IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications by the Ashburton Community Water Trust to: Canterbury Regional Council for resource consents to use, divert, dam and discharge water from the Rakaia River and to use land for the purposes of hydro electricity generation and associated consents required for the construction and operation of the Rakaia Terrace Hydro Scheme.
AND	
IN THE MATTER OF	applications by the Ashburton Community Water Trust to: Ashburton District Council for land use consents for the construction, operation and maintenance of the Rakaia Terrace Hydro Scheme, to undertake earthworks and vegetation clearance in the bed and riparian margin of the Rakaia River and un-named ephemeral streams.

Second Brief of Evidence of Neal Borrie

INTRODUCTION

1. My full name is David Neal Houston Borrie. I hold the qualifications of BE (Hons) (Agricultural Engineering) and a Post Graduate Diploma in Civil Engineering from Canterbury University. I am a member of the Institution of Professional Engineers of New Zealand, and also a member of the New Zealand Water and Wastes Association. I am currently employed as a Senior Environmental Engineer by Aqualinc Research Ltd in Christchurch, and have worked in the area of water and soil engineering for over 35 years. I have undertaken a wide range of work for central government agencies, regional and local authorities, as well as private industries and businesses.

2. I have had experience in the design and operation of irrigation schemes at both the off-farm and on-farm level, and in the preparation of reports on the Assessment of Environmental Effects for irrigation scheme resource consent applications, including the Amuri Plains Irrigation Schemes, the Barrhill Chertsey Irrigation Scheme and Lower Rakaia Northbank Irrigation Schemes.

3. I have been engaged by the Ashburton Community Water Trust to provide evidence on their behalf, in relation to resource consent applications for the proposed Rakaia Terrace Hydro Scheme. I have been responsible for the preparation of the assessment of environmental effects that accompanied these applications.

4. I have read the Code of Conduct for Expert Witnesses issued as part of the Environment Court Practice Notes and I agree to comply with this code.

SCOPE OF THIS EVIDENCE

5. In my evidence I will first provide an overview of Ashburton Community Water Trust's (ACWT) proposed Terrace Hydro Scheme, the schemes relationship with Barrhill Chertsey Irrigation Limited's (BCIL) consent to take and use water and an overview of Rakaia River water resource and the National Water Conservation (Rakaia River) Order 1988 (NWCO).

6. My evidence will then describe the hydrological modelling that has been undertaken, together with the results, to determine; (i) the flow that would be taken from the Rakaia River by ACWT's proposed take, (ii) the changes in the flow regime that would be discharged into the Rakaia River from the Highbank Power Station Tailrace, (iii) the flow that would be discharged into the Rakaia River from the Proposed Barrhill Power Station and (iv) the effects on the Rakaia River's flow regime under the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme. The modelling work reported in my evidence has been undertaken by others under my direction.

7. Finally my evidence will describe the following; (i) the effects of diverting water from the Rakaia River, (ii) the effects of discharging water and sediment back to the Rakaia River at various locations and (iii) the effects of undertaken works in the bed of the Rakaia River.

8. At this point I wish to advise the Hearing Panel that the scope of my evidence, as outlined in paragraph 5 and part of paragraph 6 above, was included in my earlier evidence presented to the Hearing Panel on 23 April 2008. It is included in my second brief of evidence for completeness.

DESCRIPTION OF PROPOSED ACTIVITY

Introduction

9. ACWT's hydro power generation proposal, located on the south side of the Rakaia River, is to take water from the Rakaia River through an intake at Happy Valley approximately 5 km downstream of the Rakaia River Gorge Bridge. Water taken from the Rakaia River would be conveyed by the proposed "Highbank Canal" that would run between the Happy Valley intake and the existing Highbank Power Station tailrace and would pass through two low-head power stations within the canal. The discharge from the Highbank Canal is to be combined with the discharge from the existing Highbank Power Station and conveyed to the top of the Rakaia terrace by canal (the "Terrace Canal"). From there, the flow will be dropped through a new power station (Barrhill

Power Station), located at the foot of the river terrace approximately 3.2 km upstream from Barrhill, and discharged back to the Rakaia River (refer to Figure 1).

10. The resource consent application (CRC021091) that was lodged jointly by ACWT and Central Plains Water Trust (CPWT) in December 2001 included the taking of up to 40 m^3/s of water from the Rakaia River. However it is understood that under the terms of the NWCO there may only be 35.5 m^3/s available to be taken from the Rakaia River.

11. On this basis, the flow modelling reported in my evidence has been based on 35.5 m^3/s of water being available from the Rakaia River. If there was in fact more water than currently thought then this would add a degree of conservatism to the modelling undertaken.

12. ACWT is applying to use the water taken for electricity generation. In the future, when additional land between the Rakaia and Rangitata Rivers has been identified and the final extent of the BCIL scheme is understood, then the applicant may consider making a resource consent application to use the water for irrigation purposes on the south bank of the Rakaia River. It is also possible that the ACWT canals could be used as a conveyance mechanism for irrigation water taken under third party consents such as those held by BCIL. Both of these possible options are undecided and they are quite separate to the current consent hearing.

13. It is proposed that the takes from the Rakaia River by CPWT and ACWT will be managed through an integrated water management agreement that ensures that the combined takes do not exceed 35.5 m^3/s (or the balance of the 70 m^3/s of water available if in fact there was more water obtainable than currently thought). Both ACWT and CPWT would share equal priority for the water abstraction, up to a combined maximum rate of 35.5 m^3/s, thereby also ensuring the combined maximum extraction limit allowed under the NWCO of 70 m^3/s would not be exceeded. Accordingly, water not required by one scheme would then to be made available to the other for use. This provides added benefit to both sides of the Rakaia River.

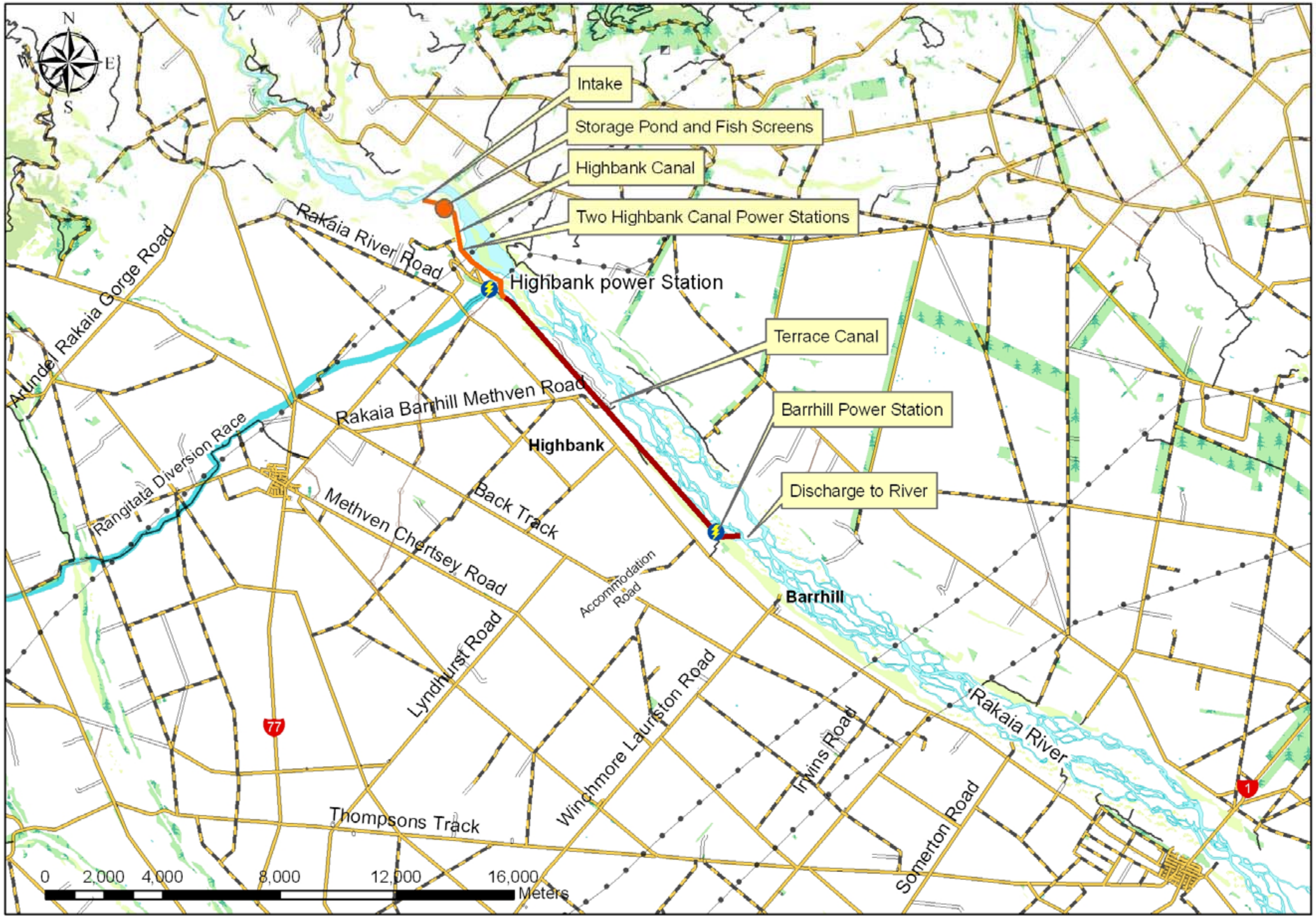

Figure 1: Proposed Rakaia Terrace Hydro Scheme layout

Electricity Ashburton Ltd and Barrhill Chertsey Irrigation Ltd Consent Applications

14. The proposed Rakaia Terrace Hydro Scheme project has been developed in close consultation with the BCIL irrigation scheme.

15. BCIL hold resource consent CRC990088 to take and use up to 17 m^3/s of water for the purpose of irrigation and electricity generation. BCIL's consent is in "band four" and hence has a higher priority than CPWT/ACWT's proposed take. However, there is a significant degree of overlap between the two projects from the Happy Valley intake to the Highbank Power Station that requires further discussion.

16. Following the lodging of the ACWT applications on 2 March 2007 for a hydro generation scheme, Electricity Ashburton Ltd (EAL) and BCIL lodged resource consents in July 2007 that form part of the scheme proposed by the ACWT. The proposed Rakaia Terrace Hydro Scheme project has been developed in close consultation with the EAL/BCIL irrigation and hydro generation scheme.

17. The ACWT application documents show the scheme in its entirety from the intake at Happy Valley along a canal approximately 14 km long to a proposed power station approximately 3.2 km upstream from Barrhill. The EAL/BCIL applications refer to the scheme from the intake at Happy Valley down to the Highbank Power Station. The ACWT and EAL/BCIL proposals therefore overlap between the intake and the Highbank Power Station tail race. The EAL/BCIL scheme in effect comprises the first stage of the overall concept outlined in the ACWT documents, and the remainder of the scheme from the Highbank Power Station to the Barrhill Power Station comprises a separate second stage. Any issues created by this overlap, and the granting of consents to ACWT, will be resolved though formal agreements between the parties.

18. I also note that if EAL/BCIL elected not to build their scheme then the ACWT applications have been advanced as if the Rakaia Terrace Hydro Scheme was a separate stand alone proposal.

THE RAKAIA RIVER

Background

19. The Rakaia River is the largest braided river in New Zealand. It has a total catchment area of 2,910 km^2, 91% of which is above the gorge. Its main tributaries are fed from the snowfields of the Southern Alps. For most of its course, it consists of large shingle flats and fast flowing rapids and runs. Downstream of the gorge, the braided river channel spreads across a wide area, which is encroached upon by broom and lupins. Between the gorge and State Highway 1, the river is incised in gravels of the Burnham Formation and has created high terraces.

20. Similar to other Canterbury rivers with alpine headwaters, the Rakaia River exhibits high flows during spring and early summer as a result of north-westerly rain and snowmelt. Freshes and floods are most frequent during the September to April period, and at this time the sediment load tends to be high. Rakaia River flows vary seasonally, tending to be highest in the spring and early summer and lowest in the winter. Mean

monthly Rakaia River flows at the gorge (1957-2004) are shown in Figure 2 (Environment Canterbury data). The mean annual flow measured in the Rakaia River at the Fighting Hill site, which is near the upstream end of the gorge, is 209 m^3/s. The lowest monthly mean flow occurs in July (137 m^3/s) and the highest in December (293 m^3/s).

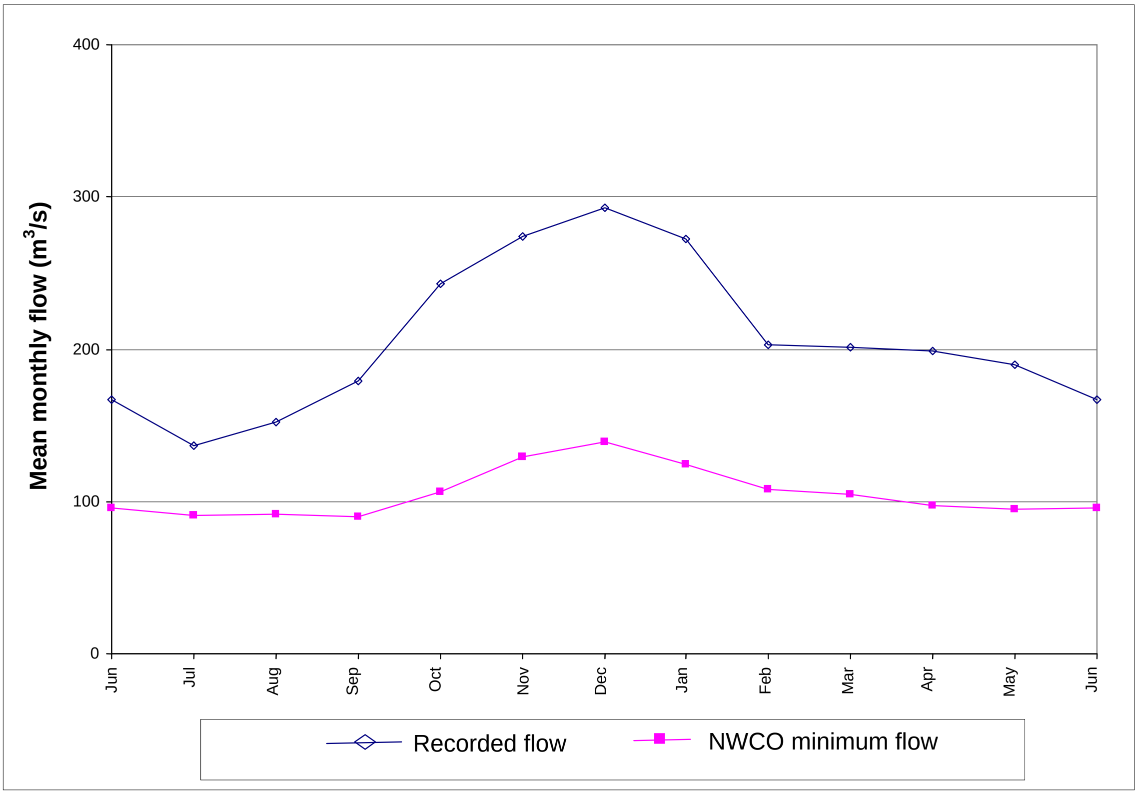

Figure 2: Mean monthly flows in the Rakaia River

21. There is a demand for out-of-stream water usage, mainly for irrigation. There are nine irrigation schemes, including the Barrhill Chertsey Irrigation Company, and many smaller scale abstractors on the Rakaia River. The Selwyn and Ashburton District Councils take water for stock purposes from the river. Water is also used for electricity generation upstream of the Gorge at the Coleridge Power Station, with diversions from the Wilberforce and Harper Rivers into Lake Coleridge. Historical flow records at the Fighting Hill site reflect flow regulation by the Coleridge Power Station. The Highbank Power Station, located approximately 3 km downstream from ACWT's proposed river intake, discharges water from the Rangitata Diversion Race (RDR) at a mean annual flow rate of approximately 13 m^3/s into the Rakaia River (with flows being predominantly confined to the winter months).

National Water Conservation (Rakaia River) Order 1988 (NWCO)

22. The Rakaia River and its tributaries are recognised to have outstanding natural character in the form of a braided river, wildlife habitat above and below the Rakaia River Gorge, fisheries, recreation, angling and jet boating. These characteristics are protected by the NWCO.

23. The NWCO establishes a set of minimum water quality and quantity standards to protect the outstanding natural characteristic and features of the Rakaia River. These

include the surface water allocation limit and the minimum flows at the Gorge to which abstractions must adhere. The minimum Rakaia River flows set in the NWCO are shown in Figure 2. The NWCO states that abstraction from the river cannot exceed 70 m^3/s. In addition, the taking of water under the NWCO is subject to a one-to-one sharing rule (i.e. for every cumec of water abstracted from the river, a cumec of water is left in the river for in-stream values/uses).

24. The proposed Rakaia Terrace Hydro Scheme take will be in full compliance with the NWCO. The existing stockwater and irrigation consents can take up to a maximum flow allocation of approximately 34.5 m^3/s from the Rakaia River. The maximum proposed water take for this proposal is 35.5 m^3/s, or the balance of the 70 m^3/s of water available to be abstracted from the Rakaia River.

