
Report No. U02/67

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Executive summary

The state of Canterbury’s water resources going into the 2002/03 summer has been reviewed.

High rainfall during January 2002 resulted in above average summer rainfall totals over the region. Autumn and winter rainfall, which provides significant recharge to water resources, although being above average in alpine areas this year, was below average over the foothills and plains, particularly in north Canterbury.

Winter river flows have reflected these rainfall patterns with alpine rivers such as the Waiau, Hurunui, Rakaia, Rangitata and Ahuriri Rivers having above average flows. Conversely, winter flows in the foothills and plains catchments were generally 60-80% of normal flows. These flow anomalies have continued and intensified going into spring.

On a regional scale groundwater levels are generally average to just below average and in most places are higher than levels recorded in spring 1998 which preceded a summer with extremely low groundwater levels. Below average aquifer recharge over autumn and winter, and a general decline of groundwater levels over this period, have been ameliorated by the high summer 2001/02 rainfall and associated low irrigation take. In a long-term context groundwater levels, although still below average in places, appear to be steadily recovering from the lows of 1999 and are currently higher than the lows experienced in the early 1970s, mid 1980s and early 1990s.

Weather forecasting organisations external to Environment Canterbury predict that a present weak El Niño climatic event will continue until the end of the 2002/03 summer, producing prevailing westerly quarter airflows. This is expected to result in above average rainfall for alpine areas and average to below average rainfall for the foothills and plains. If this occurs then the consequence will be a further intensification of high alpine river and low foothill and plains river flow anomalies. Restrictions on water abstraction have already been placed on several rivers in Canterbury this spring. On the basis of current low flows and meteorological forecasts further restrictions on foothill and coastal rivers this summer are anticipated.

Although groundwater levels over most of Canterbury are currently higher than spring 1998, the potentially drier summer would place a greater demand on groundwater resources. This, coupled with low foothill and plains river flows and a consequent lack of groundwater recharge, would place Canterbury’s aquifers under stress. This is especially so for areas dependent on shallow aquifers, such as Rangiora/Fernside, Oxford, West Melton/Yaldhurst, the Selwyn River area, the Orari area, and Pareora to Waitaki. Restrictions on groundwater abstraction associated with river flows are likely in some of these areas this summer. Areas where there has been a large increase in deep groundwater allocation such as Te Pirita and the Ashburton - Rangitata Plains may also experience very low groundwater levels.
# Table of contents

Executive summary .................................................................................................................. 3

1 Preconditions ......................................................................................................................... 9
   1.1 Rainfall ............................................................................................................................. 9
   1.2 River flows ....................................................................................................................... 11
   1.3 Groundwater recharge .................................................................................................. 12

2 Current conditions ................................................................................................................. 14
   2.1 Water balance ............................................................................................................... 14
   2.2 River flows ..................................................................................................................... 14
   2.3 Canterbury groundwater resources ............................................................................. 18
      2.3.1 Introduction .............................................................................................................. 18
      2.3.2 Overview of Canterbury groundwater ................................................................... 19
      2.3.3 Kaikoura Plains ...................................................................................................... 21
      2.3.4 Waipara/Omihia/Ashburton Plains ........................................................................ 26
      2.3.5 Ashley - Waimakariri Plains .................................................................................. 30
      2.3.6 Christchurch - West Melton Plains ........................................................................ 33
      2.3.7 Central Plains .......................................................................................................... 38
      2.3.8 Rakaia - Ashburton Plains ..................................................................................... 42
      2.3.9 Ashburton - Rangitata Plains ................................................................................ 45
      2.3.10 Rangitata - Opihi Plains ....................................................................................... 48
      2.3.11 Pareora - Waitaki Plains ....................................................................................... 51

3 Prognosis ................................................................................................................................ 54
   3.1 Climate ............................................................................................................................. 54
      3.1.1 El Niño Southern Oscillation as a climate indicator .............................................. 54
      3.1.2 Sea surface temperatures and El Niño Southern Oscillation as at mid October 2002 ......................................................................................................................... 54
      3.1.3 Implications for weather in Canterbury (until end 2002) ........................................ 55
      3.1.4 Sources for climate prediction ................................................................................. 56
   3.2 River flows ....................................................................................................................... 56
   3.3 Groundwater .................................................................................................................. 57
      3.3.1 Kaikoura Plains ...................................................................................................... 57
      3.3.2 Waipara/Omihia/Ashburton Plains ........................................................................ 57
      3.3.3 Ashley - Waimakariri Plains .................................................................................. 57
      3.3.4 Christchurch - West Melton Plains ........................................................................ 57
      3.3.5 Central Plains .......................................................................................................... 57
      3.3.6 Rakaia - Ashburton Plains ..................................................................................... 57
      3.3.7 Ashburton - Rangitata Plains ................................................................................ 58
      3.3.8 Rangitata - Opihi Plains ....................................................................................... 58
      3.3.9 Pareora - Waitaki Plains ....................................................................................... 58

Acknowledgements ................................................................................................................... 59
List of Figures

Figure 1.1 Location of rainfall sites used in analysis ...............................................................9
Figure 1.2 Winter (June, July, August) rainfall for 2002, as a percent of long-term winter rainfall .................................................................10
Figure 1.3 Geographic distribution of rainfall anomalies shown in Figure 1.2 .......................10
Figure 1.4 Location of river catchments considered in analysis ..........................................11
Figure 1.5 Winter (June, July, August) flows for 2002, as a percent of long-term mean winter flows .................................................................................12
Figure 1.6 Recharge monitoring (lysimeter) sites ................................................................12
Figure 1.7 Measured recharge at four Canterbury lysimeter sites .......................................13

