

Appendix B

Hydrology of The Cass River

**Prepared for
Glenmore Station**

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1. Executive Summary.

Within this report are the results of Boraman Consultants Limited findings relating to Hydrological information for the Cass River situated on the Western Shores of Lake Tekapo. The purpose of this report is to provide supporting information for consent applications CRC052502.

Boraman Consultants Limited investigated all previous information known on the Cass River

Correlation with Jollie River at Mt Cook Station:

Cass River = $0.6592 \times \text{Jollie} + 2680$ Litres per second
 $R^2 = 0.87$

Cass River at Godley Peaks Bridge

Mean Flow = 8093 Litres per second

Seven Day Mean Annual Low Flow = 4615 Litres per second

Mean annual Low flow = 4548 Litres per second

Five Year Seven Day Low flow = 154 Litres per second

2. Introduction

Boraman Consultants Ltd (BCL) were engaged in May 2009 to run statistical analysis on the Cass River for resource consent application no. CRC052502. This was to provide baseline information to assist with hearing decisions.

Previous information was found in 'Inventory of the Hydrology of the Waitaki River.'

This report summarises known information on the hydrology of Cass River and is a supporting document for consent applications CRC052502

3. Proposal

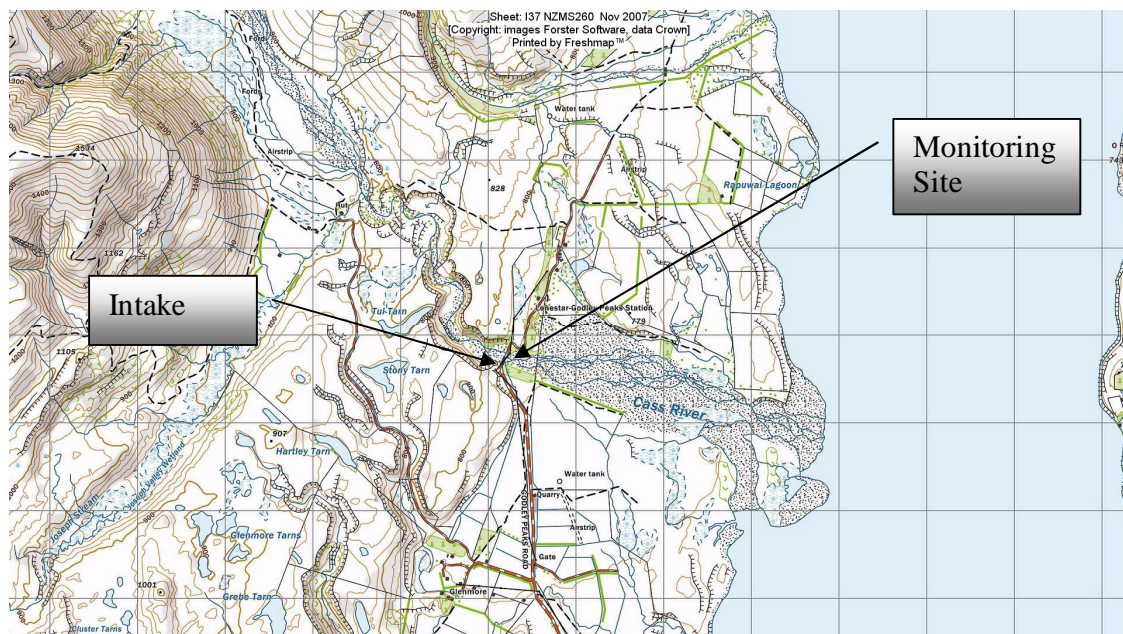


Figure 1: Cass River showing intake location

3a. Location of proposed abstraction

It is proposed under application CRC052502 to take and use 230 litres per second from the Cass River at approximate map reference I37:062-007.

3b. Amount to be Abstracted

Application CRC052502

It is proposed to take and use 230 litres per second, with a volume not exceeding 19,872 m³ per day and 1,260,000 m³ between 1 July and the following 30 June in any year.