25. The conditions under which ACWT and CPWT schemes would take water are detailed in Table 1. For each month, Table 1 details the NWCO minimum Rakaia River flows, the minimum river flow above which ACWT and CPWT can begin to take water, and the river flow at which the full flow of 35.5 m^3/s or the balance of the water available to be abstracted could be taken. Table 1 is based on a total of 69 m^3/s (including one-to-one sharing) being required by the lower abstraction bands on the river.

Table 1: Rakaia River flow levels for each month

Month	**NWCO minimum river flow (m^3/s)**	**Minimum river flow for taking of water (m^3/s)**	**River flow when full 35.5 m^3/s can be taken (m^3/s)**
January	**124**	193	264
February	108	177	248
March	105	174	245
April	97	166	237
May	95	164	235
June	96	165	236
July	91	160	231
August	92	161	232
September	90	159	230
October	106	175	246
November	129	198	269
December	139	208	279

HYDROLOGICAL MODELLING

Input Parameters

26. Hydrological modelling has been undertaken to determine; (i) the flow that would be taken from the Rakaia River at the Happy Valley intake by ACWT, (ii) the changes in the flow that would be discharged to the Rakaia River from the Highbank Power Station Tailrace and (iii) the flow that would be discharged to the Rakaia River from the Proposed Barrhill Power Station.

27. Inputs for the hydrological modelling were the Rakaia River mean daily flow data from the Fighting Hill site and Highbank Power Station Tailrace mean daily flow data. The modelling has been run using 48 years of historical data, from 1958 to 2005.

28. This modelling has been based on the following assumptions:

- The maximum combined flow available to be taken by ACWT and CPWT is 35.5 m^3/s.
- The water sharing agreement between ACWT and CPWT is ACWT 44% and CPWT 56%.
- During the non-irrigation season CPWT's take of water from the Rakaia River will allow ACWT to take up to 23 m^3/s when water it is available. Although the agreement between CPWT and ACWT could provide ACWT with a take of up to 40 m^3/s under CRC021091, in practice the currently proposed 40 m^3/s capacity of the intake and Highbank Canal means that the ACWT take would be combined with the 17 m^3/s already granted to BCIL (i.e. 17 + 23 = 40 m^3/s). Although under the take consent ACWT would still have the entitlement to take the whole 40 m^3/s, modeling has been based on an assumed take of up to 23 m^3/s.
- The irrigation season is from September to April and the non-irrigation season is from May to August.
- During both the irrigation and non-irrigation seasons (i.e. at all times) BCIL's water (i.e. 17 m^3/s) would be taken in the Highbank Canal and hence, if the flows were available, this would be able to be taken and used for hydro generation.
- During the irrigation season no BCIL water would be taken in the Terrace Canal but during the non-irrigation season BCIL water would, if flows were available, be taken in the Terrace Canal as it would not be required for irrigation. This is a conservative assumption that needs to be refined once the BCIL scheme is developed.
- For modelling the changes of flows in the Highbank Power Station Tailrace it has been assumed that during both the irrigation and non-irrigation seasons BCIL water would be taken in the Terrace Canal if the flows were available. This is a conservative assumption as it would have the least effect on reducing the existing flows in the Highbank Power Station Tailrace. Note that the more likely case is that during the irrigation season some of the BCIL water would be taken for irrigation at Highbank and hence would not be available to be taken in the Terrace Canal resulting in additional Highbank Power Station Tailrace water being taken into the Terrace Canal.
- All of the consents to take water from the Rakaia River that have been granted subsequent to the granting of BCIL's consent are on the same priority band as BCIL's consent (source: Environment Canterbury's web site).

29. The flow parameters used in the hydrological modelling are summarised in Table 2.

Table 2: Flow parameters for modelling

Parameter	**Irrigation season (m^3/s)**	**Non-irrigation season (m^3/s)**
Maximum ACWT flow taken from Rakaia River	15.6	23
Maximum BCIL flow taken into Highbank Canal	17	17
Maximum flow capacity of Highbank Canal	40	40
Maximum BCIL flow taken into Terrace Canal	0[a]	17
Maximum flow capacity of Terrace Canal	40	40
Note: (a) For modeling of the flows in the Highbank Power Station Tailrace it has been assumed that up to 17 m^3/s of BCIL water, when available, would be taken into the Terrace Canal during the irrigation season. This is a conservative assumption as it would have least effect on reducing flows in the Highbank Power Station Tailrace.		

Modelling Results for ACWT Take, Highbank Canal and Terrace Canal Flows

ACWT Rakaia River Take

30. The mean of the monthly mean flows taken by ACWT from the Rakaia River at the Happy Valley intake are detailed in Table 3 and are shown in graphical form in Figure 3. Table 3 also details the maximum of the monthly mean flows taken by ACWT from the Rakaia River and these values are shown in graphical form in Figure 4.

31. In addition, the monthly mean flows for each of the years modelled for the ACWT Rakaia River take are contained in Appendix A, Table A1.

32. The flow duration curve of the ACWT take from the Rakaia River is shown in Figure 5. Flow duration curves show the percentage of time that a given flow is equalled or exceeded. The flow duration curves presented in my evidence have been complied from all of the daily mean flow records that have been modelled. As a result the flow duration curve presented in Figure 5 shows the full range of daily mean flows over the period 1958 to 2005 that would have been taken from the Rakaia River.

Table 3: ACWT take from the Rakaia River (flows in m³/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean of monthly means	6.7	4.9	4.5	4.5	6.9	4.9	2.1	3.7	3.7	5.9	6.3	6.3
Maximum of monthly means	15.6	15.6	10.6	13.7	18.4	16.4	12.7	12.7	15.3	15.1	14.6	15.0
Proposed monthly maximum	15.6	15.6	15.6	15.6	23.0	23.0	23.0	23.0	15.6	15.6	15.6	15.6

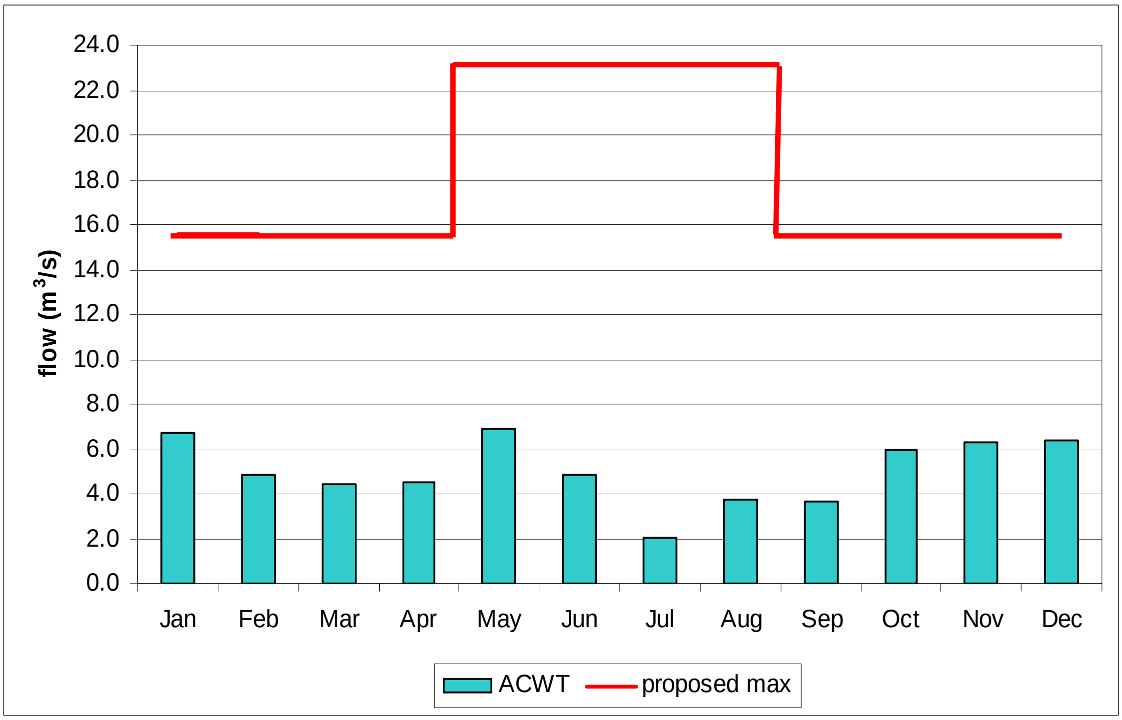

Figure 3: ACWT Rakaia River take mean of monthly means

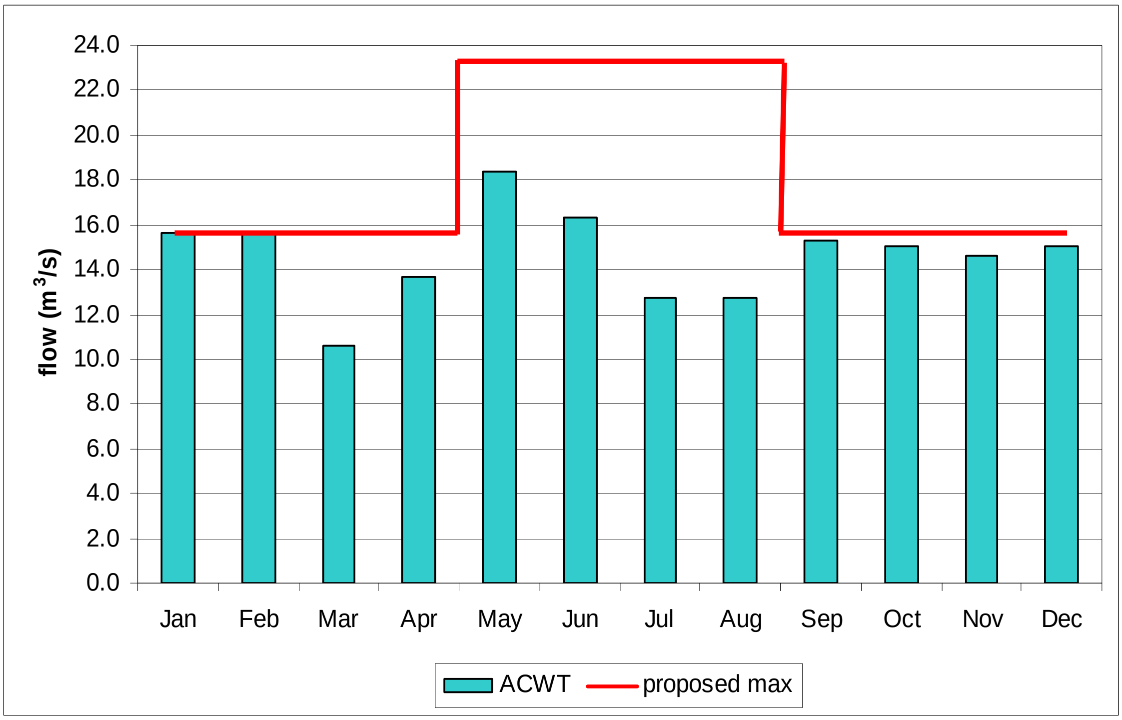

Figure 4: ACWT Rakaia River take maximum of monthly means

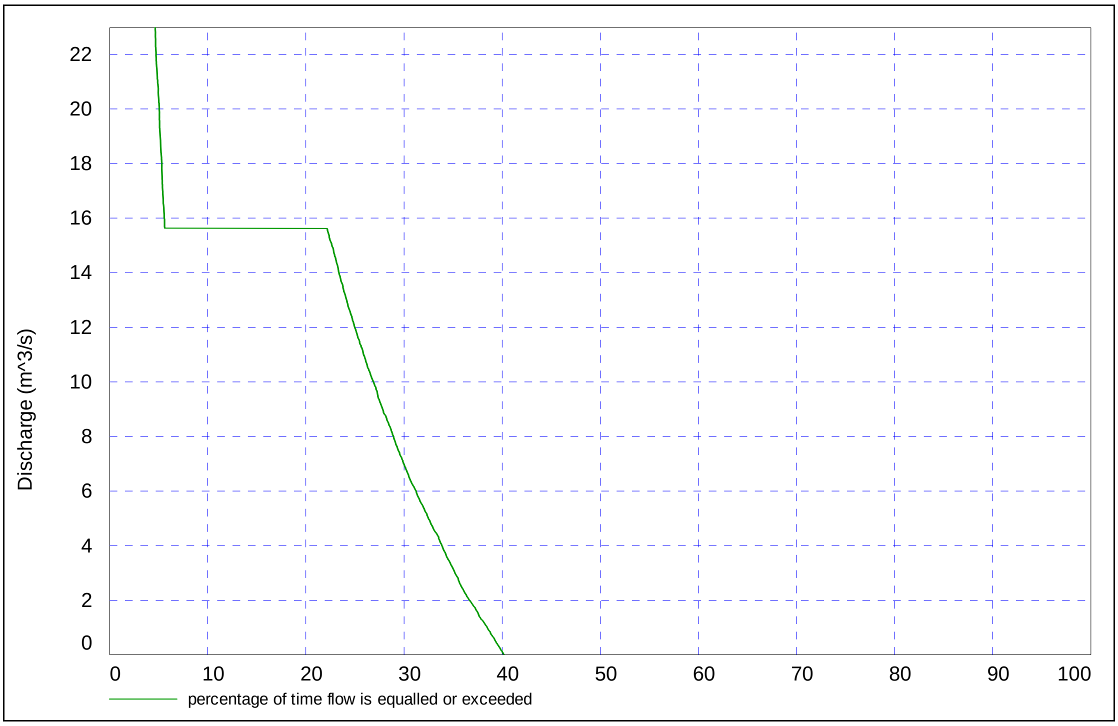

Figure 5: Flow duration curve of the ACWT Rakaia River take

Highbank Canal Flows

33. The mean of the monthly mean flows in the Highbank Canal are detailed in Table 4 and are shown in graphical form in Figure 6. The flows in the Highbank Canal are the flows that pass through the Highbank Canal Power Stations. Table 4 also details the maximum of the monthly mean flows and these values are shown in graphical form in Figure 7. Figure 7 also shows the components of the ACWT and BCIL water that comprise the flow in the Highbank Canal. In addition, the monthly mean flows for each of the years modelled for the Highbank Canal are contained in Appendix A, Table A2.

34. The flow duration curve of the flow in the Highbank Canal is shown in Figure 8. The flow duration curve presented in Figure 8 shows the full range of daily mean flows over the period 1958 to 2005 that would have been conveyed in the Highbank Canal.

Table 4: Highbank Canal total flow (flows in m^3/s)

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mean of monthly means	18.4	15.3	13.5	13.6	15.5	12.3	7.1	9.8	12.1	16.5	17.8	17.6
Maximum of monthly means	32.6	32.6	26.4	29.5	35.0	33.1	25.3	27.6	32.3	32.1	31.6	32.0
Proposed monthly maximum	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

