key Information	Why is this Useful?	What is Happening?
Quantity of waste disposed of in landfills.	Waste in landfills often contains valuable resources that could be reused or recycled. Landfills can also have significant impacts on the environment.	↓ Waste to the landfill decreased by around 3,200 tonnes per year between 1994 and 1999.
Quantity of landfilled waste per capita.	This takes into account any influence population growth has on the amount of waste generated. It also provides a measure of changes to residential waste disposal behaviour.	↓ Per capita waste decreased from 810kg per person to 700kg per person between 1994 and 1999.
Amount of green waste composted by Christchurch City Council.	Composting provides a method of reducing green waste being landfilled and produces a valuable resource in return.	↑ The amount of green waste being composted has increased to around 30,000 tonnes per year between 1997 and 1999.
Amount of waste recycled or reused.	Recycling not only reduces the amount of waste going to the landfill, it also reduces the need to extract and use new raw materials.	● Kerbside recycling collected 11,647 tonnes of waste in the year to June 1999.
Biological Oxygen Demand (BOD) discharged from wastewater treatment plant to the Avon-Heathcote Estuary.	This measures the pressure effluent places on the water environment. When BOD levels are high, more dissolved oxygen in the water is required to break down this material.	~ BOD levels averaged 31 g/m^3 for the period between 1989 and 1999.
Requests for disposal of hazardous waste.	Hazardous wastes have the greatest potential to cause environmental damage. They need to be disposed of in a way which mitigates any environmental impact.	↑ Requests for disposal of hazardous waste increased from 241 in 1993 to 521 in 1999.

Other Related Sections: Population Growth, Land Use, Groundwater, Surface Water, The Coastal Environment, The Built Environment, Urban Amenity, Part 3: The City's Economy.

Solid Waste

The production of solid waste (including household rubbish, commercial and industrial waste, and garden waste) is an inevitable consequence of most human activity. However, reduced waste production will lead to more efficient resource use and a reduction of environmental impacts from landfills and the extraction of non-renewable resources.

To effectively reduce waste, a good understanding of waste volumes, sources and composition in Christchurch is necessary. Each of the City's transfer stations and the landfill site are equipped with weighbridges to enable accurate monitoring of waste quantities. The composition of various waste streams is determined by sampling the refuse at source or at the transfer station and landfill site.

During the year to June 1999 the City produced 228,295 tonnes of solid waste (excluding hardfill) that were dumped at Burwood Landfill. It also took 10,694 tonnes of waste from Waimakariri and 1,120 tonnes from Selwyn District Councils. In addition, 31,535 tonnes of green waste were composted at the City's Bromley composting plant (Figure 2.46). Almost 17,000 tonnes of inert hardfill and rubble were also disposed of in 1999.

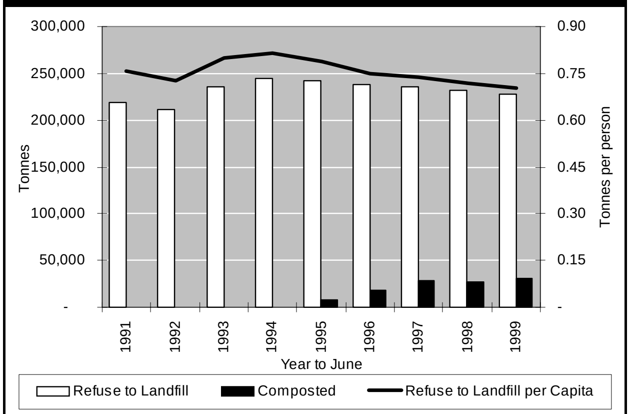
The total amount of waste going to the landfill has been decreasing steadily since 1994. This can be attributed in part to the separation of 'clean green waste' (including grass clippings, hedge and tree prunings, leaves and plants) for the Council's composting plant and, more recently, to the start of kerbside recycling in May 1998.