Figure 2.1 Mid September to mid October flows for 2002, as a percent of long-term mean flows for mid September to mid October ........................................15
Figure 2.2 Geographic distribution of mid September to mid October flow anomalies .........16
Figure 2.3 Monthly deviations of flows in selected rivers for 2002 ........................................17
Figure 2.4 Example envelope plot, bore L36/0092 ..................................................................19
Figure 2.5 Long-term hydrograph of L36/0092, Courtenay Road ........................................20
Figure 2.6 Regional groundwater levels, September 2002, compared to normal September range .......................................................................................21
Figure 2.7 Kaikoura Plains location map showing selected monitoring sites and hydrogeological zones ....................................................................................22
Figure 2.8 Bore O31/0030, Chapmans Road .........................................................................23
Figure 2.9 Bore O31/0200, Mt Fyffe Road ..........................................................................24
Figure 2.10 Bore O31/0026, Kowhai Ford Road ....................................................................25
Figure 2.11 Bore O31/0197, Inland Kaikoura Road ...............................................................26
Figure 2.12 Waipara/Omihi/Amberley location map showing selected monitoring sites .......27
Figure 2.13 Bore N34/0110, Omihi (no 1998 data available) ................................................28
Figure 2.14 Bore N34/0049, Waipara (no 1998 data available) .............................................28
Figure 2.15 Bore M34/0670, Amberley (no 1998 data available) ..........................................29
Figure 2.16 Bore M34/0095, Glasnevin (data not recorded between 1986 and 1999) .........29
Figure 2.17 Ashley - Waimakariri Plains location map showing selected monitoring sites and hydrogeological zones .................................................................30
Figure 2.18 Bore M35/0366, Rangiora Golf Course ...............................................................31
Figure 2.19 Eyre River Zone bore M35/0008, Fleming bore near Horrellville .................32
Figure 2.20 Lower Eyre River Zone bore M35/0205, Two Chain Road near Swannanoa ....32
Figure 2.21 Flow at Dalley's Weir .......................................................................................33
Figure 2.22 Christchurch – West Melton location map showing selected monitoring sites and hydrogeological zones .......................................................34
Figure 2.23 Bore M35/1000, West Melton/Yaldhurst Groundwater Management Zone trigger level bore ...................................................................................35
Figure 2.24 Bore M35/1110, West Melton/Yaldhurst Groundwater Management Zone trigger level bore ...................................................................................35
Figure 2.25 Bore M35/5560, Ilam University, Avon River spring zone .................................36
Figure 2.26 Bore M35/3691, confined aquifer pressures in a 51.8 m deep bore in the Burwood gravel .........................................................................................37
Figure 2.27 Bore M35/9056, confined aquifer pressures in a 44.4 m deep bore in the Riccarton gravel .........................................................................................37
Figure 2.28 Central Plains location map showing selected monitoring sites and hydrogeological zones .................................................................38
Figure 2.29 Bore L36/0064, upper Selwyn Zone ..................................................................39
Figure 2.30 Bore M36/0354, shallow groundwater, lower Selwyn Zone ............................40
Figure 2.31 Bore M36/0355, confined groundwater, lower Selwyn Zone ............................40
Figure 2.32  Groundwater levels in Te Pirita bores (L36/1157, L36/1226) compared to longer term record for bore L36/0092, Courtenay Road ............................................41
Figure 2.33  Rakaia - Ashburton Plains location map showing selected monitoring sites ...42
Figure 2.34  Bore L37/0022, Langdons bore near Pendarves ........................................43
Figure 2.35  Bore L36/0948, Winchmore Research Farm (no 1998 data available).........44
Figure 2.36  Bore K36/0045, between the North and South Ashburton Rivers, just upstream of Thompsons Track ..................................................45
Figure 2.37  Ashburton - Rangitata Plains location map showing selected monitoring sites.46
Figure 2.38  Bore K37/0221, Surveyors Road..................................................................46
Figure 2.39  Bore K37/0136, Flemington (no 1998 data available).................................47
Figure 2.40  Bore K37/0200, Laghmor (no 1998 data available) ....................................47
Figure 2.41  Rangitata - Opihi location map showing selected monitoring sites ...............48
Figure 2.42  Bore K37/0501, Rangitata Island .................................................................48
Figure 2.43  Bore K38/0013, Orton ....................................................................................49
Figure 2.44  Bore K37/0300, upper Coopers Creek (no 1998 data available).................50
Figure 2.45  Bore J38/0122, Pleasant Point ....................................................................51
Figure 2.46  Pareora - Waitaki location map showing selected monitoring sites ..............52
Figure 2.47  Bore J39/0006, Pareora Valley .................................................................52
Figure 2.48  Bore J40/0071, Waihao .................................................................................53

Figure 3.1  El Niño Southern Oscillation Index, 1995 to August 2002 ..............................55

List of Tables

Table 1.1  Summary of rainfall recharge monitoring results for 2002 ..............................13
Table 2.1  Current restrictions on surface water abstraction in Canterbury as at 17/10/02...18
1 Preconditions

1.1 Rainfall

Figure 1.1 shows an array of rainfall sites from which data was used in considering rainfall patterns in Canterbury for the June/July/August (winter) recharge period. Figure 1.2 shows, for each site, winter 2002 rainfall as a percent of the long-term winter mean for the site.

Rainfall in alpine areas of mid and south Canterbury was well above average for all sites, with a large proportion of this rain occurring in June. In north Canterbury, winter rainfall in alpine areas, as represented by the Glynn Wye gauge, was about average.

Conversely, rainfall during the winter recharge period over the plains and foothills was below average across the region. This was particularly so in north Canterbury, where less than 50% of the normal winter rainfall occurred in 2002. Rainfall deficits over the plains and foothills for the rest of the region were not as marked, being 70% to 80% of normal for most sites. Gauges in the Hakataramea and Lower Waitaki River valleys received 80% to 90% of normal winter rainfall in 2002.

Figure 1.3 summarises these spatial variations in rainfall recharge for the 2002 winter.

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![Map of rainfall sites](image)

**Figure 1.1** Location of rainfall sites used in analysis
Figure 1.2 Winter (June, July, August) rainfall for 2002, as a percent of long-term winter rainfall

Figure 1.3 Geographic distribution of rainfall anomalies shown in Figure 1.2
1.2 River flows

Flow records for the 2002 winter, from an array of catchments, have also been considered. Figure 1.4 shows the location of these catchments.

Figure 1.5 shows 2002 winter mean flows, for those catchments in Figure 1.4 as a percent of long-term winter mean flow. The flow patterns reflect the winter rainfall patterns outlined above – with alpine rivers such as the Waiau, Hurunui, Rakaia, Rangitata and Ahuriri having above average winter flows. These rivers typically have low flows in winter due to freezing in the upper parts of the catchments. Above average winter flows for winter 2002 were a result of both higher rainfall and milder temperatures that occurred in association with northwesterly airflows.

