Ashburton Stockwater Network

Water availability and use

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Date: August 2012
Reference: 3CW923.M0
Status: Final

Executive Summary

Ashburton District Council (ADC) maintains a stockwater race network which services an area of 235,000 ha. The network was established 120 years ago and consists of 2,399 km of water races servicing approximately 2000 individual properties.

Water is abstracted from about 27 intakes of which eight, including the largest, have been measured for several years. These eight intakes supply approximately 79% of the maximum consented allocation (i.e. 8,281 L/s). If the water races were 100% efficient i.e. all the water was used by the stock, the maximum combined take of 8,281 L/s would provide 0.3mm of water across the entire area serviced by the network each day (i.e. 3m³/ha). This is a very small amount of water in the context of irrigation demand. No information is available on the total amount of water available at each intake, only the amount actually abstracted. This is a major constraint when reviewing the dynamics and potential use of the available water resource.

If the 8,281 L/s was not used for the stockwater network, it would be sufficient to irrigate 17,890 ha at a rate of 4 mm/day; assuming that the transfer and delivery of water was 100% efficient.

The actual usage of water by stock has been estimated at only 326 L/s; 4% of the total maximum allocation. If the required 326 L/s could be delivered with 100% efficiency this would ‘free up’ 7,955 L/s of water which could be used for other purposes e.g. irrigate an additional 17,183 ha of land to a depth of 4 mm.

Two intakes (i.e. Acton, 680 L/s and Klondyke, 230 L/s) are now managed by entities separate from Ashburton District Council, or take water from the Rangitata Diversion Race (RDR). Therefore, six major intakes are managed and monitored by ADC. These intakes account for approximately 76% of the maximum consented take of 7371 L/s required to support the stockwater race network administered by ADC.

The actual amount of water abstracted at each intake is significantly less than the maximum permitted volume for the majority of the time. This is because the maximum consented take is based on the demand for water under the most adverse conditions. Such conditions occur very rarely and only for short periods of time. The demand for water under ‘normal’ conditions is therefore significantly less than anticipated under the most adverse conditions. At Methven, Pudding Hill, Winchmore, Brothers, and Cracoft water is abstracted at the maximum rate for less than 1.5% of the time. The smallest monitored intake i.e. Bushside with a current maximum take of 70 L/s; however, appears to have exceeded its limit for approximately 42% of the time. This is partly because of the fact that this maximum abstraction limit was reduced significantly during the latest resource consent process.

Therefore, the maximum consented abstraction rates for the various takes do not provide a very good indication of either the amount of water which is available, or the amount which is actually abstracted. They also do not indicate how much water may potentially be available for other purposes, including augmenting river flows.

Reducing the maximum permitted abstraction would not result in a significant change in the amount of water remaining in the various rivers and streams for the majority of the time. Such a change would effectively release only ‘paper water’, water which is not being abstracted at present for the majority of the time. This water therefore is already in the rivers and streams except for those short periods when abstraction is at the maximum consented rate. Any slight increase in the amount of water remaining in the rivers and streams would only occur over those occasional short periods when abstraction is at its maximum consented rate.

Since there are limited data available for the other intakes, it is difficult to determine how representative these six abstractions are of the total network. If the other intakes are similar in their manner of water supply and operation the results of this analysis can be simply up-scaled. However, it is more likely that the small intakes have distinctive characteristics and behaviour. Irrespective of the relationship between these six intakes and the entire scheme, since these are the largest takes they are where changes in operation and efficiency would have the greatest potential impact.

The most effective way of improving the efficiency of the stockwater race system might be to integrate it with larger irrigation schemes as they are developed. Assuming that the ALIS irrigation proposal is typical, adding the stockwater component to the volume of water required for irrigation would add only 0.012 mm/day to the irrigation demand. This is significantly less than the measurement error associated with the irrigation water take. Including the stockwater component to the irrigation scheme would also only add from $12-$19.50 per ha to the total capital cost.

The major constraint with integrating the stockwater network with an irrigation network is the timing of when water is required. While stockwater is required year-round, irrigation systems generally only supply water over part of the year. The need to supply water at low rates for stockwater when the system is not being used for irrigation would have to be considered during the design stage. The issue of water quality, and differences in the requirements of both stock and irrigation water, would also need to be considered. In some areas integration may not be feasible or practical.

If the ‘losses’ inherent in the stockwater race system currently servicing the ALIS project area could be put to alternative uses, the ‘lost’ water could irrigate approximately 2,063 ha at a rate of 4 mm/day. Using current estimates of the cost of providing pipe irrigation infrastructure (i.e. $4,000-$6,500 per ha) it would cost from $8.25M to $13.4M to fully utilise this ‘saved’ water.

Water harvesting during periods of low-demand/high river flow and storing the water for use during high demand periods may enable greater use to be made of the ‘residual’ water i.e. the difference between the maximum consented abstraction and that actually abstracted. This, however, would require significant investment in storage infrastructure.

Contents

1 Introduction

Water is critical to the Ashburton District (ADC) in terms of public health and community well-being, and its major contribution to the primary sector and economy. There has been considerable discussion regarding water management within the Canterbury region and this has significant implications for Ashburton District and its stockwater race network.

The purpose of this report is to provide a summary of the existing abstraction regimes at six major water takes administered by ADC and used to support the stockwater race network. These intakes account for approximately 76% of the maximum consented take of 7,371 L/s. Assumptions are then made as to how these major takes relate to the total abstraction required to support the entire network. The variability in abstraction, and how this relates to the maximum allowable take permitted under the existing consents, is placed in context. The potential use of any 'residual' water i.e. that water which could potentially be abstracted but which is not utilised by the stockwater network, is also discussed.

1.1 Canterbury Water Management Strategy

The Canterbury Water Management Strategy (CWMS) has been developed to provide guidance to moving water management forward and meeting critical goals and objectives. The CWMS addresses the critical water management issues in Canterbury. These issues relate to economic, environmental, social, and cultural activities; and include:

- Pressure on river and aquifer systems;
- Deteriorating water quality and associated cumulative effects on ecosystems;
- Declining cultural health of water ways;
- The need for greater water use efficiency;
- Ensuring a reliable water supply;
- Challenges created by future trends, including the need for environmental integrity of agricultural exports and climate change; and
- The need for development of infrastructure to enable the commercial use of water.

The CWMS vision is *"to enable present and future generations to gain the greatest social, economic, recreational, and cultural benefits from Canterbury's water resources within an environmentally sustainable framework".*

The CWMS also contains targets relating to:

- *Kaitiakitanga*;
- Ecosystem health and biodiversity;
- Natural character of braided rivers;

- Drinking water;
- Recreational and amenity opportunities;
- Water use efficiency;
- Irrigated land area;
- Energy security and efficiency;
- Regional and national economies; and
- Environmental limits.

1.2 Ashburton Zone Implementation Programme

As part of implementing the CWMS, 10 'local' Zone Committees have been established within the Canterbury region. The Ashburton Zone includes the area between the Rakaia and Rangitata Rivers, and the coast and the Southern Alps. Much of this area is currently serviced by the stockwater race network. The Ashburton Zone Committee has prepared a Zone Implementation Programme (ZIP). The ZIP recommends actions and approaches for integrated water management solutions to support and achieve the principles, targets, and goals of the CWMS.

The Ashburton ZIP includes recommendations to Environment Canterbury, Ashburton District Council, and other parties. It contains a number of recommendations relating to land use, water quality, and water quantity. These key themes are likely to be a focus for most, if not all, ZIPs in the Canterbury region. While the ZIP is not a statutory document, there is an expectation and commitment for the ZIPs to be implemented, resourced, and given effect to; subject to long-term plans, annual plans, and other statutory local authority processes. It is expected that the ZIP will also inform and guide initiatives from industry and communities.

The ZIP sets a number of outcomes, priorities, and recommended actions around the management of flows in the Ashburton and Hinds River catchments, and the management of water quality. It is anticipated that these recommendations will be addressed in the Land and Water Regional Plan.

The purpose of the Land and Water Regional Plan (LWRP) is to identify the resource management outcomes or goals (objectives in the plan) for managing land and water resources in Canterbury while achieving the purpose of the Resource Management Act (1991).

The areas of greatest impact/importance within the Ashburton ZIP are:

- Increased flows in the Ashburton/Hakatere Rivers, particularly during summer low flow periods;
- Ensuring the Hakatere/Ashburton sub-regional chapter (of the Land and Water Regional Plan) provides for important values;

- Managing stockwater races for multiple uses;
- Nutrient load limits;
- Protecting wetlands;
- Prioritising immediate steps; and
- Biodiversity funding.

The priority outcomes and focus of recommendations are:

- Ashburton/Hakatere River – improved and protected natural character and *Mauri*;
- Ecosystem health and biodiversity – protected and improved;
- Water quality – protected and improved; and
- Water quantity – efficiently used, and with a secure and reliable supply.

Almost all of these principal themes and priority outcomes have implications for the future management and sustainability of the Ashburton stockwater race network. In fact, the water resource implications of decisions regarding the stockwater network are likely to be the most important choices facing the Ashburton District. This is because the stockwater network is, and historically has been, critical to the Ashburton District in terms of public health, community well-being, and the economy.

2 Stockwater network

2.1 General Overview

Within Ashburton District, the Ashburton District Council operates an extensive and complex network of stockwater races. This stockwater race system is an open channel water supply network that services an area of the Canterbury plains that extends from the Rakaia River in the north to the Rangitata River in the south (Figure 2.1). The network of water races comprises five separate schemes (Figure 2.2) which service a combined area of approximately 233,000 ha. The five schemes are:

- Methven/Lauriston;
- Winchmore/Rakaia;
- Acton;
- Mount Somers/Willowby; and
- Montalto/Hinds.

Collectively these five schemes serve approximately 2,000 individual properties.