Total waste has been declining at a rate of 3,200 tonnes per year since 1994. At this rate it is estimated that the City will no longer need to landfill waste by the year 2070.

The amount of waste generated per capita takes into account the impact of population changes on waste production. It provides a measure of how individuals are changing their waste disposal behaviour and reducing domestic waste. In 1996 it was estimated that residential waste contributed around half the total waste in Christchurch City.

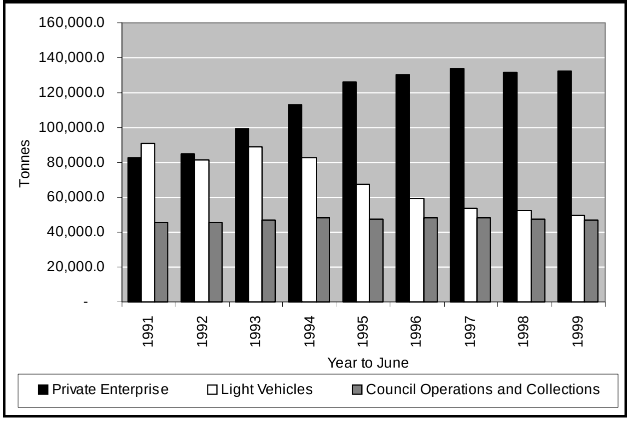
Figure 2.46 shows that per capita waste decreased

Fig 2.46 Solid Waste in Christchurch



Source: Christchurch City Council.

Fig 2.47 Origins of Waste (excluding Hardfill)



Source: Christchurch City Council.

from 810 kilograms per person in the year to June 1994, to 700 kilograms per person for the year to June 1999. This was an average decrease of 20 kilograms per person per year. At this rate the Council's goal of zero waste[48] to the landfill per person will occur in 35 years, 15 years after the year 2020 target. However, the initial goal of reducing waste by 14 per cent per capita (697 kilograms per person) of the 1994 level by the year 2000 looks like it will be achieved.

The amount of waste per capita is decreasing at a more rapid rate than total waste due to the impact of increased population growth in the mid-1990s. In fact, 55 per cent of the decline in waste per capita would have occurred solely as a result of increased population and no change in total waste. The rate of population growth declined considerably between 1997 and 1999. If this continues, the rate of decreasing per capita waste will slow down unless other waste initiatives increase the rate of reduction in total waste.

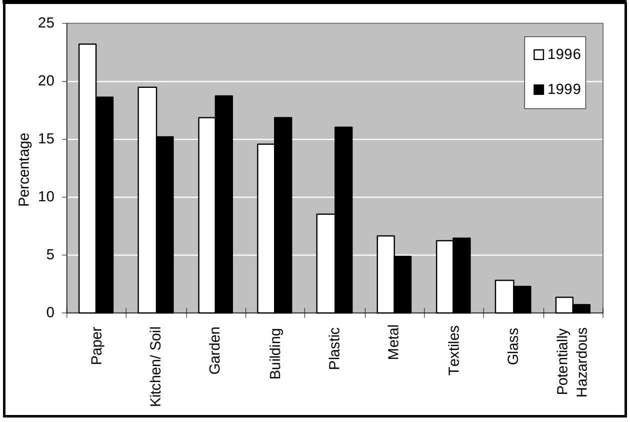
Figure 2.47 shows the origins of waste in the City. Until 1993 both light vehicles and commercial non-Council vehicles were responsible for delivering most of the waste. The Council's operations and refuse collection contributed the remaining 45,000 tonnes per year. Since then, waste from private vehicles decreased by 45 per cent to be just under 50,000 tonnes in the year to June 1999. Conversely, the amount of waste from private enterprise increased from around 100,000 tonnes in 1993 to around 130,000 tonnes per year between 1995 and 1999.

