

Hydrology of the upper reaches of Omarama Stream

Prepared for Dunstan Peaks Limited

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| | | |
|-----|---|----|
| 1 | Introduction | 1 |
| 2 | The National Water Conservation (Ahuriri River) Order 1990 | 1 |
| 3 | Hydrology..... | 2 |
| 3.1 | Overview | 2 |
| 3.2 | Previous reports and estimations of flow rates | 2 |
| 3.3 | Omarama At Dunstan Peaks | 5 |
| 4 | Flow losses and gains within the upper Omarama Stream..... | 7 |
| 5 | Discussion on Minimum flow..... | 8 |
| 6 | Recommendation..... | 8 |
| | References: | 10 |
| | Plates 1 and 2 – Omarama Stream 1 July 2009..... | 11 |
| | Plate 3 – Omarama Stream 1 July 2009..... | 12 |
| | Figure 1 : Upper Omarama Stream catchment and locations of Intake sites | 13 |
| | Figure 2 : Omarama Stream flow sites | 14 |
| | Regression – Dunstan peaks and Manuherikia River..... | 15 |
| | Regression – Dunstan peaks and Lindis River..... | 15 |

1 Introduction

Omarama Stream is located in the Upper Waitaki Basin and is a tributary of the Ahuriri River. This report summarises the hydrology of the Omarama Stream, with particular regard to the upper reaches of the Stream, and has been prepared for Dunstan Peaks Limited, who have applied for resource consents to continue to divert, take and use water for irrigation purposes.

The resource consent applications are summarised as follows:

| | |
|-----------|---|
| CRC011361 | <p>To divert water from Little Omarama Stream into an irrigation race at a maximum rate of 170L/s. Once in this race the water is dammed in a header pond which holds approximately 45,000m³.</p> <p>To take and use from the header pond at a maximum rate of 170L/s for the border dyke irrigation of up to 30 ha of land.</p> <p>To divert water from the Omarama Stream into an irrigation race at a maximum rate of 350L/s. Once in this race the water is dammed in a header pond which holds approximately 45,000m³.</p> <p>To take and use from the header pond at a maximum rate of 350L/s for the border dyke irrigation of up to 115 ha of land.</p> <p>To divert water from the Omarama Stream into an irrigation race at a maximum rate of 290L/s.</p> <p>To divert water from Middle Gully into an irrigation race at a maximum rate of 60L/s.</p> <p>To take and use from the irrigation race, sourced from both the Omarama Stream and Middle Gully, at a maximum rate of 350L/s for the border dyke and wild flood irrigation of 170 ha of land.</p> <p>To divert, take and use water from Twaddles Creek at a maximum rate of 100L/s for the border dyke irrigation of 15 ha of land.</p> <p>To divert, take and use water from Twaddles Creek at a maximum rate of 45L/s for the border dyke irrigation of 12 ha of land.</p> <p>To divert, take and use water from the Little Omarama Stream at a maximum rate of 30L/s for stock and domestic water on Twinburn Station.</p> <p>To divert, take and use water from the Omarama Stream at a maximum rate of 115L/s for micro hydro.</p> |
|-----------|---|

The location of the intakes for these various activities are shown in figure 1 of this report.

2 The National Water Conservation (Ahuriri River) Order 1990

The Omarama Stream downstream of the bridge on Broken Hut Road (NZMS 260 H39:6094-2343) is included in the "protected waters" of the National Water Conservation (Ahuriri River) Order 1990 (the "Order"). For the purposes of the Order, the Omarama Stream is managed as two reaches. The "Mid reach" extends from the Omarama Swamp Outfall (H39:6083-2471) and a point downstream of Tara Hills Station (H39:6880-2820). The reach between the latter point and the confluence with the Ahuriri River (H39:6965-3227) is referred to as the "lower reach".

Clause 6 of the Order specifies minimum flows to be retained within the “mid reach” and the “lower reach. The Order does not include the upper reaches of the Omarama Stream within the protected waters, and does not specify any minimum flow regime for the upper reaches.

3 Hydrology

3.1 Overview

Omarama Stream is a tributary of the Ahuriri River. The Stream drains the slopes of the Wether, St Bathans, Ewe and Cuthbert Ranges (see figure 1). The main tributaries are the Little Omarama, Omarama Stream, Omarama Swamp Outfall, and Cattle Creek. Water from the Ahuriri River is also periodically discharged into the lower reaches of the Omarama Stream from irrigation/transfer races operated by Omarama Station and Tara Hills Station.

Approximately 52% of the total catchment area is classified as being “steepplands” (Young, 1987).