Winter flows in the foothills and plains catchments were below average, especially in the north Canterbury and Kaikoura regions. Two anomalies are noticeable. Firstly, river flows on Banks Peninsula were not quite as low (80% of normal) due to localised orographic rainfall. Secondly, the North and South Ashburton rivers received rainfall in their alpine zones, that resulted in winter flows being only slightly less than average.

![Figure 1.4 Location of river catchments considered in analysis](image-url)
Figure 1.5 Winter (June, July August) flows for 2002, as a percent of long-term mean winter flows

1.3 Groundwater recharge

Groundwater recharge from rainfall is recorded at the six lysimeter sites shown in Figure 1.6. With the exception of the Winchmore site, which was established in the 1950s, these sites have operated since 1999 having been installed with the dual objectives of supplying data for a FRST-funded research project on natural recharge and establishing a long-term recharge monitoring network.

Figure 1.6 Recharge monitoring (lysimeter) sites
Rainfall recharge is generally concentrated in winter when low evapotranspiration rates allow soil moisture levels to rise in response to rainfall. It is relatively unusual for recharge to occur in summer, however wet conditions in January 2002 resulted in recharge being recorded as shown in Figure 1.7. Despite that summer recharge the annual total for 2002 has been average or below average as shown in Table 1.1.

![Figure 1.7 Measured recharge at four Canterbury lysimeter sites](chart)

<table>
<thead>
<tr>
<th>Site</th>
<th>2002 recharge (mm)</th>
<th>Average (1999-2001) (mm)</th>
<th>% of average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christchurch Airport</td>
<td>120</td>
<td>183</td>
<td>66%</td>
</tr>
<tr>
<td>Lincoln</td>
<td>43</td>
<td>118</td>
<td>37%</td>
</tr>
<tr>
<td>Hororata</td>
<td>195</td>
<td>263</td>
<td>74%</td>
</tr>
<tr>
<td>Winchmore</td>
<td>224</td>
<td>225</td>
<td>99%</td>
</tr>
</tbody>
</table>

Table 1.1 Summary of rainfall recharge monitoring results for 2002
2 Current conditions

2.1 Water balance

The difference between rainfall accumulation and potential evapotranspiration accumulation (basic water balance) provides a general indication of how wet or dry the region is now compared to past years. If rainfall is greater than potential evapotranspiration there is an ‘accumulated surplus’ for the period considered. If rainfall is less than potential evapotranspiration there is an ‘accumulated deficit’. In the situation of accumulated surplus, rainfall that is not lost to evapotranspiration contributes to surface runoff and drainage, and soil and groundwater recharge (this usually only occurs in winter months).

The impacts of the past dry months on the three-month accumulated water balance were considered, as at mid October 2002, for eight sites in Canterbury for which the National Institute of Water and Atmospheric Research (NIWA) supply rainfall and potential evapotranspiration data. Sites at Kaikoura, Culverden, Rangiora, Lincoln, Darfield, Winchmore, and Waimate all show current ‘accumulated water deficits’ that are greater than deficits this time last year. At Kaikoura, Culverden and Waimate the deficits were at their 10% decile, which indicates that deficits of the current magnitude have occurred at this time in only 10% of the years recorded. Conversely, Tara Hills at Omarama showed an ‘accumulated water surplus’, which is expected at this time of year for this site.

2.2 River flows

Mid September to mid October 2002 flows for the rivers shown in Figure 1.4 were considered as an indicator of available surface water in early spring and the commencement of the irrigation season. Mean flows for mid September to mid October 2002 were calculated for each river, and compared to long-term average flows for the same period (Figure 2.1).
Figure 2.1  Mid September to mid October flows for 2002, as a percent of long-term mean flows for mid September to mid October  (note: some sites considered over the winter not considered for this period due to data unavailability)

Figure 2.1 shows that the flow anomalies in the winter 2002 flows have continued and intensified into the spring. This is consistent with September rainfall statistics from NIWA, which show for Canterbury the persistence of above average rainfall in alpine areas and below average rainfall in remaining areas. Rain from southerly quarter storms in early October has done little to alleviate low flows in coastal and foothill areas. Flows in alpine rivers were above normal for mid September to mid October 2002, with flows in the Ahuriri River for the period being 153% of their norm. Rivers which have part of their catchment area in the alpine region - such as the Clarence, Waiau, Ashburton and Omarama - had average to slightly below average flows for the period. Precipitation falling in the form of snow, especially in September, will help maintain flows in alpine rivers over spring and early summer.

In contrast the remaining foothill and plains rivers considered here all had flows in mid September to mid October 2002 that were less than 50% of normal. For the case of northern rivers such as Rosy Morn (Kaikoura) and the Stanton this figure was less than 20%. Rivers in mid and south Canterbury, however, are now also showing the effects of the recent dry conditions. This is especially so for rivers south of Timaru (not including very inland rivers) - the Pareora, Waihao and Hakataramea.

Figure 2.2 shows the geographic distribution of these flow anomalies. River flows are more spatially variable than this time last year. For mid September to mid October 2002, river flows for the plains and foothill areas were similar or slightly lower than those in September 2001. Flows in alpine rivers, however, were significantly higher for September/October 2002, than they were in the spring of 2001.
Figure 2.2 Geographic distribution of mid September to mid October flow anomalies

Figure 2.3 shows for three selected rivers the monthly deviations of flow away from flow ‘normals’ since the start of 2002. Flows in the Ashley and Pareora (eastern Canterbury) rivers are seen to start falling below normal in July and August. Flows in the Rangitata (alpine river) have started to increase above their norm since the end of August.
Figure 2.3 Monthly deviations of flows in selected rivers for 2002
Due to the unusually dry spring conditions detailed above there are already some water restrictions in place in the region (see Table 2.1 for details).