Composition of Solid Waste

Waste audits were carried out in 1993, 1994, 1996 and 1999. Figure 2.48 shows the comparison between the proportion of each type of waste that went to the landfill in 1996 and 1999. Although paper was the greatest source of waste in 1996 and 1999, the proportion of total waste decreased between surveys. The proportion of total waste from garden material, building material and especially plastics increased between the 1996 and 1999 surveys.

[48] Christchurch City Council Waste Management Strategy for Solid and Hazardous Waste 1998, http://www.ccc.govt.nz/waste/ManagementPlan/index.asp

Fig 2.48 Composition of Total Waste to Transfer Stations (% by Weight)



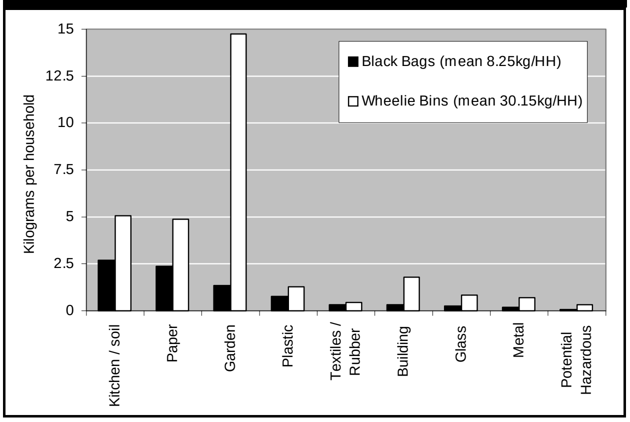
Source: Christchurch City Council.

The 1999 audit also sampled the composition of residential black rubbish bags and "wheelie" bins. Generally, more waste was collected from households with bins than those that used bags. The mean weekly household waste disposed of in black rubbish bags was 8.25 kilograms per household, whereas the mean household waste in "wheelie" bins was 30.15 kilograms per household.

Figure 2.49 shows the breakdown of waste per household for both black rubbish bags and bins. Paper, kitchen and garden material made up the greatest proportion of waste in both bins and bags. Bins contained a greater proportion of green material, kitchen waste, paper and building material than bags. A large amount of green material which went into bins should, ideally, have been composted.

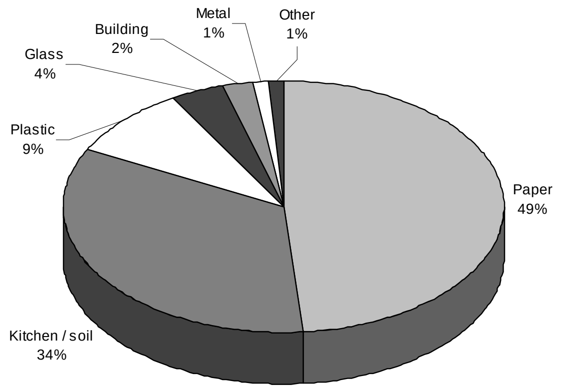
The use of bins in Christchurch increased significantly in the five years to 1999. It is difficult to know whether using a bin increased the amount of waste being disposed of, or whether households producing a large amount of waste were more likely to change to using bins due to the increased convenience. However, it is apparent that a greater amount of green waste was disposed of by households using bins compared with households using bags.

Fig 2.49 Composition of Domestic Waste collected in Council Bags and 'Wheelie' Bins, 1999



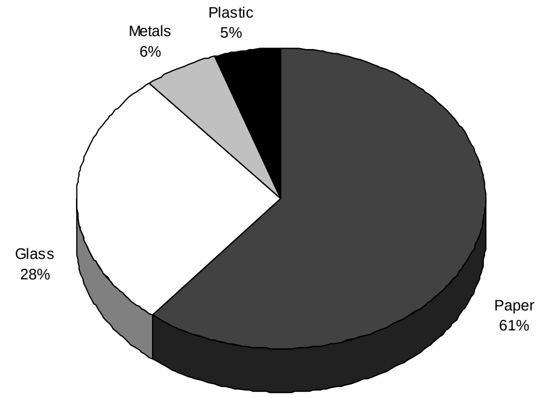
Source: Christchurch City Council.