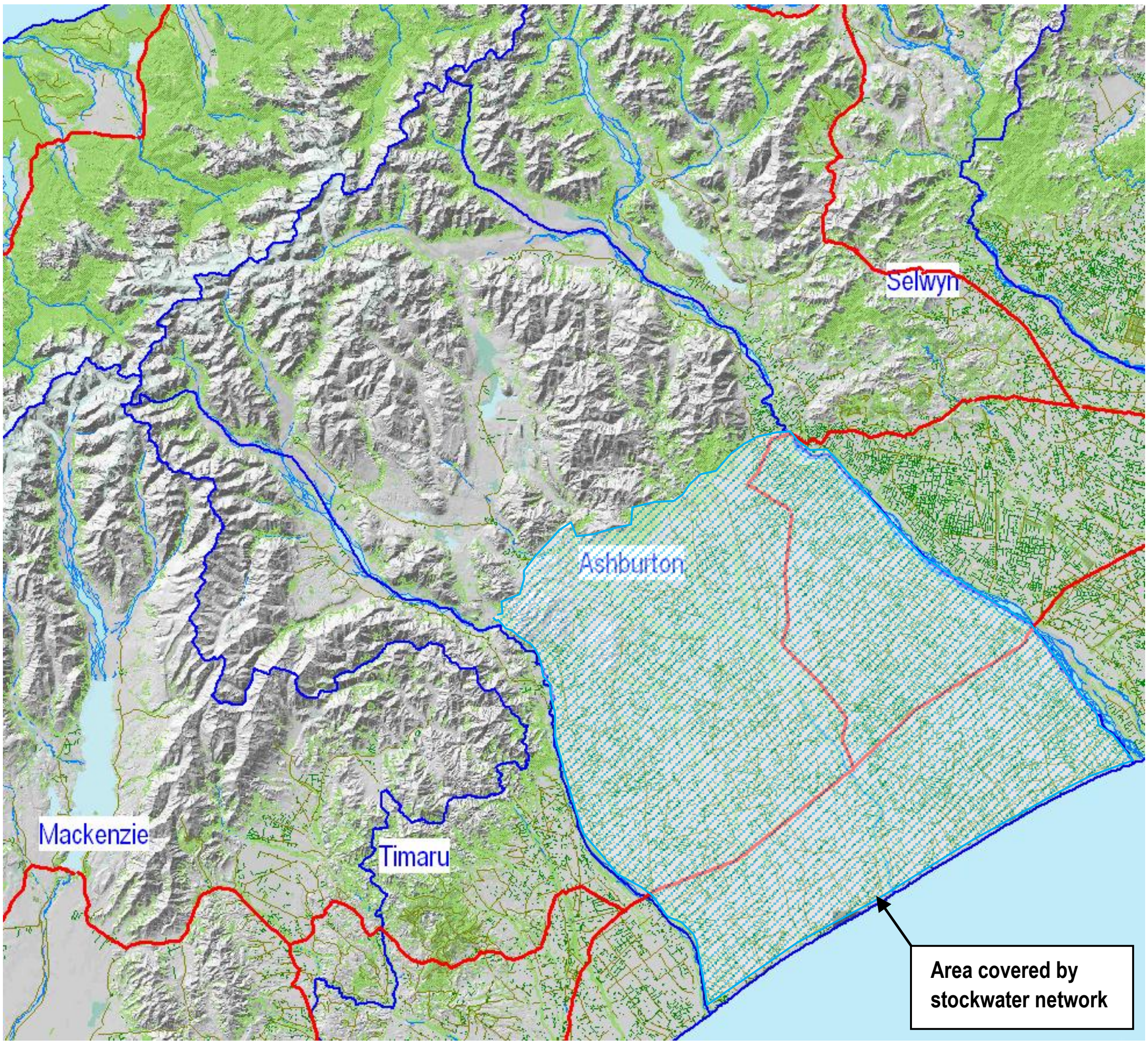

Figure 2.1: Location of the Ashburton District stockwater race network (Opus, 2011).

The water race network began operation approximately 120 years ago and was established to provide a reliable water source for agriculture. The primary purpose of the water race network today is essentially the same, although the network faces increased pressure from other resource users.

The ADC network is the largest stockwater network in Canterbury. It consists of approximately 2,399 km of water races (472 km of main races and 1,927 km of minor races) with ADC responsible for maintaining the majority of the main races. There are also a large number of intakes; 27, including one from the Rangitata Diversion Race at Klondyke and the Acton intake which is operated and managed by Acton Irrigation Ltd. There are over 100 discharge points into river beds, drains, soak pits, and the coastal marine area at the distal end of the various race networks.

Approximately 449 km of main race is operated and maintained by Ashburton District Council; a further 23 km is operated by Acton Irrigation Ltd. The remaining 1,997 km of race is operated by ADC, but maintenance is the responsibility of the property owners. Table 2.1 shows a summary of the scheme intake flows and race lengths.

Figure 2.2: Components and boundaries of the major schemes within the ADC stockwater race network (Opus, 2011).

The day to day management of each of the schemes is carried out by four water rangers. Each ranger is responsible for organising maintenance and capital work, monitoring flows, enforcing stockwater bylaws, and managing the overall operation of their scheme (Opus, 2011).

The Mt Somers/Willowby scheme has the greatest number of intakes and accounts for the largest percentage of the overall water taken. There is limited connectivity between the schemes except for the Methven/Lauriston scheme which discharges into the Winchmore/Rakaia scheme through the network of races in its lower reaches. Stockwater in the Montalto/Hinds scheme is also augmented by water from the Rangitata Diversion Race (RDR) via the Klondyke intake (Opus, 2011).

Table 2.1: Summary of scheme intakes and races (Opus, 2011).

	Intake	Source	Current Consent (L/s)	Flow Logging Now?	Flow Logging Future?	% of Total Take	Total Scheme Take (L/s)	Schemes % of Total Take	Main Race Length (km)	Race Length (km)	Total Race length	% of Total Race Length
Methven/Lauriston	**Bushside**	**Taylors Stream**	**70**	**Y**	**Y**	**0.8**	2400	29	94	651	745	31
	Durrans Terrace	Taylors Stream	100	Y	Y	1.2						
	Goughs Crossing	Taylors Stream	70	Y	Y	0.8						
	Carneys Creek	Carneys Creek	10		Y	0.1						
	Methven Auxiliary	**North Ashburton River**	**1,200** [1]	**Y**	**Y**	**14.5**						
	McFarlanes Terrace	*North Ashburton River*	*100* [5]		*?*	*1.2*						
	Pudding Hill	**Pudding Hill Stream**	**500** [1]	**Y**	**Y**	**6.0**						
	Washpen Creek	Washpen Creek	340		Y	4.1						
	Alford Forest	Springs	10	Y	Y	0.1						
Winchmore /Rakaia	Nicholls	Drain	85	Y	Y	1.0	875	11	63	309	372	16
	Winchmore	**Springs**	**790**	**Y**	**Y**	**9.5**						
Acton	Acton	Rakaia River	680 [4]	Y	Y	8.2	680	8	23	124	147	6
Mt Somers/Willowby	**Brothers Intake**	**South Ashburton River**	**1,955**	**Y**	**Y**	**23.6**	2931	35	170	356	526	22
	Clearwell springs West & East Intake	*Springs*	*100* [5]		*Y*	*1.2*						
	Flemington Drain Booster	Flemington Drain	100	Y	Y	1.2						
	Laghmor Booster	Laghmor Creek	56	Y	Y	0.7						
	Langdons North	Langdons Springs	40		Y	0.5						
	Langdons South	Langdons Creek	120		Y	1.4						
	Maginess Drain Booster	Maginess Drain	30	Y	Y	0.4						
	Remington Creek	Remington Creek	120	Y	Y	1.4						
	Russels Drain	*Springs*	*20* [5]		*Y*	*0.2*						
	Shepherds Brook	Shepherds Brook	80	Y	Y	1.0						
	Stoney Creek	Stoney Creek	110	Y	Y	1.3						
	Windermere Cutoff	Drain	200		Y	2.4						
Montalto /Hinds	Limestone Creek Intake	Limestone Creek	50	Y	Y	0.6	1395	1	122	487	609	25
	Cracroft Intake	**Rangitata River**	**1,115** [2]	**Y**	**Y**	**13.5**						
	Klondyke	RDR	230 [3]	Y	Y	2.8						
TOTAL			**8,281**			**100**	**8,281**	**100**	**472**	**1,927**	**2,399**	**100**

1. Consent conditions allow Methven Auxiliary to increase abstraction to 1700 L/s provided the Pudding Hill intake is reduced by same amount
2. Consent conditions allow for an increase from 849 L/s to 1115 L/s between 15th September and 14th May provided the increase does not continue for more than 14 consecutive days
3. Take provided through agreement with Rangitata Diversion Race Management Ltd. (RDRMC)
4. Take provided through agreement Acton Irrigation Ltd. (AIC)
5. Intakes and races in italics have subsequently been closed, or are likely to be closed soon
6. Intakes and races in bold are those with monitoring data discussed in this report

2.2 Flow Monitoring

Flow monitoring and recording has been carried out at eight of the 27 intakes under contract by Environmental Quality Services Ltd. Water level data from these intakes is presently collected at 15-minute intervals. This water level data is converted to flow information using a level/flow relationship derived from manual flow gaugings to derive a site rating. Data from these eight intakes is manually downloaded on a monthly basis. These eight intakes account for approximately 79% of the total consented take of 8,281 L/s. It is possible that the total consented take has reduced slightly as a result of the small intake and race closures highlighted in Table 2.1. Of these eight intakes, Methven Auxiliary, Brothers, and Cracroft intakes are the largest.

Three of the larger intakes (Cracroft, Pudding Hill & Winchmore) are also monitored separately by ADC. The data from these sites is transmitted by telemetry directly to the Council's offices.

Two monitored intakes (i.e. Acton, 680 L/s and Klondyke, 230 L/s) are now managed by entities separate from Ashburton District Council, or take water from the Rangitata Diversion Race (RDR). Therefore, six major intakes are managed and monitored by ADC. These intakes account for approximately 76% of the maximum consented take of 7,371 L/s required to support the stockwater race network administered by ADC.

ADC has also recently installed telemetered flow monitoring structures or meters at 14 of the smaller intakes as part of the requirements of the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010. Information from these sites is collected directly as flow data on-site prior to transmission, i.e. no post-processing is required. The remaining intakes are to have flow monitoring structures and equipment installed in the next year. There is little or no water use data available from these sites at present.

Rangers inspect flows at all intakes, discharges, and control points on a regular basis. Flows are typically estimated at control sections where a rating has been derived by flow gauging.

No continuous flow monitoring is undertaken either immediately upstream or downstream of the various intakes. Consequently, the size and dynamics of the various water sources are unknown. Whether there is additional water available at the various intakes, above that which is currently abstracted, is therefore unknown. It is known, however, that on occasions the various intakes are resource constrained i.e. there is not enough water available at the intake to meet the total demand.

2.3 Existing Water Usage

Data from Statistics NZ (2004) showed that the 'plains' area of Ashburton District supported around 1 million sheep, 90,000 beef cattle, and a lesser number of other livestock. Dairy cows were not included in the study but likely now make up a significant number of stock units. The stockwater race system also provides domestic water supplies in some areas, water for firefighting, and some household garden supply.

In considering the stockwater race system, the reliability of supply is of primary importance. Farmers are legally required to maintain *'proper and sufficient'* water for animals by the

Animal Welfare Act (1999). Livestock farms have animals on them throughout the year and therefore need access to a continuous supply of water. Consequently the supply of stockwater is distinctly different to irrigation water supplies which require a greater volume of water but generally only for a relatively short irrigation season.

Because of the way that stockwater race systems operate, a 10% change to the flow rate in the headwater race may equate to a 50% change in flow within a minor race at the distal end of the network.

2.4 Legislative Constraints

The Water and Soil Conservation Act (1967) gave priority regarding the allocation of water to domestic supply, stockwater, and firefighting. These provisions were carried over into the Resource Management Act (1991) which allows the taking and using of water for domestic purposes, or for stock drinking purposes, without the need for resource consent. Specifically, section 14(3)(b) of the RMA allows the taking and using of water for an individual's reasonable domestic needs; or the reasonable needs of an individual's animals for drinking water as long as there is no adverse effect on the environment.

As the stockwater network is a *'scheme'*, the water is not being taken for an individual's animal's needs. Section 14(3)(b) therefore cannot be used. This means that a resource consent was required for the network.

The Regional Council have prepared a new regional plan (notified 11 August 2012). It is noted that through the policies, priority is to be given to stock drinking water supplies.