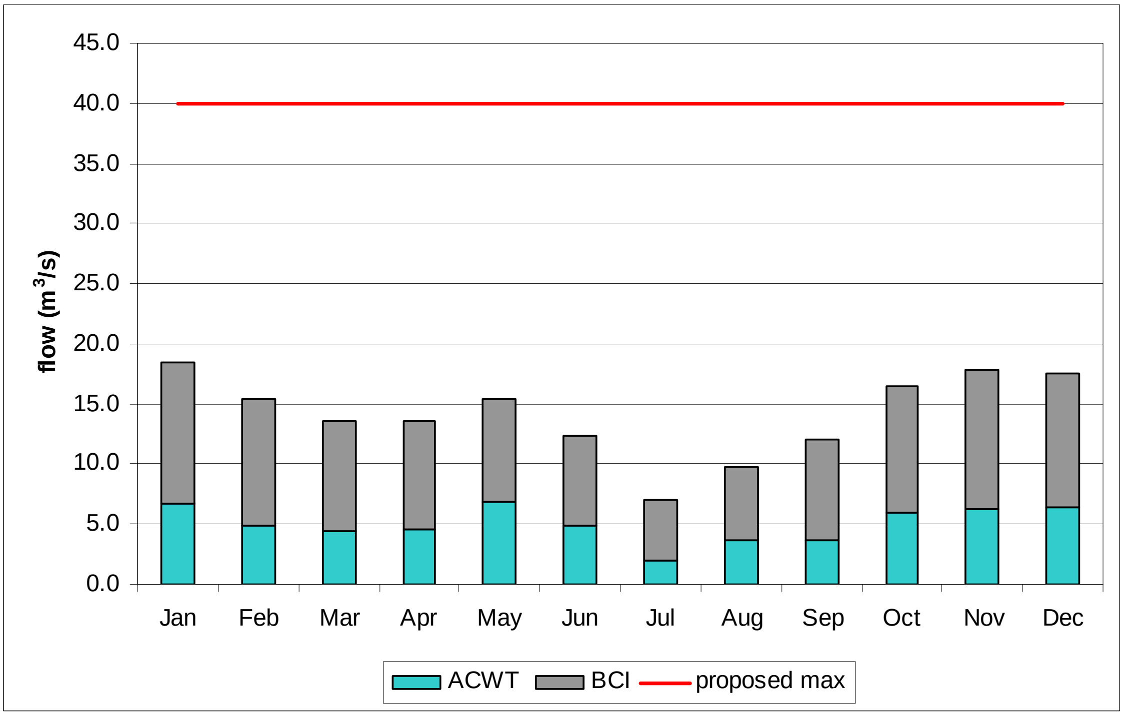

Figure 6: Highbank Canal mean of monthly means showing components of the flow

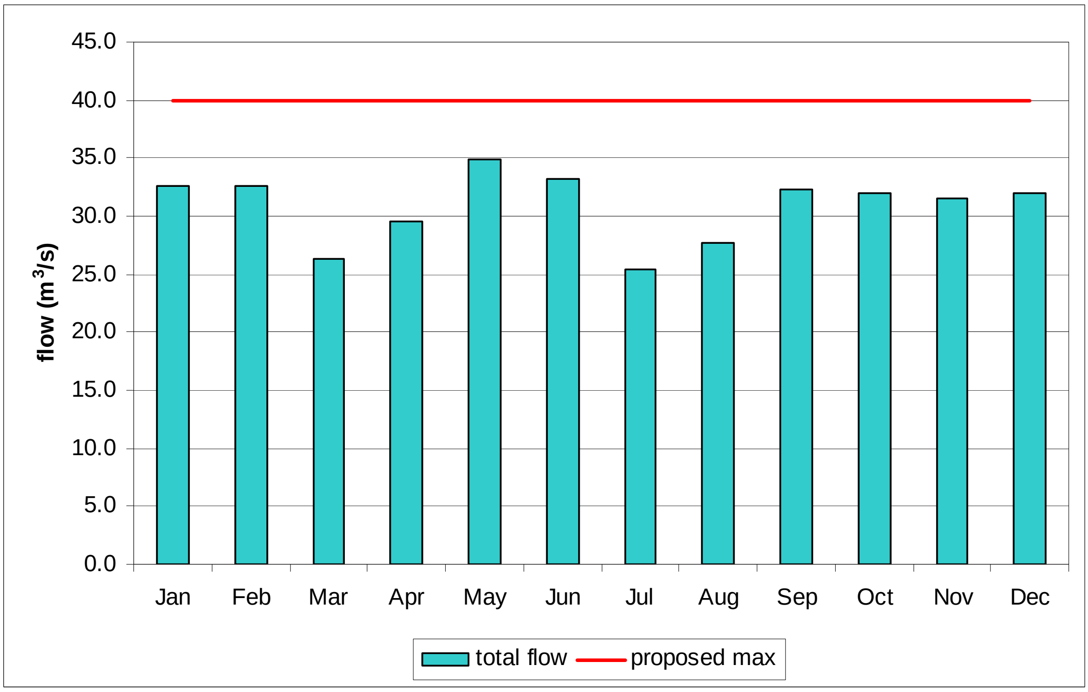

Figure 7: Highbank Canal flow maximum of monthly means

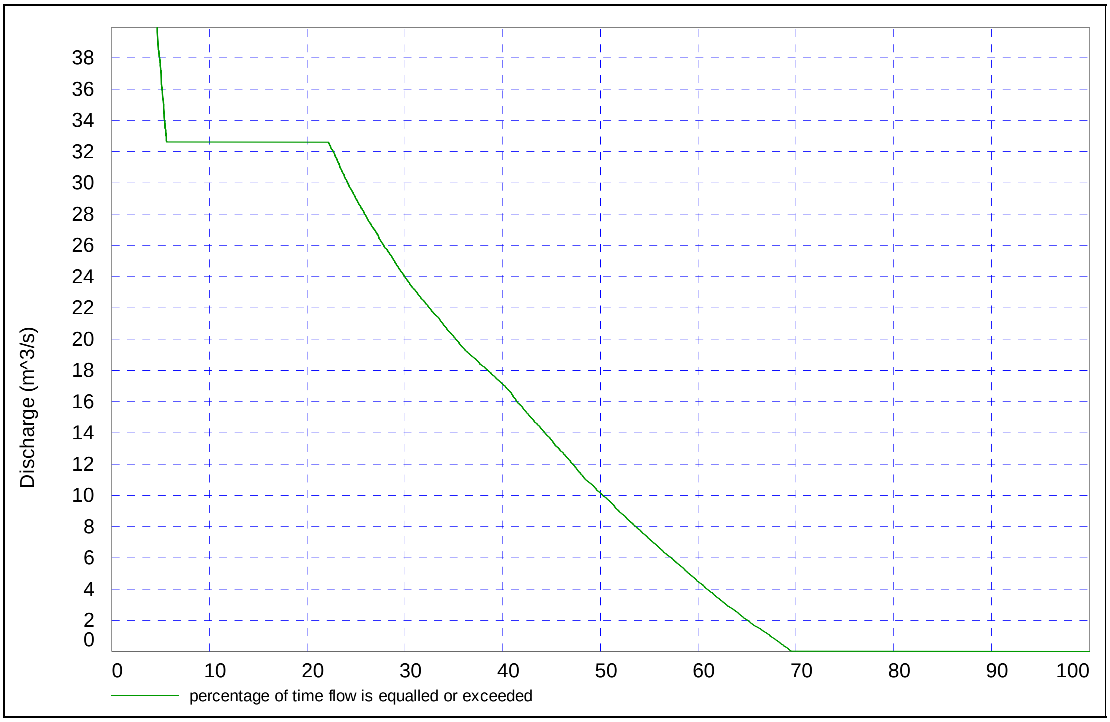

Figure 8: Flow duration curve of the Highbank Canal flow

Terrace Canal flows and discharge to the Rakaia River from the Proposed Barrhill Power Station

35. The mean of the monthly mean flows in the Terrace Canal are detailed in Table 5 and are shown in graphical form in Figure 9. The flows in the Terrace Canal are the flows that would pass through the Barrhill Power Station and that would be discharged back

to the Rakaia River upstream of Barrhill. Table 5 also details the maximum of the monthly mean flows and these values are shown in graphical form in Figure 10. Figure 10 also shows the components of the ACWT, BCIL and RDR (or Highbank Power Station tailrace) water that comprises the flow in the Terrace Canal. In addition the monthly mean flows for each of the years modelled for the Terrace Canal are contained in Appendix A, Table A3.

36. The flow duration curve of the flow in the Terrace Canal and the discharge back to the Rakaia River from the Proposed Barrhill Power Station is shown in Figure 11. The flow duration curve presented in Figure 11 shows the full range of daily mean flows over the period 1958 to 2005 that would have been conveyed in the Terrace Canal and hence discharged to the Rakaia River from the proposed Barrhill Power Station.

Table 5: Terrace Canal total flow and discharge to the Rakaia River from the Proposed Barrhill Power Station (flows in m^3/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean of monthly means	9.9	7.3	8.7	14.2	27.5	29.9	27.7	28.9	22.0	18.6	13.1	11.2
Maximum of monthly means	23.2	23.2	25.7	34.2	39.7	39.9	39.0	38.9	37.2	38.3	28.9	24.7
Proposed monthly maximum	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

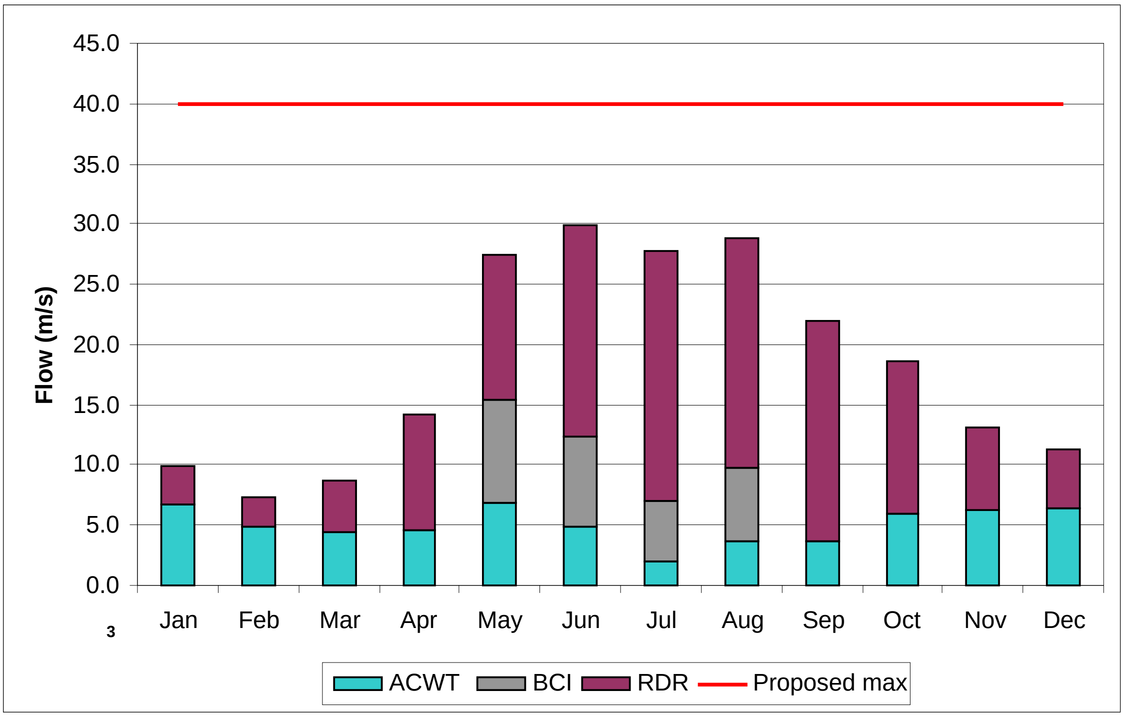

Figure 9: Terrace Canal and discharge to Rakaia River from the Proposed Barrhill Power Station mean of monthly means showing components of the flow

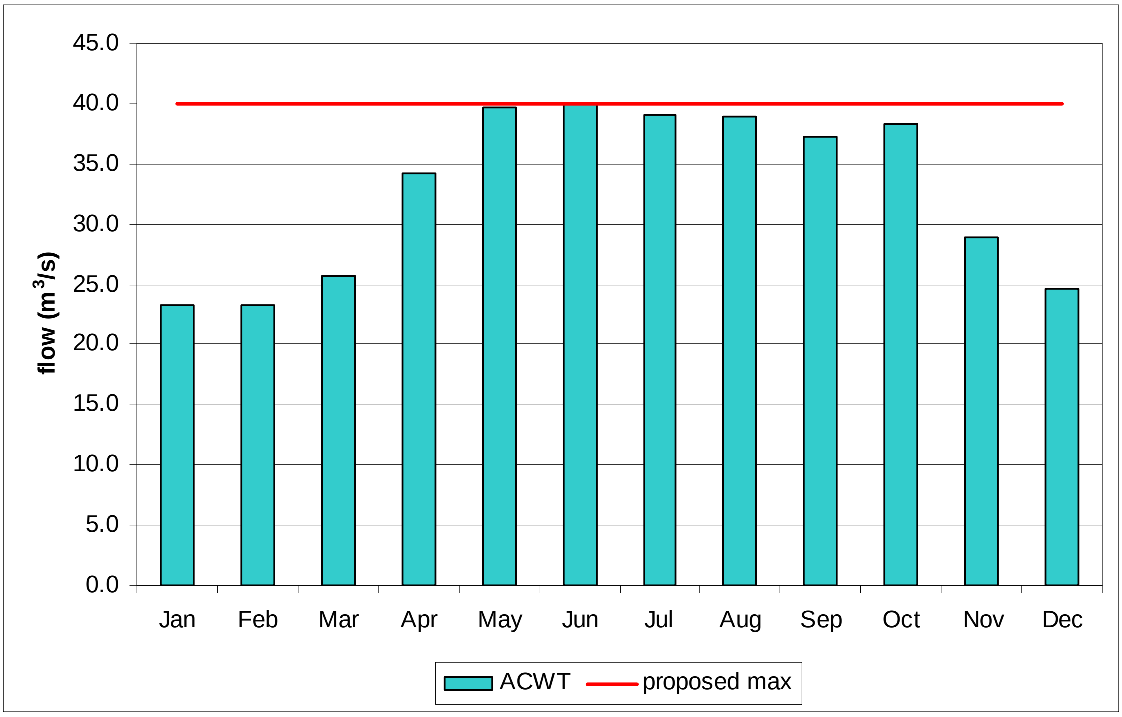

Figure 10: Terrace Canal and discharge to Rakaia River from the Proposed Barrhill Power Station maximum of monthly means

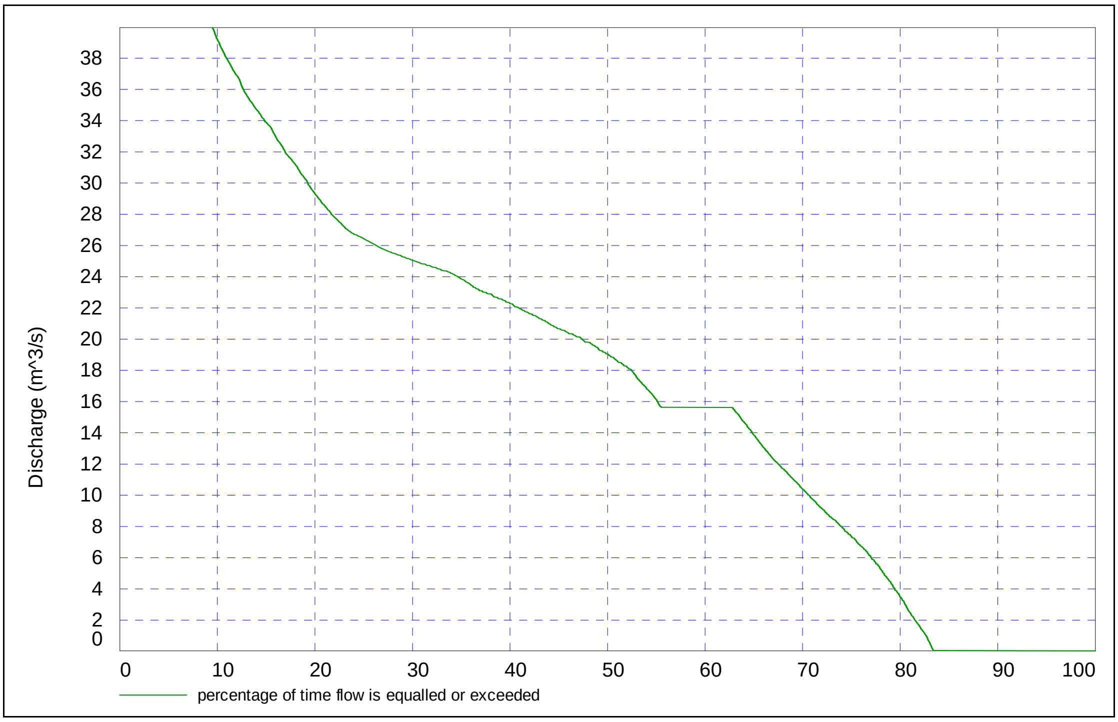

Figure 11: Flow Duration Curve of the Terrace Canal flow and the discharge to the Rakaia River from the Proposed Barrhill Power Station

Mean annual flows

37. The mean annual flows of the ACWT take from the Rakaia River, the Highbank Canal and the Terrace Canal and discharge to the Rakaia River from the Proposed Barrhill Power Station are presented in Table 6.

Table 6: Mean annual flows

	Mean annual flow (m^3/s)
Mean annual flow of ACWT take from Rakaia River	5.0
Mean annual flow of Highbank Canal	14.1
Mean annual flow of Terrace Canal and the discharge to the Rakaia River from the Proposed Barrhill Power Station	18.3

Modelling Results for the Highbank Power Station Tailrace Discharge Flows under Different Flow Regimes

38. The modelling results, showing the discharge of water from the Highbank Power Station Tailrace to the Rakaia River, are presented as three scenarios as follows:

- Scenario 1 presents the existing (historical) operation of the Highbank Power Station Tailrace discharge to the Rakaia River.
- Scenario 2 models the discharge of the historical flow through the Highbank Power Station plus all of the water taken under the BCIL consent being discharged into the Highbank Power Station Tailrace. That is the BCIL water is being used solely for hydro generation. This scenario is the existing consented discharge from the Highbank Power Station Tailrace (i.e. resource consents CRC011249 and CRC080361).
- Scenario 3 models the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme. Water taken from the Rakaia River under the ACWT and BCIL consents and discharged into the Highbank Power Station Tailrace via the Highbank Canal is then diverted into the Terrace Canal and additional water from the Highbank Power Station discharge is also diverted into the Terrace Canal to bring the flow in the Terrace Canal up the canal's capacity (i.e. 40 m^3/s) whenever possible.

Scenario 1 – Existing Highbank Power Station discharge

39. The mean of the monthly mean flows of the existing discharge to the Rakaia River via the Highbank Power Station Tailrace are detailed in Table 7 together with the maximum of the monthly mean flows discharged. In addition, the monthly mean flows discharged for each year are contained in Appendix B, Table B1.

40. The flow duration curve of the flow of the existing Highbank Power Station Tailrace discharge is shown in Figure 12. The flow duration curve presented in Figure 12 shows the full range of daily mean flows over the period 1958 to 2005 that have been discharged to the Rakaia River from the Highbank Power Station Tailrace.