Fig 2.50 Composition of CBD Waste in Black Rubbish Bags, 1999



Source: Christchurch City Council.

Fig 2.51 Proportion of Materials Collected from Kerbside Recycling



Source: Recovered Materials Foundation.

The composition of commercial and business waste was also estimated in the waste audit. Black rubbish bags from the central business district (CBD) were sampled. Unfortunately it was impossible to distinguish between Central City residential waste and waste from commercial premises. However, there was a distinct difference in the proportions of waste in these bags compared with residential bags and bins. Figure 2.50 shows the majority of waste in the commercial business district was paper (49 per cent) and kitchen waste (34 per cent). As expected, there was very little garden waste.

The composition of business waste was dominated by paper, wood, rubble and plastic. Combined, these made up approximately 75 per cent of business waste. Garden and kitchen waste combined contributed less than 15 per cent of total business waste.

Composting Green Waste

Composting not only reduces the amount of landfilled waste, it also lessens greenhouse gas emissions. The aerobic composting process produces carbon dioxide, rather than methane, which results if the material decomposes without oxygen (as occurs in landfills).

Council composting started in the year to June 1995 and rapidly increased to around 30,000 tonnes by the year to June 1997 (Figure 2.46). Since then green waste appears to have stabilised at around 30,000 tonnes per year. If this green waste was not composted, it would have added an additional 13 per cent more waste to the landfill, based on figures for the year to June 1999.

In addition to the Council-operated compost plant, many residents also compost their own green waste for reuse in their gardens. The Annual Survey of Residents found that 57 per cent of residents in 1999 composted some of their garden and food waste. The survey also asked residents whether they took green waste to the transfer station. Sixty seven per cent of respondents had taken green waste to the transfer station in the previous 12 months.

Kerbside Recycling

Recycling and reuse of materials such as glass, paper, wood, oil, plastic and metals is another way of reducing the amount of waste being disposed in landfills. Reuse is the repeated or continued use of a product in its original form. Recycling involves the breakdown of products into their constituent materials either by melting (in the case of metal, glass or plastic) or maceration (in the case of paper), followed by the reformation of the material into new products.

In May 1998 the Christchurch City Council started a kerbside recycling programme that enabled glass, newspaper, some plastics, cardboard, and aluminium and steel cans to be collected. Previously, newspaper was the only material collected at the kerbside, while other materials could be recycled at the transfer stations and drop off points throughout the City.

In the year to June 1999, 11,647 tonnes of material were collected from kerbside recycling. This removed 5 per cent of the waste that would otherwise have gone to the landfill. The greatest proportion by weight of material collected as part of kerbside recycling was paper and cardboard (61 per cent), then glass (28 per cent), with plastic and metal each contributing around 5 per cent to the total (Figure 2.51).

Ninety per cent of residents questioned in the Annual Survey of Residents thought the Council's kerbside recycling programme was good or very good. While this is encouraging it is interesting to note that when this question was asked in 1997, when only newspapers were being collected, 88 per cent of residents thought the kerbside recycling was either good or very good. This probably measures the quality of service rather than satisfaction with the range of materials that can be recycled.

Before 1999 the Annual Survey of Residents asked a question on recycling habits. In 1998, 61 per cent of residents recycled glass, 78 per cent newspapers, 40 per cent aluminium cans and 37 per cent plastic. These percentages remained reasonably stable between 1991 and 1998, and showed that many residents were already accustomed to recycling before kerbside recycling commenced.

Target Zero[49] – Cleaner Production Principles

Between mid-1997 and June 1999 a trial programme to develop cleaner production methods in 12 Christchurch companies was carried out. The Target Zero programme was funded by the Christchurch City Council, the Ministry for the Environment, and the Electricity Corporation of New Zealand. As a result of the trial the following savings were achieved:

Inputs:

- 94,200m^3 of water
- 17,740 GJ of fossil fuels
- 535 MWh of electricity
- $489,440 of materials

Outputs:

- 123,990m^3 of trade waste
- 890 tonnes of solid waste
- $684,160 of product
- 1,850 tonnes of CO_2 emissions.