Strategic Policy 4.3: Water is managed to maintain the life-supporting capacity of ecosystems, support customary uses, and provide for community and stock drinking water supplies, as a first priority; and to meet the needs of people and communities for water for irrigation, hydro-electricity generation and other economic activities and to maintain river flows and lake levels needed for recreational activities, as a second priority.

It is a moot point whether the water which has been taken for stockwater can be used for other purposes. At the very least a change in use would require a new consent. It may, however, be that if some or all of the water is to be used for 'other purposes', which do not have priority, then abstraction would be restricted or prohibited (particularly during summer). Other values and use of the water may be considered more important than what is proposed and consequently have higher priority.

This has significant implications for both the efficient and alternative use of water which is abstracted to supply the stockwater race network. Just because the water is not used for stockwater does not mean that it can be used for a purpose which is different to that for which its abstraction has been authorised.

3 Stockwater Use

While the open water race network is designed to supply stockwater throughout the district, there are no data relating to the actual demand or usage of this water by stock. Little is known of stock numbers, or the mix of stock which are supported by the water race network. This lack of information acts as a major constraint on the level of analysis and reliability of any results relating to the efficiency and effectiveness of the water race network.

The only information is available relates to the surface flows into and out of the various race networks. All other 'water transactions' relating to the water races are unknown.

At a general level, the stockwater network supplies water to approximately 235,000 ha. The maximum consented take across all 27 intakes is 8,281 L/s. If it was assumed that the water races were 100% efficient i.e. all the water was used by stock, at the maximum consented take this would provide 0.3mm of water across the entire area each day (i.e. 3m^3/ha). This is a very small amount of water in the context of irrigation water demand. The actual amount of water used by stock, however, is significantly less than this because:

- The maximum consented rate of abstraction is seldom or never taken; and
- The stockwater race network is certainly not 100% efficient.

While it is possible to quantify the actual rate of abstraction, and this is done in the next section, quantifying the efficiency of the race network is problematic. Losses from the races vary both spatially and temporally and so are not constant.

If the 8,281 L/s of water was not used as stockwater but for irrigation, it would be sufficient to irrigate only 17,890 ha at a rate of 4 mm/day; assuming that the transfer and delivery of water were 100% efficient.

3.1 Stockwater Balance

Opus (2011) attempted to quantify a water balance for the Ashburton stockwater race network. The key elements of that water balance are discussed below.

Water used by livestock

A typical allowance for stockwater is between 72 and 230 L/ha/day depending on stocking rates. An overall estimate of approximately the average of this range i.e. 120 L/ha/day, has been used for the area serviced by the Ashburton stockwater race network.

Domestic irrigation

Water from the races is also used for domestic irrigation, although the exact volume of water has never been quantified. ADC (2008) recognise that some water race customers are reliant on the races for domestic use. Twenty-one percent of respondents to a survey of all stockwater customers carried out in May 2002 indicated that they were reliant on the stockwater races for domestic use. Stockwater, however, is not intended for human consumption therefore domestic use is not a key objective of the water race network. Five percent of the total take has been allowed for this domestic usage.

Losses

EVAPORATION LOSSES

Evaporation losses to the atmosphere occur from the surface area of all water races. In Ashburton District the 2,399km of races have an assumed average width of 0.5m. This provides an estimate of average evaporation losses of 5 mm/day; with peak instantaneous losses equivalent to 12 mm/day. These evaporation rates are equivalent to a sustained water loss of 87 L/s (i.e. 5 mm/day), and a peak instantaneous flow loss of 210 L/s (i.e. 12 mm/day).

TRANSPIRATION

Another loss from the stockwater races is by transpiration. This occurs when plants, hedges and trees alongside the water races draw water from the race and transpire it into the atmosphere. Over the entire Ashburton District stockwater race network the transpiration loss has been assessed at 278 L/s under normal conditions.

DISCHARGES

Water is also discharged from the water race system directly into surface streams, drains, rivers, and to the sea. For most of the discharges this is a relatively small volume (less than 10 L/s) but during wet weather these may increase significantly as the races receive surface runoff. Discharges from the water race network have previously been assessed to be approximately 8% of the total water abstracted, however, they are thought to have been lowered to 3-5% since the last assessment.

INFILTRATION LOSSES

Water is lost to groundwater by seepage from the races. Water is also discharged directly to the ground at the ends of small distributor races.

Few field measurements of infiltration losses along the races have been carried out. Such losses are likely to very both spatially and temporally and so a high degree of scatter would likely be found in any field sampling programme. The calculation provided in Opus (2011), and summarised in Table 3.1 and Figure 3.1, indicates that approximately 82% of the abstracted water is lost to infiltration. This figure is consistent with 80-90% losses reported by de Joux (2000a & b), and in previous reports where flow measurements were carried out in the Ashburton and Selwyn Districts.

Therefore, despite being a stockwater race network only about 4% of the water passing into the scheme is actually used as stock drinking water. The bulk of the water in the race network is lost to infiltration.

Table 3.1: Water balance for the overall stockwater race network.

Water Use	Consumption (L/s)
Stock Use	326
Evaporation	69
Transpiration	278
Discharges to Drains/Rivers/Sea	414
Domestic Irrigation	414
Total Water Used/Discharged	*1,501*
Total Take	8,281
Infiltration	6,780

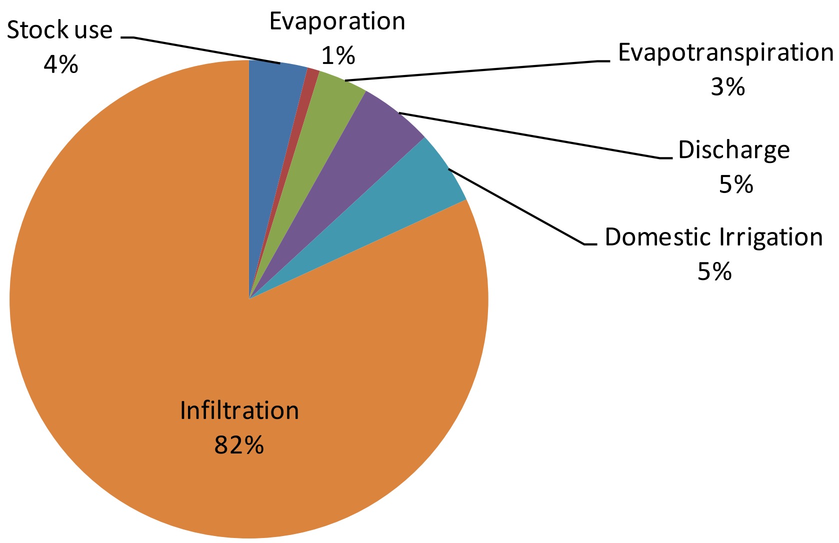

Figure 3.1: Summary of the overall water balance for the stockwater race network.

Assuming that this water balance is reasonably representative of average conditions, it suggests that the actual water needs of stock within the network area could be met with a flow of only 326 L/s. This would require that this water could be delivered with 100% efficiency.

Therefore, the total consented abstraction rate for the stockwater network is 8,281 L/s, while the actual stock demand is 326 L/s. If the required 326 L/s could be delivered with 100% efficiency this would 'free up' 7,955 L/s of water which could potentially be used for other purposes.

For comparative purposes, 326 L/s could irrigate approximately 704 ha to a depth of 4 mm/day. The remaining 7,955 L/s could irrigate an additional 17,183 ha to a depth of 4 mm/day.

4 Water Abstraction

4.1 Flow Monitoring

As discussed previously, flow monitoring and recording has been carried out at eight of the 27 intakes under contract by Environmental Quality Services Ltd (EQS). These eight intakes account for approximately 79% of the total consented take of 8,281 L/s. Of these eight intakes, Methven Auxiliary, Brothers and Cracroft intakes are the largest. ADC is currently in the process of installing flow monitoring devices at all of the intakes, but there is little or no data available for the smaller intakes.

The flow series relating to seven of these eight major water takes were obtained from both EQS (ADC's consultant hydrologist) and from NIWA (Graeme Horrell, *pers com.*). The Klondyke intake is supplied from the RDR, and is therefore distinctly different to the other intakes managed by ADC. Any change in water use at this intake will also not affect the local rivers and streams. Consequently, the flow data from the Klondyke intake is not analysed in this report. The flow series from the remaining six intakes account for 5,630 L/s, or 76% of the maximum consented take of 7,371 L/s across all those intakes administered by ADC and used to support the stockwater race network.

It was assumed that the flow series from both EQS and NIWA would be the same. However, inspection of Figure 4.1 shows that there are significant differences between the two flow series. While the general patterns of flow are consistent, the actual volume of water in the race occasionally varies over different periods of the record. It would appear that different rating curves have been used by NIWA for certain periods of the record to those provided by EQS.

Both EQS and NIWA were contacted in an attempt to resolve which of the data series is correct. EQS have primary responsibility for the collection of water level data, maintenance of the various flow monitoring sites, flow gauging and maintenance of accurate rating curves, and quality assurance.

NIWA indicated that they had reviewed the data and provided their own internal quality assurance. This apparently consisted of having an 'experienced' person review all the data and make 'adjustments' they thought appropriate. No report or any form of documentation was produced relating to this quality assurance process, or the reasons for those changes considered necessary.

Because it was impossible to verify why NIWA had changed some of the ratings, and they have not undertaken any additional gaugings to justify such changes, this study has assumed that the data provided by EQS is the more reliable and consistent. However, at some stage in the future the reasons for the two sets of data need to be explored, and the differences explained. There should only be one set of flow data.

4.2 Individual Abstractions

Ashburton District Council has a number of water permits to abstract water for the stockwater race network from various sources. Figures 4.1-4.6 show the actual volume of water abstracted at each of the six main sites administered by ADC, together with the current maximum consented take. These six sites account for approximately 76% of the total consented abstraction to support the stockwater network, excluding the take from the RDR at Klondyke.

In most cases the actual amount of water abstracted from each site is significantly less than the maximum permitted. This reflects the nature of water permits when applied to stockwater and irrigation. The maximum consented take reflects the maximum amount of water that will be required under the most extreme circumstances. The need for security of supply, while avoiding breaching consent conditions, requires that the peak demand be sought even if it will only be used on rare occasions and for short durations.

