IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	various applications by the Central Plains Water Trust to the Canterbury Regional Council.

Report of Maurice Duncan

Date of Hearing: 12 – 16 October 2009

1. My full name is Maurice John Duncan.

2. My qualifications and experience have been presented to the Commissioners in my primary brief of evidence and are not repeated here.

3. I have read the code of conduct for expert witnesses set out in the Environment Court practice note, and I confirm that I have complied with the code in the preparation of my evidence.

Scope of evidence

4. My area expertise is in surface water hydrology and I will comment on the aspects of the revised Central Plains Water Enhancement Scheme (CPWES) relating to surface water hydrology.

5. I have simulated the effects of various take scenarios and my results are very similar to those presented by Mr Tipler.

6. I present flow duration curves that illustrate the effects of the flow take options in the durations that flows are suitable for recreation and instream values. I also present results of time series invertebrate modelling.

Summary of evidence

7. I show flow duration curves for the CPWES proposal and various gap options for the periods critical to a range of recreational and environmental values.

8. The flow duration curves show that gaps of 20 to 40 m^3s^{-1} above the current B permit minimum flow of 63 m^3s^{-1} increase the time that flow remains within the preferred range for various activities, above that of the 1:1 sharing regime proposed. The cost of this extra time in the preferred range is a reduced volume and reliability of take.

9. A gap of 30 m^3s^{-1} appears optimum, but a gap of 20 m^3s^{-1} would increase the time within the preferred flow range for important activities, but for some activities the flows would be sub-optimal. A gap of 20 m^3s^{-1} would allow an increased volume and reliability of take over schemes with larger gaps.

10. Having made those comments, the differences in time in the preferred flow ranges between the proposed 1:1 scenarios and the current A Block takes are relatively small in terms of days per year (less than ± 4.5 days/year on average) for most cases.

11. The difference in time available in the preferred flow ranges between the proposed Predicted 1:1 flow sharing and the Predicted 30 gap regimes ranges from 8.6 days/season for jet boating and salmon angling to 11 days/breeding season for riverbed-nesting birds.

12. Results from a preliminary invertebrate time series model indicate there is no material difference in invertebrate productivity between the proposed 30-25-1:1 abstraction regime and the 30 gap regime.

Revised CPWES description

13. I understand that the revised scheme relies upon run-of river-supply and that the locations of the intakes are unchanged. Also unchanged are the scheme command area and the area to be irrigated. I understand the level of service will be different from that of the earlier application and that the upper plains will have an unreliable water supply, but the lower plains will have a more reliable water supply because they will be able to use groundwater when surface water is unavailable.

14. I also understand that the Rakaia River take will usually be limited to 30 m^3s^{-1} (with the ability to take up to 40 m^3s^{-1}). This is within allowable take as set out in the Rakaia Water Conservation Order and that any water demand by CPWES will first be attempted to be filled from the Rakaia River and only when the Rakaia River cannot satisfy the demand will water be taken from the Waimakariri River. Thus very little has changed in relation to the Rakia River take from the earlier application, except that CPWES has gained access to some more reliable water than it had earlier. As there is little change to the Rakaia River application and as the Commissioner's Minute 9 appeared to have few issues with the application to take water from the Rakaia River this evidence does not comment further on aspects of the application relating to the Rakaia River.

15. As there is no provision for water storage, abstractions will be driven by irrigation demand, with a nominal demand of 1 m^3s^{-1} during winter. While there is irrigation demand from September to May, the Rakaia River has sufficient flow to meet the predicted irrigation demand in September and May and in April for most years (20 out of 34 for 1967 to 2001). For the 14 years when water was required only a small amount (mean 40 l/s, range 0-300 l/s) was predicted to be required from the Waimakariri River, whereas 170 l/s (range 0-440 l/s) is available according to the demand data supplied by URS. Accordingly no water is required from the Waimakariri River during May to September and only small amounts during April.