Table 7: Scenario 1 - Existing discharge from the Highbank Power Station (flows in m^3/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean of monthly means	3.2	2.4	4.3	9.7	16.1	22.7	22.8	22.9	18.4	12.7	6.8	4.9
Maximum of monthly means	16.9	12.5	19.8	24.1	25.9	26.5	27.4	26.8	26.5	25.2	17.8	17.1

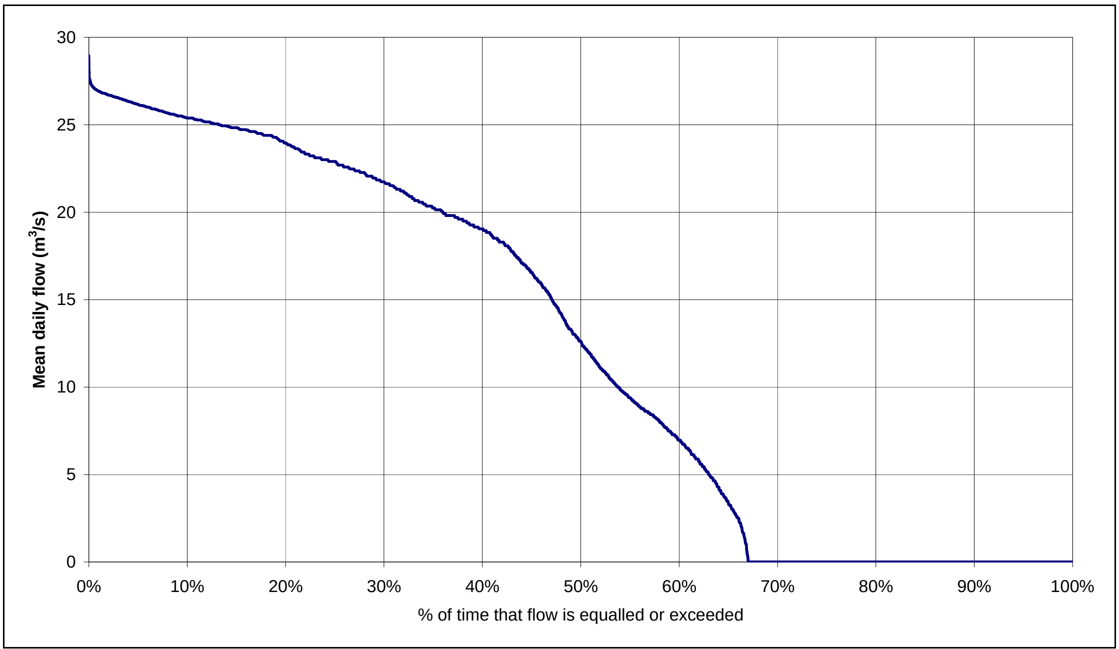

Figure 12: Flow duration curve of the existing discharge from the Highbank Power Station Tailrace

Scenario 2 – Existing discharge from the Highbank Power Station plus the discharge of water taken under the BCIL consent

41. The mean of the monthly mean flows that are discharged to the Rakaia River via the Highbank Power Station Tailrace for scenario 2 are detailed in Table 8 together with the maximum of the monthly mean flows discharged. In addition, the monthly mean flows discharged for each year are contained in Appendix B, Table B2.

42. The flow duration curve of the flow of the discharge to the Rakaia River via the Highbank Power Station Tailrace for scenario 2 is shown in Figure 13. The flow duration curve presented in Figure 13 shows the full range of daily mean flows over the period 1958 to 2005 that would have been discharged to the Rakaia River from the Highbank Power Station Tailrace from the existing discharge of the Highbank Power Station plus the discharge of water taken under the BCIL consent.

Table 8: Scenario 2 - Existing discharge from the Highbank Power Station plus the discharge of water taken under the BCIL consent (flows in m3/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean of monthly means	15.0	12.9	13.3	18.8	24.7	30.2	27.8	29.0	26.8	23.2	18.3	16.1
Maximum of monthly means	28.9	25.4	34.3	37.2	41.6	42.2	41.0	41.1	41.1	42.0	31.8	27.4

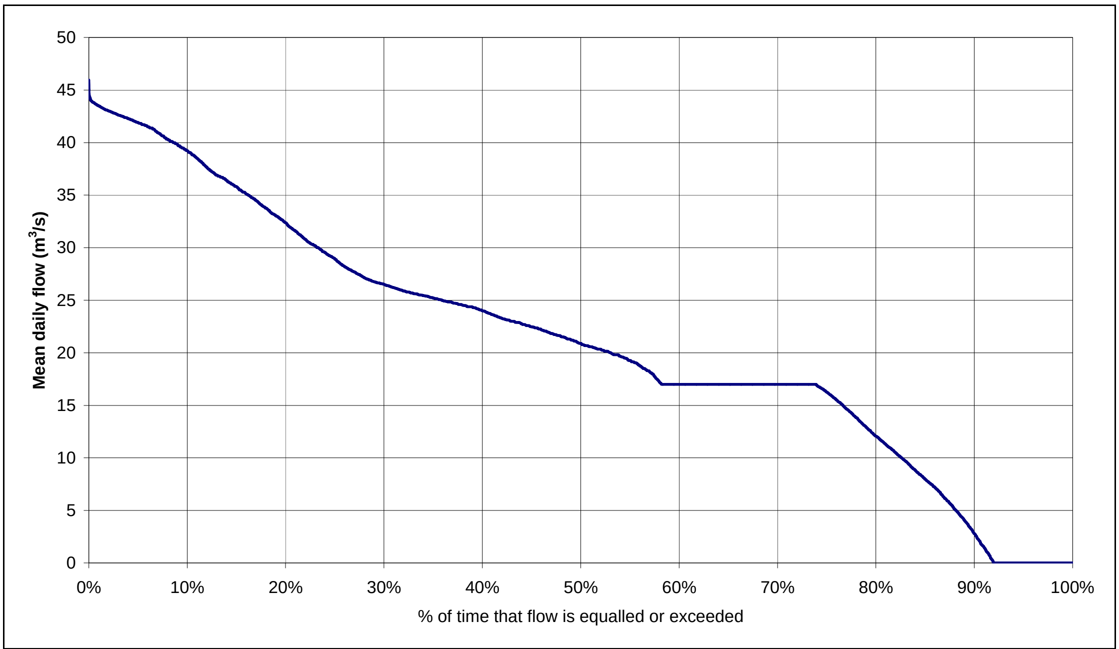

Figure 13: Flow duration curve of the existing discharge from the Highbank Power Station plus the discharge of water taken under the BCIL consent

Scenario 3 – Discharge from the Highbank Power Station Tailrace under the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme

43. The mean of the monthly mean flows that are discharged to the Rakaia River via the Highbank Power Station Tailrace for scenario 3 are detailed in Table 9 together with the maximum of the monthly mean flows discharged. In addition, the monthly mean flows discharged for each year are contained in Appendix A, Table A3.

44. The flow duration curve of the flow of the discharge to the Rakaia River via the Highbank Power Station Tailrace for scenario 3 is shown in Figure 14. The flow duration curve presented in Figure 14 shows the full range of daily mean flows over the period 1958 to 2005 that would have been discharged to the Rakaia River from the Highbank Power Station Tailrace under the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme.

Table 9: Scenario 3 – Discharge from the Highbank Power Station Tailrace under the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme (flows in m3/s)

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mean of monthly means	0.4	0.4	0.5	2.0	4.1	5.2	2.1	3.8	2.5	2.8	1.3	0.5
Maximum of monthly means	3.9	4.2	4.4	12.1	16.9	18.6	14.2	14.3	14.8	15.9	7.4	5.7

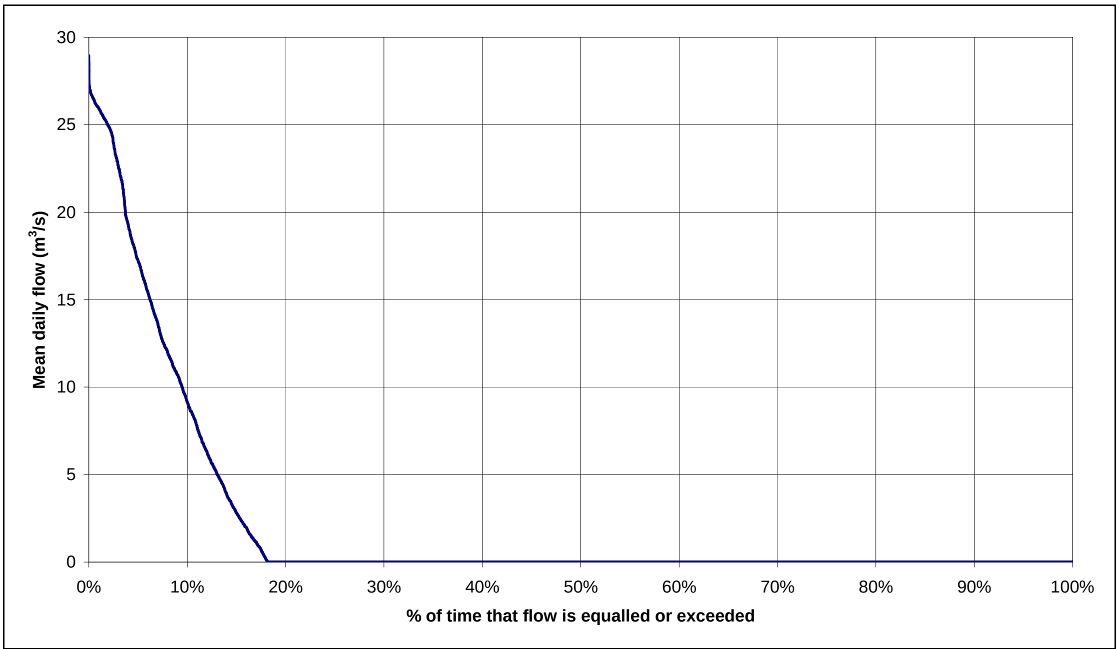

Figure 14: Flow duration curve of the discharge from the Highbank Power Station Tailrace under the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme

Summary of Highbank Power Station Tailrace flow regimes under three scenarios

45. To compare the mean monthly discharges from the Highbank Power Station Tailrace for the three scenarios, these discharges are shown in graphical form in Figure 15 and as flow duration curves in Figure 16. Figures 15 and 16 show that with the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme (scenario 3) the quantity of water discharged from the Highbank Power Station Tailrace will be substantially reduced for all months of the year when compared to the existing discharge from the tailrace (scenario 1). There is an even greater reduction in the quantity of water discharged via the tailrace under the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme when compared to the currently consented discharge (scenario 2).

46. Martin Unwin of NIWA in a letter to MWH dated 29 June 2007 (and appended to the 'Application for Resource Consent – Barrhill Chertsey Irrigation Scheme Intake and Primary Canal, July 2007') refers to a study of the Highbank Power Station Tailrace conducted on behalf of TrustPower Ltd in 2000 which suggests that the number of salmon salvaged annually increases exponentially as the tailrace flow increases. On this basis a change in the Highbank Power Station Tailrace flow regime that reduces the flows in the tailrace will reduce the attraction of salmon to the tailrace.

47. It is therefore concluded that as the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme will substantially reduce the flow regime in the Highbank Power Station Tailrace, the proposed scheme's operation will have a beneficial effect on the Rakaia River as it will reduce the attraction of upstream migrating salmon to the tailrace discharge.

48. This section of my evidence on the hydraulic modelling undertaken on the Highbank Power Station Tailrace discharge flows under the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme also addresses the issue raised in paragraph 248 of Environment Canterbury's Section 42A Officer's Report.

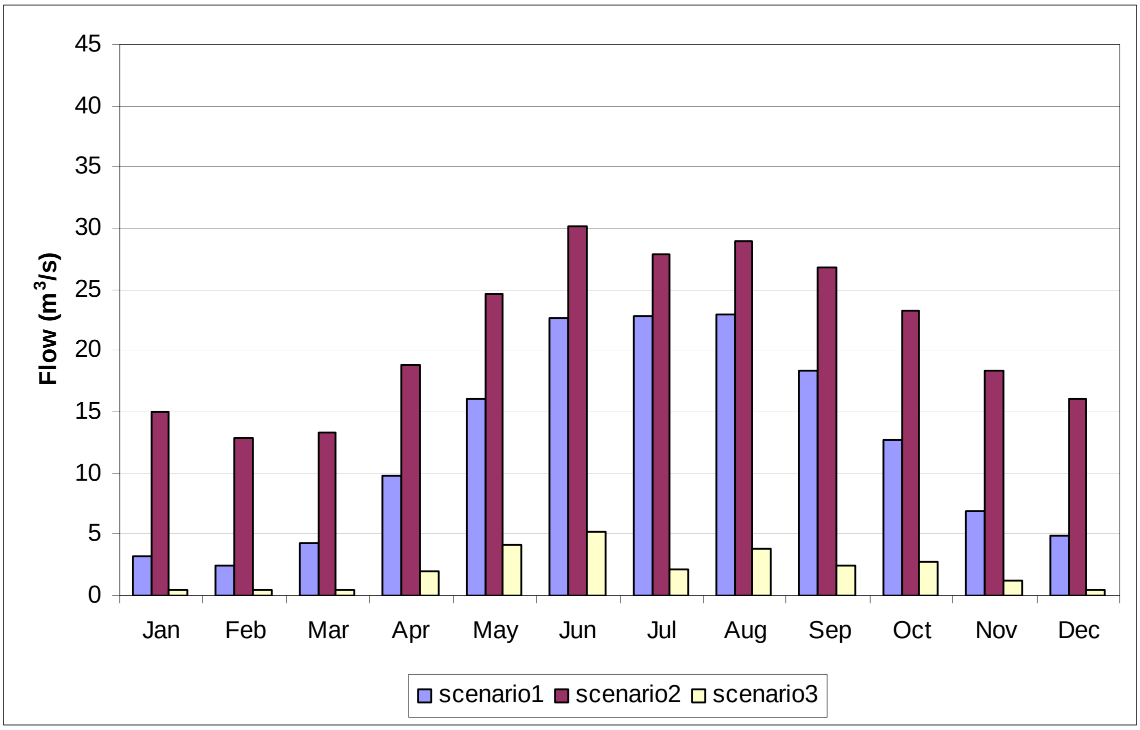

Figure 15: Highbank Power Station Tailrace discharges showing mean of monthly mean flows under scenarios 1, 2 and 3

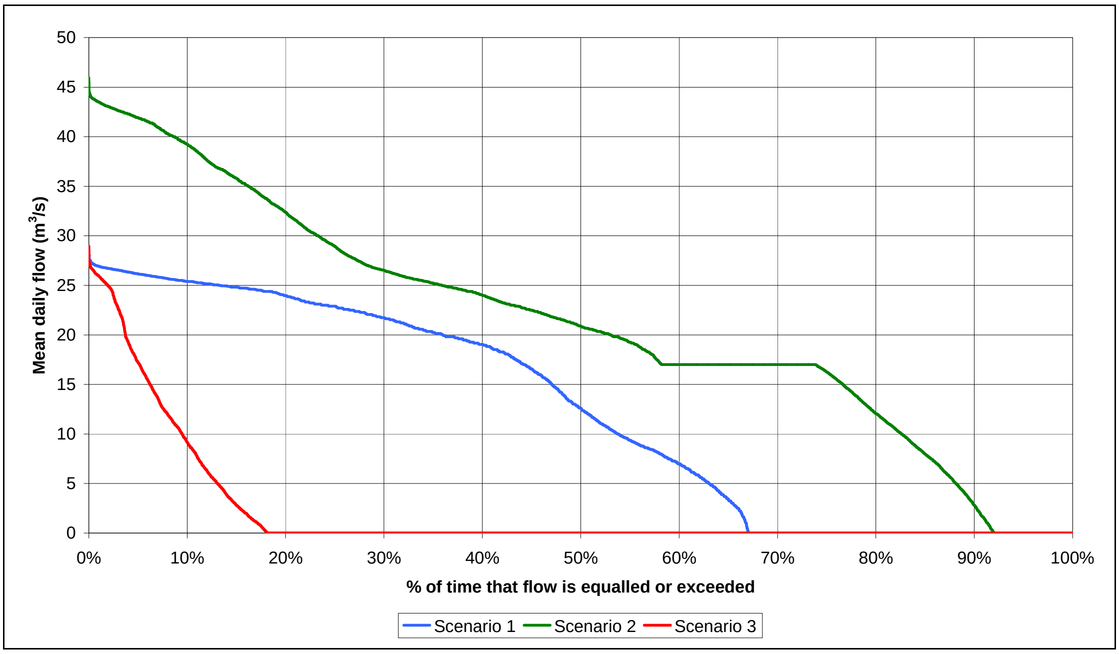

Figure 16: Highbank Power Station Tailrace discharges showing flow duration curves of daily mean flows under scenarios 1, 2 and 3

EFFECTS OF DIVERTING WATER

49. The operation of the intake will involve diverting water from the Rakaia River through the intake structure into the storage/settling pond. From the storage/settling pond, water will be taken into the canal after passing through the fish screen and inlet control structure.

50. The NWCO that is in force on the Rakaia River was established specifically to maintain the natural characteristics of the river while providing for a certain level of abstractive use. Investigations and evidence presented at the NWCO hearings analysed the effects of abstraction on flow patterns, sediment flows and riverbed morphology (NWSCA, 1984). A system of minimum flows, and rules for sharing of flows in excess of these minimums, was put in place to achieve the desired protection of the natural characteristics of the river.

51. Therefore, water diversions and abstractions, which comply with the NWCO, have been judged to not significantly change the natural character of the river. The proposed activity will be in full compliance with the NWCO and, hence, have no significant adverse effects on the river and its associated values.

52. The NWCO specifically protects the outstanding wildlife habitat above and below the Rakaia River Gorge and outstanding fisheries. While the amount of water taken will not have a significant effect on ecosystems, the manner in which it is taken can have an adverse effect on the migration of both adult and juvenile fish. These effects can be mitigated by appropriate design of the intake structure, fish screens and bypass system for returning fish to the river as described in Mr S Woods evidence.