3.2 Previous reports and estimations of flow rates

Young (1987)

Young describes the history of flow measurements carried out at various locations within the catchment, and provides tables of flow gaugings and estimations of flow statistics. In doing so, he divided the catchment into an upper catchment above Twin Peaks Bridge (NZMS 260 H39:6128-2517), and a lower Omarama downstream of that point.

“(a) Upper Omarama catchment

Below the gauged site of Dunstan Peaks the principal user of water is Dunstan Peaks Station with an estimated abstraction rate of between 100-150 l/s. Various small abstractions elsewhere account for no more than 70 l/s. The major tributary inflows are from the Little Omarama and Omarama Swamp Outfall, the latter is fed by the smaller subcatchment tributaries of Twaddles and neighbouring unnamed catchments and during irrigation through a series of races which continue on from Dunstan Peaks Station distribution system. A further 50 l/s is bypassed from Omarama Swamp by race to Berwen station and thereafter to the Omarama. Manuka Creek flows into the Omarama just upstream of Twin Peaks Bridge. Actual rates are not known but are considered to be insignificant.

(b) Lower Omarama catchment

Downstream of the gauging site of Twin Peaks Bridge at Berwen the diversion from Omarama Swamp re-enters the Omarama. The principal user of water in the remaining downstream catchment is Tara Hills Station with an abstraction rate of around 480 l/s (further discussed in Section 7).. Tributary inflows consist of the combined flow of Tara Hills Swamp and Little Cattle Gully. During irrigation the latter has some augmentation indirectly from irrigation bywash, Cattle Creek, Wardells Race (further discussed in section 6) and Old Man Creek, and from bores, and also from a supplementary race (often referred to as Purvis’s Race) which diverts water from the Omarama above Omarama Station homestead. Omarama Station diverts 350 l/s to run its power plant (see Figure 5.4.1). This is subsequently bypassed back into the Omarama.”

“It wasn’t until the early seventies however that a gauging programme began in earnest in the catchment. Sites were selected at Dunstan Peaks, Twin Peaks Bridge and the Highway Bridge at Omarama, later to be moved upstream to Wardells Bridge. Daily staff gauge records were kept by Dick Wardell of Omarama Station for the gauge at the Highway Bridge at Omarama from May 1972 to September 1974. It was possible to generate daily mean flows from this record. These are given in Appendix F. Comments on the data are discussed in Appendix C in the sites history. The

data for these sites were briefly reviewed in preparation of the Ahuriri Water Management Statement (September 83). As a consequence it was found necessary to further assess the water balance of the immediate and lower regime of the catchment. To do so a number of water level recorders were installed and a gauging programme instigated to monitor the respective inflows and outflows to this system. The water level recorders were placed in:

- (a) the Outflow channel from Omarama Swamp.
- (b) the Omarama Stream at Tara Hills and
- (c) Wardell's Race above its confluence with the Omarama

The Omarama at Tara Hills (71179) site is located downstream of the Tara Hills Station irrigation intake, and as a consequence during irrigation months it records the residual flow left in the Omarama after abstraction by Tara Hills. Tara Hills in their own right maintain a site (171179) on the intake headrace during the irrigation season so as to monitor their abstraction rates. Figure 5.1.1 shows the location of the hydrological sites and also the meteorological sites in the Omarama catchment. It was noted during the course of reviewing the earlier data that the contribution from Omarama Swamp to the Omarama was significant and therefore worthy of further investigation. (refer Figure 5.1.2).

A water level recorder was subsequently located upstream from the confluence with the Omarama.

The recorder on Wardell's Race was similarly established in order to understand the significance diversion flows have on the lower reaches of the Omarama. Wardell's Race is discussed separately in Section 6.

5.2 MEAN AND MEDIAN FLOWS

A relatively short period of record exists for all of the water level recorder sites. Mean and median flows for these are tabled in Table 5.2.1. Originally regression techniques were applied to the earlier gauged sites of Dunstan Peaks (71163) and Twin Peaks Bridge (71150) to derive mean and median flows. The gauged data were collated with daily mean flows from the Manuherikia at D/S Forks (75251) and the Ahuriri at South Diadem (71116). The Manuherikia like the Omarama is sourced from the St Bathans and Ewe/Hawkdun Ranges; but drains to the south (refer Figure 2.1.1).

