# Proposed Plan Change 3B

# (Pomahaka catchment minimum flow)

# Section 32 Evaluation Report

# Regional Plan: Water for Otago

***This Section 32 Evaluation Report should be read in conjunction with Proposed Plan Change 3B (Pomahaka catchment minimum flow) to the Regional Plan: Water for Otago.***

**16 August 2014**

Otago Regional Council

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# Abbreviations used in this report

| | |
|---|---|
| MALF | Mean annual low flow |
| ORC | Otago Regional Council |
| Proposed Plan Change 3B | Proposed Plan Change 3B (Pomahaka catchment minimum flow) to the Regional Plan: Water for Otago |
| RMA | Resource Management Act 1991 |
| Water Plan | Regional Plan: Water for Otago (updated to 1 May 2014) |

# 1 Introduction

Proposed Plan Change 3B (Pomahaka catchment minimum flow) seeks to improve the management of the Pomahaka catchment by identifying a primary allocation limit and minimum flow regime. It also addresses a supplementary minimum flow and allocation block size for the river.

The Pomahaka catchment has reliable rainfall and a low need for irrigation but, if climate and land use change, there may be increased demand for irrigation water which, without management, may put pressure on aquatic ecosystems, natural character and other instream values.

Section 32 of the RMA requires an evaluation of the realistically practicable options, assessing their effectiveness and efficiency and summarising the reasons for deciding on the proposed provisions. This report makes that assessment, and should be read in conjunction with the proposed plan change.

# 2 Background

## 2.1 The NPS for Freshwater Management 2011

The National Policy Statement on Freshwater Management 2011 (NPSFM) requires Council to prevent the over-allocation of water resources, by establishing environmental levels for all surface water bodies and aquifers in the region and ensuring the objectives within Otago's Water Plan give effect to the NPSFM objectives.

The Water Plan was made operative on 1 January 2004. Its objectives give effect to the NPSFM by recognising the need to provide for the water needs of Otago's communities and industries, while maintaining long-term water flows and levels in the region's water bodies. The `Plan achieves this by establishing primary allocation limits, supplementary blocks for surface water and aquifer maximum allocation limits for groundwater resources; with appropriate minimum flows and aquifer restriction levels. Catchments with primary allocation limit and minimum flow regimes are listed in Schedule 2A.

As the proposed plan change is intended to extend existing minimum flow arrangements to include the Pomahaka catchment, there will not be any evaluation of this Water Plan framework. This Section 32 evaluation reflects the implications of the plan change and evaluates the environmental, economic, social and cultural effects of the regime as applied to the Pomahaka catchment.

## 2.2 Pomahaka catchment flows and current allocation

The Pomahaka River catchment is located in Southwest Otago. It has a relatively high reliable rainfall, which reduces dependence on irrigation. Burkes Ford, the flow monitoring site in the lower Pomahaka has recorded the river having a mean flow of 26,800 l/s and a mean annual low flow (MALF) of 4,300 l/s.

Currently, the Pomahaka River is under-allocated in terms of Policy 6.4.2 of the Water Plan. The default primary allocation limit is 50% MALF under that policy, which equals 2,150 l/s. At present, 772 l/s is available for further primary allocation, as approximately 1,378 l/s is allocated in surface water take consents. Current allocation is approximately 30% of MALF, with further new applications being made occasionally. Therefore, it is considered that water taking is not yet having a significant adverse effect on instream values but, because this situation could change in the near future, there is community support for closing further primary allocation. Jowett and Hayes (2004) recommend that for rivers with greater than 30% of MALF allocated, more in-depth consideration is needed for the minimum flow.

Some current takes of groundwater are from alluvium connected to the river, so would be appropriately considered as primary allocation of surface water, as discussed in ORC Report 2014/0749. That report suggests these be considered as surface water in terms of Policy 6.4.1A(a).

## 2.3 Pomahaka catchment values

The Pomahaka River is recognised in Schedule 1A of the Water Plan as having a regionally significant presence of trout. This catchment and its Waipahi tributary are the only catchments identified for this in the Water Plan. Some consider the Pomahaka the most significant brown trout fishery in Otago. Schedule 1A recognises the catchment's significant trout and salmon spawning areas, and significant areas for development of juvenile fish, as well as its native fish and invertebrate diversity.