There is no proposed discharge associated with this consent application

4. Catchment Description

Cass River drains directly into Lake Tekapo and is located on the western side of the lake between the Glenmore Station and Godley Peaks Station. Cass River at Godley Peaks Bridge has a catchment area of 201 km² (Figure 2)

The catchment altitude ranges from 700m up to 2800m, this means that much of the winter months the upper basins are covered with snow and water becomes ‘locked up’ as seasonal ice. The geology of the catchment is predominantly greywacke, with the lower reaches being post glacial deposits. (GNS)

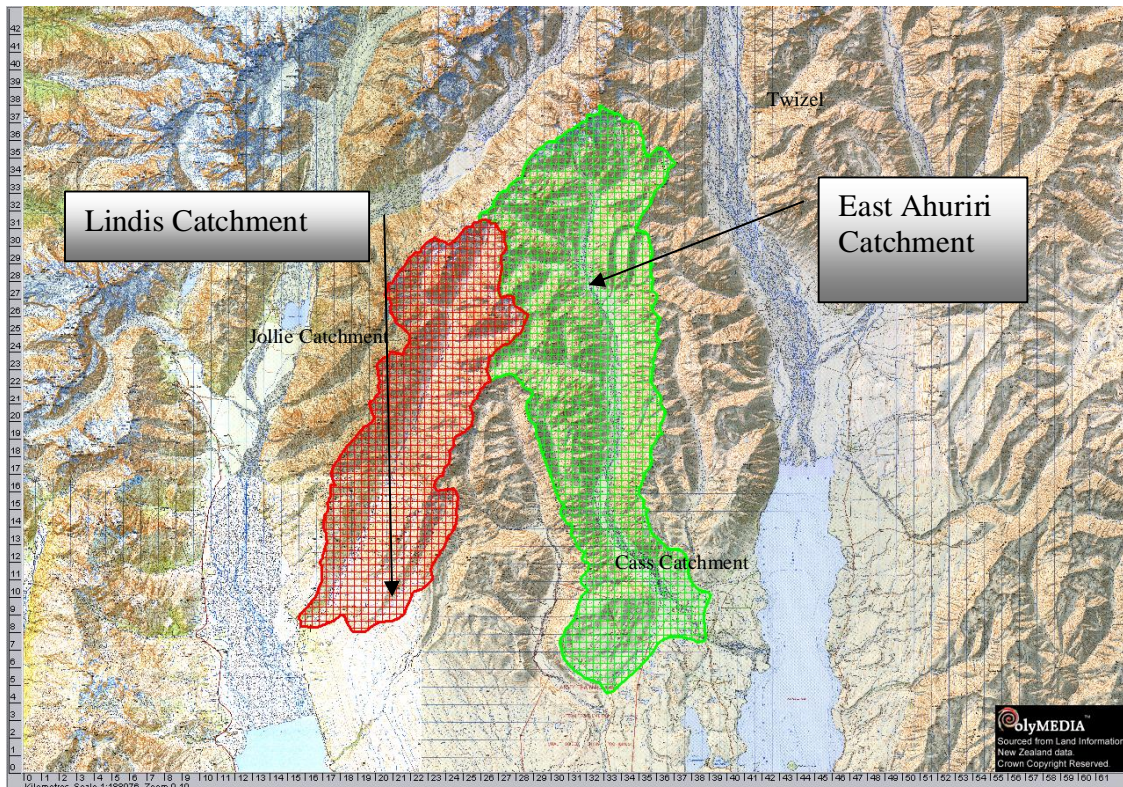


Figure 2. Cass Catchment showing Jollie Catchment for correlation

5. Rainfall

Precipitation in the catchment, is provided predominantly by spillover from the westerly weather systems. Much of the winter precipitation in the upper catchment falls as snow which melts out completely over spring and summer. Cass River is approximately 14km from the main divide. Annual rainfall is highest close to the divide and drops off sharply toward the east with increasing distance from the divide.

Rainfall maps were obtained from Volume 2 of the ‘Waitaki water and soil resource management plan’. Figure 43 of the plan indicates annual rainfall at in the Cass River at about 3500mm per year in the upper catchment and as low as 700mm per year in the lower catchment.