Relationships derived are:

$$\text{DUNSTAN PEAKS} = 0.438 \times \text{MANUHERIKIA} - 0.564$$

(R= 0.93, n = 21)

$$\text{TWIN PEAKS BRIDGE} = 0.501 + 0.404 \times \text{MANUHERIKIA} - 0.0114 \times \text{AHURIRI}$$

(R = 0.99, n = 41)

However with the more recent introduction of recorders within the catchment it has been possible to develop in-catchment relationships. These are discussed further in Section 5.4. With the use of the graphed relationships depicted in Figure 5.4.3 mean and median flows are derived for the historic sites of Dunstan Peaks and Twin Peaks Bridge (see Table 5.2.1 below).

| Site | Period | % missing | Mean m ³ /s | Mean l/s/km ² | Median m ³ /s | Median l/s/km ² | Ratio Median to mean (%) |
|-----------------------------|---------------------|-----------|------------------------|--------------------------|--------------------------|----------------------------|--------------------------|
| Dunstan Peaks | 21.09.71 - 25.03.82 | n/a | 0.60 | 19.4 | 0.54 | 17.4 | 90 |
| Waldron Rd Bridge | 26/07/78 – 02/12/80 | n/a | 0.52 | 9.0 | 0.46 | 7.9 | 88 |
| Omarama above Omarama Swamp | 04.09/84 – 22.08.86 | 0 | 0.89 | 9.6 | 0.66 | 7.1 | 74 |
| Omarama Swamp | 04.09.84 – | 0 | 0.86 | 13.4 | 0.85 | 13.3 | 99 |

| | | | | | | | |
|--|------------------------|-----|------|------|------|-----|----|
| outfall | 22.08.86 | | | | | | |
| Twin Peaks Bridge ¹ | 13.12.71 – 08.02.83 | n/a | 1.64 | 9.6 | 1.48 | 8.7 | 90 |
| Tara Hills less Tara Hills Station abstraction | 13.07.84 – 14.10.86 | 0 | 1.68 | 9.5 | 1.56 | 8.8 | 92 |
| Tara Hills | 13.07.84 – 14.10.86 | 0 | 1.81 | 10.2 | 1.66 | 9.4 | 92 |
| Wardells Bridge ² | 17.05.72 – 01.09.74 | 0.6 | 2.23 | 7.9 | 1.91 | 6.8 | 85 |

¹Mean and median values derived from Figure 5.4.3

²Wardells Race augmentation included

Some caution should be exercised when comparing flows at different sites in Table 5.2.1 because of the different time periods that apply. Table 5.2.1 shows that with the exception of the sites above Omarama Swamp, the median to mean ratio in all cases is 85% or greater. The significance of this figure tends to illustrate the influence the consistent non variable rate of inflow from Omarama Swamp has on downstream flows. This ratio ranks as the highest of any gauging station in the Waitaki Catchment or in immediate neighbouring catchments. Appendix E gives a list of these sites and their respective median to mean ratios.

Flow duration curves for the gauging stations Omarama Swamp and the Omarama at Tara Hills are presented in Figure 5.2.1. These curves depict the percentage of time a nominated flow is equal to or greater than the given values. For example a flow of 1.0 m³/s for Omarama Swamp Outfall (refer Figure 5.2.1) is equalled or exceeded 30% of the time or conversely is equalled less than 70% of the time.

Note the near parallelism of the Omarama Swamp and the Omarama at Tara Hills curves shown in Figure 5.2.1; particularly within the percentile range 30-100% (ie for a flow greater than or equal). This again reflects the significance Omarama Swamp flows have on the lower order flows. This will be discussed further in Section 5.4.

Snow-melt (or meltwater) contribution is noticeable in September and October. Rarely does it exist through to November. A tabulation of daily and monthly mean flows for these sites and for the Omarama at Wardells Bridge are listed in Appendix F.

Inflows from Omarama Swamp (see Figure 4.3.1) to the Omarama are shown to be a significant proportion of the mean flow. At Tara Hills this represents on average 48% of the recorded flow. This proportion increases as flows decrease during mid to late summer and into autumn. During this period the Omarama Swamp in fact provides nearly all the maintenance flow for the lower Omarama. Rainfall and flow records suggest that near baseflow levels (refer Figure 4.3.2 for baseflows) are reached on a 1 in 3 year return frequency. On such occasions the Omarama dries up between Waldron Road Bridge and Clifton Downs Bridge a stretch of some 6 kilometres.

Gabites & Horrell (2005)

Gabites and Horrell prepared estimations of seven day mean annual low flows (7DMALF) for the tributaries of the Waitaki river based on regression equations with long term primary flow sites. The Omarama Stream at the Dunstan Peaks site was correlated with the primary recorder site Manuherikia at Downstream Forks. It is noted that this site was closed in 2004.

In referring to the Omarama Stream upstream of Twin Burn Bridge, Section 3.2.1 of Gabites & Horrell makes the following relevant comments.