53. In his evidence to the hearing panel on the joint CPWT/ACWT application to take water from the Rakaia River Dr G Glova addresses the issues of fish passage and fish habitat and concludes;

> "Passage for adult salmon and trout is not likely to be adversely affected by CPWT/ACWT take in the Rakaia River as the monthly minimum flows of the NWCO adequately provide for safe upstream passage of these fish." and

> "The take of up to 40 m^3/s from the Rakaia River is not likely to adversely affect the availability of potential habitat for salmonids as the river is adequately protected by the minimum flows of the NWCO."

54. The NWCO specifically protects the outstanding recreational, angling and jet-boating features of the Rakaia River. Therefore, water abstractions that comply with the NWCO have been judged to not significantly alter the provision of recreational opportunities including jet boat access. The intake structure will have appropriate signage warning recreational users of its location. In addition, the inlet to the intake structure will have a screen placed over it.

Effects of Diverting Water on the Rakaia River Flow Regimes

55. The effects of diverting water from the Rakaia River on the river's flow regime has been examined. This has been done by considering the flows in two reaches of the river separately as follows:

- Reach 1 – between the intake and Highbank Power Station Tailrace.
- Reach 2 – between the Highbank Power Station Tailrace and the Proposed Barrhill Power Station Tailrace.

In the reach downstream of the Proposed Barrhill Power Station Tailrace there is no change in the flow regime as all of the water diverted by the ACWT take is returned to the river at the Proposed Barrhill Power Station Tailrace.

56. The flows for each reach were calculated using results from the hydrological modelling described earlier in my evidence. Note that the flows reported in each reach do not include the effects of other existing or proposed takes from the Rakaia River.

57. The flow regime in each reach of the river has been presented as flow duration curves that show the full range of daily mean flows over the period 1958 to 2005. Due to the close linkage between the ACWT take and water taken under the BCIL consents the flows in each reach are reported as the flow regime with the ACWT take only and the flow regime with both the ACWT and BCIL takes. In each reach the flow duration curve for the Rakaia River without the ACWT or BCIL take occurring is also shown as the status quo curve.

58. Figure 17 shows the flow duration curves for reach 1 between intake and the Highbank Power Station Tailrace. The effect of the ACWT take on the Rakaia River in reach 1 for a typical year (2001-02), that shows a range of river flows, is presented in Figure C1 in Appendix C. Figures 17 and C1 show that the change in the Rakaia River's flow regime between the intake and the Highbank Power Station Tailrace, as a consequence of the ACWT take, is relatively minor.

59. Figure 18 shows the flow duration curves for reach 2 between the Highbank Power Station Tailrace and the Proposed Barrhill Power Station Tailrace. In this reach the status quo flow is the Rakaia River mean daily flow from the Fighting Hill site plus the existing Highbank Power Station Tailrace mean daily flow. The effect of the ACWT take on the Rakaia River in reach 2 for a typical year (2001-02), that shows a range of river flows, is presented in Figure C2 in Appendix C.

60. Figures 18 and C2 show that the change in the Rakaia River's flow regime between the Highbank Power Station Tailrace and the Proposed Barrhill Power Station Tailrace as a consequence of the ACWT take while greater than the change shown in reach 1 is still relatively small and hence will have only a minor impact on the river. The reason for the greater change in the river flow regime in reach 2 is due to some of the existing Highbank Power Station Tailrace flow being conveyed in the Terrace Canal and discharged at Barrhill instead of at Highbank.

61. This section of my evidence on the effects on the Rakaia River's flow regime under the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme also addresses the issue raised in paragraphs 193 and 194 of Environment Canterbury's Section 42A Officer's Report.

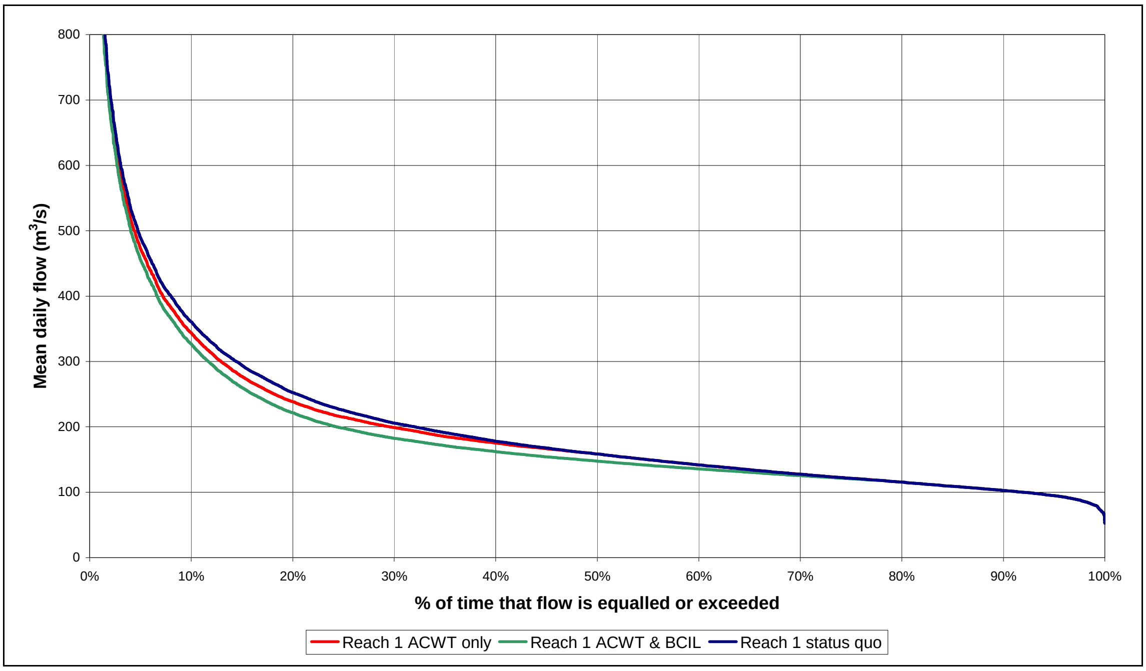

Figure 17: Flow duration curves for reach 1 of the Rakaia River

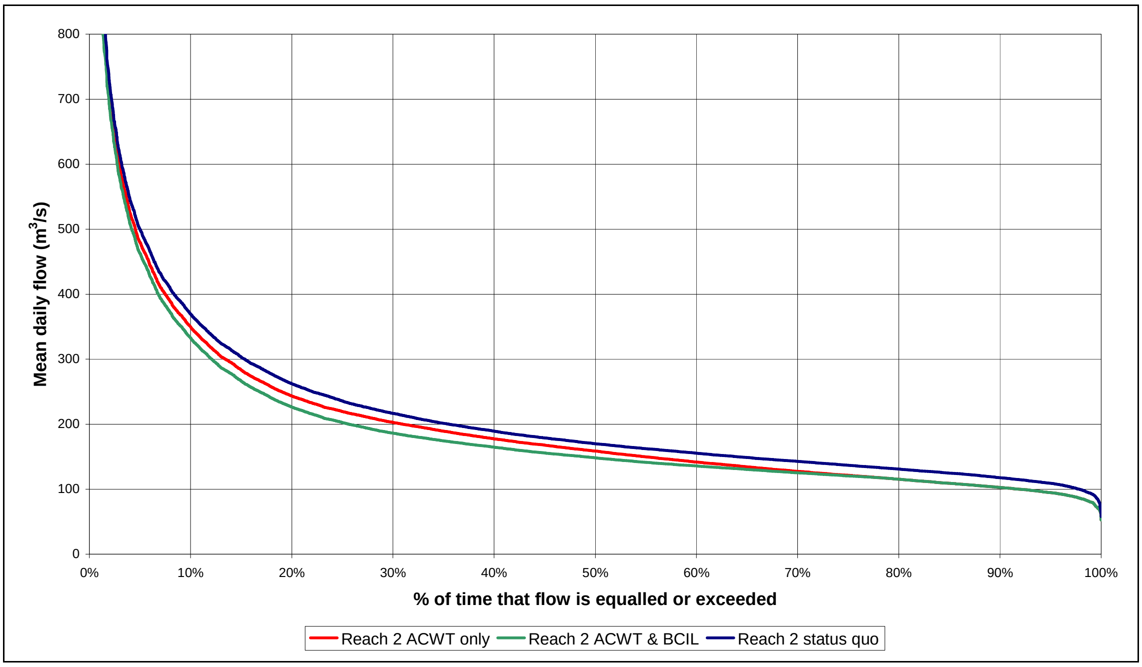

Figure 18: Flow duration curves for reach 2 of the Rakaia River

EFFECTS OF DISCHARGES OF WATER AND SEDIMENT

62. ACWT have applied for resource consents to discharge water and sediment to the Rakaia River in the following locations:

- From the fish bypass channel located downstream of the fish screens, to discharge up to 2 m^3/s (consent application CRC072638).
- From the Highbank Canal in emergency situations at a location approximately 500 m upstream of the Highbank Power Station, to discharge up to 40 m^3/s (consent application CRC072639).
- From the Highbank Power Station Tailrace, to discharge up to 40 m^3/s (consent application CRC072640).
- From the Proposed Barrhill Power Station Tailrace, to discharge up to 40 m^3/s (consent application CRC072640).

63. Fish excluded from entering the Highbank Canal by the fish screens will be able to return to the river via the fish bypass channel. This fish bypass channel will discharge water to an active river braid. A fish barrier structure will be constructed on the bypass channel, in accordance with the design recommended by suitably qualified ecologists and engineers, to prevent fish entering this channel from the downstream end.

64. The Highbank Canal will include the provision of an emergency discharge spillway located at or about map reference NZMS 260 K36:075-367. Emergency discharges via this spillway will only occur to prevent overtopping of the canal in the event of an unintended shutdown. Such discharges would only occur infrequently and would be of short duration.

65. While the operation of ACWT's Rakaia Terrace Hydro Scheme will result in water being discharged into the Highbank Power Station Tailrace from the Highbank Canal this water will be then diverted out of the tailrace into the Terrace Canal. Hence the discharge of water and sediment from the Highbank Power Station Tailrace into the Rakaia River will only occur in emergency situations in the event of unintended shut down in the Terrace Canal and/or the Proposed Barrhill Power Station. Such a discharge would only occur infrequently and would be for a relatively short duration and is discussed in the evidence of Mr S Wood.

66. A fish barrier structure will be constructed on the Proposed Barrhill Power Station Tailrace to prevent adult migrating salmon and other fish from entering the tailrace. A fish velocity barrier is proposed of the type used on the Branch River Hydro Scheme's tailrace discharge back to the Wairau River. A photograph of this fish velocity barrier is attached as Figure D1 in Appendix D. The fish velocity barrier would be constructed in accordance with the design recommended by suitably qualified ecologists and engineers and it would be located on the existing Rakaia River bank as defined by the edge of the existing vegetation. In addition, a channel would be maintained to ensure that fish attracted to the downstream end of the fish velocity barrier are able to return to a flowing braid of the river.

67. Warning signs will be erected at the locations where discharges of water and sediment enter a braid of the Rakaia River, (including the location of emergency discharges) to warn people of the possible release of water in that area.

68. The water discharged back to the Rakaia River at the locations described in my evidence will have only minor effects on the river's water quality. This is because any water discharged will pass through the storage/settling pond where some settling of the suspended material will occur prior to being discharged, so that its suspended sediment load, and hence its turbidity, would be similar to (or less than) the turbidity of the existing river flow that it is discharged into.

EFFECTS OF RIVERBED WORKS ON THE RAKAIA RIVER

69. There are five situations where riverbed works will or may be required, which are as follows:

- Construction and maintenance of the intake will require works in the riverbed (consent application CRC072644).
- Construction and maintenance of the fish barrier structures (consent application CRC072645).
- On an ongoing basis, river works may be required to maintain a reliable supply of water from the Rakaia River to the scheme intake (consent application CRC072643). These works involve the use of temporary gravel banks to divert flows into the existing braid.
- Works in the river will be required to maintain the existing river bank protection works adjacent to the intake and to install and maintain river protection works in the section from approximately 1.8 km upstream of the Highbank Power Station to approximately 2.2 km downstream of the Highbank Power Station (consent applications CRC072643 and CRC072647).

- Riverbed works will be required to construct and maintain the discharge channels so that they will discharge into a flowing braid of the Rakaia River (consent application CRC072643).

70. These works in the bed of the Rakaia River comprise those that will be required during the construction phase (i.e. the intake, fish barrier structures, installation of river protection works and construction of the discharge channels) and those that will be required to maintain the operation of the hydro scheme. The predominant machinery used for riverbed works will be bulldozers, although diggers may be required occasionally.

71. Ongoing river works to divert flow to the intake will only be needed if the river shifts away from the existing braid. The proposed intake point is adjacent to a stable major channel braid. Evidence from aerial photographs and neighbouring landowners is that the proposed intake is adjacent to a stable, major river channel braid. Therefore, based on past evidence, it is most likely that these river works would only be required infrequently.

72. If the channel was to move from the current position, it would be diverted back using low level uncompacted gravel banks. These river works would be carried out primarily with a bulldozer, although a digger could also be used. A bulldozer would be used to push up low level uncompacted gravel banks in the riverbed. These banks would be designed to wash out if river levels rise. Provided these gravel banks are constructed to have only a small freeboard, are not compacted and have a small cross section (i.e. steep batters and a narrow top width) a minor rise in the river flow will overtop the bank and wash it out. This approach is used effectively on other irrigation takes from the Rakaia River and other Canterbury gravel bed rivers where methods have been developed for creating gravel banks that breach easily and that minimise disturbance of the riverbed. The gravel is sourced from the upstream side of the redirection point to minimise disruption to the downstream riverbed natural armouring.

73. The river works will have a minor effect on river morphological processes because the river will destroy the temporary banks at a flow of about 400 m^3/s. The river works will have very minor effects on flood levels because the weirs are designed to wash out once river flows exceed 400 m^3/s and the scale of the works is minor.

74. For riverbed works on other existing Rakaia River irrigation diversions, bulldozers and other equipment travel to the work sites using established tracks and stream crossings. The blade is kept lifted while travelling. These measures will be adopted for the proposed river works and will minimise the adverse effects of transporting equipment to the works site.

75. Ongoing river works will also be required to ensure that there is a continuous flow path between discharge points and a flowing braid. The frequency at which these river works will be required is unknown, but will not be necessary unless flows in the river exceed about 400 m^3/s, which, from observation, is the flow that marks the beginning of minor changes in braiding pattern. Events of this size occur on average 12 times per year (range 3 to 23 times per year).

76. Any works required to maintain river protection works would only be necessary following larger flood events.

77. While riverbed works are in progress, silt and fines will be released and the water discoloured for a distance downstream. The amount of silt released will be insignificant in comparison to sediments carried down the river during a fresh. In addition the re-instatement of the gravel banks or channels will occur immediately after a fresh or flood in the river when the bed will be in a disturbed state and the water is likely to be discoloured. The effects of the riverbed works on the river ecosystem are addressed in the evidence of Dr D Rowe.

SUMMARY

78. ACWT's Proposed Rakaia Terrace Hydro Scheme water take from the Rakaia River will be in full compliance with the NWCO.

79. Hydrological modelling of the proposed operation of ACWT's Rakaia Terrace Hydro Scheme has been undertaken using historical flow records from the period 1958 to 2005 to determine; (i) the flow that would be taken from the Rakaia River at the Happy Valley intake, (ii) the changes in the flow regime that would be discharged to the Rakaia River from the Highbank Power Station Tailrace, (iii) the flow that would be discharged to the Rakaia River from the Proposed Barrhill Power Station and (iv) the effects on the Rakaia River's flow regime between the intake at Happy Valley and the discharge at the Proposed Barrhill Power Station's Tailrace.

80. The output of this modelling has been presented as the monthly mean flows for each year of the years modelled and as flow duration curves that show the full range of daily mean flows over the period 1958 to 2005.

81. With the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme the quantity of water discharged from the Highbank Power Station Tailrace will be substantially reduced for all months of the year when compared to the existing discharge from the tailrace. It is therefore concluded that the proposed scheme's operation will have a beneficial effect as it will reduce the attraction of upstream migrating salmon to the Highbank Power Station Tailrace discharge.

82. The changes in the Rakaia River's flow regime, both between the intake and the Highbank Power Station Tailrace and between the Highbank Power Station Tailrace and the Proposed Barrhill Power Station Tailrace, as a consequence of the ACWT take, are both relatively small and hence will have only a minor impact on the river's flow regime.

83. Any potential adverse effects on fish from the discharge of water and sediment to the Rakaia River via both the fish bypass channel and the Proposed Barrhill Power Station Tailrace can be mitigated by the construction of fish barrier structures and the maintenance of a channel to ensure that fish attracted to the downstream end of the fish barrier structures are able to return to a flowing braid of the river.

84. The proposed works in the bed of the Rakaia River comprise those that will be required during the construction phase and those that will be ongoing as required to maintain the operation of the hydro scheme. Due to the minor scale of these works they will have only minor effects on the Rakaia River.