<table>
<thead>
<tr>
<th>River</th>
<th>Site</th>
<th>Minimum flow</th>
<th>Latest flow assessment (17/10/02)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rangitata</td>
<td>Klondyke</td>
<td>50-60 m³/s, RDR reduced to 26 m³/s</td>
<td>55.91 m³/s</td>
</tr>
<tr>
<td>Hinds</td>
<td>Boundary Road</td>
<td>0.300 m³/s, 50% restriction</td>
<td>0.226 m³/s</td>
</tr>
<tr>
<td>Opihi</td>
<td>State Highway 1</td>
<td>15 m³/s for BN permit holders</td>
<td>10.38 m³/s</td>
</tr>
<tr>
<td>Pareora</td>
<td>Huts</td>
<td>1.5 m³/s for consent CRC020599</td>
<td>0.667 m³/s</td>
</tr>
<tr>
<td>Waihao</td>
<td>McCulloughs</td>
<td>0.600 m³/s, 50% restriction</td>
<td>0.500 m³/s</td>
</tr>
</tbody>
</table>

Table 2.1 Current restrictions on surface water abstraction in Canterbury as at 17/10/02

2.3 Canterbury groundwater resources

2.3.1 Introduction

This section deals with the state of the groundwater resource in the Canterbury region. For ease of perusal, the Canterbury region has been divided into several smaller areas outlined in full later in this chapter, these being:

- Kaikoura Plains
- Waipara/Omihi/Amberley
- Ashley - Waimakariri Plains
- Christchurch - West Melton
- Central Plains
- Rakaia - Ashburton Plains
- Ashburton - Rangitata Plains
- Rangitata - Opihi
- Pareora - Waitaki

Groundwater level records are presented in each section through the use of bore hydrographs and envelope plots. An envelope plot is a summary graph that has been created to display several years of data in one plot, and to indicate how present groundwater levels relate to past measurements. An example of an envelope plot of bore L36/0092 (see Figure 2.28 for location), which has over 50 years of measurements, is illustrated in Figure 2.4 below.

The left vertical axis indicates the level of the groundwater in metres below ground. The bottom horizontal axis is a year’s time scale in months, in this case from December to November. The blue line indicates the levels measured over the last year, with the most recent reading, 16/10/02, indicated. The green line is the data from the same period in 1998 plotted for comparison. 1998 was chosen as it was a season of generally low autumn and winter recharge, similar to that of 2002, and is a year within peoples’ recent memory in which many areas experienced record low groundwater levels during the 1998/99 summer. Although the 1997/98 summer was meteorologically dry due to a strong El Niño effect, the 1997 winter was one of good recharge, so comparisons are not reasonable. All envelope plots used as part of this report have included data from the 1998 year if available. Water levels that fall within the white area of the plot are within one standard deviation of the mean.
groundwater level for each month, so in theory 68% of all readings will be within this range. This white area represents the ‘normal range’ expected in groundwater levels. The light grey shaded zones are between one standard deviation of the mean and the maximum or minimum recorded for each month. Water levels within this zone indicate that levels are either high or low compared to the normal range. The dark grey shaded area indicates levels above the maximum or below the minimum recorded in an individual month at each bore. Hence for October 2002, the groundwater level at L36/0092 is presently at -45.31m, which is slightly below what it was in October 1998, and is within the normal range expected. The lowest recorded reading in an October is around -52m, and the highest is around -27m below ground level.

Figure 2.4 Example envelope plot, bore L36/0092

2.3.2 Overview of Canterbury groundwater

2.3.2.1 Long-term groundwater level trends

Bore L36/0092 (Courtenay Road), lies in the upper zone of the Central Plains, between the Selwyn and Waimakariri Rivers (see Figure 2.28 for location). L36/0092 penetrates a deep aquifer, and due to its distance from the Selwyn and Waimakariri Rivers is recharged by rainfall. Because of this rainfall recharge source, and the long-term record of groundwater levels available (since 1951) L36/0092 is a good indicator of overall climate-induced groundwater level trends. The long-term hydrograph from L36/0092 is shown below in Figure 2.5.
Groundwater levels were relatively stable from 1951 to the mid 1960s, when levels began a steady downwards trend, bottoming out in the early 1970s. These recovered to highs in the late 1970s. Other lows have been experienced in the mid 1980s, the late 1980s to early 1990s, and present lows that have been established since 1999. From the long-term record, it can be seen that water levels, while at the low end of the range, are not as low as experienced in the past, and in the last three to four years appear to have been slowly recovering from the lows of 1999.

2.3.2.2 Regional groundwater levels

On a Canterbury-wide scale, groundwater levels are practically all at average to low levels. The areal distribution of groundwater lows from the Ashley River to Timaru is illustrated in Figure 2.6, where red triangles indicate levels 1-2 standard deviations below the September mean (as in the grey area on the envelope plot), orange average to below average readings, and blue above average. The map shows some particularly low areas such as the Selwyn River Zone, but otherwise low levels are fairly evenly distributed around the Canterbury region.
2.3.3 Kaikoura Plains

Rainfall data from Luke Creek indicates that rainfall since autumn has been below normal in the Kaikoura area. Summer 2001/02 rainfall was 167% of the summer mean, autumn 2002 rainfall was 53% of the autumn mean and the winter 2002 rainfall was 64% of the winter mean. Based on Middle Creek flow data from December 2001 to July 2002, the stream flows draining Mt Fyffe were significantly below average especially during autumn. Levels have started to decline in most wells since August, similar to 2001. Soil moisture in many areas has also declined and some irrigation began in late September and early October.
There are only three wells with long-term continuous groundwater level records that are currently monitored. The network has been recently reviewed and six additional wells have been monitored since May 2001. Based on the review the area was subdivided into four groundwater zones (Figure 2.7).
2.3.3.1 Mt Fyffe fans

The groundwater level is within its normal range – currently similar to water levels for the same time in 2001 and higher than 1998 (Figure 2.8).

Figure 2.8 Bore O31/0030, Chapmans Road
2.3.3.2 Central Kaikoura Plains

Inland, the groundwater level has recovered from a June/July low to an average water level in September (Figure 2.9). The current water level is lower than for the same time in 2001 but higher than 1998. At the coast the shallow water table is at its lowest for this time of year, similar to 2001 levels.

Figure 2.9 Bore O31/0200, Mt Fyffe Road
2.3.3.3 **Kowhai River East**

Inland the groundwater level has recovered from a May/June low to an average level, albeit lower than for the same time in August 2001 and slightly higher than levels for August 1998 (Figure 2.10). In the coastal confined aquifer the water level is average, higher than for the same time in 2001 and 1998.

2.3.3.4 **Kowhai River West**

Inland, water levels recovered from an April/May low to below average levels for August in response to winter recharge. The current water level is lower than for the same time last year – there are no records available for 1998 (Figure 2.11). The water table aquifer at the coast shows a similar trend to inland water levels.
Data from White Gorge (Waipara River) indicates that rainfall was high for summer but autumn rainfall was below average. Summer 2001/02 rainfall was 234% of the summer mean, autumn 2002 rainfall was 86% of the autumn mean and the winter 2002 rainfall was 67% of the winter mean. Despite the below average rainfall since autumn groundwater levels at present are generally average, benefiting from the high January 2002 rainfall.