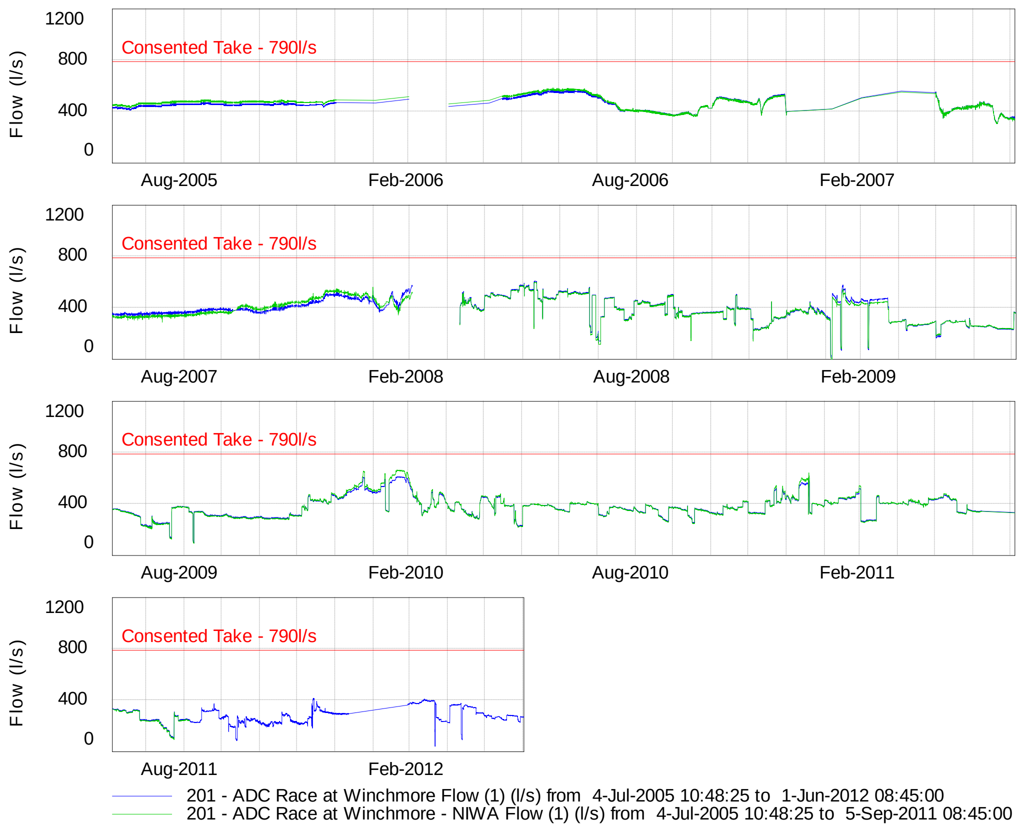

Figure 4.1: Ashburton District Council (ADC) stockwater race at Winchmore (ADC blue; NIWA green).

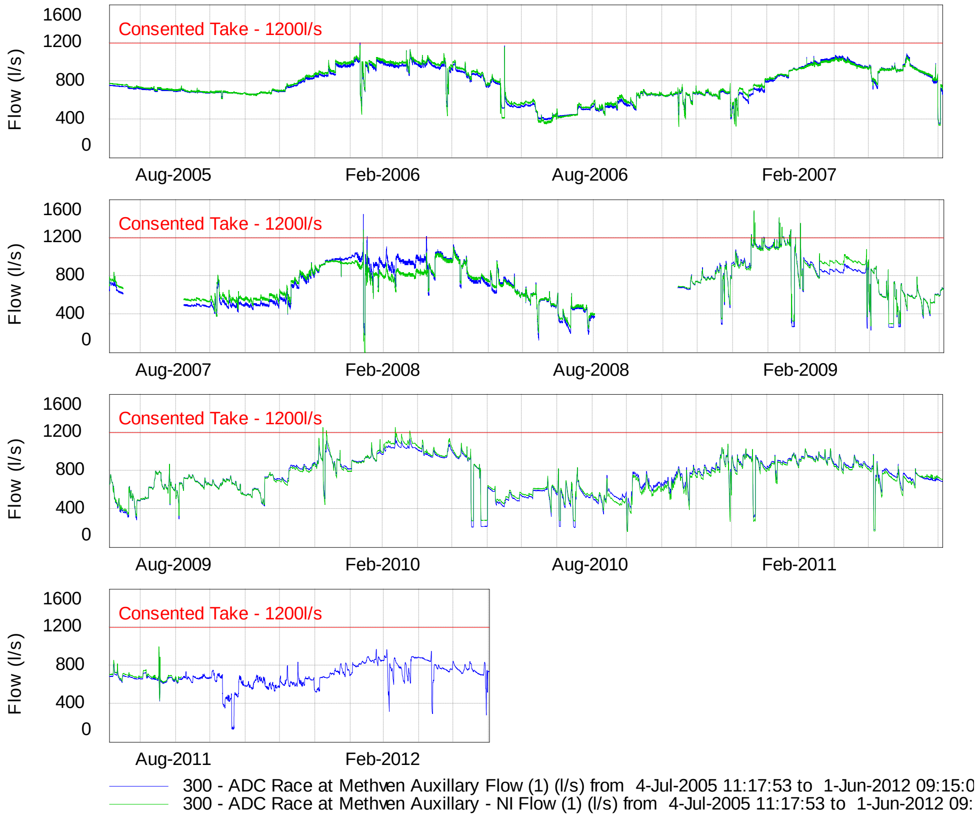

Figure 4.2: ADC stockwater race at Methven Auxillary (ADC blue; NIWA green).

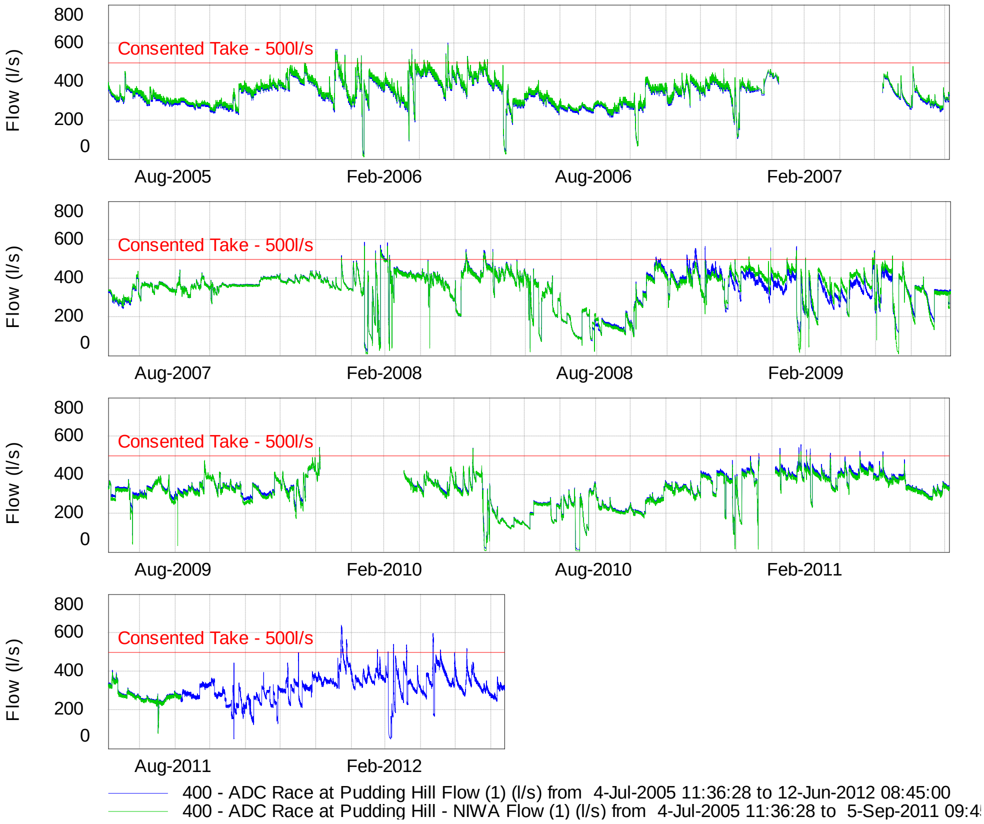

Figure 4.3: ADC stockwater race at Pudding Hill (ADC blue; NIWA green).

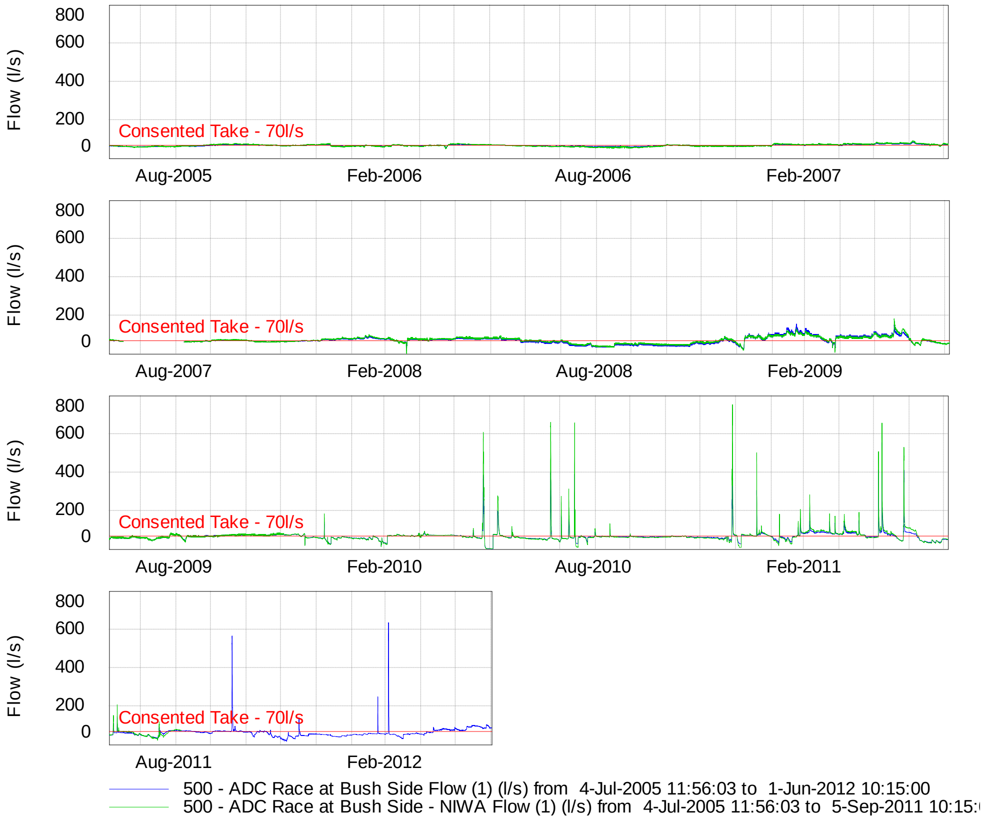

Figure 4.4: ADC stockwater race at Bushside (ADC blue; NIWA green).