“A discussion with Rod Patterson, of Dunstan Peaks Station, on 01/10/04, revealed that a reach of the Omarama Stream goes dry downstream of the Twin Burn Bridge almost every summer, usually

for about 3-4 months, with exceptions of very wet years. Despite two divert/take/discharges above this dry reach, Robinson (1983) stated that it had not been established whether abstractions in the upper catchment (Twin Burn and Berwen Takes) affect flows below Omarama Swamp. The dry reach effectively cuts off the headwater inflows to the catchment except that discharged from the Dunstan Peaks divert/take/discharge directly into the swamp. According to Robinson (1983) the divert/take/discharge generally begins before the reach dries up, but did state during years when the onset of drought happened quickly, the drying of the reach is likely to be a natural phenomenon.

Young (1983) states that "Inflows from Omarama Swamp to Omarama Stream have shown to be a significant proportion of the mean flow, like 48% of the recorded flow at Tara Hills. . This proportion increases as flows decrease during mid to late summer and into autumn. During this period the Omarama Swamp in fact provides nearly all the maintenance flow in the lower Omarama"

A similar pattern occurs on the other side of valley where Manuka Creek disappears underground at the Killermont/Twin Peak Boundary most of the time and only flows into Omarama Stream during higher flows. Similarly, Frosty Gully only contributes to Manuka Creek during periods of high flows (Consent Application CRC040180).

Keeping the above points in mind when trying to naturalise this flow record it was considered that adding back 50% of those abstractions above the dry reaches was not appropriate. This is because the effects of abstraction upstream of the dry reaches on flows at Tara Hills are likely to be delayed and subdued by the complexity of the underground flow. Therefore assumptions regarding abstractions for naturalising this site were revised based on;

-25% of the average daily consented allocation for all takes above the dry reach of Omarama Stream,

-25% of the average daily consented allocation on Manuka Creek and Frosty Gully, and

-50% for the consented allocation for the rest of the catchment above Tara Hills.

This amount was totalled and added to the Tara Hills flow record for the months of October through to April. From all of the above evidence it was decided not to normalise the 15 years of data as errors introduced by naturalising flows would be magnified by further regression, when attempting to normalise the flow record.

The naturalised 7DMALF for Omarama Stream at above Tara Hills was calculated at 652 litres per second".

3.3 Omarama At Dunstan Peaks

Robinson (1983) quotes a correlation for Omarama Stream at Dunstan Peaks (H40:6108-1548) as:

$$Q = 0.079 \text{ Ahuriri Sth Diadem} + 0.021 \quad r^2 = 0.83 \text{ (presumably } q \text{ in m}^3\text{/s)}$$

Gabites & Horrell used the Manuherikia River flow site to obtain the following regression:

$$Q = 0.1267 \text{ Manuherikia} + 67.462 \quad r^2 = 0.79$$

Flow sites have recently been established at:

- Little Omarama Stream above the Twinburn Intake (2263480mE 5616650mN)
- Omarama Stream above the Twinburn intake (2261320mE 5615770mN)¹
- Twaddle Creek above the Dunstan Peaks intake (2260280mE 5619780mN)
- Middle Gully above the Dunstan Peaks intake (2260950mE 5618480mN)

Staff gauges have been installed within these tributaries and also within each irrigation intake (including Dunstan peaks intake @ Omarama Stream, 2261384mE 5617539mN). A set of 4 gaugings have been carried out between 12 December 2008 and 22 April 2009, and these are provided in table @. At this time there is insufficient data to obtain reliable flow correlations with other sites.

| | Omarama Stream u/s Twinburn Intake | Twinburn Intake @ Omarama Stream | Dunstan Peaks intake @ Omarama Stream | Little Omarama stream u/s Twinburn Intake | Twinburn Intake @ Little Omarama Stream | Middle Gully Stream u/s Dunstan Peak Intake | Dunstan Peak intake @ Middle Gully | Twaddle Creek u/s Dunstan Peak Intake | Dunstan Peak intake @ Twaddles Creek |
|------------|------------------------------------|----------------------------------|---------------------------------------|---|---|---|------------------------------------|---------------------------------------|--------------------------------------|
| 12/12/2008 | 892 | 354 | 247 | - | - | - | n/a | - | n/a |
| 17/02/2009 | 230 | - | - | 103 | 56 | 18 | n/a | 40 | n/a |
| 30/03/2009 | 265 | - | 133 | 123 | 53 | 28 | n/a | 74 | n/a |
| 6/04/2009 | 253 | 19 | - | 112 | 48 | 25 | n/a | 66 | n/a |
| 22/04/2009 | 247 | 18 | - | 106 | 50 | 22 | n/a | 58 | n/a |

The most relevant flow sites suitable for correlations are the Manuherikia at Downstream Forks (site 75251) and the Lindis at Lindis Peak (site 75219). Of these sites, the Manuherikia is more representative of the hydrology of the upper Omarama Stream as its headwaters adjoin the Omarama catchment and the recorder site is located approximately 12km to the south. Unfortunately, this site has now been closed therefore it cannot be used to correlate any of the more recent gaugings.