Consultation with iwi through Kai Tahu ki Otago and Te Ao Marama has helped identify cultural values of the river. Over recent years the ORC called a number of public workshops to identify the catchment values held by its community and by visitors. These values are described below. In addition, technical reports for this catchment have provided input to the process. The reports identify management flows to maintain habitat for adult brown trout and a number of other fish species.

The main community values identified were:

- The regionally significant brown trout fishery;
- Habitat for native fish including lamprey and longfin eels;
- Agricultural out-of-stream uses for stock drinking water and dairy shed supply;
- Recreational use;
- Amenity values;
- Irrigation for agricultural and horticultural purposes.

Adult brown trout fishery values were considered of highest significance.

A technique known as instream flow incremental methodology (IFIM) analysis has determined flow requirements for a number of fish species found within the Pomahaka catchment. Table 1 outlines these flow requirements at the Burkes Ford flow monitoring site.

**Table 1.** Flow requirements for fish species at the Burkes Ford flow monitoring site.

| Fish Species | Optimum Flow (l/s) | Flow below which habitat declines (l/s) |
|---|---|---|
| Adult brown trout | 13,000 | 7,500 |
| Yearling brown trout | 6,400 | 2,500 |
| Brown trout fry | 6,000 | 2,500 |
| Galaxiid sp. | 2,200 | 1,000 |
| Upland bully | 2,600 | - |
| Common bully | 3,000 | 2,000 |
| Longfin eel | 3,000 | 1,500 |
| Shortfin eel | 3,000 | 500 |

The optimum flow and flow at which habitat declines sharply for adult brown trout are higher than MALF. Therefore, the natural low flows of the Pomahaka River are restricting habitat for adult brown trout, even though a regionally significant fishery persists. Jowett (2009) has explained this type of situation as not uncommon: provided the river flows are above 90% of MALF, adult trout will be sustained and, thus, it is expected the adult trout fishery will be maintained.

The flow requirements for fish species and historic take restrictions for consent holders were presented at community workshops in 2010-2011. The workshops built further on this information and allowed the community to identify a number of values important to them, and the flows required to meet these values.

# 3 Options overview

The following sections discuss the costs and benefits of the options considered and provide a detailed analysis of the preferred option as required by Section 32 of the RMA.

## 3.1 Irrigation season take management options

The following four options are considered in developing a primary allocation limit and minimum flow regime that protects the values of the Pomahaka River. These options are briefly:

**OPTION 1: Maintain the status quo**

Option 1 describes the current situation. This option relies on "default" provisions in the Water Plan: default primary allocation limit and no catchment-wide minimum flow; connected groundwater beyond 100 m from perennial surface water body excluded from take calculations.

**OPTION 2: Adopt a suggested primary allocation limit and minimum flow regime for the brown trout fishery**

Option 2 proposes to set a minimum flow of 3,600 l/s (summer, primary) and a primary allocation limit of 1,000 l/s.

### OPTION 3: Easier economic development

Option 3 proposes to set a minimum flow lower than 3,600 l/s (summer, primary) and a higher primary allocation limit than 1,000 l/s.

### OPTION 4: More natural river flows

Option 4 proposes to set a minimum flow higher than 3,600 l/s (summer, primary) and a lower primary allocation limit than 1,000 l/s.

In Options 2 to 4, any takes of connected groundwater that can be considered surface water are included, which allows for greater accuracy of the effects of taking.

Note that if those who have primary allocation status consents have been allocated more water than the primary allocation limit established by this plan change, there is no policy in the Water Plan to remove that status. In many Otago catchments, primary allocation exceeds the primary allocation limit set by the Plan, but holders of those consents may continue to benefit from that primary allocation status.