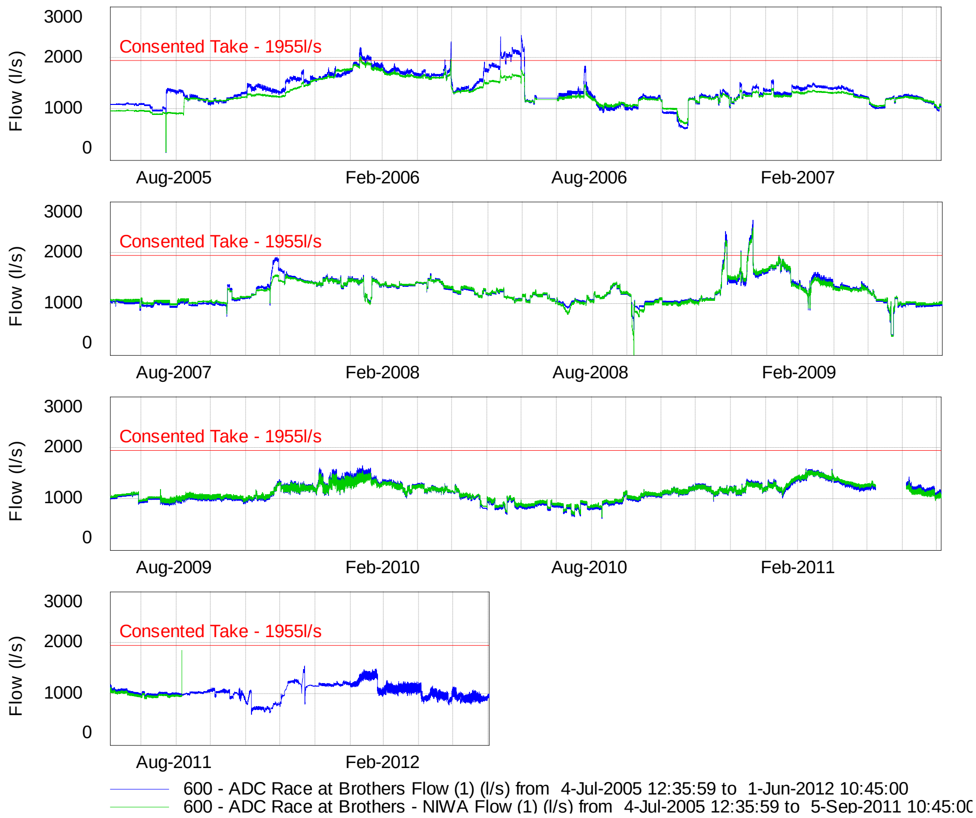

Figure 4.5: ADC stockwater race at Brothers (ADC blue; NIWA green).

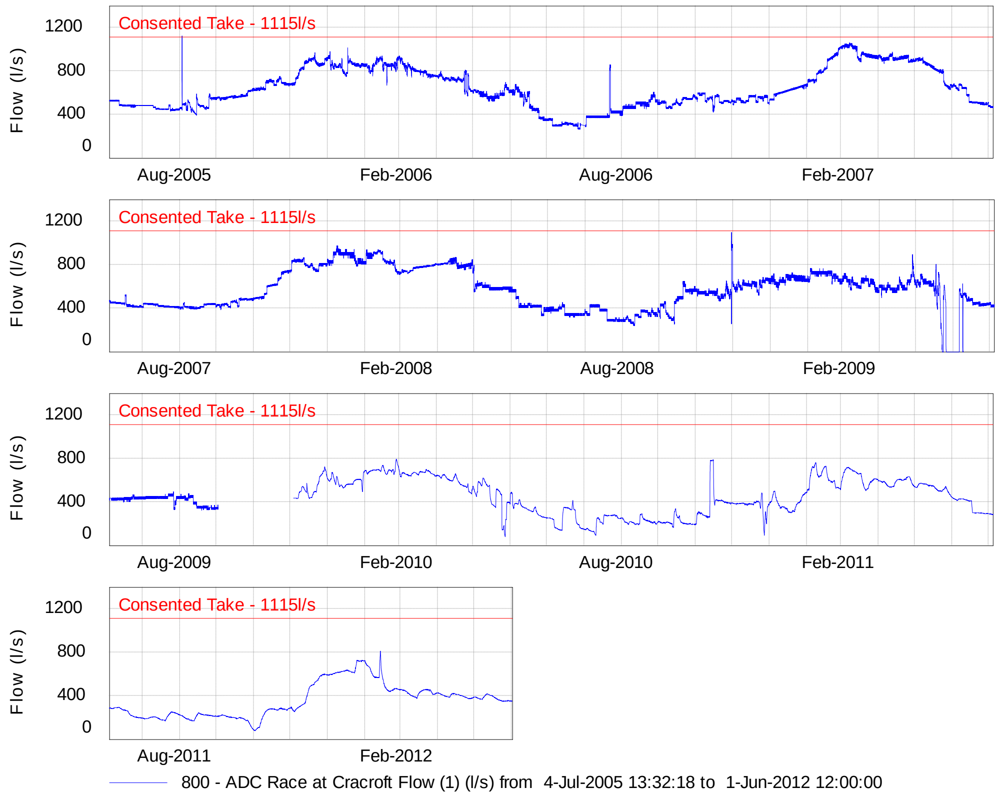

Figure 4.6: ADC stockwater race at Cracoft (ADC blue; NIWA green).

Table 4.1 summarises the amount of water actually abstracted from each of the six water takes, together with the current maximum consented take at each site. It should be noted that some of the maximum consented abstractions from specific intakes were changed during the latest resource consent process.

Table 4.1: Summary statistics for the seven major water takes which support the ADC stockwater race network (flow is in L/s).

Site	Consented maximum *(as of 2012)*	Min	Max	Mean	Std Dev	LQ	Median	UQ
Winchmore	790	0	614	395	91	335	399	460
Methven	1200	131	1471	742	186	617	726	894
Pudding Hill	500	14	642	334	83	285	342	329
Bushside	70	3	638	69	19	63	68	75
Brothers	1955	154	2645	1222	257	1040	1191	1360
Cracoft	1115	0	1125	530	200	395	520	659

Note LQ and UQ are the lower and upper quartiles respectively. Flows are less than the lower quartile 25% of the time, and therefore above the LQ for 75% of the time. The 'reverse' is the case for the upper quartile.

It is apparent that while the maximum consented abstraction has been exceeded at all sites except Winchmore, these breaches are of short duration. In general, considerably less water is abstracted to support the stockwater race network than is consented. For example, the median abstraction rate is generally about half the current maximum consented rate. This means that the limits stated on the consents are not a very good indication of the amount of water which is either potentially available or abstracted. There are also periods when there is just not enough water available in the source supply to meet the potential demand of the stockwater network. It should be noted, however, that there is no actual monitoring of flows in the various sources immediately upstream (or downstream) of the intakes. Periods of restricted supply are therefore impossible to quantify.

If the current maximum consented abstraction had been operative for the duration of the flow records then this limit (or more) has actually been abstracted for a very small percentage of time i.e. less than a 1.5% (Table 4.2). Part of the reason for Bushside apparently exceeding its consented maximum abstraction for 42% of the time is that the abstraction limit at this site was only reduced to 70 L/s in 2012. Prior to this the maximum permitted take was approximately twice this level. It is also important to recognise that the Bushside take is the smallest measured. It is therefore relatively easy for abstraction at this intake to exceed the permitted maximum.

Table 4.2: Percentage of time that the current maximum consented take has actually been abstracted.

Site	Percentage of time at or above the maximum consented take
Winchmore	0.0
Methven	0.2
Pudding Hill	1.0
Bushside	41.6
Brothers	1.5
Cracoft	0.0

Most of the occasions when abstraction exceeds the consented amount occur during high flow conditions when the river level rises rapidly and additional water flows into the stockwater intake until the gate is adjusted. Since a manual response is required as there are no automated intake structures on the schemes, this can take some time. These breaches, however, are likely to be of little concern to the consenting authority because they occur when there are high flows in the source rivers. These higher than consented abstraction rates therefore have no adverse environmental impacts.

Consequently, the maximum consented abstraction rates for the various takes do not provide a very good indication of either the amount of water which is available, or the amount which is actually abstracted. The actual amount of water abstracted from each location is generally significantly less than permitted.

Reducing the maximum permitted abstraction would therefore not result in a significant change in the amount of water remaining in the various rivers and streams for the majority of the time. Such a change would effectively release only 'paper water', water which is not being abstracted at present for the majority of the time. This water therefore is already in the rivers and streams except for those short periods when abstraction is at the maximum consented rate. Any slight increase in the amount of water remaining in the rivers and streams would only occur over those occasional short periods when abstraction is at its maximum consented rate.

While the summary statistics relating to the various abstractions provide some information regarding the magnitude of the water takes (Table 4.1) these are best summarised as a flow duration table (Tables 4.3-4.8). These tables show the percentage of time that abstractions are above certain flow values.

For example, in Table 4.3 the maximum flow is 614 L/s (i.e. exceeded 0% of the time) and the minimum flow is 0 L/s (i.e. exceeded 100% of the time). The flow that is exceeded 25% (i.e. 25th percentile) of the time is 460 L/s. The duration of all other flows can be obtained in the same manner.

Table 4.3: Distribution of abstractions at Winchmore (L/s). **The 25th percentile is highlighted.**

	0	1	2	3	4	5	6	7	8	9
0	614	571	558	555	550	543	535	529	520	515
10	510	504	499	497	492	489	483	479	476	472
20	470	469	467	463	462	***460***	458	456	454	454
30	454	451	449	448	446	443	441	437	433	430
40	426	422	420	416	412	410	407	405	404	402
50	399	397	394	391	389	387	382	382	380	377
60	375	372	369	367	364	362	360	358	355	352
70	349	346	344	341	338	335	331	327	322	319
80	315	311	309	302	298	296	293	288	282	276
90	269	261	256	251	248	240	235	229	221	188
100	0									

Table 4.4: Distribution of abstractions at Methven Auxillary (L/s).

	0	1	2	3	4	5	6	7	8	9
0	1471	1115	1071	1047	1035	1024	1010	999	989	982
10	976	972	967	964	959	955	949	944	939	933
20	927	922	914	908	901	894	886	879	872	866
30	861	856	852	846	839	834	827	821	811	802
40	794	785	777	770	762	756	750	743	738	731
50	726	721	717	713	708	704	700	695	691	688
60	684	681	679	676	674	671	668	664	662	657
70	653	648	639	632	624	617	609	602	595	588
80	576	564	555	549	542	535	530	522	514	508
90	501	495	489	480	468	451	436	410	363	267
100	131									

Table 4.5: Distribution of abstractions at Pudding Hill (L/s).

	0	1	2	3	4	5	6	7	8	9
0	642	498	476	464	455	449	444	439	435	432
10	428.8	426	422	420	417	415	412	410	408	406
20	404	402	399	397	394	392	390	387	385	383
30	380	378	376	373	372	370	368	367	365	364
40	362	360	358	356	354	352	350	348	346	344
50	342	340	338	336	335	333	331	329	327	325
60	323	320	318	316	313	311	308	305	303	300
70	298	295	292	289	287	285	282	280	278	276
80	273	271	268	264	260	256	252	249	243	237
90	230	221	213	204	186	170	160	147	130	95.5
100	14									

Table 4.6: Distribution of abstractions at Bushside (L/s).

	0	1	2	3	4	5	6	7	8	9
0	638	116	103	100	96	94	90	89	87	85
10	83	82	81	80	79	79	78	78	77	77
20	76	76	76	75	75	75	74	74	74	74
30	73	73	73	73	72	72	72	71	71	71
40	71	71	70	70	70	69	69	69	69	68
50	68	68	68	67	67	67	67	67	66	66
60	66	66	66	66	65	65	65	65	65	64
70	64	64	64	63	63	63	62	62	61	61
80	60	60	59	58	57	56	56	55	54	52
90	51	50	48	47	45	44	43	41	38	33
100	3									

Table 4.7: Distribution of abstractions at Brothers (L/s).