The alternate site is the Lindis, however that site is located more distant (approximately 23km) in a south-westerly direction. The Lindis River has a higher proportion of lower altitude catchment than the Omarama Catchment.

The data from the Lindis site provides the following regression:

$$\text{Dunstan Peaks} = 0.076 \times \text{Lindis}^{1.0634} \quad r^2 = 0.7077$$

Table 1: Summary of estimates of low flow

| | Mean | 7DMALF | 1:5yr MALF |
|--------------------------|-------|--------|------------|
| Ahuriri Sth Diadem | 23696 | 8990 | 7750 |
| Manuherikia ¹ | 3051 | 940 | 725 |
| Dunstan Peaks estimates | | | |
| Robinson | 1893 | 731 | 633 |
| Gabites & Horrell | 453 | 187 | 159 |
| ECS Manuherikia | 537 | 187 | 148 |
| ECS Lindis | 820 | 142 | 88 |

¹ This site is referred to by Environment Canterbury as Omarama Stream @ Dunstan Peaks (site 71163). Historic gaugings are available from 1972 to 1982.

Young quotes a mean flow of 600 l/s for Dunstan Peaks, but his regression infers a mean flow of 770 l/s.

Little Omarama Stream

There is no historic flow data – Catchment Area is 13.7 km² (cf Omarama = 40 km²). Proportionally, then mean flow is estimated to be approximately 55 l/s, 7DMALF is 64 l/s and 1:5 is 54 l/s.

At present, there is insufficient information on which to base a reliable estimate of low flow at Dunstan Peaks.

4 Flow losses and gains within the upper Omarama Stream

There are observations by local landowners and others that show that the Omarama Stream does not support continuous flow under natural conditions between Waldron Road Bridge and Clifton Downs Bridge a stretch of some 6 kilometres. The Stream is regularly dry throughout this section. The effect of upstream abstraction on the frequency and extent to which the stream ceases to flow needs to be determined.

Anecdotal evidence suggests that this reach will cease to maintain a continuous flow regardless of any upstream abstractions:

Wing (2001) refers to the Omarama Stream comprising two separate reaches for fisheries purposes. *“The reason being, during the majority of the year from a point downstream of the bridge (near Clifton Downs) on the Broken Hut Road (map ref H39:610234) to downstream of the bridge (map ref H39:613193) between the Dunstan Peaks homestead and the Twinburn homestead the river dries up. This is a distance of approximately 4.5km certainly preventing passage of fish. Old records and local knowledge indicate that this occurred long before any water abstraction.”*

The alluvial plain in this area no doubt is very porous allowing the water to freely disappear into the ground.”

Robinson (1983) refers to the dry reach of the upper Omarama Stream (section 3.8.3). *“It has not been established that abstractions in the upper catchment affect flows below the Omarama Swamp. Omarama stream usually goes dry at the bridge on the Berwen Road (map reference S116:580309) in mid-late December, effectively cutting off the surface flow from the principle headwaters apart from about 60 – 100 litres per second discharged more directly to the Swamp when Dunstan Peaks irrigation commences. Usually this event precedes the drying up of the main stream, but in years when the onset of instream droughts were very sudden it was possible to establish ephemerality as a natural phenomenon.”*

Young (1987) refers to numerous flow gaugings carried out at various sites throughout the Omarama Stream catchment. Unfortunately, there are no concurrent measurements taken at appropriate sites to be able to quantify the known flow losses within the upper Omarama Stream².

Young also states *“Rainfall and flow records suggest that near baseflow levels (refer Figure 4.3.2 for baseflows) are reached on a 1 in 3 year return frequency. On such occasions the Omarama dries up between Waldron Road Bridge and Clifton Downs Bridge a stretch of some 6 kilometres.”*

Plates 1 to 3 show the flows within the upper Omarama Stream taken on 1st July. These clearly show the rates of flow upstream (Twinburn Bridge) and downstream (Twin Peaks Bridge), and the intervening dry section of Stream (Clifton Downs Bridge). No water had been abstracted from the

² The Dunstan Peaks site gaugings were carried out between 1971 and 1982. The Omarama Stream above Omarama Swamp gaugings are between 1984 and 1985, Waldron Road gaugings were between 1978 and 1980.

Stream for irrigation purposes since April 2009. Significant rainfalls have occurred during May 2009 and June 2009, and the catchment was certainly not in a “dry” state. Despite this, the Stream does not maintain a continuous flow.