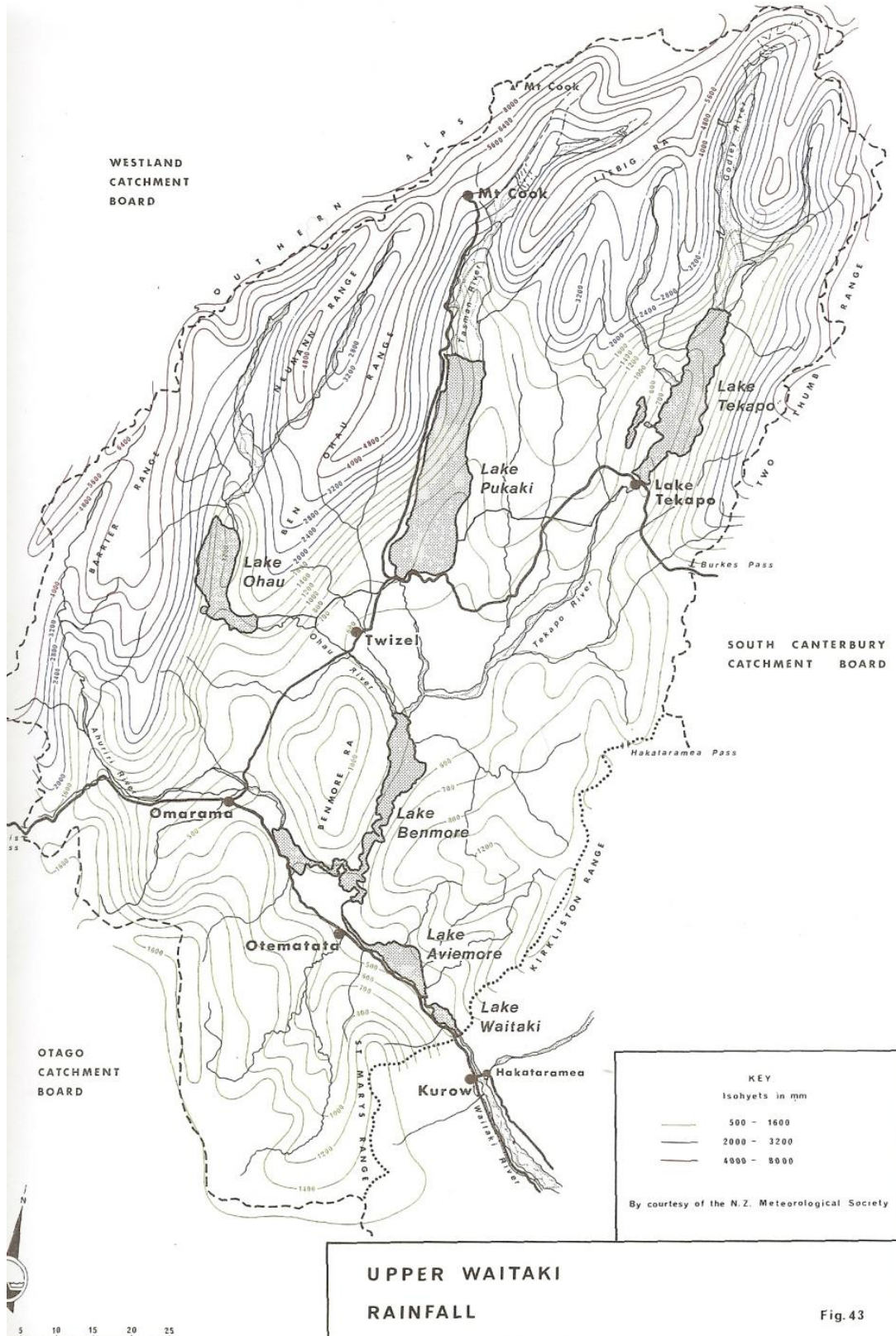


Figure 3 Upper Waitaki Rainfall

6. Hydrology

6a. Background

There were 12 previous flow measurements carried out possibly by the Waitaki Catchment commission from 1972 to 1982 these listed in the 'Inventory of the Hydrology of the Waitaki River (IHWR)'. Further investigation with ECan came up with a total of 20 flow measurements, however the flows were different from that in IHWR. It is believed that the flow measurements were recalculated using Ricoda. In the report by Gabites/Horrell, 'Seven day mean annual low flow mapping of the tributaries of the Waitaki River, only 10 flow measurements were used and an exponential regression used.

6b. Cass River Gauging Statistics

Gaugings carried out were done generally upstream of the bridge by the Waitaki Catchment Commission.

Statistics of Cass River Gaugings

Minimum gauged flow: 4605 Litres per second

Maximum gauged flow: 21240 Litres per second

No. of gaugings: 20

6c. Previous Work

Table 1 shows the statistics established by both ECan and BCL for the Jollie River, the first column shows the ECan results specified in the 'Seven Day Mean Annual Low Flow Mapping of the Waitaki River Tributaries' the second column shows the result Boraman Consultants came up with using a similar data set as ECan. The third column shows the result Boraman Consultants came up with after getting NIWA to review the data.