Dated: 8 September 2008

DNH Borrie

Appendix A: Modelling Results for the ACWT Take, Highbank Canal and Terrace Canal Flows

Table A1: ACWT Rakaia River take monthly mean flows (flows in m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1958	15.598	15.620	9.501	4.701	13.567	4.537	0.000	1.866	2.574	5.007	6.366	8.468	*7.317*	*15.620*
1959	0.180	1.145	2.836	2.280	0.225	3.425	0.000	0.000	4.827	2.086	7.762	9.096	*2.822*	*9.096*
1960	6.552	7.604	4.614	0.035	3.036	3.565	0.048	3.787	3.693	5.937	1.937	1.109	*3.493*	*7.604*
1961	0.060	4.464	8.911	4.773	0.000	1.533	0.966	1.149	0.000	4.256	5.240	0.575	*2.661*	*8.911*
1962	10.511	0.520	0.246	0.078	16.297	9.078	5.590	5.350	4.564	9.435	6.804	3.232	*5.975*	*16.297*
1963	1.614	7.699	3.615	1.227	11.000	9.781	0.929	4.092	7.639	1.008	5.607	0.653	*4.572*	*11.000*
1964	12.478	1.724	7.356	1.664	18.378	5.824	5.237	5.849	0.610	1.642	1.618	11.849	*6.186*	*18.378*
1965	13.814	6.992	0.999	0.709	3.231	4.900	0.000	0.000	0.329	1.863	11.049	6.922	*4.234*	*13.814*
1966	8.823	10.268	2.245	10.283	4.261	1.423	0.000	0.000	0.005	0.000	4.771	5.921	*4.000*	*10.283*
1967	5.024	5.622	10.428	11.531	12.031	0.000	3.960	11.443	0.994	5.219	10.482	8.690	*7.119*	*12.031*
1968	7.743	6.133	6.134	3.919	15.638	0.000	0.148	2.665	1.087	9.263	6.898	2.696	*5.194*	*15.638*
1969	2.534	1.359	5.325	3.681	3.421	0.000	0.518	0.000	8.487	0.272	0.407	4.569	*2.548*	*8.487*
1970	4.575	0.924	5.352	4.604	0.000	0.767	0.000	4.679	15.310	3.234	6.370	4.787	*4.217*	*15.310*
1971	0.206	0.878	0.000	0.000	0.265	7.921	0.000	0.000	1.767	10.532	1.784	3.784	*2.261*	*10.532*
1972	4.438	0.044	7.284	4.590	14.644	0.064	0.000	0.000	8.711	10.031	13.120	5.047	*5.664*	*14.644*
1973	0.541	0.000	0.428	7.102	6.546	4.746	0.000	0.742	1.617	5.660	10.255	2.106	*3.312*	*10.255*
1974	2.030	4.422	2.395	10.094	0.000	0.274	4.567	0.000	0.000	3.890	4.255	1.191	*2.760*	*10.094*
1975	1.739	4.547	7.381	10.115	12.473	4.332	3.356	7.369	3.550	5.949	7.638	5.311	*6.147*	*12.473*
1976	6.420	4.268	2.686	0.151	4.323	6.393	0.000	0.000	0.000	0.323	0.476	8.178	*2.768*	*8.178*
1977	11.177	4.540	3.872	0.983	0.674	0.000	0.118	0.000	0.000	1.008	5.745	1.990	*2.509*	*11.177*
1978	4.953	0.611	2.664	10.739	9.780	4.696	0.140	12.438	10.721	7.603	4.681	1.829	*5.905*	*12.438*
1979	3.527	5.743	5.519	5.492	15.030	0.854	0.000	0.000	3.556	12.571	14.598	15.047	*6.828*	*15.047*
1980	10.074	6.695	4.284	4.123	4.926	0.014	0.032	5.011	11.594	6.911	7.739	3.942	*5.445*	*11.594*
1981	2.658	5.244	8.891	4.166	11.173	11.109	2.514	0.673	0.203	12.669	5.552	13.300	*6.513*	*13.300*
1982	9.125	5.959	4.389	0.000	6.301	1.736	0.000	0.000	0.133	0.000	11.661	10.174	*4.123*	*11.661*
1983	10.070	0.429	4.211	10.375	16.603	4.337	7.148	7.797	6.714	12.019	12.097	10.326	*8.511*	*16.603*
1984	8.320	8.226	1.427	1.010	0.000	0.914	5.721	9.297	1.884	6.288	8.699	13.380	*5.430*	*13.380*
1985	13.161	1.694	0.662	2.546	1.484	3.726	1.759	3.297	4.756	0.000	2.351	8.831	*3.689*	*13.161*
1986	5.257	5.021	1.567	5.940	5.343	12.505	0.589	0.771	0.000	11.187	3.396	5.311	*4.741*	*12.505*
1987	9.297	6.141	5.409	10.064	7.858	12.389	0.000	0.888	1.321	9.150	4.972	4.918	*6.034*	*12.389*
1988	1.530	4.286	4.666	2.441	4.549	8.552	7.839	8.224	8.590	15.058	12.294	14.534	*7.714*	*15.058*
1989	13.165	8.732	5.369	1.726	1.789	9.501	0.916	0.000	0.000	0.000	4.535	6.912	*4.387*	*13.165*
1990	9.692	2.380	2.966	4.682	18.386	4.297	3.848	10.102	0.000	4.896	3.399	8.501	*6.096*	*18.386*
1991	7.475	13.820	0.347	5.097	0.000	0.201	0.000	12.729	4.040	4.719	0.045	1.885	*4.197*	*13.820*
1992	7.431	6.823	6.397	1.046	0.416	0.000	1.484	8.310	0.000	5.180	10.155	7.210	*4.538*	*10.155*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1993	10.718	2.063	2.873	3.288	5.894	16.353	1.484	0.000	0.000	7.374	0.521	3.478	*4.504*	*16.353*
1994	15.447	2.411	5.779	2.994	9.138	6.381	7.935	10.881	5.474	0.990	13.206	11.038	*7.639*	*15.447*
1995	9.926	5.424	9.441	12.028	14.930	0.000	0.100	1.043	13.580	13.898	7.445	14.960	*8.565*	*14.960*
1996	5.631	8.972	5.062	13.668	11.513	0.562	0.000	0.000	2.660	14.888	8.936	3.491	*6.282*	*14.888*
1997	1.433	5.576	2.519	8.630	4.323	1.069	2.865	6.013	0.000	1.473	5.350	13.215	*4.372*	*13.215*
1998	6.837	10.260	10.576	8.093	1.517	3.695	12.688	12.329	7.758	14.047	4.065	4.431	*8.025*	*14.047*
1999	2.464	1.905	4.972	4.305	11.860	7.395	0.776	0.009	1.144	8.398	11.729	0.576	*4.628*	*11.860*
2000	5.263	6.764	0.000	6.899	5.112	14.350	5.430	11.666	8.103	13.544	0.995	4.630	*6.896*	*14.350*
2001	2.495	1.021	1.993	0.303	0.307	3.884	0.000	0.093	0.000	2.822	6.928	9.966	*2.484*	*9.966*
2002	10.175	0.048	6.515	0.818	0.670	15.213	1.835	4.184	7.232	4.608	4.684	7.994	*5.331*	*15.213*
2003	4.505	4.891	1.621	2.030	12.971	7.764	5.148	0.000	4.996	4.866	4.615	5.626	*4.919*	*12.971*
2004	7.445	10.361	7.874	0.592	8.679	13.158	1.831	4.276	2.563	3.268	7.252	1.682	*5.748*	*13.158*
2005	6.855	4.504	4.084	0.463	0.429	0.000	0.882	0.000	3.744	0.075	0.807	1.206	*1.921*	*6.855*
Mean	*6.687*	*4.891*	*4.452*	*4.502*	*6.896*	*4.859*	*2.050*	*3.730*	*3.678*	*5.940*	*6.277*	*6.345*	5.025	
Max	*15.598*	*15.620*	*10.576*	*13.668*	*18.386*	*16.353*	*12.688*	*12.729*	*15.310*	*15.058*	*14.598*	*15.047*		*18.386*

Table A2: Highbank Canal monthly mean flows (flows in m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1958	32.6	32.62	22.59	17.84	27.35	10.86	0	6.426	18.13	12.53	23.14	20.72	*18.73*	*32.62*
1959	2.08	3.476	7.643	9.448	2.637	10.61	1.193	0	13.06	7.881	21.86	26.05	*8.827*	*26.05*
1960	23.17	23.52	15.75	3.181	7.129	10.95	3.036	9.473	16.23	20.41	7.616	5.413	*12.16*	*23.52*
1961	5.873	17.33	25.54	16.03	0.276	3.61	2.572	4.728	0	13.59	14.06	2.843	*8.871*	*25.54*
1962	26.12	4.599	2.256	1.255	33.26	25.67	21.16	20.42	20.06	25.78	22.98	12.9	*18.04*	*33.26*
1963	7.138	19.69	13.25	7.67	26.36	25.19	9.727	15.33	23.78	7.727	19.75	5.096	*15.06*	*26.36*
1964	29.47	14.1	21.53	10.21	34.96	21.04	21.05	19.52	10.95	11.02	6.392	26.78	*18.92*	*34.96*
1965	30.71	21.36	4.46	3.519	9.114	13.38	1.858	0.245	4.528	5.494	24.66	23.21	*11.88*	*30.71*
1966	25.3	26.56	9.054	26.03	10.75	5.195	0.582	0	3	1.149	15.06	17.63	*11.69*	*26.56*
1967	11.88	19.35	25.44	27.97	25.78	0.504	14.05	26.17	5.519	18.49	24.58	22.57	*18.52*	*27.97*
1968	22.85	15.44	19.46	13.58	30.47	4.571	3.784	8.392	6.454	23	21.79	11.88	*15.14*	*30.47*
1969	8.872	3.74	16.73	14.86	10.09	0.211	1.17	0.006	22.04	6.275	1.548	13.91	*8.287*	*22.04*
1970	12.26	3.341	14.09	14.46	0	3.393	1.774	11.46	32.31	17.88	18.59	14.81	*12.03*	*32.31*
1971	2.197	2.658	0	0	1.911	16.55	0	0	8.427	26.36	10.57	12.98	*6.804*	*26.36*
1972	12.62	1.203	18.82	11.67	28.83	1.619	2.329	1.176	21.18	24.56	29.58	14.6	*14.02*	*29.58*
1973	5.372	3.371	2.222	17.1	15.51	9.644	0	1.516	15.14	16.8	26.28	9.339	*10.19*	*26.28*
1974	7.028	14.88	7.451	25.03	1.299	2.429	12.06	3.262	1.595	15.36	9.585	4.187	*8.68*	*25.03*
1975	4.481	16.93	23.35	25.5	26	14.91	9.516	20.62	13.69	16.55	20.07	20.4	*17.67*	*26*
1976	20.14	20.16	12.49	1.127	12.34	18.24	1.786	0	0	7.129	2.308	21.96	*9.806*	*21.96*
1977	27.87	19.12	18.59	7.61	5.606	1.489	1.781	0	0	2.151	22.02	13.86	*10.01*	*27.87*
1978	15.45	7.07	6.307	26	21.65	12.34	6.678	26.94	27.6	23.2	18.47	11.44	*16.93*	*27.6*
1979	10.88	16.27	18.64	19.34	29.78	3.956	0.446	0.582	14.9	29.57	31.6	32.05	*17.33*	*32.05*
1980	26.14	18.18	13.78	13.36	10.83	2.305	3.73	12	28.59	21.22	24.13	18.01	*16.02*	*28.59*
1981	15.42	19.72	23	17.24	25.02	26.04	9.458	3.283	1.735	28.71	17.76	30.02	*18.12*	*30.02*
1982	22.04	17.22	11.72	0.243	14.69	5.354	0	0.458	4.532	0.01	28.06	26.13	*10.87*	*28.06*
1983	25.86	4.745	11.04	26.15	33.21	13.61	19.35	19.48	19.02	28.11	28.92	25.94	*21.29*	*33.21*
1984	24.93	22.03	11.2	4.828	3.226	2.565	16.19	20.39	9.442	16.55	22.95	30.16	*15.37*	*30.16*
1985	29.95	8.043	3.282	7.48	3.92	8.909	4.588	9.027	15.27	0.482	6.985	23.31	*10.1*	*29.95*
1986	14.71	10.49	7.142	17.14	16.06	28.13	4.805	4.571	1.234	26.76	15.29	14.46	*13.4*	*28.13*
1987	22.31	18.9	14.82	26.35	18.91	27.19	2.136	3.551	7.512	24.29	15.46	15.81	*16.44*	*27.19*
1988	6.376	11.66	14.04	8.66	12.73	17.99	16.32	20.22	23.72	32.06	29.21	31.53	*18.71*	*32.06*
1989	30.17	25.7	17.58	7.431	5.21	20.05	4.703	0	0	0.561	13	16.05	*11.7*	*30.17*
1990	24.94	14.31	7.443	12.02	34.93	10.28	8.596	24.31	1.619	14.53	11.63	20.54	*15.43*	*34.93*
1991	20.3	30.82	2.991	16.26	0.718	1.239	0	25.61	14.96	12.69	2.015	6.783	*11.2*	*30.82*
1992	23.43	21.1	22.08	4.523	1.296	0	2.795	20.87	1.692	13.55	26.51	20.77	*13.22*	*26.51*
1993	27.71	9.538	11.43	14.53	14.59	33.14	8.743	0.008	0	20.08	2.524	10.07	*12.7*	*33.14*
1994	32.45	9.024	16.08	12.65	18.46	16.38	22.81	25.9	19.72	5.068	29.34	27.28	*19.59*	*32.45*
1995	26.92	20.99	22.09	29.03	31.29	6.848	6.691	6.885	30.43	30.9	23.97	31.96	*22.33*	*31.96*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1996	16.65	21.48	13.87	29.54	26.4	6.017	0.675	0.031	12.62	31.76	25.68	14.55	*16.61*	*31.76*
1997	9.644	20.5	10.56	22.69	11.82	4.698	12.66	18.54	1.098	6.188	15.53	30.22	*13.68*	*30.22*
1998	18.86	26.58	26.38	22.8	6.639	8.968	25.33	27.63	18.87	31.05	10.9	13.34	*19.78*	*31.05*
1999	12.77	5.862	17.62	15.36	21.73	18.43	5.934	0.843	7.032	20.67	28.07	3.211	*13.13*	*28.07*
2000	12.74	21.51	1.399	18.75	13.64	30.2	13.93	26.21	23.21	30.54	4.916	15.09	*17.68*	*30.54*
2001	10.43	5.862	4.705	2.616	1.15	11.48	0.307	2.003	0.066	12.8	20.88	24.12	*8.034*	*24.12*
2002	24.73	3.779	17.48	7.271	2.725	27.68	8.38	11.56	21.51	15.99	16.57	21.45	*14.93*	*27.68*
2003	18.07	16.07	6.052	7.733	27.4	21.63	14.16	0	12.82	20.37	17.97	16.63	*14.91*	*27.4*
2004	20.09	25.97	23.16	3.727	21.5	26.02	8.117	10.98	13.06	12.01	21.75	5.633	*16*	*26.02*
2005	22.15	19.8	13.64	3.27	3.023	0.439	2.595	0.728	10.82	1.255	2.257	5.24	*7.101*	*22.15*
Mean	*18.42*	*15.35*	*13.55*	*13.56*	*15.46*	*12.33*	*7.074*	*9.82*	*12.07*	*16.48*	*17.81*	*17.56*	14.12	
Max	*32.6*	*32.62*	*26.38*	*29.54*	*34.96*	*33.14*	*25.33*	*27.63*	*32.31*	*32.06*	*31.6*	*32.05*		34.96