## 3.1.1 Analysis of options

| **Option 1** | **Maintain the status quo** |
|---|---|
| **BENEFITS:** | • No plan change required.<br>• More water can be taken as primary allocation, allowing for increased irrigation opportunity. |
| **COSTS/RISKS:** | • Administrative inefficiencies through assessment to impose individual minimum flows or residual flows on a case-by-case basis with every application to take water, resulting in increased consent processing costs for applicants.<br>• No encouragement for collaboration among those taking water when there is no whole-catchment minimum flow in place.<br>• No certainty for maintaining aquatic ecosystem or natural character values when there is no environmental bottom-line set.<br>• Default primary allocation limit allows for more water to be taken, without specific investigation of its sustainability.<br>• Any increased taking will lead to low flows, including any minimum flow, being reached more quickly and frequently. This can lead to “flat-lining” where the river can stay at a particular flow for lengthy periods while all available water above that flow is taken. |

| **Option 2** | **Adopt a suggested primary allocation limit and minimum flow regime for the brown trout fishery** |
|---|---|
| **BENEFITS:** | • Little change in certainty and reliability of supply to current consent holders.<br>• Reasonable economic opportunities based on taking water remain, with potential for employment in industries based on water takes.<br>• Reasonable level of maintenance of aquatic ecosystem and natural character values.<br>• Reduced potential for “flat-lining” of the river flow.<br>• All existing primary allocation consent holders retain primary allocation |

| | |
|---|---|
| | status. |
| **COSTS/RISKS:** | • Constraints on taking water in a dry year may require some investment in water storage.<br>• Fewer economic opportunities for new takers.<br>• Some need to reduce current allocation to the primary allocation limit (which happens over time through attrition) before any further allocation to primary can be anticipated.<br>• For consent renewal, primary allocation consent holders will be limited to no more water than they have historically taken (Policy 6.4.2A).<br>• Plan change required. |

| **Option 3** | **Easier economic development** |
|---|---|
| **BENEFITS:** | • Economic opportunities based on taking water enhanced, with potential for employment in industries based on water takes or supporting industries; new employment opportunities provided to new takers.<br>• Reduced need for investment in water storage.<br>• Little need to reduce current allocation to the primary allocation limit, before any further allocation to primary can be anticipated.<br>• All existing primary allocation consent holders retain primary allocation status.<br>• If the new primary allocation limit is set higher than the current primary allocation, primary allocation consent holders can apply, upon consent renewal. for more water than they have historically taken (Policy 6.4.2A). |
| **COSTS/RISKS:** | • Lower level of maintenance of aquatic ecosystem and natural character values.<br>• Reduction in economic opportunities to current consent holders, from lower certainty and reliability of supply, as more new primary consents could be granted, and more rationing would be required during low river flows.<br>• Increases potential for "flat-lining" of the river flow.<br>• Plan change required. |

| **Option 4** | **More natural river flows** |
|---|---|
| **BENEFITS:** | • Greater reduction in the potential for "flat-lining" of the river flow.<br>• Higher level of maintenance of aquatic ecosystem and natural character values.<br>• Increase in certainty and reliability of supply to current consent holders as fewer new primary consents granted.<br>• All existing primary allocation consent holders retain primary allocation status. |
| **COSTS/RISKS:** | • Economic opportunities based on taking water constrained, with potential for no growth in, or reduction in, employment in industries |

| | |
|---|---|
| | based on water takes; fewer economic opportunities for new takers.<br>• Increased constraints on taking water in a dry year requiring significant investment in water storage.<br>• Reduces the amount of water available for out-of-stream uses during low flow periods.<br>• Greater need to reduce current allocation to the primary allocation limit, before any further allocation to primary can be anticipated.<br>• For consent renewal, primary allocation consent holders will be limited to no more water than they have historically taken (Policy 6.4.2A).<br>• Plan change required. |

## 3.2 Winter season take management options

The following two options are considered in developing a primary allocation minimum flow regime for the values of the Pomahaka River over the winter period. These options are briefly:

**OPTION 1: Maintain the status quo**

Option 1 describes the current situation. This option relies on "default" provisions in the Water Plan: no catchment-wide minimum flow; connected groundwater beyond 100 m from perennial surface water body excluded from take calculations.

**OPTION 2: Adopt a suggested primary minimum flow for winter to provide for spawning requirements of the brown trout fishery**

Option 2 proposes to set a minimum flow of 7,000 l/s (from May to September, for primary allocation). Any takes of connected groundwater that can be considered surface water are included, which allows for greater accuracy of the effects of taking.