Jollie River Statistics

Jollie River Catchment Area: 139 Km²

| Statistic | Niwa (Ecan) | Niwa (BCL) | Niwa Revised (BCL) |
|------------------|--------------------------|--------------------|---------------------------|
| Period | 7/12/64 to Not Specified | 7/12/64 to 16/4/07 | 7/12/64 to 16/4/07 |
| 7DMALF | 2843 L/s | 2927 L/s | 2936 L/s |
| 5Y7dLF | 2350 L/s | 2373 L/s | 2379 L/s |
| MALF | - | - | 2834 L/s |
| Mean Flow | 8242 L/s | 8207 L/s | 8211 L/s |

Table 1 Jollie River Statistics (showing revised).

ECan compared the Cass Gaugings with the Jollie River Mean Flow, although some gaugings were omitted for various reasons, (BCL omitted similar gaugings for the same reasons) see table 2 Ecan Data set. From this a regression was established. (figure 4)

| Date | Jollie Flow Daily Mean L/s | Cass Flow Gauged L/s |
|--------------|----------------------------|----------------------|
| 29 Jan 1974 | 4552 | 5593 |
| 13 Feb 1974 | 5417 | 6533 |
| 22 Jan 1975 | 7878 | 8033 |
| 4 Feb 1975 | 8600 | 11300 |
| 12 Feb 1975 | 6005 | 6933 |
| 9 Jul 1975 | 3230 | 4759 |
| 19 Nov 1975 | 8519 | 10190 |
| 23 Feb 1976 | 5576 | 6256 |
| 12 May 1980 | 6112 | 5972 |
| 7 April 1982 | 4482 | 6002 |

Table 2: ECan dataset

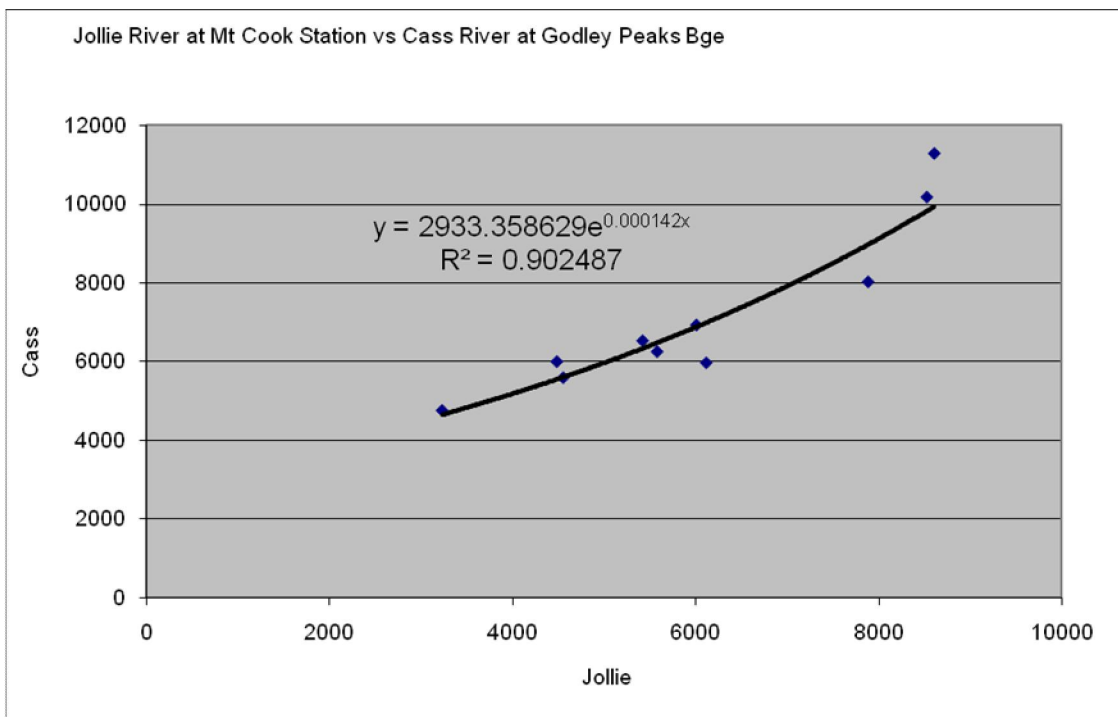


Figure 4: Regression - Cass River Gaugings vs Jollie at Mt Cook Daily Mean Flow (ECan)