	0	1	2	3	4	5	6	7	8	9
0	2645	2044	1873	1811	1755	1722	1690	1659	1621	1583
10	1550	1522	1496	1479	1466	1452	1441	1433	1423	1417
20	1407	1398	1386	1376	1367	1360	1351	1343	1333	1325
30	1318	1310	1303	1295	1285	1277	1269	1262	1256	1248
40	1242	1237	1231	1225	1219	1218	1212	1207	1202	1197
50	1191	1186	1179	1173	1165	1158	1150	1142	1135	1127
60	1118	1112	1106	1098	1094	1090	1084	1078	1072	1066
70	1061	1056	1051	1048	1044	1040	1036	1031	1027	1023
80	1019	1014	1009	1003	997	994	987	982	974	966
90	960	949	937	926	912	885	856	833	806	724
100	154									

Table 4.8: Distribution of abstractions at Cracoft (L/s).

	0	1	2	3	4	5	6	7	8	9
0	1125	949	928	917	907	890	872	859	846	833
10	817	808	799	789	774	751	740	728	717	708
20	698	687	679	674	667	659	653	647	641	634
30	629	624	617	613	608	602	597	592	587	580
40	576	571	567	561	557	551	546	540	535	526
50	520	515	508	501	494	487	484	480	470	463
60	457	453	450	446	442	439	435	431	428	423
70	418	415	413	408	402	395	392	388	381	372
80	362	355	348	336	324	310	302	295	285	278
90	269	255	237	222	216	207	201	195	174	133
100	0									

4.3 Combined Abstraction

Rather than considering the individual abstractions from each of the six monitored intakes, the total amount of water abstracted at these sites can be analysed (Figure 4.7). It should be noted that these sites supply about 76% of the water required to support the stockwater race network administered by ADC. Since there are limited data available for the other intakes, it is difficult to determine how representative these six abstractions are of the total network. If the other intakes are similar in their manner of water supply and operation, the results of this analysis can be simply up-scaled. However, it is more likely that the small intakes have distinctive characteristics and behaviour. Irrespective of the relationship between these six intakes and the entire scheme, since these are the largest takes, they are where changes in operation and efficiency would have the greatest potential impact.

The total daily take was determined by summing the average daily abstractions at each of the six intakes. The total daily abstraction can then be compared to the maximum consented abstraction across these six intakes i.e. 5,630 L/s (Figure 4.7).

The combined abstraction across the six intakes has never exceeded the maximum permitted value. Generally the total abstraction is just over half (i.e. 57%) of the consented maximum.

The summary statistics and flow duration distribution for the total abstraction across the six intakes to support approximately 76% of the stockwater race network are presented in Table 4.9 and Table 4.10.

Figure 4.7: Daily take across all six intakes relative to the maximum total consented abstraction.

Table 4.9: Summary statistics relating to the total abstraction across all six intakes (L/s). The total maximum consented abstraction is 5630 L/s.

Consented maximum	Min	Max	Mean	Std Dev	LQ	Median	UQ
5630	1491	5176	3196	662	2686	3193	3675

Table 4.10: Distribution of total abstraction across the six intakes (L/s).

	0	1	2	3	4	5	6	7	8	9
0	5176	4639	4498	4418	4353	4295	4259	4225	4192	4147
10	4088	4041	4017	3993	3957	3926	3898	3869	3838	3816
20	3794	3772	3738	3713	3691	3675	3656	3639	3624	3609
30	3594	3580	3560	3533	3513	3491	3475	3454	3436	3418
40	3397	3378	3357	3330	3306	3284	3259	3239	3222	3208
50	3193	3176	3159	3145	3127	3102	3079	3058	3036	3014
60	2992	2974	2959	2929	2913	2889	2873	2847	2826	2807
70	2788	2768	2751	2732	2707	2686	2660	2636	2609	2579
80	2541	2510	2489	2465	2445	2420	2394	2363	2334	2305
90	2276	2249	2226	2205	2185	2166	2146	2120	2072	1987
100	1491									

4.4 Residual Availability

Since the amount of water abstracted to support the stockwater race network is generally less than the maximum consented abstraction rate there is a 'residual' volume of water available. Assuming that this water is actually available in the source rivers and streams (and there are certainly periods when it is not), and that regulatory constraints do not limit its use, this 'residual' water could potentially be used for other purposes.

The total daily take across all six intakes was therefore subtracted from the maximum consented take to determine how much water is potentially available for other uses across about 76% of the stockwater network (Figure 4.8).

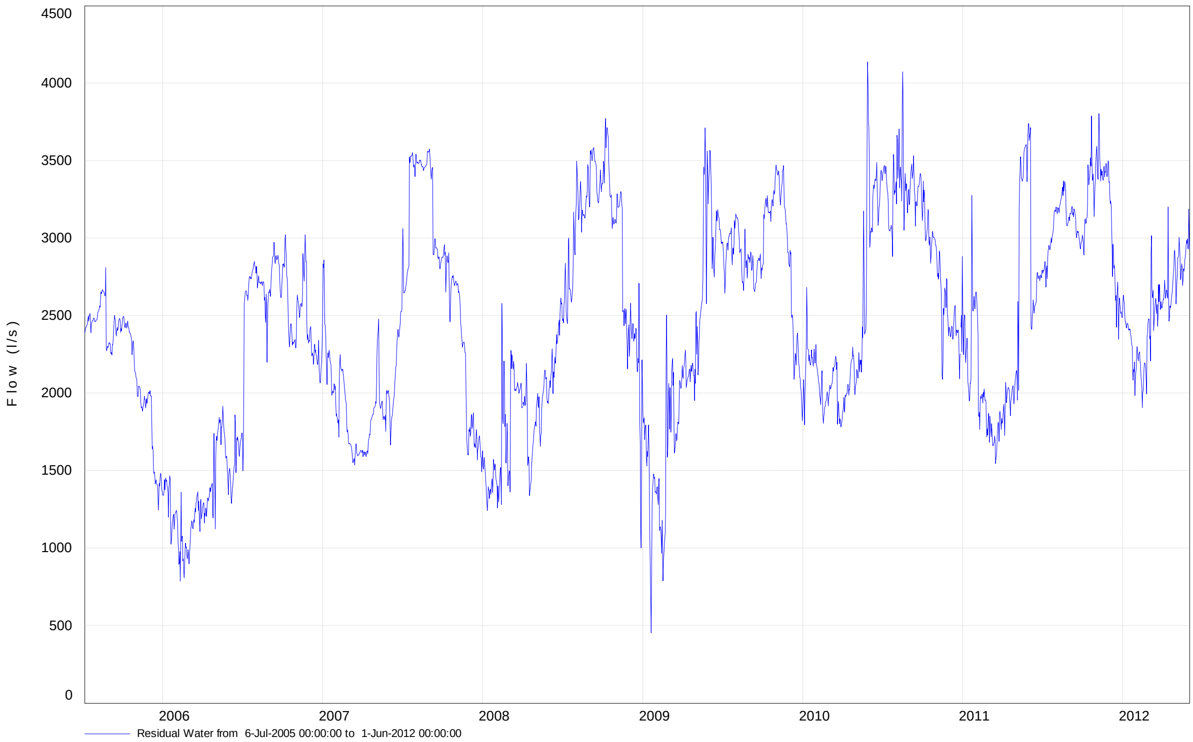

Figure 4.8: 'Residual' water that is potentially available for other uses.

A strong pattern of seasonal variation in the volume of 'residual' water is apparent. Over summer the volume of 'residual' water is significantly lower than the average, and can drop to between 1000 and 500 L/s during a dry summer. Utilising this 'residual' water may therefore require water harvesting and storage during low demand/high flow periods for use during dry periods when demand is high but supply low. This would require investment in storage infrastructure.

The summary statistics and flow duration distributions for this 'residual' water are presented in Table 4.11 and Table 4.12.

Table 4.11: Summary statistics relating to the 'residual' water which may be available across all six intakes (L/s).

Min	Max	Mean	Std Dev	LQ	Median	UQ
454	4139	2434	662	1955	2437	2944

Table 4.12: Distribution of 'residual' water across the six intakes (L/s).

	0	1	2	3	4	5	6	7	8	9
0	4139	3643	3558	3510	3484	3464	3445	3425	3404	3381
10	3353	3325	3296	3267	3236	3209	3185	3164	3141	3120
20	3089	3051	3021	2994	2970	2944	2923	2898	2879	2862
30	2842	2823	2804	2783	2757	2741	2717	2701	2671	2655
40	2638	2616	2594	2572	2551	2528	2503	2485	2471	2454
50	2437	2422	2408	2390	2371	2346	2324	2300	2273	2252
60	2232	2212	2194	2176	2156	2139	2117	2097	2070	2050
70	2036	2021	2006	1991	1974	1955	1939	1917	1892	1858
80	1836	1814	1792	1761	1732	1704	1673	1637	1613	1589
90	1542	1483	1438	1405	1371	1335	1277	1212	1132	991
100	454									

4.5 Water Surplus to Stockwater Demand

While a considerable volume of water is abstracted to support the stockwater race network, previous analysis has shown that only about 326 L/s is actually required by the stock. The rest is 'lost' throughout the system. Assuming that the delivery of water to the stock was 100% efficient (i.e. only 326 L/s is required) then only 21,406 m³/day would need to be abstracted (on a peak day) to meet the water demand from the 76% of the race network supplied by the six intakes reviewed.

Since the existing abstraction is significantly greater than the amount required only to support stock, there is potentially water available which could support alternative activities if the stockwater could be delivered more efficiently. The volume of water therefore potentially available to meet other needs is shown in Figure 4.9.

The summary statistics and flow duration distribution of the water which is currently abstracted and not used directly by stock are shown in Tables 4.13 & 4.14.

Assuming that the stockwater component of the existing abstraction across the six major intakes could be delivered with 100% efficiency, the additional water which is currently abstracted could be used to irrigate approximately 6,362 ha (based on the median daily 'surplus extraction').

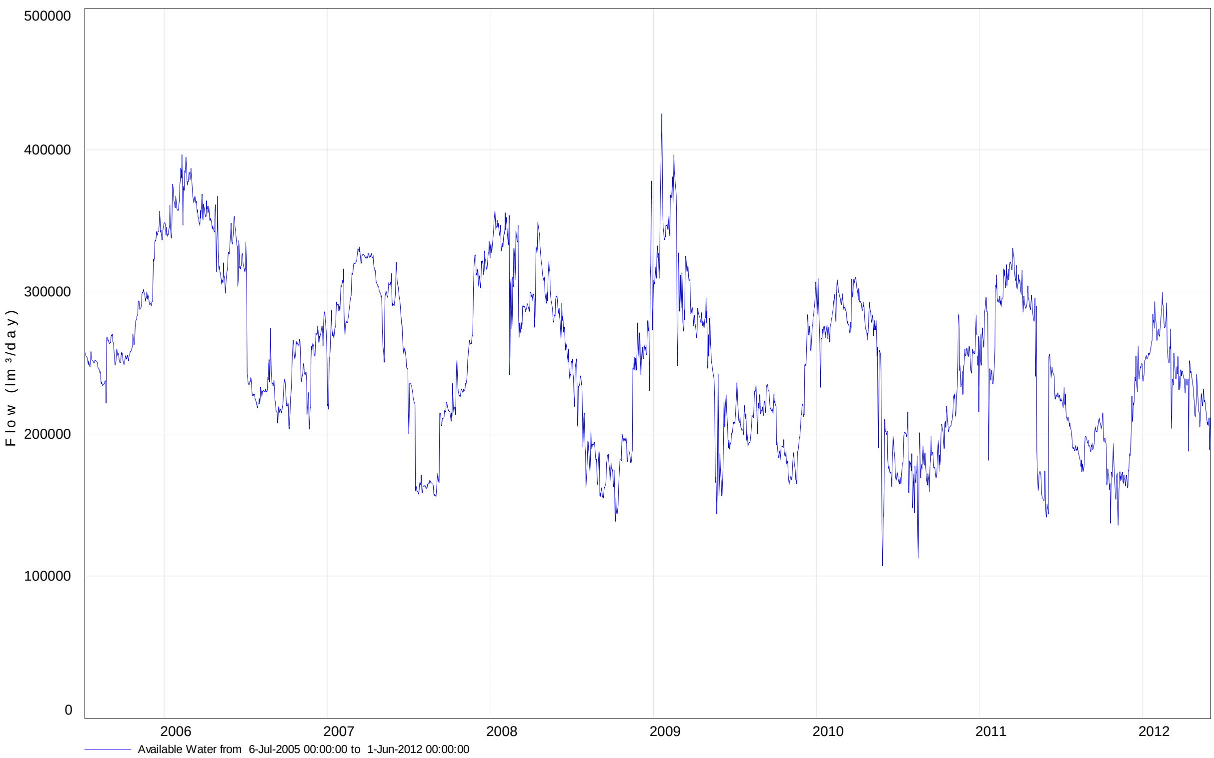

Figure 4.9: Water abstracted and not used directly by stock (m³/day).