Only one bore (M34/0095) in the current monitoring network has groundwater level records longer than three years. It is therefore difficult to determine trends and whether water levels are abnormally low with respect to a measured long-term range. Figure 2.12 shows the location of representative monitoring bores.
Figure 2.12 Waipara/Omihi/Amberley location map showing selected monitoring sites

North of the Waipara River, groundwater levels are currently average to above average and are higher than for the same time last year. Groundwater levels in most bores remained high over last summer and have continued to slowly rise during autumn/winter (Figures 2.13 and 2.14). In Omihi the water level in a deep (171m) and a shallow (25m) bore, while still average, have declined a little since autumn.
Figure 2.13 Bore N34/0110, Omihi (no 1998 data available)

Figure 2.14 Bore N34/0049, Waipara (no 1998 data available)

South of the Waipara River groundwater levels for most monitored bores vary from average to below average and all are currently higher than for the same time last year. Levels have been declining steadily, however, since autumn/winter in most bores (Figure 2.15) except very shallow bores less than 10m deep which have experienced some recovery since a
June low (Figure 2.16). In common with many other bores, M34/0095 benefited from a wet 2001/02 summer.

Figure 2.15  Bore M34/0670, Amberley (no 1998 data available)

Figure 2.16  Bore M34/0095, Glasnevin (data not recorded between 1986 and 1999)
2.3.5 Ashley - Waimakariri Plains

The Ashley - Waimakariri Plains (Figure 2.17) have experienced below average winter rainfall and rainfall recharge. The rivers that influence this sector of the plains (the Ashley, Eyre and Waimakariri), however, have impacted groundwater levels such that, with the exception of areas influenced by the Ashley River, they are generally at higher levels than they were at the same time in 1998. The delayed effect of summer flows (and lesser winter flows in the upper catchment) in the Eyre River following floods in January 2002 means that Eyre River Zone levels are around average for this time of year.

Figure 2.17 Ashley - Waimakariri Plains location map showing selected monitoring sites and hydrogeological zones

Normal water levels for this time of year are currently occurring in the coastal confined aquifers, and the aquifers that drive the springfed streams that rise near the coast away from the Ashley River.

The aquifers associated with the Ashley River in the vicinity of Fernside and Rangiora are just below average for this time of year and in some cases are lower than September 1998 levels. Flows in the Ashley River have been well below average since December 2001 (Figure 1.5) and record low groundwater levels were recorded in August 2002 as a result (Figure 2.18).

These levels, however, are only a fraction of a metre below average values and recent drought years have shown that groundwater levels in the Ashley River Recharge Zone (and flows in the associated springfed streams such as the Cam River) mainly depend on whether or not the Ashley River goes dry in the Rangiora area in the summer, and the duration of this drying.
The shallow aquifers associated with the Eyre River (including bores as far afield as Bennettts, Cust, and also those to the south of South Eyre Road) are usually the ones most impacted by dry winters. Eyre River flow along its full length in January 2002 ensured that groundwater levels in this area were high at the start of the year (Figures 2.19 and 2.20) and despite a general decline since then they are mostly in normal ranges for this time of year. They are generally significantly higher than levels in 1998 which was followed by a summer season of very low water levels and some water shortages.

Winter flows in the upper Eyre River (extending downstream of Oxford on occasion) are now producing a delayed rise in some groundwater levels (Figure 2.19) which should extend further downstream with time.

Figure 2.18 Bore M35/0366, Rangiora Golf Course
Of most concern in the Ashley-Waimakariri Plains is the flow of the Ashley River in the forthcoming summer and the sustainability of flows in some of the associated springfed...
streams (Cam River, Taranaki Creek, Waikuku Stream). At this stage it would seem that some Ashley-influenced springfed streams may reach minimum flows.

Springfed streams away from the Ashley River are likely to be more reliable. Data from a spring in the Ohoka Stream (Figure 2.21) shows that flows are currently at similar levels to those recorded in September 1997 and 2000 after which minimum flows were not recorded. These flows are significantly higher than in September 1998 when this spring was almost dry and restrictions on groundwater abstraction in the Ohoka catchment were considered.

![Flow at Dalley's Weir](image)

**Figure 2.21** Flow at Dalley's Weir (note that this spring was dry by the end of September 1998, and that current flow rates are similar to those recorded at the same time in 1997 and 2000)

2.3.6 Christchurch – West Melton

Groundwater levels in the Christchurch – West Melton area (Figure 2.22) are generally at or below average levels for this time of year and have been falling since August. In some areas groundwater levels are close to the lows experienced at the same time in 1998 – a period affected by an extended dry spell. The unexpected rainfall recharge which occurred in January had a marked effect on groundwater levels at the beginning of the year, arresting the steady decline that would have otherwise been experienced.
2.3.6.1 Unconfined aquifer zone

Groundwater use in the West Melton/Yaldhurst Groundwater Management Zone is managed in terms of specified trigger levels in five monitoring bores (M35/1000, M35/1110, M35/1691, M35/5696 and M36/0217). Groundwater levels for M35/1000, the most inland of the trigger level bores, are shown in Figure 2.23 together with the levels recorded in 1998. Levels are currently around average and have remained above the first trigger level below which restrictions would begin to apply. Groundwater levels for M35/1110 (Figure 2.24), on the eastern side of the management zone, are significantly below average and are at similar levels to those recorded in 1998. Groundwater levels in the other trigger level bores are also below average and close to or below 1998 levels. Early spring rain may help to improve the situation but there is still a possibility that abstractions within some of the West Melton/Yaldhurst Groundwater Management Zone will face restrictions over the coming summer.
Figure 2.23  Bore M35/1000, West Melton/Yaldhurst Groundwater Management Zone
trigger level bore

Figure 2.24  Bore M35/1110, West Melton/Yaldhurst Groundwater Management Zone
trigger level bore
2.3.6.2  **Spring zone**

Groundwater conditions within the zone most significant for springflow are represented by the groundwater levels for bore M35/5560 shown in Figure 2.25. Despite the summer recharge, which resulted in record high groundwater levels in February and March, levels have fallen back to be below average and similar to those recorded in 1998. Groundwater levels in the spring zone are generally below average and this is reflected in Avon River flow which is currently about 75% of average for this time of year.