### 3.2.1 Analysis of options

| **Option 1** | **Maintain the status quo** |
|---|---|
| **BENEFITS:** | • No plan change required. |
| **COSTS/RISKS:** | • Administrative inefficiencies through assessment to impose individual minimum flows or residual flows on a case-by-case basis with every application to take water, resulting in increased consent processing costs for applicants.<br>• No encouragement for collaboration among those taking water when there is no whole-catchment minimum flow in place.<br>• No certainty for maintaining aquatic ecosystem or natural character values when there is no environmental bottom-line set.<br>• Minimum flow on some consents could allow taking that degrades habitat for spawning brown trout.. |

| **Option 2** | **Adopt a suggested primary minimum flow for winter to provide for spawning requirements of the brown trout fishery** |
|---|---|
| **BENEFITS:** | • Little change in certainty and reliability of supply to current consent |

| | |
|---|---|
| | holders.<br>• Retention of economic opportunities based on taking water, with potential for employment in industries based on water takes.<br>• Maintenance of aquatic ecosystem and natural character values.<br>• Near-optimum conditions maintained for brown trout spawning. |
| **COSTS/RISKS:** | • A single minimum flow throughout the year for primary allocation takes would provide ease in administration but no environmental benefits.<br>• Plan change required. |

## 3.3 Supplementary allocation management options

The following two options are considered in developing a year-round supplementary allocation block and minimum flow regime in the Pomahaka River. One is the status quo, the other is a suggested supplementary allocation block with an associated minimum flow. These options are briefly:

**OPTION 1: Maintain the status quo**

Option 1 describes the current situation. This option relies on the "default" minimum flow provisions in Policy 6.4.9(a) of the Water Plan if water is applied for in excess of the primary allocation limit; connected groundwater beyond 100 m from perennial surface water body excluded from take calculations.

**OPTION 2: Establish a minimum flow for supplementary allocation of 13,000 l/s with a block size established by the existing Water Plan provision**

Option 2 proposes to set a supplementary minimum flow of 13,000 l/s (all year). Any takes of connected groundwater that can be considered surface water are included, which allows for greater accuracy of the effects of taking.

### 3.3.1 Analysis of options

| Option 1 | Maintain the status quo (use of default minimum flow under Policy 6.4.9(a) |
|---|---|
| **BENEFITS:** | • No plan change required. |
| **COSTS/RISKS:** | • In a catchment not significantly over-allocated, the default supplementary allocation and minimum flow arrangements in Water Plan Policy 6.4.9(a) provide an inequitable minimum flow, potentially lower than that for primary allocation, which is contrary to the logical implementation of the Plan's framework.<br>• This would create administrative difficulty and costs if applicants relinquish primary allocation in favour of supplementary allocation.<br>• Any such minimum flow would be calculated on a case-by-case basis for every application to take supplementary water, resulting in increased consent processing costs for applicants, and possible litigation. |

| Option 2 | Establish a minimum flow for supplementary allocation of 13,000 l/s with a block size established by the existing Water Plan provision |
|---|---|
| **BENEFITS:** | • Reasonable economic opportunities based on taking water remain, with potential for employment in industries based on water takes.<br>• Maintenance of natural flow variability and the aquatic ecosystem and natural character values supported by that variability.<br>• Optimum flow for adult brown trout fishery is not reduced by supplementary allocation takes.<br>• Flow requirements of native fish is not reduced by supplementary allocation takes. |
| **COSTS/RISKS:** | • Constraints on new takes of water in a dry year requires investment in water storage to supply all irrigation needs.<br>• New takes may have no water availability for 58% of a typical year.<br>• Plan change required. |

# 4 Preferred options: Maintaining a brown trout fishery while enabling economic wellbeing

The following regime is recommended to provide for the habitat of the regionally significant adult brown trout fishery, while enabling an appropriate level of access to water for economic uses. The preferred options above are those that provide the most sustainable balance between instream and out-of-stream benefits and costs.

| | |
|---|---|
| Minimum flow monitoring site | Burkes Ford |
| Primary minimum flows | 3,600 l/s (October to April) |
| | 7,000 l/s (May to September) |
| Primary allocation limit | 1,000 l/s |
| Supplementary minimum flow (Block 1) | 13,000 l/s |
| Supplementary allocation (Block 1) | 500 l/s |

## 4.1 Detailed assessment

*Primary minimum flow*

The summer minimum flow of 3,600 l/s proposed is the flow recommended for the habitat of the regionally significant adult brown trout fishery. It will protect the instream values from taking when the river is naturally flowing low. This minimum flow is also in the flow range for maintaining habitat for native fish species present in the river.