Ideally, concurrent measurements need to be taken above the Omarama Swamp outfall; at a point where the surface flow reappears; at a point upstream of where the surface flow disappears; and at the Dunstan Peaks gauging site. The information would assist in determining the natural rates of flow loss and gains within these reaches of the Stream.

5 Discussion on Minimum flow site

Regardless of the accuracy of estimates of the low flow for the Omarama stream at Dunstan Peaks, Table 3, Rule 2 of the WCWARP requires that a minimum flow is to be set at the “downstream end of the catchment”.

The abstractions by Dunstan Peaks Limited are from reaches of the Omarama Stream that are outside (upstream) of the “protected waters” and are therefore technically not included within the Ahuriri River Conservation Order. The abstractions are from water bodies specified in Table 3(xxii) Rule 2 of the WCWARP. They are required to cease abstraction when a minimum flow equal to the 5-year 7 day MALF “set at the downstream end of the catchment” is reached.

Gabites & Horrell have estimated the 5 year 7DMALF for Omarama Stream as:

| Site | Map reference | 5yr 7DMALF |
|---------------------------------|---------------|------------|
| Omarama Stream at Dunstan Peaks | H40:611-154 | 159 |
| Omarama Stream at Twin Peaks | H39:612-251 | 370 |
| Omarama Stream above Tara Hills | H39:625-259 | 470 |

A minimum flow based at Dunstan Peaks is upstream of the abstractions and therefore is not consistent with Table 3(xxii) Rule 2.

A minimum flow based on the flow at Twin Peaks is consistent with Table 3(xxii) Rule 2, but that site is located within the “protected waters” of the Ahuriri Conservation Order, therefore the environmental flow regime set out in the Order applies. It is also noted that the 5yr 7DMALF at Twin Peaks (370 l/s) is more restrictive than the 250 l/s flow specified within the Order.

There is an underlying assumption that any surface flow within the upper Omarama Stream will either flow directly into the lower Omarama Stream, or will be intercepted as underflow by the Omarama Swamp. Accordingly, it is presumed that any abstraction of water from the upper reaches of Omarama Stream and its tributaries will reduce the volume of water entering Omarama Swamp which, in turn, will reduce the flow in the middle and lower reaches of Omarama Stream.

6 Recommendation

Until such time as a better understanding is gained of the natural flow losses within the upper reaches of Omarama Stream it seems logical to restrict the taking of water by Dunstan Peaks in accordance with the Ahuriri Conservation Order flow sharing regime. Reasons for this include:

- Any abstraction of water within the upper catchment reduces the volume of water entering the Omarama Swamp and ultimately impacts on the rates of flow within the lower Omarama Stream. It appears to be an anomaly that the upper Omarama Stream was not included within the “protected waters” specified in the Ahuriri Conservation Order.

- Consistency with other abstractions on Omarama Stream. Resource consent CRC960328, which authorises the taking of water from Little Omarama Stream by Berwen Station has conditions specifying the Conservation Order flow regime. Consent CRC960328 is adjacent the Dunstan Peaks intake on Little Omarama Stream.
- Logically, Dunstan Peaks Limited have an interest in ensuring as much water as possible reaches the Omarama Swamp, as this will reduce the frequency at which abstractions must cease.
- It would be inequitable to impose a more restrictive minimum flow on the Dunstan Peaks abstractions than required by other downstream users. To do so would require this abstraction to cease while allowing downstream users to continue abstract the resulting residual flow.

References:

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_____; 2006: *Waitaki Catchment Water Allocation Regional Plan*. Prepared by the Waitaki Catchment Water Allocation Board, July 2006.

Plates 1 and 2 – Omarama Stream 1 July 2009.



Photo taken 1 July 2009 – Omarama Stream at Twinburn (upper most bridge over the stream)



Photo taken 1 July 2009 – Omarama Stream at Clifton Downs (“middle” bridge over the stream)

Plate 3 – Omarama Stream 1 July 2009.