![Figure 2.25 Bore M35/5560, Ilam University, Avon River spring zone](image)

2.3.6.3  **Confined aquifer zone**

Groundwater conditions in the confined aquifer zone are illustrated in Figures 2.26 and 2.27. Both records show a response to summer recharge or a drop in demand. Groundwater levels recorded in bore M35/3691 have generally fluctuated within the normal range and are currently slightly below average. In bore M35/3056 at the coast, groundwater levels reached record high levels in August but have fluctuated above average levels since then. Generally, throughout most of the confined aquifer zone pressures are below the average for this time of year and are close to the levels recorded in 1998.
Figure 2.26  Bore M35/3691, confined aquifer pressures in a 51.8 m deep bore in the Burwood gravel

Figure 2.27  Bore M35/3056, confined aquifer pressures in a 44.4 m deep bore in the Riccarton gravel
2.3.7 Central Plains

2.3.7.1 Selwyn Zone

Groundwater levels in the Selwyn Zone (Figure 2.28) are influenced by recharge from the Selwyn River. In the upper Selwyn Zone, groundwater levels are presently within the normal range expected although somewhat lower than those recorded in 1998 (Figure 2.29).

Figure 2.28 Central Plains location map showing selected monitoring sites and hydrogeological zones
In the lower Selwyn Zone, groundwater levels were low until January when they started to rise due to the wet summer and a lack of irrigation. The Selwyn River flowed at the State Highway 1 bridge, recharging the aquifers.

Shallow groundwater levels (Figure 2.30) are at 1998 levels and are considerably higher than last year due to lack of irrigation demand and the Selwyn River recharging the aquifers. All the springfed rivers flowed last summer, although Doyleston Drain was dry for a month before the heavy January rainfall. The Irwell River flowed throughout most of the last year.

Figure 2.29  Bore L36/0064, upper Selwyn Zone
Confined aquifers in the lower Selwyn Zone (Figure 2.31) have shown high levels over the last year after a low start.
2.3.7.2 **Central Plains**

The groundwater area north of the Selwyn Zone on the Waimakariri fan is presently experiencing relatively low groundwater levels, similar to the beginning of the 1998-99 season. Bore L36/0092 on Courtenay Road has been used as a climatic indicator in past investigations, as it responds to long-term rainfall patterns. The longer term record in L36/0092, measured since 1951 (Figure 2.5) shows present levels have been in recovery since lows in 1998-99, but that lower levels were recorded in the late 1960s to mid 1970s. The level in this bore is still on a slow long-term rise since the 1998 dry year.

2.3.7.3 **Te Pirita**

The Te Pirita area showed a sharp recovery in groundwater levels following the cessation of irrigation around April 2002 (Figure 2.32). The general pattern from the beginning of the measurements in Te Pirita in 1996 is an initial declining trend with a levelling in the last few years. The range of water levels seems to have increased which is a normal pattern in areas where abstractions are growing. When compared to bore L36/0092 (see previous section) this seems to match the long-term climatic trend in the wider area. Levels this spring show that irrigation has started early this year, due to the last three months being drier than normal.

![Graph showing groundwater levels in Te Pirita](image)

**Figure 2.32** Groundwater levels in Te Pirita bores (L36/1157, L36/1226) compared to longer term record for bore L36/0092, Courtenay Road
2.3.8 Rakaia - Ashburton Plains

Rainfall recharge as measured at Winchmore occurred over the summer period, but has been significantly below average (Table 1.1) throughout the autumn and winter seasons. At the same time the North Ashburton River was dry over much of its middle reach until well into winter 2002. Groundwater observed in many long-term monitoring bores (Figure 2.33) has risen to average levels with the exceptions being shallow inland bores that are dependent on rainfall recharge. It is for these aquifers that most concerns are held with respect to summer reliability.

Figure 2.33 Rakaia - Ashburton Plains location map showing selected monitoring sites
Long-term monitoring bores on the coastal side of State Highway 1 responded to irrigation turnoff following heavy rainfall in January and then continued to rise following average levels from March onwards (Figure 2.34). Levels are generally the same or a little higher than those in 1998, and are now starting to decline in response to early September irrigation. They now appear to be following a similar trend to the high demand 1998-99 season.
Mid plains levels further inland are generally average (Figure 2.35) or a little high. Water levels in some bores have been trending down since May as is typical. Many of these started rising to high levels from January onwards in response to summer rainfall and irrigation under the Ashburton - Lyndhurst Scheme. Water levels around Ashburton town are also about average for this time of year, and are now trending downwards.
Inland bores that are dependent on annual rainfall recharge on the plains (e.g. shallow bores near Methven and the North Ashburton River), are currently at low or very low levels for this time of year. Most of these are continuing to trend downwards, however a number have responded to recent rainfall (Figure 2.36).

2.3.9 Ashburton – Rangitata Plains

Groundwater levels in the Hinds area (between the Rangitata and Ashburton Rivers, Figure 2.37) have fallen to average levels or just below average levels for the time of year. On the coastal side of State Highway 1 between Hinds and Lowcliffe normal winter levels are below summer levels due to the recharge effect of border dyke irrigation during summer (Figure 2.38).
Figure 2.37 Ashburton - Rangitata Plains location map showing selected monitoring sites

Figure 2.38 Bore K37/0221, Surveyors Road

The coastal area between Hinds and Ashburton (not affected by irrigation recharge) showed average levels over past year and a rise after the high January rainfalls (Figure 2.39).
To the north of State Highway 1 groundwater levels are currently slightly below average (Figure 2.40).

Figure 2.39  Bore K37/0136, Flemington (no 1998 data available)

Figure 2.40  Bore K37/0200, Laghmor (no 1998 data available)
2.3.10 Rangitata – Opihi

2.3.10.1 Rangitata River

Groundwater levels to the south of the Rangitata River (Figure 2.41) recovered from the record lows of the 2001 spring to return to average levels and have been consistently at or just below normal since then (Figure 2.42).