The summer minimum flow gives a reasonable surety of supply to current consent holders.

A minimum flow higher than the catchment's MALF of 4,300 l/s would be unlikely to be exceeded naturally throughout most of the irrigation season. Such a minimum flow would be extremely restrictive to consent holders while having insignificant environmental benefit and is thus not considered to provide sustainable management of the water resource.

The winter minimum flow of 7,000 l/s is proposed to provide for adult trout habitat during the winter high flow period. This will provide a reasonable surety of supply to consent holders during the winter period.

*Primary allocation limit and the effects of its associated minimum flows on taking*

If primary allocation is greater than 1,000 l/s the river could reach the minimum flow more quickly and frequently. This will impact on aquatic ecosystems and other instream values, including recreational and amenity values. The suggested primary allocation limit will provide a reasonable reliability of supply to current consent holders.

Tables 2 and 3 show the effect of the proposed minimum flows over the period of record since 1962, assuming that the actual take from the catchment had been 1,000 l/s. The columns "Number of days for rationing" indicate on how many days there was less than an allocated 1,000 l/s available above the minimum flow, and thus rationing would have been required.

Where primary allocation exceeds the proposed limit of 1000 l/s, and taking reflects the greater allocation, river flows would be reduced and so the number of days without full availability would be greater than the figures in these tables and in Appendix A. Appendix A draws on 50 years of hydrograph records, to show historic water availability.

The table columns "Number of days no water is available" indicate the number of days where flows were less than the minimum flows of 3,600 l/s (Oct-Apr) or 7,000 l/s (May-Sept), so that no water would have been available for taking. The columns of "Greatest number of continuous days" shows for how long the longest stretch of no water availability lasted throughout a year in the period 1962 to the present.

**Table 2:** The effect of the proposed minimum flow and allocation limit on historic water availability in the Pomahaka River (Oct-Apr, minimum flow of 3,600 l/s)

| | Number of days for rationing (Oct-Apr) | Number of days no water is available (Oct-Apr) | Greatest number of continuous days when no water available (Oct-Apr) |
|---|---|---|---|
| **Average** | **12.6** | **13.1** | **7.4** |
| **Minimum** | **0** | **0** | **0** |
| **Maximum** | **57** | **65** | **50** |

**Table 3:** The effect of the proposed minimum flow and allocation limit on historic water availability in the Pomahaka River (May-Sept, minimum flow of 7000 l/s)

| | Number of days for rationing (May-Sept) | Number of days no water is available (May-Sept) | Greatest number of continuous days when no water available (May-Sep) |
|---|---|---|---|
| **Average** | **2.1** | **3.4** | **2.4** |
| **Minimum** | **0** | **0** | **0** |
| **Maximum** | **19** | **19** | **17** |

As can be seen in Table 2, under a Burkes Ford minimum flow of 3,600 l/s and 1,000 l/s being taken, water rationing would be required for 12.6 days in an average irrigation season, and 13.1 days where no water would be available at all to consented takes. Since records began, the greatest number of irrigation season days when takes may have needed rationing was 57 in 1989/90. In 1972/3 no water would have been available for 65 days in total as the flow was below this minimum flow. These data are presented in Appendix A attached, which shows that the longest *continuous* period with no water would have been in that 1972/3 season with no water available for taking under consents for 50 of those 65 days. The next longest continuous periods would have been 42 days in 1977/8, 23 days in 1970/1, 22 days in both 1967/8 and 1998/9; then 21 days in the 2012/3 irrigation season. In those five decades the average continuous length of days with no water is estimated to have been 7.4 days and, of the last decade, in 8 years that length was 0 to 7 days.

Appendix A also shows the number of days in past irrigation seasons when rationing would have been necessary and there was water available, assuming no more than 1000 l/s is taken in total.

Table 3 summarises the situation outside the irrigation season, if a minimum flow of 7000 l/s had been applied during the period of record. In an average year, less than 4 days of low (or no) water availability occur in that period for primary allocation, and in the driest winter on record (1995) there would have been 19 days with no water available to consented takes, with a continuous stretch of 17 days. It is unlikely that more than 1000 l/s would be taken at any time outside the irrigation season, so the number of days without full availability would be fewer than the figures in Table 3

Note the numbers in Tables 2 and 3 are revised from those presented in Table 2 in the Consultation Draft version of this report, using a more sophisticated statistical method.