Using the Ecan regression the statistics for the Cass at Godley Bridge are:

$$\text{Cass} = 2933.4e^{0.000142 * \text{Jollie}}$$

R2 = 0.89

| Statistic | Jollie Ecan | Cass Ecan |
|-----------|--------------------------|--------------------------|
| Period | 7/12/64 to Not specified | 7/12/64 to Not Specified |
| 7DMALF | 2843 L/s | 4393 L/s |
| 5Y7dLF | 2350 L/s | 4096 L/s |
| MALF | | |
| Mean Flow | 8242 L/s | 9453 L/s |

Table 3: Cass Statistics (ECan)

6d. Boraman Consultants Analysis

The 20 flow measurements located:

| Date | Time | Cass Ecan | Jollie Ecan | Jollie BCL |
|-----------|------|-----------|-------------|--------------|
| 5-Jul-72 | 1020 | 4605 | | Missing data |
| 29-Jan-74 | 1100 | 5593 | 4552 | 4552 |
| 13-Feb-74 | 1110 | 6533 | 5417 | 5417 |
| 22-Jan-75 | 1520 | 8033 | 7878 | 7878 |
| 4-Feb-75 | 1105 | 11300 | 8600 | 8600 |
| 12-Feb-75 | 1500 | 6933 | 6005 | 6005 |
| 9-Jul-75 | 1105 | 4759 | 3230 | 3230 |
| 14-Aug-75 | 1430 | 7566 | 4484 | 5557 |
| 3-Sep-75 | 1100 | 5895 | 2784 | 3746 |
| 19-Nov-75 | 1200 | 10190 | 8519 | 8519 |
| 23-Feb-76 | 900 | 5576 | 5576 | 5567 |
| 5-Feb-80 | 1215 | 21240 | 10188 | 10188 |
| 14-Apr-80 | 1030 | 8292 | 10175 | 8666 |
| 12-May-80 | 1410 | 5972 | 6112 | 6112 |
| 7-Apr-82 | 1430 | 6002 | 4482 | 4482 |
| 22-Jul-83 | 1200 | 6072 | | 4309 |
| 22-Jul-83 | 1515 | 5961 | | 4309 |
| 19-Nov-84 | 1245 | 14080 | | 10181 |
| 15-May-85 | 1015 | 4814 | | 3906 |
| 15-May-85 | 1038 | 4674 | | 3906 |

Table 4: BCL data set.

Note: Values in red show changes after being checked and reworked by Niwa

There is a change in the relationship between the Jollie and the Cass above Cass mean flow, therefore all gaugings above 9.0 m³/s have been omitted. See table 5

| Date | Time | Cass Ecan | Jollie BCL | Reasoning |
|-----------|------|-----------|------------|---|
| 4-Feb-75 | 1105 | 11300 | 8600 | > 9m ³ /s |
| 14-Aug-75 | 1430 | 7566 | 5557 | Possibly rating issues with the Jollie data |
| 3-Sep-75 | 1100 | 5895 | 3746 | Possibly rating issues with the Jollie data |
| 19-Nov-75 | 1200 | 10190 | 8519 | > 9m ³ /s |
| 5-Feb-80 | 1215 | 21240 | 10188 | > 9m ³ /s |
| 19-Nov-84 | 1245 | 14080 | 10181 | > 9m ³ /s |

Table 5: Gaugings omitted from data set.