Table 4.13: Summary statistics relating to water abstracted but not used directly by stock (m³/day).

Min	Max	Mean	Std Dev	LQ	Median	UQ
107444	425766	254772	57203	210701	254478	296080

Table 4.14: Distribution of water abstracted but not used directly by stock (m³/day).

	0	1	2	3	4	5	6	7	8	9
0	425766	379413	367234	360278	354730	349696	346537	343675	340813	336889
10	331805	327756	325648	323571	320466	317818	315359	312880	310166	308248
20	306433	304514	301542	299359	297506	296085	294495	292978	291675	290391
30	289084	287889	286177	283808	282118	280231	278809	277053	275471	273899
40	272137	270438	268631	266286	264192	262342	260174	258486	256960	255782
50	254479	252977	251531	250305	248810	246642	244646	242848	240916	238982
60	237141	235576	234273	231644	230283	228195	226825	224575	222725	221143
70	219493	217727	216269	214618	212513	210701	208391	206323	204031	201431
80	198160	195475	193655	191619	189851	187702	185459	182728	180266	177762
90	175291	172948	170951	169075	167360	165752	163981	161757	157652	150249
100	107444									

5 Potential Improvements

5.1 General

There has been considerable discussion in the past regarding the apparent 'inefficiency' of the stockwater race system in delivering water to meet the needs of stock. At the basic level of simply delivering the 326 L/s required by stock throughout the area serviced by the network, the race system is inefficient, i.e. only about 4% of the water abstracted is used by stock. However, the stockwater race system is extremely efficient from other perspectives. It provides a wide range of additional environmental benefits e.g. habitat diversity and sustainability, groundwater recharge, economic efficiency etc.

A number of previous studies have investigated options for improving the efficiency of the stockwater race network (Beca, 1994; Opus, 2008; Opus, 2011). These studies have generally concluded that only small gains in efficiency are possible without converting the open races to a piped network.

As discussed previously in this report, the total volume of water used by the stockwater race network is actually very small in the context of an irrigation scheme. Any gains resulting from increased efficiency are therefore also likely to be very small, likely within the margins of error inherent in current data and information relating to the stockwater race network.

5.2 Options

As a gravity-fed, open-channel water conveyance system, the stockwater race network is less efficient than a piped system. This is primarily because of losses resulting from evapotranspiration and infiltration. In addition, the races must follow the hydraulic grade line and this limits the layout efficiency and flexibility. These features which affect efficiency are common to all open-channel water reticulation systems.

The majority of the 'loss' of water in the system is through infiltration (i.e. 82%). Consequently, the greatest gains in efficiency would come through reducing these infiltration losses.

Other potential areas of improvement include:

- Decreasing the amount of water discharged at the distal end of the network by controlling the intakes more closely; and
- Reducing the scale of the network (Opus, 2011).

Physical / Design improvements

REDUCING INFILTRATION LOSSES

There are several potential means of reducing infiltration losses. These include:

- Reducing the permeability of the channel by installing clay, bentonite, or concrete lining;

- Converting the open races to a pipe system in areas of high loss; and
- Increasing the flow velocity in the races by keeping them cleaner (i.e. removing weeds and other growth) and improving their hydraulic efficiency.

Large scale lining of the channels presents a number of problems. These include:

- Capital cost: If concrete is used, and only the main races were lined, the capital cost would be in excess of $6 million (depending on method used and assuming average race wetted perimeter of 1m).
- Operational issues: The races will continue to silt up as a result of sediment transported into and through the races. If clay or bentonite lining is used, removing the silt without damaging the lining would be difficult.
- Effectiveness: ADC only manages 449km of the 2,399km network directly. Lining only the main races would therefore only address a small portion of the overall infiltration losses throughout the network. Losses could still potentially occur in the lined sections as a result of leaks through cracks etc. Infiltration losses may therefore still be significant even after lining.

Identifying high loss areas is difficult because it requires detailed, and extremely accurate, flow gauging at regular intervals along all of the races. Any flow gauging would also have to be completed under stable flow conditions so that any changes in flow can be related solely to infiltration losses. Such an exercise would be extremely time consuming and expensive, and given the inherent accuracy of flow gauging i.e. ±8%, it may not be particularly effective. Given the size of the network, the flows involved, and the continually changing nature of flows within the system, such an exercise is not really practical.

Increasing the flow velocity within the races by keeping them clear of vegetation and other obstacles would reduce infiltration losses. However, there is a practical limit to maintenance of these higher velocities as weeds and other obstructions will return relatively quickly. Furthermore, if the velocity is too high the flow will scour and remove any fine sediment or silt which has been deposited within the channel. This fine material helps to decrease the permeability of the bed of the race and therefore reduces infiltration losses (Opus, 2011).

REDUCING DISTAL DISCHARGES

There are over 100 discharge points at the distal end of the stockwater race network. The long distance between the head of the race and the various discharge points means that any change in the conditions at the intake or upstream may take days to affect the discharge throughout the network. Also, because of the way that stockwater race systems operate, a 10% change to the flow rate in the headwater race may equate to a 50% change in flow within a minor race at the distal end of the network towards the coast. Rainfall and stormwater runoff interception also mean that discharge flows can fluctuate regardless of the intake flows or conditions further upstream.

Reducing distal discharges is therefore problematic and may not result in any increase in the overall efficiency of the stockwater race network.

Rationalisation

As land use in the district has changed, and large irrigation schemes are developed, the requirement for stockwater is decreasing. It is likely that land use change, and particularly a move toward dairy farming, explains the relatively low consumption of stockwater from the network at present i.e. only 326 L/s. Dairying farms require greater volumes of water, and water of higher quality, than can be provided by the existing stockwater network. Consequently, alternative water sources have been developed to meet the specific needs of individual water users.

Ashburton District Council has implemented a programme aimed at closing at least 100 km of stockwater races each year. Maps of the location of closed races show that these are widely scattered throughout the four stockwater schemes. Because of the dispersed nature of race closures to date, this process is unlikely to have had any noticeable effect on the flows required to operate the stockwater network (Opus, 2008).

A recent period of dry years, with generally low groundwater levels, appears to be making it more difficult to get water through the stockwater system. Spring-fed areas have dried up, and springs which formerly added flow to the water races have disappeared (Opus, 2008).

Closing races that are no longer required, and focusing on maintaining and improving the remainder of the network would be beneficial but the potential effect on efficiency difficult to quantify (Opus, 2011).

Control improvements

ADC is currently in the process of installing additional flumes and flow recorders at all intakes. This is part of the requirements of the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010.

While flow monitoring systems are installed on the major intakes this information is not used to automatically control the scheme intakes. There may be some benefit obtained by automating the key intakes. The feasibility of intake automation depends on particular conditions of each site, and the ability to provide power. The long lag time between changes and the intake and flows further downstream, however, means that operational control would be difficult. Any potential gains may be relatively small. Such an automated system would, however, improve the rangers' ability to effectively manage flows in a timely manner (Opus, 2011).

Management Improvements

As mentioned in the previous paragraph, additional control automation may increase the management efficiency of the scheme, although it is unlikely to result in more than a small improvement (Opus, 2011).

5.3 Low Flow Trials

Optimal efficiency could be perceived as ensuring that the intake of water is such that flow only just reaches the furthest part of the scheme i.e. there is no discharge at the distal end of the network.

A 'base minimum flow' is therefore the flow needed to keep the water race system operating under hot and dry summer conditions. If flows are cut back to this level, as a result of water shortage or other restrictions, it is usually possible to maintain flow in the races for around two to three weeks.

When sections of a race are dry for any period of time, the base of the race is prone to cracking. Once this happens it can subsequently take longer to 're-wet' and seal the race. This means that reducing race flows even temporarily can be potentially counter-productive (Opus, 2008).

In really dry summers, like in 1998, 1999, 2004, and 2008, flows fall away in the headwater streams and the volume of water able to be abstracted for the stockwater network falls well below the "base minimum flow". The stockwater races go dry under these conditions.

In an attempt to establish the minimum amount of water necessary to sustain the stockwater race network, a series of low flow trials were conducted in 2003 (Opus, 2008). The results from the low flow trials indicate that it is possible to operate ADC's four stockwater schemes (i.e. not Acton) in the "base minimum flow" mode using 5,187 litres per second. Major reductions in abstraction of around 1000 L/s occur in both:

- The Methven–Lauriston scheme where the base minimum flow is 1,501 L/s; and
- The Mt. Somers–Willowby scheme where the base minimum flow is 1,676 L/s.

While these are significant reductions in water abstraction, it is only possible to maintain the delivery of stockwater throughout the network for two to three weeks when operating at the "base minimum flow". Longer periods of abstraction below the "base minimum flow" result in flows reducing and the stockwater races going dry (Opus, 2008). This leads to a loss of service to some scheme users.

6 Ashburton Lyndhurst Irrigation Scheme (ALIS)

6.1 General

The Ashburton Lyndhurst Irrigation Scheme (ALIS) currently has a water distribution network using open water races that has performed well over its life to date. However, a proposal is being developed to upgrade the scheme with the view of enhancing its level of service to shareholders, and improving resource management.

ALIS covers an area of approximately 28,000 ha and services around 250 individual properties. The system originally delivered water through a race system for flood irrigation. ALIS has already converted 25% of their races to a gravity-fed pressure pipe network. They are currently determining the viability of piping the remaining 75% of the races. The drive behind this has been primarily to utilise the available water more efficiently.

The key objectives for this scheme upgrade are to:

- Minimise water losses resulting from:
    - Inaccurate delivery (over-delivery);
    - Leakage in races; and
    - Evaporation (small amount).
- Allow selling of water that is gained from reduced leakage to new shareholders; and
- Supply water on demand to properties signing up for the upgraded scheme.