A single minimum flow across the catchment applying to all those in primary allocation provides the opportunity for collaboration within a water allocation committee. This arrangement can assist in rationing, which is intended to avoid a minimum flow being reached. Rationing in a collaborative arrangement can take into consideration unique requirements for water by, for example a small seasonal crop. The ORC may instigate its own rationing regime if a catchment-wide water allocation committee is not set up (Policies 6.4.12B - 6.4.13)

Note that while community water supply takes are within primary allocation, they are not currently subject to a catchment-wide minimum flow, but are normally subjected to a “residual flow” to prevent large portions of the flow of a river being taken at the point of take.

*Supplementary regime*

A supplementary allocation block size is proposed in accordance with Method 15.8.1A of the Water Plan. The associated minimum flow gives a reasonable surety of access to water for future consent holders, who will need to store taken water to ensure a guaranteed supply. It is adequate to ensure supplementary taking does not impact on the adult brown trout fishery.

This form of allocation helps protect availability of water for primary allocation consent holders while the system of subsequent blocks ensures 50:50 flow-sharing between supplementary takes and the river. It is intended to reflect the community concerns, and will leave more water in the river than the quantity that can be taken under supplementary status consents.

*Groundwater*

In all cases, takes of groundwater connected to the river's surface water are to be considered as effectively surface water, in terms of Policy 6.4.1A(a). This requires mapping of the ribbon aquifers associated with the river's surface water, and inclusion within Schedule 2C.

*Socio-economic impact*

It is considered that employment opportunities and other economic measures for activities based on taking water are provided for adequately by the preferred options. Those relying on existing consents will continue to have access to water where the water is used efficiently, and new developments will be able to take into consideration effects on the wider catchment values.

## 4.2 Summary of evaluation

The recommended regime is seen as the most effective and efficient option as it:

- Provides further water for future users as supplementary allocation;
- Will have minimal adverse effects on instream values and will avoid further degradation;
- Maintains the instream values as far as practicable in a dry year;
- Avoids the loss of natural flow variability, avoiding "flat-lining";
- Provides a reasonable surety of supply to primary allocation consent holders;
- Provides for recreational and amenity values, especially that dependent on brown trout.

Groundwater in the ribbon aquifers is treated as surface water. It is important to consider these as surface water in terms of Policy 6.4.1A(a) and subject them to the same allocation and minimum flow regimes as the surface water takes that are more directly affecting river flows. This way all takes are subject to the same management and can collaborate to avoid adverse effects on river flows.

It is considered that the proposed changes to the Water Plan will promote sustainable management of taking water within the Pomahaka catchment.

# 5 Consultation

Four community workshops were held to identify community values for the catchment, consider options and assess the effects of the options. Workshops were held in Tapanui, hosted by the ORC, on 20 April 2010 (20 attendees), 19 July 2010 (15 attendees), 5 May 2011 (15 attendees) and 6 May 2014 (31 attendees).

A Consultation Draft for the Plan Change was released from 4 June to 23 June 2014, with 7 written responses received. Many responses were positive, while one sought a higher primary minimum flow for October to April, and another sought a lower one for that minimum flow. A request that was beyond the intended scope of the Plan Change was made, and another request was for a minor correction. A meeting was held to discuss comments made by the Otago Fish and Game Council on 9 July 2014.

# 6 Conclusion

The purpose of the RMA is to promote the sustainable management of natural and physical resources. It is considered that Proposed Plan Change 3B (Pomahaka catchment minimum flow) enables the ORC to better manage the water resources of the Pomahaka catchment, now and for the future, with particular focus on the regionally significant brown trout fishery, while enabling water taking for economic development.