Photo taken 1 July 2009 – Omarama Stream at Tara Hills

Figure 1 : Upper Omarama Stream catchment and locations of Intake sites

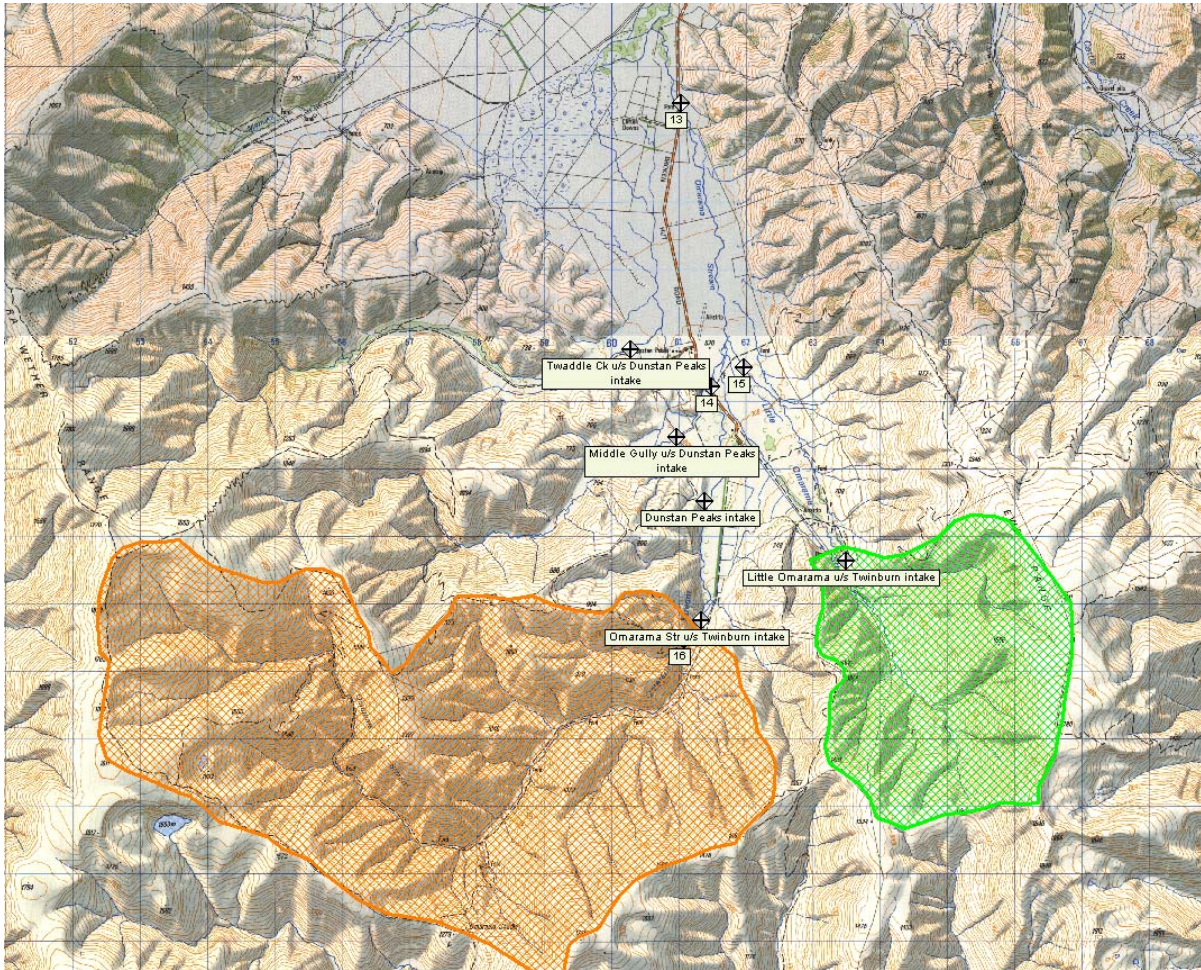
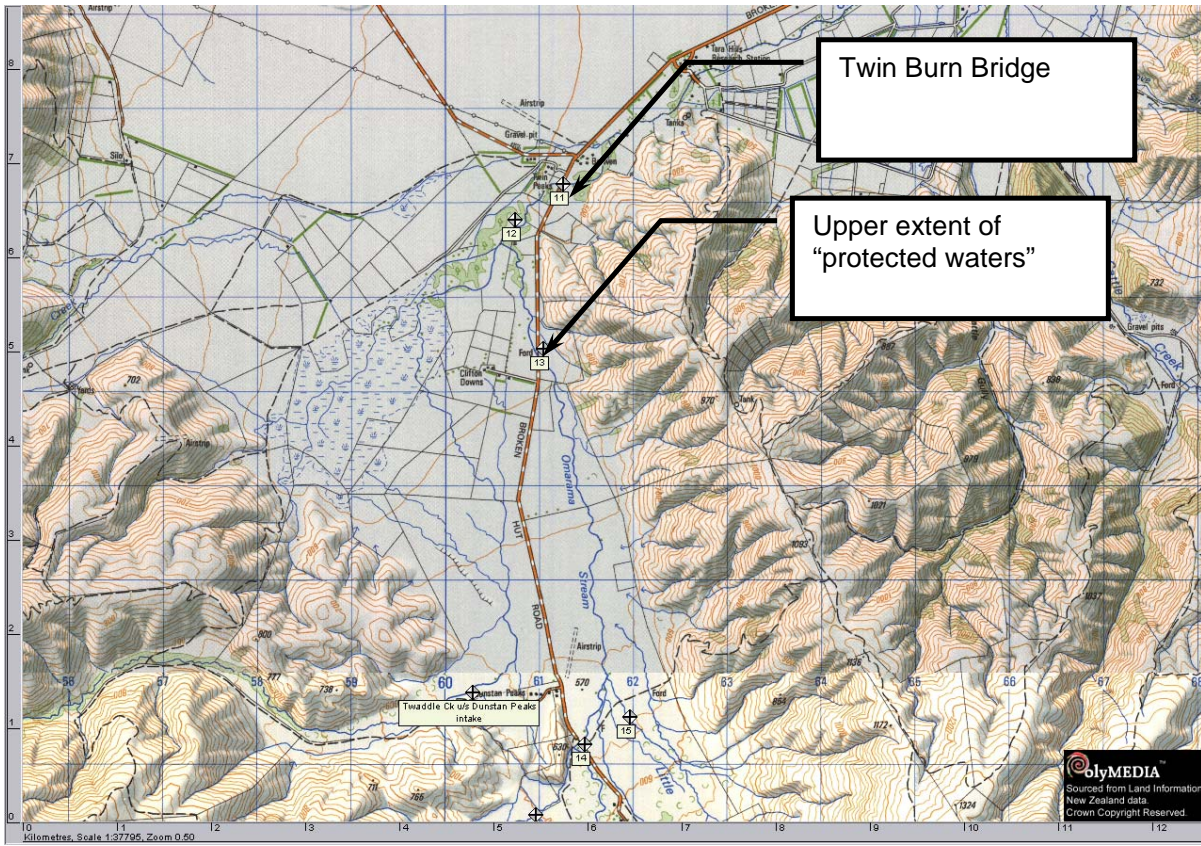