Although the initial trial has finished, the Target Zero programme is still continuing locally with manufacturers. It has also expanded to include a green retailers programme, focusing on commercial waste from retailing.

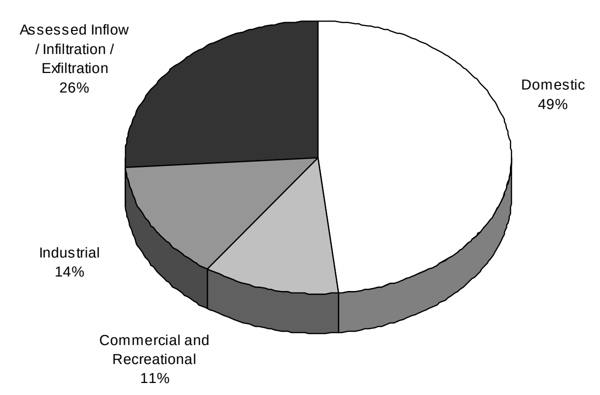
Liquid Waste

Waste water treatment is an extremely large, complex and expensive operation that is vital for the health and well-being of the community. Waste water, which is almost all used water, is carried through a network of underground pipes to the treatment plant. The aim of waste water treatment is to remove all pollutants and produce an effluent that is as near as possible to fresh water, which can then be safely reused or returned to the environment.

In the year to June 1999 the City's waste water treatment system processed approximately 48,659 mega litres[50] of waste through the City's three waste water treatment plants. Almost all of this was processed at the Bromley treatment plant (98.3 per cent), with the Belfast and Templeton plants processing the remaining 1.0 and 0.7 per cent of the total waste water respectively.

Approximately half of the waste water originated from domestic sources (49 per cent). Industrial sources contributed 14 per cent, and commercial and recreational sources 11 per cent of the liquid waste.

Fig 2.52 Sources of Waste Water, 1999



Source: Christchurch City Council.

The remaining 26 per cent was from the infiltration and inflow of groundwater and stormwater (Figure 2.52).

Domestic effluent flow has increased at a rate consistent with population growth, although the total annual flow fluctuates from wet year to dry year due to the infiltration and inflow of ground water and stormwater into the system.

All three treatment plants carry out primary and secondary treatment. Liquid effluent is discharged from the Bromley treatment plant into the Avon-Heathcote Estuary twice daily, a few hours after high tide. This ensures that most of the discharge moves straight out to sea with the falling tide. Before being discharged in the Estuary, effluent flows through 230 hectares of oxidation ponds. These are also an important habitat for a variety of bird species at the Te Huinga Manu Wildlife Refuge. Liquid effluent from the Belfast treatment plant is discharged into the south branch of the Waimakariri River, and effluent from the Templeton treatment plant is discharged directly on to pasture.

Effluent discharged into the Avon-Heathcote Estuary has 90 per cent of the biological oxygen demand (BOD) removed. The average amount of BOD in the effluent discharged into the Estuary was 25 micrograms per litre during the year to June 1999. In the period from July 1989 to June 1999, BOD concentrations averaged 31 grams per cubic metre. The treatment plant also removed 99.91 per cent of the faecal coliforms from the liquid waste. The median number of faecal coliforms discharged in the Estuary in the year to June 1999 was 5,600 per 100 millilitres. Micro-organisms remaining in the effluent are a mixture of those that survive the pond system and those contributed by resident bird life. They do not normally have an adverse effect on the Estuary except in a small area adjacent to the outfalls.