# 7 Supporting information and references


National Policy Statement on Freshwater Management 2011

Resource Management Act 1991

ORC Regional Plan: Water for Otago (updated to 1 May 2014)

**ORC Reports to committee or Council:**

*2014/0749: South Otago basin aquifers*

*2014/0838: Consultation Draft Proposed Plan Change 3B (Pomahaka catchment minimum flow)*

*2014/0958: Notification of Proposed Plan Change 3B (Pomahaka catchment minimum flow)*

**ORC Technical Reports:**

- *Management Flows for Aquatic Ecosystems in the Pomahaka River*, August 2006
- *The Water Resources of the Pomahaka and Waiwera Rivers*, June 2007
- *Groundwater resource management review of the South Otago Basins*, April 2014

**Other reference material:**

Jowett, I., 2009. Instream habitat and minimum flow requirements in the middle and lower Oreti River. Prepared for Environment Southland, Ian Jowett Consulting, Client Report IJ0903.

Jowett, I & Hayes, J. 2004. Review of methods for setting water quantity conditions in the Environment Southland draft Regional Water Plan. Prepared for Environment Southland, NIWA Client Report HAM2004-018.

*ORC Pomahaka catchment information sheet*, July 2010

*ORC Pomahaka community workshop notes*, 2010-2011

*ORC Pomahaka catchment information sheet*, May 2014

*ORC Pomahaka community workshop notes and feedback forms*, May 2014

# Appendix A

**Pomahaka catchment:**

**Analysis of hydrograph 1962–present, showing historic water availability**

| Irrigation season | No. days rationing (3,600 – 4,600 l/s) | No. days of no water (<3,600 l/s) | Max continuous days of no water (<3,600 l/s) |
|---|---|---|---|
| 1962/63 | 13 | 28 | 10 |
| 1963/64 | 22 | 24 | 9 |
| 1964/65 | 0 | 3 | 1 |
| 1965/66 | 15 | 16 | 13 |
| 1966/67 | 25 | 2 | 1 |
| 1967/68 | 22 | 35 | 22 |
| 1968/69 | 17 | 13 | 3 |
| 1969/70 | 0 | 4 | 1 |
| 1970/71 | 17 | 42 | 23 |
| 1971/72 | 7 | 11 | 6 |
| 1972/73 | 14 | 65 | 50 |
| 1973/74 | 17 | 17 | 9 |
| 1974/75 | 17 | 21 | 15 |
| 1975/76 | 15 | 57 | 18 |
| 1976/77 | 23 | 28 | 13 |
| 1977/78 | 16 | 50 | 42 |
| 1978/79 | 0 | 0 | 0 |
| 1979/80 | 0 | 0 | 0 |
| 1980/81 | 32 | 18 | 10 |
| 1981/82 | 11 | 0 | 0 |
| 1982/83 | 0 | 0 | 0 |
| 1983/84 | 0 | 0 | 0 |
| 1984/85 | 9 | 0 | 0 |
| 1985/86 | 16 | 10 | 4 |
| 1986/87 | 0 | 0 | 0 |
| 1987/88 | 0 | 0 | 0 |
| 1988/89 | 9 | 0 | 0 |
| 1989/90 | 57 | 9 | 5 |
| 1990/91 | 0 | 0 | 0 |
| 1991/92 | 0 | 1 | 1 |
| 1992/93 | 0 | 0 | 0 |
| 1993/94 | 0 | 0 | 0 |
| 1994/95 | 34 | 19 | 8 |
| 1995/96 | 19 | 7 | 4 |
| 1996/97 | 0 | 0 | 0 |
| 1997/98 | 7 | 0 | 0 |
| 1998/99 | 28 | 27 | 22 |

| | | | |
|---|---|---|---|
| 1999/00 | 2 | 0 | 0 |
| 2000/01 | 31 | 12 | 10 |
| 2001/02 | 5 | 0 | 0 |
| 2002/03 | 19 | 14 | 14 |
| 2003/04 | 15 | 36 | 20 |
| 2004/05 | 0 | 0 | 0 |
| 2005/06 | 0 | 0 | 0 |
| 2006/07 | 8 | 3 | 3 |
| 2007/08 | 41 | 30 | 7 |
| 2008/09 | 17 | 10 | 5 |
| 2009/10 | 21 | 6 | 6 |
| 2010/11 | 6 | 0 | 0 |
| 2011/12 | 7 | 3 | 3 |
| 2012/13 | 11 | 48 | 21 |
| **Average** | 12.6 | 13.1 | 7.4 |
| **Minimum** | 0 | 0 | 0 |
| **Maximum** | 57 | 65 | 50 |