Waimakariri River Hydrology

16. My understanding is that the maximum proposed take by CPWES from the Waimakariri River is to be 25 m^3s^{-1} with any Class B water shared on a 1:1 basis. CPWES have arranged for 1 m^3s^{-1} of Class A water and propose to take 24 m^3s^{-1} of Class B water after the existing Ngai Tahu Properties Ltd Class B allocation of 1.24 m^3s^{-1}.

Simulations

17. I have used the unmodified time series prepared by Mr de Joux and the Waimakariri River ñPredictedò and ñAvailableò take time series supplied by URS to explore the abstraction options proposed by CPWES and those offered by the Commissioners and set out in their Minute 9.

18. As indicated by Mr Tipler there are notified Proposed Plan Changes to the Waimakariri River Regional Plan (WRRP) in relation to a gap of 30 m^3s^{-1} between the present unmodified flow Class A permit upper limit of 63 m^3s^{-1} and the commencement of new Class B takes. The effect of this gap and others will be explored in my evidence.

19. Also notified in Plan Change 1 is a change to the point of measurement for allocation purposes from the Old Highway Bridge site upstream to Otarama. As this new site is upstream of any current abstractions it would remove the apparent confusion between modified and unmodified flows at the Old Highway Bridge site and would be welcome. However I have, like Mr Tipler, maintained the same conventions as presented in earlier evidence in relating flow to the Old Highway Bridge site. This will also aid comparisons with Mr Tiplerõs earlier and current evidence.

20. I will use the same conventions as Mr Tipler to describe take regimes, i.e., 30-25-1:1 for the CPWES proposal and ñ30 gapò for the Proposed Plan Change to the WRRP and a similar notation for gaps of other sizes. I also use the terms ñPredictedò and ñAvailableò as defined by Mr Tipler to describe the range of takes likely from the Waimakariri River.

21. I have carried out simulations of the 30-25-1:1 regime and the 30 gap option for both ñPredictedò and ñAvailableò take regimes. I was not able to confirm the exact numbers in Mr Tiplerõs evidence, but the differences between my results and Mr Tiplerõs were not material. Thus I will not be presenting alternative hydrological analysis results to those presented by Mr Tipler.

22. I will present a number of flow duration curves that will illustrate the changes in flow brought about by the various current and proposed Waimakariri River take regimes. Figure 1 shows the Available and Predicted 1:1 and 30 gap options for the summer (October to March). The summer data is illustrated because that is when the proposed abstraction would take place. On an annual basis, the differences between curves are about half that shown in Figure 1 (See Figure 2 for full year flow duration curves). The points to note are that:

    (a) CPWES would take less water than A Permit holders.

    (b) There is no flat lining at ~41 m^3s^{-1} attributable to the proposed CPWES take. This is a direct result of the proposed 1:1 flow sharing regime.

    (c) At flows greater than ~70 m^3s^{-1} there is very little difference in the residual flows between the 1:1 sharing regimes and the 30 gap regimes.

    (d) In the flow range ~41 m^3s^{-1} to ~70 m^3s^{-1} the difference between the black line and red and magenta lines on Figure 1 show the volumes of water that would be gained by CPWES if their proposed 1:1 option was adopted rather that the 30 gap option if the Predicted take and if all Available water was taken respectively.

    (e) The before CPWES curve assumes a 22 m^3s^{-1} A Permit allocation and 1.24 m^3s^{-1} B Permit allocation with both taken only in summer.