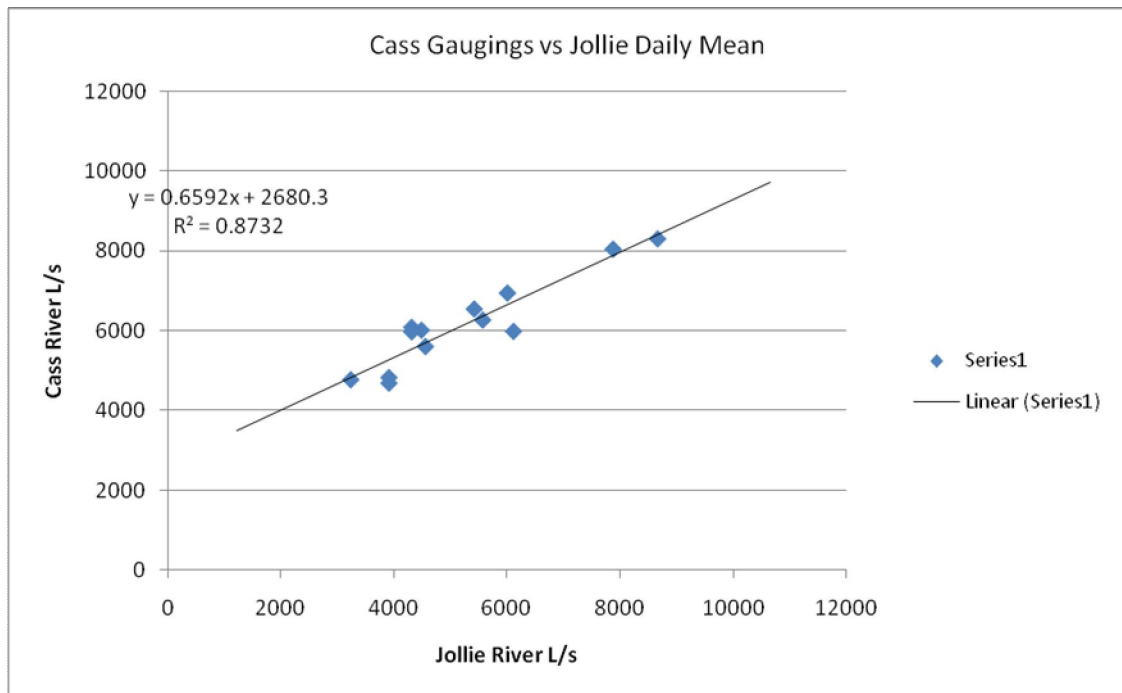


Figure 5: Regression plot Cass Gaugings vs Jollie Daily Mean Flow (BCL)

Using the BCL regression the statistics for the Cass at Godley Bridge are:

$$\text{Cass} = 0.6292 * \text{Jollie} + 2680$$

$$R^2 = 0.87$$

6e. Cass River at Godley Bridge Statistics

| Statistic | Jollie Ecan | Cass Ecan | Jollie BCL | Cass BCL |
|-----------|--------------------------|--------------------------|--------------------|--------------------|
| Period | 7/12/64 to Not specified | 7/12/64 to Not Specified | 7/12/64 to 16/4/07 | 7/12/64 to 16/4/07 |
| 7DMALF | 2843 L/s | 4393 L/s | 2936 L/s | 4615 |
| 5Y7dLF | 2350 L/s | 4096 L/s | 2379 L/s | 4248 |
| MALF | 2790 L/s* | 4358L/s* | 2834 L/s | 4548 |
| Mean Flow | 8242 L/s | 9453 L/s | 8211 L/s | 8093 |

Table 6: Cass River Statistics.

*Using old dataset before NIWA rework

7. Summary

My analyses support the contention that the appropriate figure for the MALF of The Cass River at Godley Peaks Bridge is 4548 litres per second. (4550 L/s).

BCL analysis does not 'fit' as well as the ECan regression, however some of the figures for the Jollie River have been changes due to the addition of several rating curves. I would recommend that ECan review the figures that it presented in the 'Seven day mean low flow mapping of the Tributaries of the Waitaki River' with the new dataset.

I recommend a formal audit for the data of the Jollie River at Mt Cook Station by Ecan

The proposed application is for an abstraction rate of 230 Litres per second which is 5% of MALF, therefore the abstraction rate is within the allocation limit of 10% set in the WCWARP. Taking this into account no minimum flow is recommended for this application.

8. Acknowledgements

NIWA (Kathy Walter) - Data Source, Flow Information; Jollie at Mt Cook Station
ECan, Adam Martin – Data source, Gabites/ Horrell analysis.

9. References

Suzanne Gabites, Graeme Horrell (2006) *Seven day mean annual low flow mapping of the tributaries of the Waitaki River* Technical Report, Investigations and monitoring group, Environment Canterbury

Waitaki Catchment Water Allocation Board (2005) *Waitaki Catchment Water Allocation Regional Plan*

Inventory of the Hydrology of the Waitaki River Waitaki Catchment Commission and Regional Water Board