Table A3: Terrace Canal flows and discharge to the Rakaia River from the Proposed Barrhill Power Station monthly mean flows (flows in m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1958	23.214	23.229	15.264	16.03	35.897	26.828	19.168	25.791	12.589	22.081	16.265	17.668	*21.17*	*35.9*
1959	0.678	7.644	15.2	23.146	26.926	30.653	25.279	24.361	20.756	12.71	7.762	9.096	*17.02*	*30.65*
1960	6.552	7.604	4.614	1.812	27.132	31.72	25.883	30.045	26.331	27.709	19.086	18.175	*18.89*	*31.72*
1961	9.419	12.154	9.675	21.408	21.829	26.335	25.694	27.618	23.304	18.279	14.096	9.771	*18.3*	*27.62*
1962	19.836	8.5	6.951	8.832	34.402	39.765	38.916	38.523	27.512	23.739	15.531	11.22	*22.81*	*39.77*
1963	8.88	12.823	6.33	9.427	32.488	38.439	31.54	34.422	30.49	14.881	11.115	9.054	*19.99*	*38.44*
1964	16.052	1.724	7.356	1.664	35.099	38.46	39.037	37.027	21.009	9.276	11.45	18.978	*19.76*	*39.04*
1965	21.246	16.645	5.179	20.556	28.374	31.272	24.401	23.201	22.25	12.969	28.872	15.545	*20.88*	*31.27*
1966	12.475	14.733	15.202	28.363	29.471	26.407	23.334	22.596	21.167	15.507	16.666	15.21	*20.09*	*29.47*
1967	8.678	7.102	10.428	20.145	33.888	23.151	32.753	37.452	20.904	19.616	27.477	19.654	*21.77*	*37.45*
1968	11.954	6.502	17.155	21.47	37.553	26.144	24.896	27.386	13.339	26.194	15.099	11.015	*19.89*	*37.55*
1969	7.952	1.359	5.325	4.444	17.77	22.824	23.12	22.32	26.699	1.603	1.68	15.586	*12.56*	*26.7*
1970	16.515	3.566	17.813	18.542	21.565	24.796	23.767	27.216	31.983	3.234	6.37	4.787	*16.68*	*31.98*
1971	0.206	0.878	1.687	11.262	18.596	30.692	21.164	20.77	18.921	25.171	13.8	8.969	*14.34*	*30.69*
1972	7.861	2.775	13.6	20.905	30.096	21.507	22.308	21.072	23.57	25.127	21.916	15.854	*18.88*	*30.1*
1973	4.886	2.696	0.428	7.102	15.51	25.336	19.723	20.869	20.337	15.306	17.996	7.669	*13.16*	*25.34*
1974	6.326	14.931	20.026	27.592	20.973	21.712	28.078	22.818	18.716	21.845	16.786	4.933	*18.73*	*28.08*
1975	5.877	10.189	25.722	27.837	35.457	30.774	26.086	33.984	21.458	21.779	21.529	7.68	*22.36*	*35.46*
1976	11.904	6.46	3.513	9.83	24.146	32.249	20.538	18.943	16.166	9.478	0.476	8.178	*13.49*	*32.25*
1977	11.177	4.54	3.872	4.152	25.228	22.045	22.274	20.886	20.949	16.226	7.909	1.99	*13.44*	*25.23*
1978	4.953	0.611	3.947	26.71	35.587	31.991	31.115	38.002	34.684	30.314	19.858	15.22	*22.75*	*38*
1979	10.624	5.833	16.222	28.769	34.098	27.642	24.544	24.824	25.816	33.412	27.972	24.692	*23.7*	*34.1*
1980	22.876	6.893	4.284	4.123	26.099	27.101	28.403	31.173	25.408	11.895	21.445	15.242	*18.75*	*31.17*
1981	4.403	5.244	13.493	13.032	37.49	38.49	32.016	27.101	19.295	27.745	14.995	13.3	*20.55*	*38.49*
1982	9.355	5.959	4.389	15.12	19.76	27.383	24.825	25.346	15.106	16.694	20.525	14.652	*16.59*	*27.38*
1983	11.392	0.429	8.56	19.822	33.211	13.608	19.345	23.453	30.937	36.14	22.046	21.947	*20.07*	*36.14*
1984	13.458	8.226	1.427	6.91	26.572	27.895	35.598	35.379	18.586	6.57	9.552	17.357	*17.29*	*35.6*
1985	13.161	1.694	0.662	2.546	19.131	30.746	29.035	31.187	26.139	1.39	5.338	21.752	*15.23*	*31.19*
1986	9.274	5.021	21.276	22.162	29.09	39.544	30.39	30.291	26.492	36.049	15.527	9.584	*22.89*	*39.54*
1987	9.297	6.141	8.651	20.156	35.818	38.511	28.466	28.267	19.456	18.12	6.715	7.383	*18.92*	*38.51*
1988	1.593	4.286	4.666	2.441	19.248	33.06	33.454	36.562	19.725	16.503	12.294	14.534	*16.53*	*36.56*
1989	13.165	8.732	5.616	2.104	27.476	35.103	28.917	21.026	13.224	7.07	4.658	6.912	*14.5*	*35.1*
1990	9.692	2.38	2.966	4.682	35.769	30.865	28.86	38.374	22.4	17.599	11.48	9.216	*17.86*	*38.37*
1991	7.475	16.844	0.927	12.241	23.154	22.543	18.037	35.298	28.082	12.443	6.988	6.966	*15.92*	*35.3*
1992	11.15	6.823	6.397	1.046	13.19	15.818	19.761	36.525	24.778	29.748	18.757	14.359	*16.53*	*36.53*
1993	11.254	2.063	2.873	3.288	23.27	39.943	31.437	21.168	12.666	13.635	0.521	3.478	*13.8*	*39.94*
1994	15.447	2.411	5.779	2.994	18.459	34.28	38.696	38.875	20.039	21.825	15.344	11.038	*18.77*	*38.88*
1995	9.926	5.424	9.441	28.07	39.687	30.802	30.205	29.514	37.243	38.265	18.461	16.189	*24.44*	*39.69*
1996	5.631	21.508	23.265	34.174	26.44	29.093	23.723	24.78	19.792	19.434	13.397	3.589	*20.4*	*34.17*
1997	7.849	14.472	10.497	27.775	30.342	26.284	32.6	35.949	20.891	13.075	5.35	13.215	*19.86*	*35.95*
1998	6.837	10.26	14.37	8.293	24.735	28.108	36.34	38.883	20.985	19.976	5.305	4.431	*18.21*	*38.88*

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1999	2.464	1.905	13.649	20.701	23.226	35.804	31.159	26.321	21.968	18.266	27.142	9.647	*19.35*	*35.8*
2000	22.014	17.384	5.926	20.179	33.383	39.52	33.283	38.432	8.606	20.945	0.995	6.295	*20.58*	*39.52*
2001	2.495	1.021	1.993	0.303	16.927	30.683	23.075	26.381	10.227	2.854	6.935	9.966	*11.07*	*30.68*
2002	10.175	0.048	6.515	3.988	25.158	34.737	30.49	31.764	21.109	15.863	6.119	8.047	*16.17*	*34.74*
2003	4.505	4.891	1.783	26.109	37.99	34.895	34.322	24.634	29.939	26.366	8.472	5.866	*19.98*	*37.99*
2004	7.445	12.658	8.841	5.93	26.465	36.795	32.764	27.868	26.424	26.358	8.918	1.682	*18.51*	*36.8*
2005	6.855	4.504	4.084	15.223	25.956	22.61	23.119	22.131	18.418	11.705	1.438	1.206	*13.1*	*25.96*
Mean	*9.926*	*7.286*	*8.705*	*14.24*	*27.5*	*29.9*	*27.75*	*28.89*	*22.02*	*18.6*	*13.09*	*11.23*	18.26	
Max	*23.21*	*23.23*	*25.72*	*34.17*	*39.69*	*39.94*	*39.04*	*38.88*	*37.24*	*38.27*	*28.87*	*24.69*		*39.94*

Appendix B: Modelling Results for the Highbank Power Station Tailrace Discharge Flows under Different Flow Regimes

Table B1: Scenario 1 - Existing Highbank Power Station Discharge to the Rakaia River monthly mean flows (flows in m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1958	7.615	7.609	5.762	11.329	22.182	20.691	19.168	21.134	10.015	17.074	9.899	9.199	13.473	22.182
1959	0.499	6.499	12.364	20.867	24.573	23.318	24.087	24.361	15.929	10.624	0.000	0.000	13.593	24.573
1960	0.000	0.000	0.000	1.777	23.147	24.953	22.954	24.832	22.637	21.772	17.149	17.065	14.691	24.953
1961	9.359	7.690	0.764	16.635	21.553	24.359	24.174	24.144	23.304	14.023	8.856	9.196	15.338	24.359
1962	9.325	7.980	6.705	8.754	7.487	23.963	23.872	23.971	22.948	14.304	8.727	7.988	13.835	23.971
1963	7.266	5.124	2.715	8.199	11.692	22.884	22.804	23.196	22.852	13.873	5.508	8.401	12.876	23.196
1964	3.574	0.000	0.000	0.000	3.292	23.444	23.615	23.576	20.399	7.634	9.832	7.129	10.208	23.615
1965	7.432	9.653	4.180	19.847	22.506	22.793	22.543	22.956	21.921	11.106	17.824	8.622	15.949	22.956
1966	3.652	4.464	12.957	18.080	22.711	22.633	22.752	22.596	21.162	15.507	11.895	9.289	15.642	22.752
1967	3.654	1.481	0.000	8.615	14.302	22.647	22.645	22.302	19.910	14.397	16.995	10.964	13.159	22.647
1968	4.211	0.369	11.021	17.551	21.394	21.573	21.158	21.246	12.251	16.931	8.201	8.319	13.686	21.573
1969	5.418	0.000	0.000	0.763	11.068	22.612	22.464	22.314	18.212	1.331	1.273	11.017	9.706	22.612
1970	11.940	2.642	12.460	13.938	21.565	22.148	21.993	20.142	16.672	0.000	0.000	0.000	11.958	22.148
1971	0.000	0.000	1.687	11.262	16.685	21.535	21.164	20.770	17.154	14.639	12.016	5.185	11.841	21.535
1972	3.423	2.731	6.315	16.315	5.289	19.888	19.979	19.896	14.859	15.096	8.796	10.807	11.950	19.979
1973	4.345	2.696	0.000	0.000	0.000	19.913	19.723	20.010	18.720	9.646	7.741	5.563	9.030	20.010
1974	4.296	10.509	17.632	17.499	19.675	19.451	19.625	19.555	18.716	17.955	12.531	3.742	15.099	19.675
1975	4.139	5.642	18.341	17.722	19.573	19.416	19.212	17.140	17.908	15.830	13.892	2.369	14.265	19.573
1976	5.484	2.192	0.827	9.679	14.905	18.987	18.753	18.943	16.166	9.155	0.000	0.000	9.591	18.987
1977	0.000	0.000	0.000	3.168	20.016	20.556	20.536	20.886	20.949	15.219	2.164	0.000	10.291	20.949
1978	0.000	0.000	1.283	15.982	24.653	24.704	24.661	24.761	24.032	22.743	15.177	13.391	15.949	24.761
1979	7.097	0.090	10.703	23.305	7.447	24.731	24.098	24.243	22.259	20.841	13.374	9.645	15.653	24.731
1980	12.802	0.198	0.000	0.000	20.600	24.875	24.767	24.863	13.848	4.984	13.706	11.300	12.662	24.875
1981	1.745	0.000	4.602	8.866	24.676	25.218	25.549	24.670	19.092	15.076	9.443	0.000	13.245	25.549
1982	0.230	0.000	0.000	15.120	8.888	24.026	24.825	24.888	14.973	16.694	8.865	4.478	11.915	24.888
1983	1.322	0.000	4.350	9.447	0.000	0.000	0.000	3.971	24.238	24.358	10.005	11.621	7.443	24.358
1984	5.138	0.000	0.000	5.900	23.409	26.481	26.650	26.003	16.702	0.283	0.853	3.977	11.283	26.650
1985	0.000	0.000	0.000	0.000	15.211	26.270	26.285	25.840	21.702	1.390	2.987	12.921	11.050	26.285
1986	4.017	0.000	19.758	16.443	16.570	26.357	26.307	26.763	26.492	25.151	12.131	4.272	17.022	26.763
1987	0.000	0.000	3.242	10.156	25.599	26.127	26.330	25.916	18.199	8.970	1.742	2.465	12.396	26.330
1988	0.064	0.000	0.000	0.000	11.830	24.543	26.220	26.040	11.134	1.445	0.000	0.000	8.440	26.220
1989	0.000	0.000	0.247	0.378	23.722	26.094	25.456	21.026	13.224	7.070	0.122	0.000	9.778	26.094
1990	0.000	0.000	0.000	0.000	5.637	25.721	24.671	25.849	22.400	12.719	8.081	0.715	10.483	25.849
1991	0.000	3.024	0.580	7.144	22.436	21.470	18.037	23.972	24.043	7.724	6.943	5.081	11.704	24.043
1992	3.719	0.000	0.000	0.000	12.089	15.818	18.577	24.913	24.778	24.634	8.602	7.149	11.690	24.913

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1993	0.536	0.000	0.000	0.000	8.678	25.414	24.321	21.160	12.666	6.261	0.000	0.000	8.253	25.414
1994	0.000	0.000	0.000	0.000	2.102	25.787	26.174	26.052	14.671	20.835	2.139	0.000	9.813	26.174
1995	0.000	0.000	0.000	16.041	25.256	24.007	23.697	24.072	24.247	25.040	11.016	1.228	14.550	25.256
1996	0.000	12.536	18.204	20.583	1.611	23.614	23.048	24.749	17.137	4.546	4.461	0.098	12.549	24.749
1997	6.416	8.896	7.978	19.145	23.335	22.757	23.144	24.183	20.891	11.602	0.000	0.000	14.029	24.183
1998	0.000	0.000	3.794	0.200	18.706	22.807	25.239	25.139	13.227	5.929	1.240	0.000	9.690	25.239
1999	0.000	0.000	8.677	16.410	9.365	26.210	26.274	25.584	20.873	9.868	15.413	9.071	13.979	26.274
2000	16.906	10.645	5.926	13.320	25.645	25.710	25.516	25.635	0.503	7.610	0.000	1.665	13.257	25.710
2001	0.000	0.000	0.000	0.000	16.113	23.630	22.768	24.542	10.227	0.032	0.007	0.000	8.110	24.542
2002	0.000	0.000	0.000	3.170	23.051	22.169	24.175	22.295	13.876	11.255	1.435	0.053	10.123	24.175
2003	0.000	0.000	0.162	24.148	25.872	20.521	26.450	24.634	25.395	21.728	3.909	0.240	14.422	26.450
2004	0.000	2.298	0.968	5.338	5.245	25.965	27.360	21.866	23.996	23.090	1.666	0.000	11.483	27.360
2005	0.000	0.000	0.000	14.760	23.551	22.171	21.545	21.403	14.808	11.630	0.630	0.000	10.875	23.551
Mean	3.242	2.395	4.254	9.747	16.144	22.728	22.820	22.896	18.382	12.700	6.818	4.880	12.251	
Max	16.906	12.536	19.758	24.148	25.872	26.481	27.360	26.763	26.492	25.151	17.824	17.065		27.360

Table B2: Scenario 2 - Existing discharge to the Rakaia River from the Highbank Power Station plus the discharge of water taken under the BCIL consent monthly mean flows (flows in m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1958	24.615	24.609	18.846	24.472	35.965	27.013	19.168	25.693	25.568	24.598	26.675	21.453	24.890	35.965
1959	2.399	8.830	17.171	28.035	26.985	30.499	25.279	24.361	24.158	16.419	14.098	16.949	19.599	30.499
1960	16.614	15.912	11.140	4.923	27.240	32.340	25.942	30.518	35.174	36.244	22.827	21.369	23.354	36.244
1961	15.173	20.554	17.396	27.893	21.829	26.435	25.780	27.722	23.304	23.357	17.678	11.465	21.549	27.893
1962	24.934	12.060	8.715	9.931	24.450	40.557	39.441	39.041	38.442	30.652	24.902	17.660	25.899	40.557
1963	12.790	17.117	12.350	14.642	27.053	38.289	31.601	34.430	38.992	20.592	19.646	12.844	23.362	38.992
1964	20.570	12.372	14.176	8.546	19.878	38.657	39.424	37.248	30.742	17.011	14.606	22.063	22.941	39.424
1965	24.324	24.018	7.641	22.658	28.389	31.269	24.401	23.201	26.121	14.737	31.435	24.907	23.592	31.435
1966	20.129	20.752	19.767	33.826	29.195	26.404	23.334	22.596	24.156	16.656	22.181	21.001	23.333	33.826
1967	10.508	15.204	15.011	25.053	28.048	23.151	32.731	37.024	24.435	27.672	31.089	24.841	24.564	37.024
1968	19.313	9.675	24.351	27.211	36.229	26.144	24.794	26.974	17.618	30.672	23.097	17.498	23.631	36.229
1969	11.757	2.381	11.400	11.945	17.737	22.824	23.117	22.320	31.765	7.334	2.414	20.355	15.446	31.765
1970	19.628	5.059	21.196	23.797	21.565	24.775	23.767	26.924	33.672	14.645	12.217	10.021	19.772	33.672
1971	1.991	1.780	1.687	11.262	18.331	30.164	21.164	20.770	23.814	30.462	20.801	14.382	16.384	30.462
1972	11.600	3.889	17.854	23.399	19.471	21.444	22.308	21.072	27.326	29.622	25.259	20.355	20.300	29.622
1973	9.176	6.068	1.794	9.994	8.963	24.811	19.723	20.783	32.243	20.780	23.768	12.796	15.908	32.243
1974	9.294	20.962	22.688	32.430	20.973	21.606	27.116	22.818	20.312	29.430	17.860	6.737	21.019	32.430
1975	6.881	18.024	34.305	33.110	33.101	29.994	25.372	30.394	28.045	26.429	26.327	17.456	25.786	34.305
1976	19.201	18.078	10.635	10.656	22.924	30.832	20.538	18.943	16.166	15.962	1.833	13.779	16.629	30.832
1977	16.696	14.577	14.714	9.795	24.947	22.045	22.199	20.886	20.949	16.362	18.442	11.865	17.790	24.947
1978	10.492	6.459	4.925	31.247	36.519	32.348	31.198	39.260	40.907	38.339	28.962	23.000	26.971	40.907
1979	14.450	10.621	23.822	37.152	22.196	27.833	24.544	24.824	33.606	37.841	30.374	26.645	26.159	37.841
1980	28.864	11.681	9.499	9.232	26.505	27.166	28.466	31.849	30.848	19.292	30.092	25.370	23.239	31.849
1981	14.508	14.476	18.709	21.938	38.524	40.145	32.493	27.279	20.624	31.115	21.647	16.718	24.848	40.145
1982	13.144	11.264	7.331	15.363	17.281	27.644	24.825	25.346	19.371	16.704	25.268	20.433	18.664	27.644
1983	17.107	4.316	11.177	25.224	16.609	9.270	12.197	15.656	36.546	40.448	26.832	27.231	20.218	40.448
1984	21.745	13.801	9.771	9.718	26.635	28.132	37.117	37.095	24.261	10.550	15.106	20.758	21.224	37.117
1985	16.790	6.349	2.620	4.934	17.647	31.453	29.114	31.569	32.216	1.873	7.621	27.398	17.465	32.216
1986	13.466	5.464	25.333	27.645	27.289	41.984	30.523	30.563	27.726	40.728	24.023	13.416	25.680	41.984
1987	13.010	12.761	12.653	26.440	36.650	40.930	28.466	28.580	24.390	24.113	12.229	13.356	22.798	40.930
1988	4.910	7.378	9.379	6.218	20.016	33.976	34.703	38.038	26.259	18.445	16.919	17.000	19.437	38.038
1989	17.000	16.972	12.454	6.084	27.143	36.645	29.244	21.026	13.224	7.631	8.585	9.135	17.095	36.645
1990	15.250	11.928	4.477	7.334	22.176	31.708	29.418	40.053	24.019	22.355	16.313	12.753	19.815	40.053
1991	12.824	20.024	3.224	18.307	23.154	22.508	18.037	36.851	34.965	15.699	8.914	9.978	18.707	36.851
1992	19.717	14.278	15.685	3.477	12.969	15.818	19.889	37.468	26.470	32.999	24.959	20.714	20.370	37.468
1993	17.529	7.475	8.559	11.240	17.376	42.204	31.580	21.168	12.666	18.967	2.003	6.593	16.447	42.204
1994	17.000	6.613	10.300	9.651	11.424	35.782	41.043	41.070	28.912	24.912	18.272	16.241	21.768	41.070
1995	16.990	15.568	12.653	33.041	41.612	30.855	30.287	29.913	41.101	42.040	27.539	18.228	28.319	42.040
1996	11.018	25.048	27.009	36.450	16.497	29.069	23.723	24.780	27.096	21.419	21.201	11.160	22.873	36.450