![Figure 2.41 Rangitata - Opihi location map showing selected monitoring sites](image1)

![Figure 2.42 Bore K37/0501, Rangitata Island](image2)
2.3.10.2 Rangitata-Orari Deep Aquifer

Drawdown increase in the deep aquifer, compared to last summer, was as expected due to the increasing abstraction demand for irrigation placed on it. Groundwater levels have recovered and stabilised to normal levels following the cessation of pumping of the 2001/02 irrigation season (Figure 2.43).
2.3.10.3 Orari River System

Groundwater levels to the south of the Rangitata River have recovered from the record lows of last year to normal levels over the 2001/02 summer mainly due to the relatively wet summer period and less need for irrigation. Groundwater levels have dropped to low levels since June/July due to lack of recharge from a relatively dry winter (Figure 2.44).

2.3.10.4 Levels Plains

Groundwater levels in the upper Levels Plains have been at or above normal over the last year and are currently at similar levels to those at the same time last year (Figure 2.45). The lower plains recovered from the lowest ever levels over the 2001/02 summer to return to normal levels and are currently below normal for this time of year.

2.3.10.5 Fairlie-Ashwick Flats

There are only three years of groundwater data available, thus trends are difficult to establish. Groundwater levels, however, have been consistently higher over the 2001/02 year compared with previous two years.
2.3.11 Pareora – Waitaki

The Pareora-Waitaki groundwater systems are dependent on sustained flows in the foothill rivers (Pareora, Otaio, Makikihi, Hook, Waihao, Figure 2.46) throughout the summer, as the aquifers have little storage. These rivers experienced good recharge over the 2001/02 summer as a response to summer rainfall, leading to groundwater recharge in the January-February period to above normal levels. Flows since the summer, however, have dropped to below average levels and current groundwater levels are normal to below normal for this time of year.

Figure 2.45  Bore J38/0122, Pleasant Point
2.3.11.1 Pareora

Levels have been generally within or just below the normal range over the last year and are currently at similar levels to those in 1998 (Figure 2.47).

Figure 2.46 Pareora - Waitaki location map showing selected monitoring sites

Figure 2.47 Bore J39/0006, Pareora Valley
2.3.11.2 Otaio

Levels in the upper catchment have been within the normal range for the last year. Levels near the coast have been low over the 2002 winter but only four years of data is available for comparison with previous years.

2.3.11.3 Waihao

Levels have generally been within or just below the normal range and are currently similar to levels recorded for the same time last year (Figure 2.48).

Figure 2.48 Bore J40/0071, Waihao
3 Prognosis

3.1 Climate

3.1.1 El Niño Southern Oscillation as a climate indicator

Parameters such as wind, rainfall and temperature are determined by the passage of different weather systems over New Zealand. These systems are linked to larger global circulations that fluctuate between seasons and between years. Water temperatures in the Pacific Ocean determine one such circulation, the El Niño Southern Oscillation (ENSO).

ENSO fluctuates between cool (La Niña) and warm (El Niño) phases, and these phases have a direct bearing on climatic conditions in New Zealand. La Niña produces a dominant northerly airflow across the country, bringing reduced rainfall to south and southwest areas. El Niño produces a dominant westerly flow, which commonly produces dry or drought conditions in eastern areas.

Pressure differentials between Tahiti and Darwin are used as a measure of El Niño/La Niña occurrence and magnitude. The pressure differential, referred to as the Southern Oscillation Index (SOI), has become a useful tool in seasonal and long-term climate forecasting. It should be noted, however, that the ENSO phase (as indicated by the SOI) is superimposed on other phenomena, that together determine the exact nature of the conditions that occur. Climatic predictions provided by weather experts below should therefore be interpreted only as likely indicators, especially when the tools used in long-term forecasting are at a weak or undefined stage.

3.1.2 Sea surface temperatures and El Niño Southern Oscillation as at mid October 2002

The Meteorological Service and NIWA have both reported above average sea surface temperatures in the Tasman Sea, which is likely to result in enhanced humidity and trough activity in this area over spring. Cooler sea surface temperatures to the east of the South Island suggest air masses arriving from the east will tend to be drier than usual.

On a larger scale, warmer sea surface temperatures in the eastern Pacific Ocean (1°C above normal) have established a negative SOI, which indicates an El Niño circulation over the Pacific region at present (Figure 3.1). NIWA notes that this El Niño state has become more persistent over the last month. On the basis of previous similar sea surface temperature anomalies (especially 1972 and 1980), however, the Meteorological Service, NIWA and Blue Skies Weather forecast the current El Niño to be weak. The models are in agreement that El Niño conditions will continue for the next five months, with the Meteorological Service forecasting the demise of the El Niño event after February 2003. The Meteorological Service highlights that the current El Niño pattern is not following that of the severe El Niño event that occurred over the 1997/98 summer when sea surface temperatures in the central Pacific Ocean were as high as 4°C above normal. Similarly, Blue Skies Weather states that there is little chance of any serious intensification of El Niño through the summer. Information on the current state and development of the El Niño conditions can be found on the World Meteorological Organisation website at www.wmo.ch.
3.1.3 Implications for weather in Canterbury (until end 2002)

It is expected that large frontal bands, that form between the warm air masses in the west and cooler air masses in the east, will periodically cross over the South Island. These frontal passages will result in cooler temperatures and some rain. Depressions that are anticipated to develop over the Tasman Sea may bring the odd day of heavy rain should they cross over the region.

These regional scale weather features will be superimposed on a prevailing westerly air stream that typifies El Niño circulation events. All three forecasting institutes predict warm drying conditions in the eastern South Island (especially to the north), and rain and wind from northwesterlies in alpine areas. The following paragraphs outline these predictions in more detail.

For spring in the Canterbury High Country, the Meteorological Service predicts above average rainfall with northwesterlies increasing over spring, and increased frequency and intensity of frontal passages (high confidence). For the Kaikoura Coast and the Canterbury Plains sunshine hours and temperatures are expected to be above average, due to a prolonged period of spring westerly flows. Rainfall is expected to be average inland, but below average about the coast. Lows developing east of New Zealand will bring occasional southerly winds, hail and late frosts to the area, but little rainfall is expected to result from these events (moderate confidence).

For October, November and December in the Canterbury foothills and plains, NIWA predicts average to above average temperatures and average to below average rainfall, soil moisture and rivers flows.