Other outputs for the year to June 1999 from the waste treatment plant included: 4,496 tonnes of solid waste, (which was sent to the Burwood Landfill), and 4.7 million cubic metres of methane. The methane is used

[49] For more information on Target Zero see: http://www.ccc.govt.nz/TargetZero/

[50] One mega litre = 1,000,000 litres or one million litres

to run the Bromley treatment plant, which is 100 per cent self-sufficient in energy. Surplus electricity goes to the national grid.

Hazardous Waste

Hazardous wastes are solid or liquid wastes which have properties that could pose dangers to human health, property or the environment if they are not properly treated, stored, transported, disposed of or otherwise managed. Waste is considered hazardous if it is ignitable, corrosive, reactive or toxic.

Hazardous waste, while not produced in large quantities in Christchurch, is the category of waste with the greatest potential to harm the environment if not properly managed. The 1999 waste audit estimated potentially hazardous waste made up 0.7 per cent of the total waste. Hazardous wastes are produced by industry and business and also, in smaller quantities, by households (Table 2.29).

The Christchurch City Council receives requests for the disposal of hazardous waste from industry and business. Between June 1994 and June 1997 the annual number of applications received more than doubled. Between 1997 and 1999 there was an average of 525 applications each year. This increase in applications is believed to reflect general public concern about the safe disposal of hazardous waste.

Table 2.30 shows that the City Council received 521 applications to dispose or recycle 8,281 tonnes of solid and 4,229 litres of liquid hazardous waste in the year to June 1999. There was a marked reduction in liquid waste compared with the year to June 1998, due to one operator now being able to discharge directly into the sewerage system after meeting trade waste standards.

Seventy two per cent of requests for disposal of hazardous waste were for industrial waste, with domestic and agricultural waste accounting for 23 and 5 per cent of requests respectively. The quantity of waste from industrial sources made up 99.7 per cent of the total solid and 57 per cent of the total liquid hazardous waste.
Recycling and reuse continue to play a significant part in the disposal request process with 17 per cent of requests leading to products being recycled. In the year to June 1999, less than 1 per cent of solid hazardous waste was recycled or reused while 62 per cent of liquid hazardous waste was recycled or reused.

There is no clear trend in the quantities of hazardous waste. Both increases and decreases can potentially have beneficial environmental results. Increasing waste volumes can reflect greater awareness of hazardous wastes, while decreasing trends in hazardous waste can reflect the impact of cleaner production practices.

Table 2.29 Sources of Hazardous Waste

Priority Waste Streams	Industry Groups
Cyanide Wastes	electroplaters, laboratories, pest control.
Chlorinated solvents and sludges	Drycleaners, aircraft maintenance, paint strippers, laboratories, engine repairs.
Agrichemical wastes	Agrichemical spray contractors, pest control.
Timber treatment sludges	Timber treatment plants and chemical suppliers
Waste Oil	Engine repairs, service stations, aircraft maintenance, electricity generation.
Metal processing wastes	Electroplaters and galvanisers, aircraft maintenance, tanning.
Household hazardous waste	Includes: garden sprays, poisons and pesticides, medicines, dietary supplements and animal remedies, small batteries, automobile batteries, mineral oils, paints and related products, aerosols etc.

Source: CRC Summary Report: Hazardous Waste Management Options for Canterbury Region.

Table 2.30 Quantity of Hazardous Waste Received by Christchurch City Council

	Recycled			Disposed			Total		
Year to June	Requests	Solid (tonnes)	Liquid (litres)	Requests	Solid (tonnes)	Liquid (litres)	Requests	Solid (tonnes)	Liquid (litres)
1994	55	34	65,717	186	4,049	38,022	241	4,083	103,739
1995	70	3,258	17,765	302	2,908	48,191	372	6,166	65,956
1996	63	2	7,050	407	2,669	606,316	470	2,671	613,366
1997	83	43	9,204	458	4,001	114,314	541	4,044	123,518
1998	91	21	30,601	427	3,296	958,959	518	3,318	989,560
1999	91	9	2,633	430	8,272	1,596	521	8,281	4,229

Source: Christchurch City Council.