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

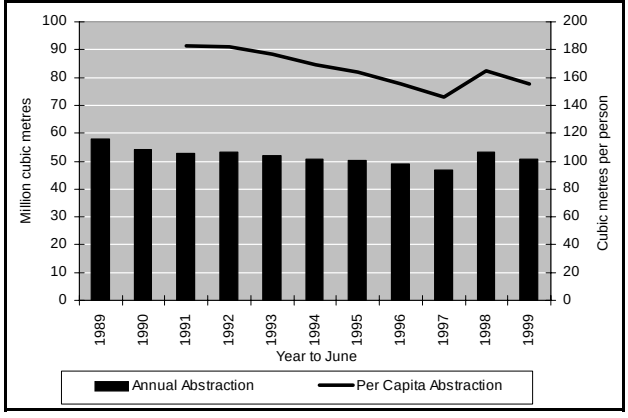
The groundwater resource beneath Christchurch is currently the sole source of drinking water for the City's residents. It is relied on to continuously provide high quality water without treatment from 150 bores which range in depth from 25 to 180 metres.

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.

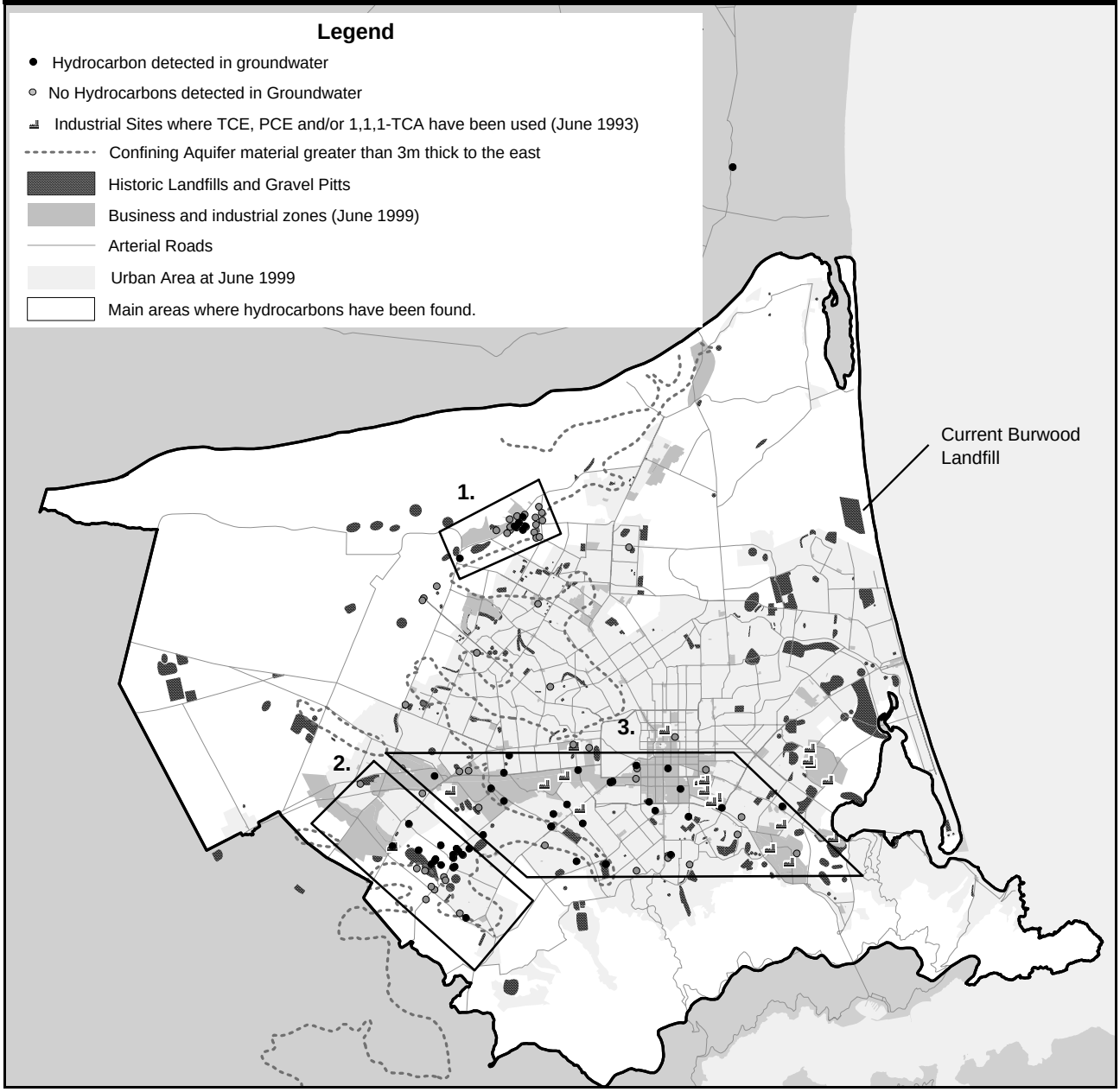
Leachate Monitoring at Burwood Landfill[17, 18]

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.