For October, November and December in Canterbury, Blue Skies Weather predicts rainfall to be average to below average, with November and December more likely to be dry. Temperatures and sunshine hours are expected to be above normal, especially during November and December.
3.1.4 Sources for climate prediction

NIWA provides a ‘Climate Update’ every month, which reflects on climate over the last month and offers predictions for the three months in advance. The ‘Climate Update’ can be received by mail or viewed on the Internet at www.niwa.co.nz/ncc/current.html.

The Meteorological Service provides a two month forecast after the 10th of each month in fax form. ‘Metfax’ provides a summary of current indicators, and separate forecasts for climatically similar regions within New Zealand. The Metfax number is 0900 999 88.

Blue Skies Weather provides three month forecasts every month for the Canterbury region which include a brief summary of conditions that occurred over the last month and predictions of weather patterns and rainfall, temperature and sunshine parameters. Forecasts can be obtained from Blue Skies Weather and Climate Services Ltd, PO Box 17621, Christchurch, telephone 03 326 4234 or email forecasters@blueskies.co.nz.

All these avenues provide good ongoing climate predictions, and it is recommended that water users employ such tools to help in their management of the Canterbury water resource.

3.2 River flows

Below average winter rainfall over the plains and foothills in Canterbury has continued into spring. The dominance of westerly quarter airstreams over the region reflect both the onset of a ‘weak’ El Niño event, and the trend of prevailing westerly winds in spring time.

In response to these conditions, river flows over winter were above average in alpine-fed rivers and below average in plains and foothill rivers. This pattern has continued and intensified into spring, with rivers in coastal parts of the very north and very south of the region being worst affected.

Climate forecasts indicate that the El Niño circulation pattern is likely to continue into at least early 2003. In this case the climatic conditions associated with El Niño – westerly flows with warm dry conditions for the Canterbury Plains, foothill and inland basins – will also continue.

Given that flows in alpine rivers are currently average to above average, and that ongoing westerly conditions (which bring rainfall to the upper catchments of alpine rivers) are forecast, it is unlikely that irrigators who abstract water from alpine-fed rivers will face restrictions over the next few months, if at all, this summer.

Conversely, in a water management context, the Meteorological Service state that there are strong reasons to suggest that eastern areas from Hawkes Bay to East Otago are heading for a drought this summer. They highlight that a dry winter and currently below average soil moisture, coupled with prolonged periods of hot dry northwesterlies which are forecast for the months ahead, will result in parched pasture early next year.

The Environment Canterbury database indicates that flows in eastern Canterbury are currently lower than they were prior to the 1997/98 summer. A strong El Niño circulation during 1997/98 (Figure 3.1) produced hot, dry conditions that resulted in many restrictions on surface water abstraction. The current El Niño event, and associated weather conditions this summer, is not predicted to be as severe, but the current low flows coupled with generally warm and dry weather predicted should be seen as a concern for surface water management. All irrigators and water users who abstract water from rivers originating in the inland basins or eastern foothills should, at this stage, be anticipating water restrictions.
3.3 Groundwater

3.3.1 Kaikoura Plains

Despite below average rainfall for autumn and winter, groundwater levels are generally within their normal range at present (apart from the low groundwater levels in the shallow coastal aquifer north of Kaikoura) having benefited from high rainfall in January. No concerns are expected at this stage, however if drought conditions develop, shallow groundwater resources may be placed under stress.

3.3.2 Waipara/Omihi/Amberley

Groundwater levels have stabilised over the past nine months due to the wet 2001/02 summer but are now starting to decline. It is anticipated that groundwater levels may approach but not exceed previous lows.

3.3.3 Ashley - Waimakariri Plains

Groundwater supplies should be sustained through the summer, however two zones are currently experiencing low levels and are of concern.

Firstly, if flow in the Ashley River in the Rangiora/Fernside area is not maintained over the summer then the associated groundwater level can be expected to decline to low levels. This is possible, based on the climatic forecast. As a consequence, associated springfed streams (such as the Cam River, Taranaki Creek and Waikuku Stream) may reach minimum flows. The springfed streams away from the Ashley River (such as Ohoka Stream and the Kaiapoi River) are likely to be more reliable.

Secondly, groundwater upstream of Oxford is declining to very low levels and shallow bores may be subject to water supply problems this summer.

3.3.4 Christchurch - West Melton

Groundwater levels in the unconfined area are currently below average, and based on climate predictions, water users in the West Melton/Yaldhurst Groundwater Management Zone may experience restrictions over summer. No difficulties, however, are expected with groundwater supply in the confined zone.

3.3.5 Central Plains

With groundwater levels currently average to just below average, few difficulties with water supply are expected, with the exception of areas near the Selwyn River. Shallow bores (10-40m deep) in the upper Selwyn Zone and springfed streams such as the Irwell River and Doyleston Drain in the lower Selwyn Zone may be placed under significant stress as a result of forecasted below average rainfall in the Canterbury foothills and plains.

Water levels around Te Pirita recovered to normal levels over the winter, however recent growth in groundwater demand may see levels drop lower than previous years.

3.3.6 Rakaia - Ashburton Plains

In general it is anticipated that a similar pattern to that experienced in 1998-99 will be followed throughout this sector of the plains through the spring and summer. In 1998-99 this resulted in few problems in the area on the coastal side of State Highway 1, although there has been some increase in groundwater allocation for irrigation since then which could
cause levels to drop one or two metres below the lowest recorded levels from 1999. It is possible, however, that people with shallow inland bores will be subject to very low water levels and even water shortages as were experienced in the dry autumn of 2001.

3.3.7 Ashburton - Rangitata Plains

As for the 2001/02 irrigation season, it is anticipated that groundwater levels will rise over this summer, especially downstream of State Highway 1, as a consequence of artificial recharge caused by irrigation schemes in the upper plains.

3.3.8 Rangitata - Opihi

Groundwater levels for the 2002/03 irrigation season are dependent on the flow in the Orari River. If the river experiences a low flow summer then current groundwater levels, similar to those at the start of the 2001/02 season, would be expected to fall once again. Thus restrictions on groundwater abstractions related to low flows in the Orari River are likely.

Deep groundwater levels around Rangitata are currently average, however high demand on the aquifer due to the forecasted dry summer could cause water levels to drop to, or below, previous lows.

3.3.9 Pareora - Waitaki

Groundwater levels in the Pareora - Waitaki area are currently average. These aquifers, however, are dependent on river recharge and with surface water flows already low and predicted to decline, those with restrictions associated with river flows can expect continuing restrictions over summer.
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