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1997	14.628	23.824	16.016	33.204	30.834	26.386	32.937	36.709	21.989	16.318	10.182	17.000	23.336	36.709
1998	12.023	16.318	19.599	14.902	23.829	28.080	37.883	40.443	24.337	22.929	8.074	8.905	21.443	40.443
1999	10.304	3.957	21.322	27.468	19.235	37.242	31.432	26.418	26.762	22.138	31.750	11.705	22.478	37.242
2000	24.381	25.392	7.325	25.174	34.175	41.564	34.019	40.184	15.605	24.610	3.921	12.125	24.039	41.564
2001	7.938	4.841	2.713	2.313	16.956	31.223	23.075	26.452	10.292	10.007	13.955	14.155	13.660	31.223
2002	14.551	3.731	10.967	9.624	25.106	34.636	30.720	29.675	28.150	22.637	13.318	13.512	19.719	34.636
2003	13.566	11.182	4.594	29.851	40.300	34.385	35.461	24.634	33.219	37.235	17.262	11.242	24.411	40.300
2004	12.644	17.903	16.255	8.473	18.068	38.830	33.646	28.570	34.490	31.833	16.158	3.950	21.735	38.830
2005	15.294	15.297	9.556	17.567	26.144	22.610	23.258	22.131	21.880	12.811	2.080	4.034	16.055	26.144
Mean	14.974	12.851	13.349	18.809	24.711	30.202	27.844	28.986	26.769	23.242	18.348	16.095	21.348	
Max	28.864	25.392	34.305	37.152	41.612	42.204	41.043	41.070	41.101	42.040	31.750	27.398		42.204

Table B3: Scenario 3 - Discharge from the Highbank Power Station Tailrace under the operation of ACWT's Proposed Rakaia Terrace Hydro Scheme monthly mean flows (flows in m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1958	3.308	3.128	0	0.804	13.64	4.722	0	1.768	0.014	3.574	1.129	1.011	2.758	13.64
1959	0	0	0.8	1.981	0.284	3.271	0	0	1.591	0.606	0	0	0.711	3.271
1960	0	0	0	0	3.144	4.185	0.107	4.26	3.575	5.341	1.129	0.785	1.877	5.341
1961	0	0.754	0	1.952	0	1.633	1.052	1.253	0	1.05	0.488	0.079	0.688	1.952
1962	1.209	0	0	0	6.345	9.869	6.115	5.868	4.632	4.234	0.444	0.082	3.233	9.869
1963	0.01	0	0.363	0.382	5.565	9.63	0.991	4.1	7.613	0	0.902	0.09	2.471	9.63
1964	0.004	0	0	0	3.157	6.021	5.624	6.07	0.478	0	0.416	0.325	1.841	6.07
1965	0.911	0.86	0	0.643	3.246	4.897	0	0	0.136	0.672	7.017	0.823	1.6	7.017
1966	0.282	0.088	0.821	6.472	3.985	1.42	0	0	0	0	0.981	1.042	1.258	6.472
1967	0	0.041	0	3.163	6.192	0	3.938	11.02	0.909	1.044	6.375	2.994	2.972	11.02
1968	0.133	0	1.49	1.308	14.31	0	0.046	2.252	0.389	5.518	0.649	0.229	2.194	14.31
1969	0.366	0	0	0	3.388	0	0.514	0	5.717	0	0	1.915	0.992	5.717
1970	1.196	0	0.755	3.122	0	0.746	0	4.387	10.12	0	0	0	1.694	10.12
1971	0	0	0	0	0	7.393	0	0	0.187	4.461	0.478	0	1.043	7.393
1972	0.256	0	0.453	2.921	4.019	0	0	0	3.266	5.311	1.915	1.362	1.625	5.311
1973	0	0	0	0	0	4.221	0	0.656	0.815	0.598	0.682	0.01	0.582	4.221
1974	0.124	1.517	1.197	5.849	0	0.167	3.605	0	0	2.331	2.107	0.025	1.41	5.849
1975	0	1.375	4.382	6.095	10.12	3.552	2.642	3.779	2.114	2.674	2.557	0	3.274	10.12
1976	0.178	0	0	0	3.101	4.977	0	0	0	0	0	0	0.688	4.977
1977	0	0	0	0.346	0.394	0	0.043	0	0	0	0	0	0.065	0.394
1978	0	0	0.569	6.855	10.71	5.053	0.224	13.7	11.64	7.913	0.888	0.788	4.861	13.7
1979	0.256	0	1.301	5.636	3.128	1.044	0	0	3.35	10.48	7.391	2.394	2.915	10.48
1980	2.869	0	0	0	5.332	0.079	0.094	5.686	4.467	0	2.21	0.139	1.74	5.686
1981	0	0	1.331	0.639	12.21	12.76	2.991	0.852	0.028	7.112	1.407	0	3.278	12.76
1982	0	0	0	0	3.823	1.997	0	0	0	0	1.764	0.004	0.632	3.823
1983	0	0	0.622	3.972	0	0	0	0	7.241	13.27	5.603	5.699	3.034	13.27
1984	0.921	0	0	0.571	0.063	1.151	7.241	11.01	1.278	0	0	0.871	1.926	11.01
1985	0	0	0	0	0	4.432	1.838	3.679	4.643	0	0	3.481	1.506	4.643
1986	1.655	0	1.208	4.857	3.541	14.95	0.722	1.042	0	13.17	1.582	0	3.56	14.95
1987	0	0	0.585	3.301	8.69	14.81	0	1.2	1.649	0.974	0	0.139	2.612	14.81
1988	0	0	0	0	5.316	9.468	9.088	9.7	2.162	0.081	0	0	2.985	9.7
1989	0	0	0	0	1.456	11.04	1.242	0	0	0	0	0	1.145	11.04
1990	0	0	0	0	4.793	5.14	4.407	11.78	0	3.733	1.367	0	2.602	11.78
1991	0	0.359	0	0	0	0.166	0	14.28	4.412	0	0	0.187	1.617	14.28
1992	0.67	0	0	0	0.196	0	1.612	9.254	0	5.915	1.835	0.077	1.63	9.254
1993	0	0	0	0	0	18.61	1.626	0	0	1.068	0	0	1.776	18.61
1994	0	0	0	0	2.102	7.883	10.28	13.08	3.566	0.129	0.312	0	3.113	13.08
1995	0	0	0	7.562	16.86	0.053	0.182	1.442	14.76	15.94	4.254	0	5.087	16.86
1996	0	4.213	4.148	12.14	1.57	0.538	0	0	2.116	0.466	0.002	0	2.1	12.14

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max
1997	0.338	2.945	0.37	6.113	4.815	1.171	3.201	6.773	0	0.585	0	0	2.193	6.773
1998	0	0	1.015	0	0.61	3.666	14.23	13.89	0.011	1.952	0.007	0	2.948	14.23
1999	0	0	0.983	2.902	7.87	8.833	1.049	0.106	1.327	1.351	4.817	0.139	2.448	8.833
2000	3.913	3.33	0	3.444	5.904	16.39	6.166	13.42	0	4.41	0	0	4.748	16.39
2001	0	0	0	0	0.336	4.425	0	0.164	0	0	0	0	0.41	4.425
2002	0	0	0	0	0.618	15.11	2.065	2.095	2.057	0.423	0	0	1.864	15.11
2003	0	0	0	2.305	15.28	7.254	6.286	0	6.494	5.339	1.412	0	3.698	15.28
2004	0	0.94	0	0	0.281	15.19	2.713	4.978	2.622	1.885	0	0	2.384	15.19
2005	0	0	0	0	0.617	0	1.022	0	2.242	0	0	0	0.323	2.242
Mean	0.388	0.407	0.467	1.986	4.104	5.165	2.145	3.824	2.45	2.783	1.294	0.514	2.127	
Max	3.913	4.213	4.382	12.14	16.86	18.61	14.23	14.28	14.76	15.94	7.391	5.699		18.61

Appendix C: Modelling of the Rakaia River flow hydrographs for a typical year

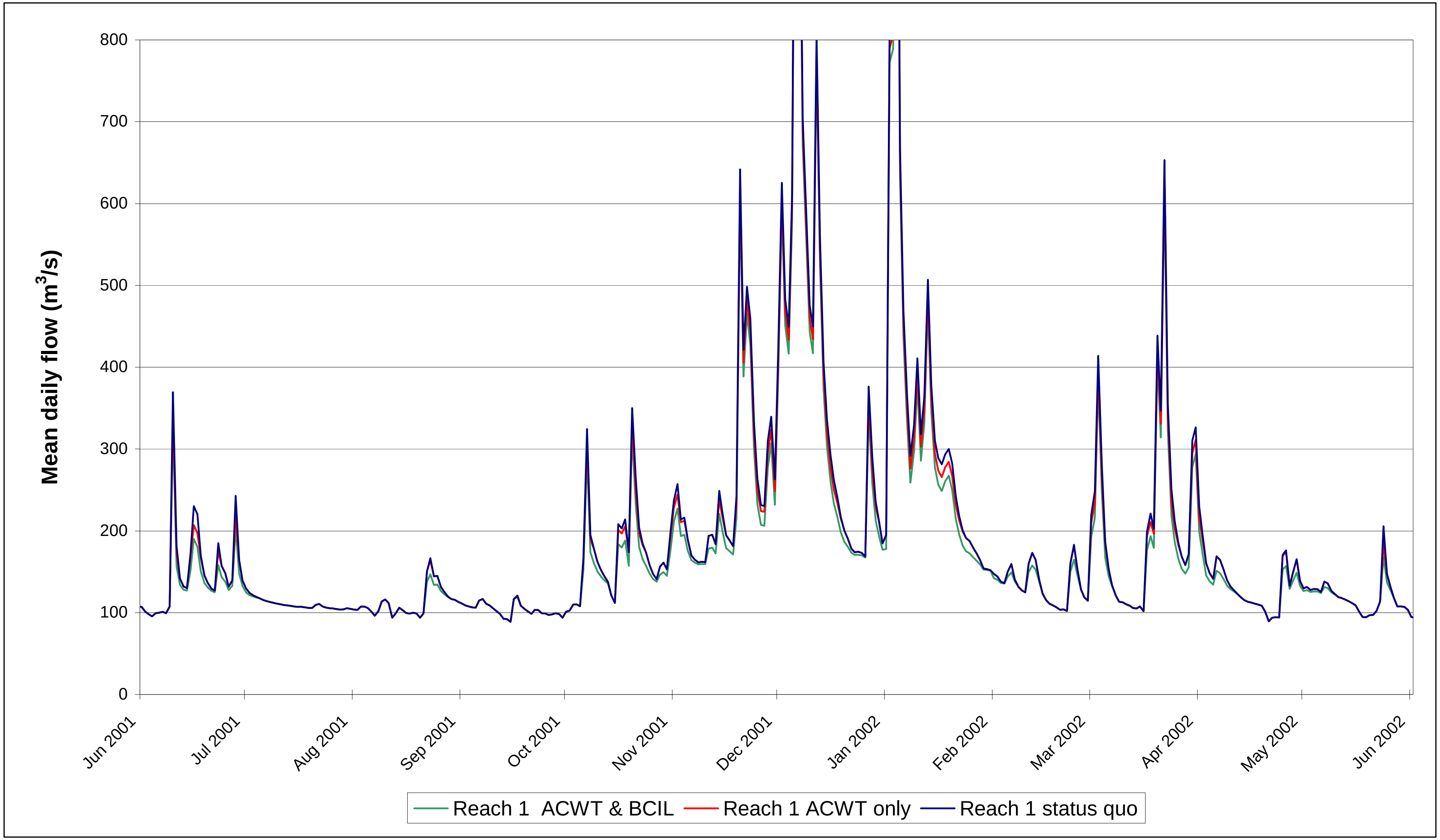

Figure C1: Rakaia River flow hydrographs for 2001-02 for reach 1

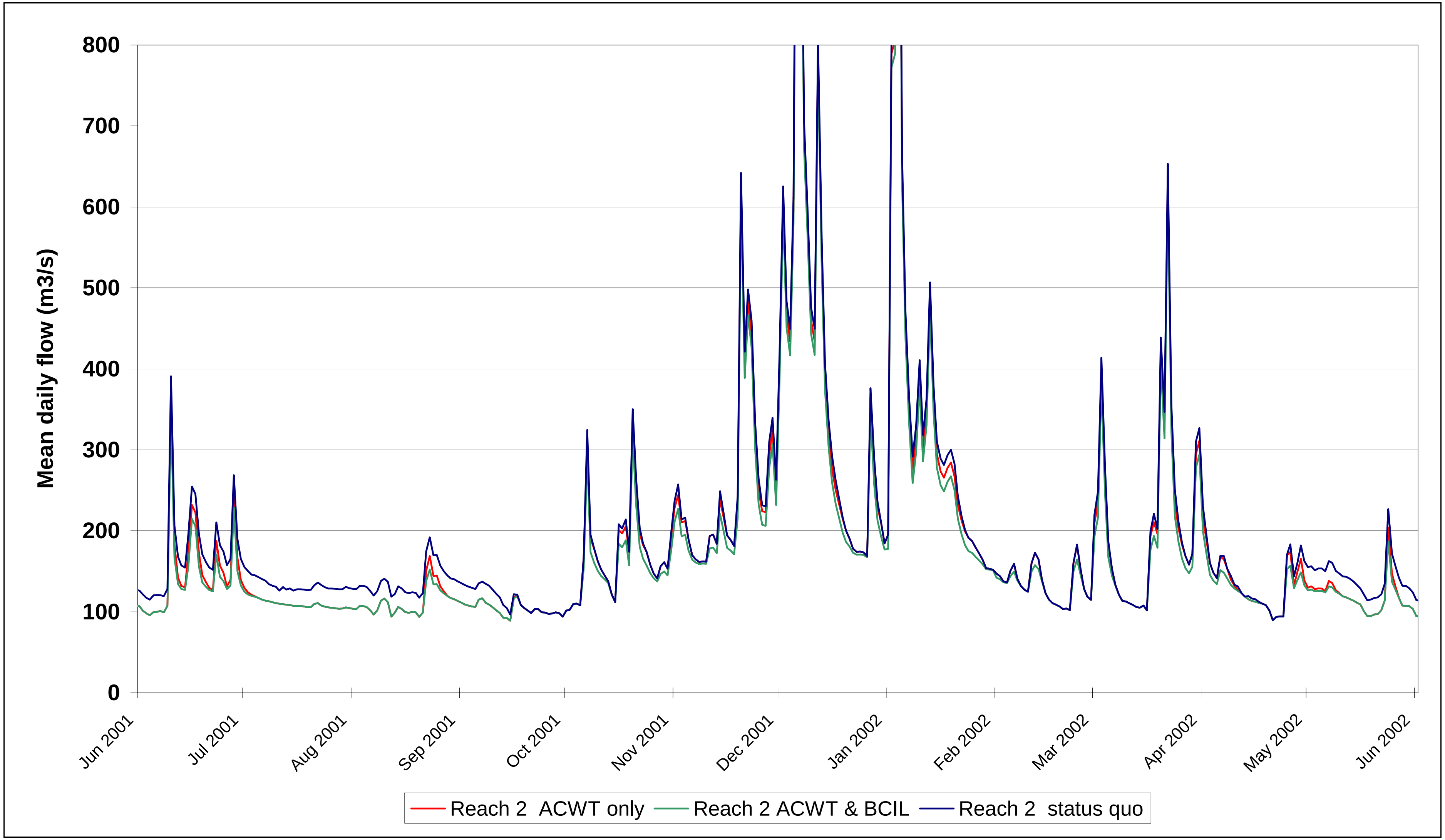

Figure C2: Rakaia River flow hydrographs for 2001-02 for reach 2

Appendix D: Fish velocity barrier

Figure D1: Fish velocity barrier on the Branch River Hydro Scheme's tailrace discharge to the Wairau River