ALIS therefore provides a model for other water resource-based infrastructure projects being developed for the Canterbury plains, particularly those with an irrigation focus.

The drive towards the development of large community or district-based irrigation schemes is typical of recent moves in major rural infrastructure. Such developments would appear to be supported by government policy and funding initiatives.

Within the project area of ALIS there are two open race networks; one to support irrigation and the other the stockwater race network. Integration of the two networks during any upgrading process would therefore seem logical.

The most obvious and cost effective way to improve the efficiency of the stockwater race network therefore may be to incorporate them within future piped irrigation schemes. The four major schemes where such an approach would be worth considering are: Valletta; Mayfield-Hinds: Ashburton-Lyndhurst; and Barhill-Chertsey.

6.2 Stockwater Race and Irrigation Networks

As can be seen from Figure 6.1 and Figure 6.2 both the existing stockwater races and the proposed pipe network within the Ashburton Lyndhurst project area follow more or less the same routes. There is considerable potential therefore to integrate the water demands from the two systems to improve overall efficiency and water resource management.

In general terms, for most large scale irrigation projects the associated stockwater demand is negligible i.e. probably within the measurement resolution of the irrigation scheme. An initial assessment of the costs associated with integrating the stockwater demand with the irrigation demand over ALIS is presented below.

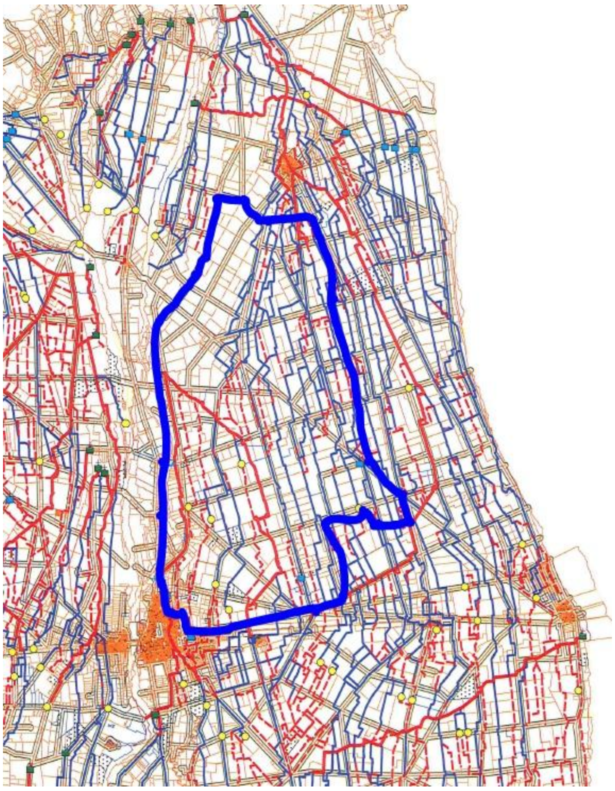

Figure 6.1: Stockwater race network maintained by ADC in the ALIS project area.

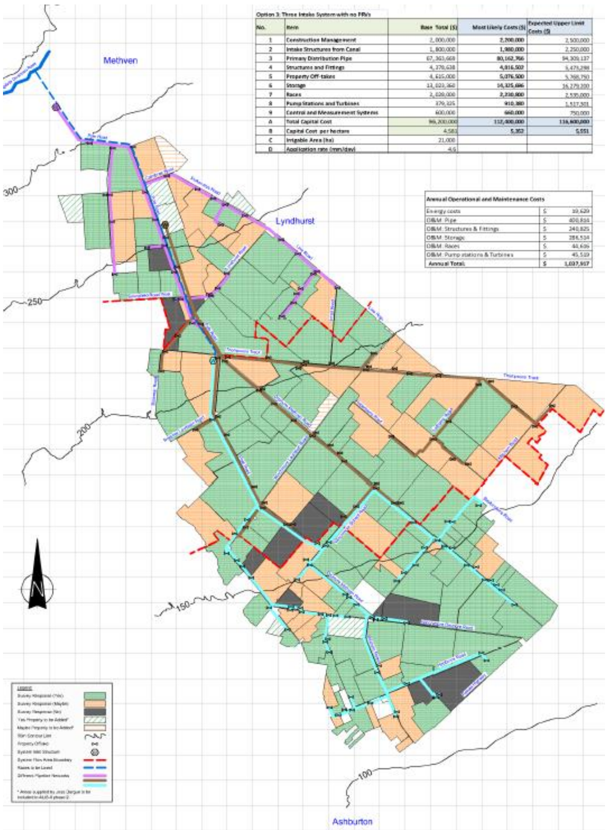

Figure 6.2: Proposed pipe network for ALIS.

6.3 Integrating Stockwater and Irrigation

If it is assumed that the ALIS project area is typical of conditions throughout the wider ADC-managed stockwater race network, then the costs of integration and the potential for using any ‘spare’ water can be assessed.

ALIS at 28,000 ha makes up approximately 12% of the area serviced by the stockwater race system. Therefore, the ALIS area requires 994 L/s of the consented stockwater abstractions (i.e. 8281 L/s) to provide 39 L/s of stockwater.

Supplying 39 L/s over an area of 28,000 ha is the equivalent of irrigating 0.012 mm/day. This represents only 0.003% of an irrigation demand of 4 mm/day. Consequently, the marginal cost of adding the stockwater component of water demand to the irrigation scheme is negligible. For example, at a cost of providing piped irrigation of $4000-$6500 per ha, this additional flow would only add from $12-$19.50 per ha to the total cost. Such an integration of the two water resource networks, however, would either allow 994 L/s to be ‘returned’ to the rivers and streams, or to be used for other purposes.

If the ‘losses’ in the current allocation to support the stockwater network within the ALIS project area (i.e. 954 L/s or 82,512 m^3/day) could be put to alternative uses, this water could irrigate approximately 2,063 ha at a rate of 4 mm/day. Using current estimates of the cost of providing pipe irrigation infrastructure (i.e. $4,000-$6,500 per ha) it would cost from $8.25M to $13.4M to fully utilise the ‘saved’ water.

The major constraint with integrating the stockwater and irrigation networks is the timing of when water is required. While stockwater is required year-round, irrigation systems generally only supply water over part of the year i.e. the irrigation season. The need to supply water at low rates for stockwater when the system is not being used to meet the needs of irrigation would have to be considered during the design stage. The low volumes of water required for stockwater mean that system capacity is unlikely to be a constraint.

The issue of water quality, and difference in the requirements of stock and irrigation water, would also need to be considered. In some areas integration may not be feasible or practical but it is worth consideration during the conceptual and design stages of any large-scale irrigation scheme.

7 Conclusions

Ashburton District Council (ADC) maintains a stockwater race network which services an area of 235,000 ha. The network was established 120 years ago and consists of 2,399 km of water races servicing approximately 2000 individual properties.

Water is abstracted from about 27 intakes of which eight, including the largest, have been measured for several years. These eight intakes supply approximately 79% of the maximum consented allocation (i.e. 8,281 L/s). If the water races were 100% efficient i.e. all the water was used by the stock, the maximum combined take of 8,281 L/s would provide 0.3mm of water across the entire area serviced by the network each day (i.e. 3m^3/ha). This is a very small amount of water in the context of irrigation demand. No information is available on the total amount of water available at each intake, only the amount actually abstracted. This is a major constraint when reviewing the dynamics and potential use of the available water resource.

If the 8,281 L/s was not used for the stockwater network, it would be sufficient to irrigate 17,890 ha at a rate of 4 mm/day; assuming that the transfer and delivery of water was 100% efficient.

The actual usage of water by stock has been estimated at only 326 L/s; 4% of the total maximum allocation. If the required 326 L/s could be delivered with 100% efficiency this would 'free up' 7,955 L/s of water which could be used for other purposes e.g. irrigate an additional 17,183 ha of land to a depth of 4 mm.

Two intakes (i.e. Acton, 680 L/s and Klondyke, 230 L/s) are now managed by entities separate from Ashburton District Council, or take water from the Rangitata Diversion Race (RDR). Therefore, six major intakes are managed and monitored by ADC. These intakes account for approximately 76% of the maximum consented take of 7371 L/s required to support the stockwater race network administered by ADC.

The actual amount of water abstracted at each intake is significantly less than the maximum permitted volume for the majority of the time. This is because the maximum consented take is based on the demand for water under the most adverse conditions. Such conditions occur very rarely and only for short periods of time. The demand for water under 'normal' conditions is therefore significantly less than anticipated under the most adverse conditions. At Methven, Pudding Hill, Winchmore, Brothers, and Cracoft water is abstracted at the maximum rate for less than 1.5% of the time. The smallest monitored intake i.e. Bushside with a current maximum take of 70 L/s; however, appears to have exceeded its limit for approximately 42% of the time. This is partly because of the fact that this maximum abstraction limit was reduced significantly during the latest resource consent process.

Therefore, the maximum consented abstraction rates for the various takes do not provide a very good indication of either the amount of water which is available, or the amount which is actually abstracted. They also do not indicate how much water may potentially be available for other purposes, including augmenting river flows.

Reducing the maximum permitted abstraction would not result in a significant change in the amount of water remaining in the various rivers and streams for the majority of the time. Such a change would effectively release only 'paper water', water which is not being abstracted at present for the majority of the time. This water therefore is already in the rivers and streams except for those short periods when abstraction is at the maximum consented rate. Any slight increase in the amount of water remaining in the rivers and streams would only occur over those occasional short periods when abstraction is at its maximum consented rate.

Since there are limited data available for the other intakes, it is difficult to determine how representative these six abstractions are of the total network. If the other intakes are similar in their manner of water supply and operation the results of this analysis can be simply up-scaled. However, it is more likely that the small intakes have distinctive characteristics and behaviour. Irrespective of the relationship between these six intakes and the entire scheme, since these are the largest takes they are where changes in operation and efficiency would have the greatest potential impact.

The most effective way of improving the efficiency of the stockwater race system might be to integrate it with larger irrigation schemes as they are developed. Assuming that the ALIS irrigation proposal is typical, adding the stockwater component to the volume of water required for irrigation would add only 0.012 mm/day to the irrigation demand. This is significantly less than the measurement error associated with the irrigation water take. Including the stockwater component to the irrigation scheme would also only add from $12-$19.50 per ha to the total capital cost.

The major constraint with integrating the stockwater network with an irrigation network is the timing of when water is required. While stockwater is required year-round, irrigation systems generally only supply water over part of the year. The need to supply water at low rates for stockwater when the system is not being used for irrigation would have to be considered during the design stage. The issue of water quality, and differences in the requirements of both stock and irrigation water, would also need to be considered. In some areas integration may not be feasible or practical.

If the ‘losses’ inherent in the stockwater race system currently servicing the ALIS project area could be put to alternative uses, the ‘lost’ water could irrigate approximately 2,063 ha at a rate of 4 mm/day. Using current estimates of the cost of providing pipe irrigation infrastructure (i.e. $4,000-$6,500 per ha) it would cost from $8.25M to $13.4M to fully utilise this ‘saved’ water.

Water harvesting during periods of low-demand/high river flow and storing the water for use during high demand periods may enable greater use to be made of the ‘residual’ water i.e. the difference between the maximum consented abstraction and that actually abstracted. This, however, would require significant investment in storage infrastructure.

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