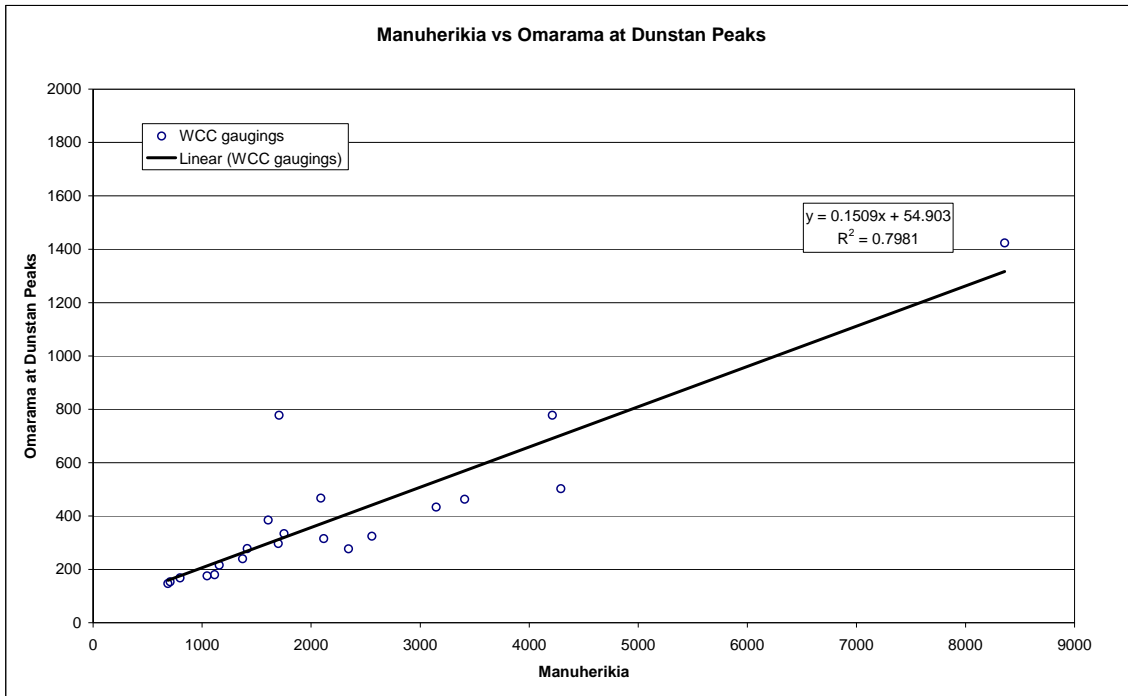


Figure 2 : Omarama Stream flow sites



Regression – Dunstan peaks and Manuherikia River



Regression – Dunstan peaks and Lindis River