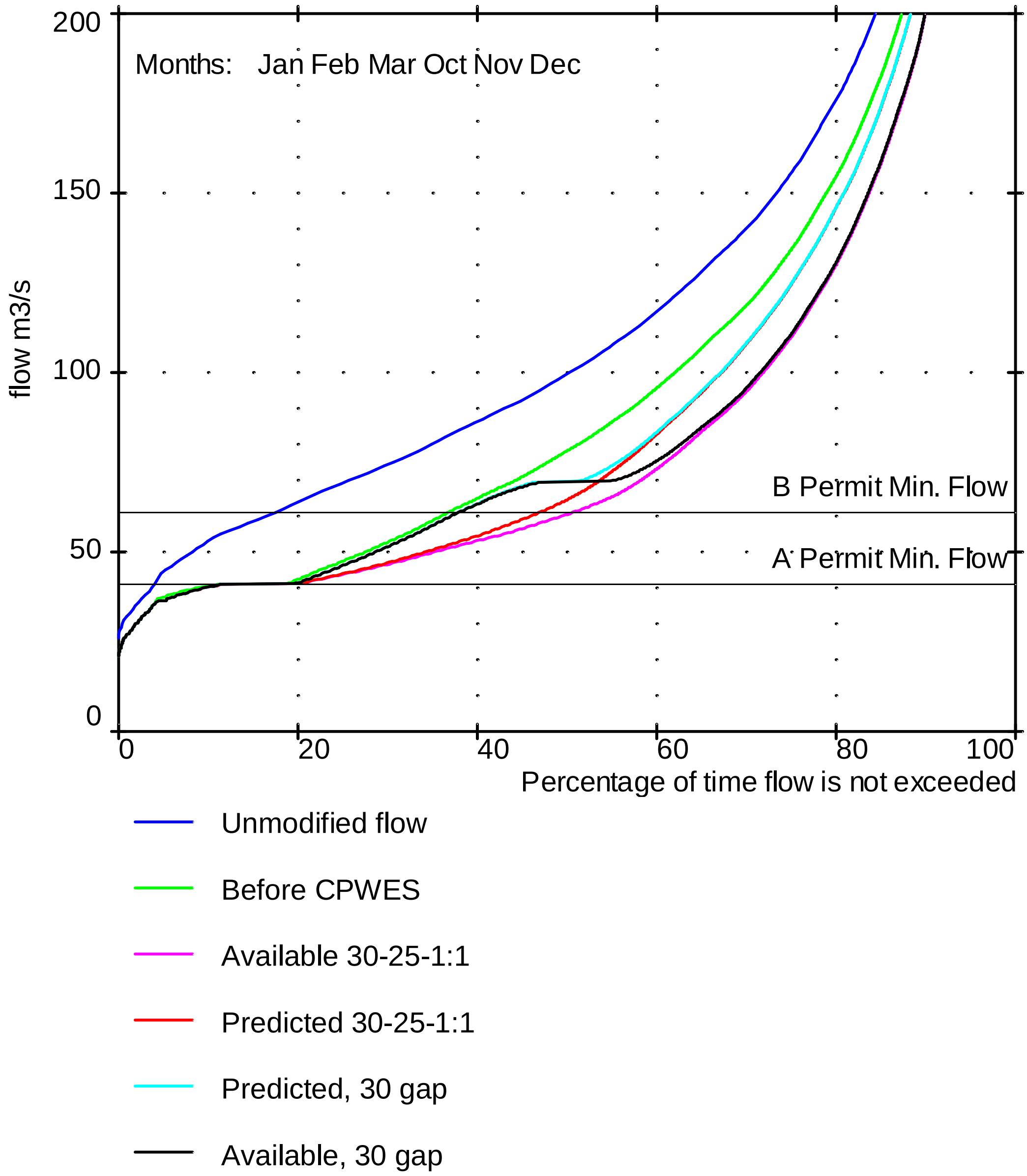

Figure 1. Summer (October to March) flow duration curves for 1967 to 2001 for the 30-25-1:1 and 30 gap options.

23. Paragraph 8.13 of Minute 9 listed a number of take scenarios and I will show flow duration curves of those options in relation to the various recreational and environmental flow requirements for the time periods those requirements are critical. The figures following show the applicants 30-25-1:1 preference and the effect of 20, 30 and 40 m^3s^{-1} gaps that allow CPWES B permit takes at flows greater than 83, 93 and 103 m^3s^{-1} respectively. These flows are close to the B permit extractions above flows of 80, 90 and 100 m^3s^{-1} as suggested in Minute 9, however were chosen to be consistent with the Proposed Plan Change.

Kayaks

24. Figure 2 shows flow duration curves for the whole year for the abstraction scenarios and the flow limits for kayaking from the lower limit of adequate flows to the upper limit of optimal flows (Paragraph 9.10 of Minute 9).

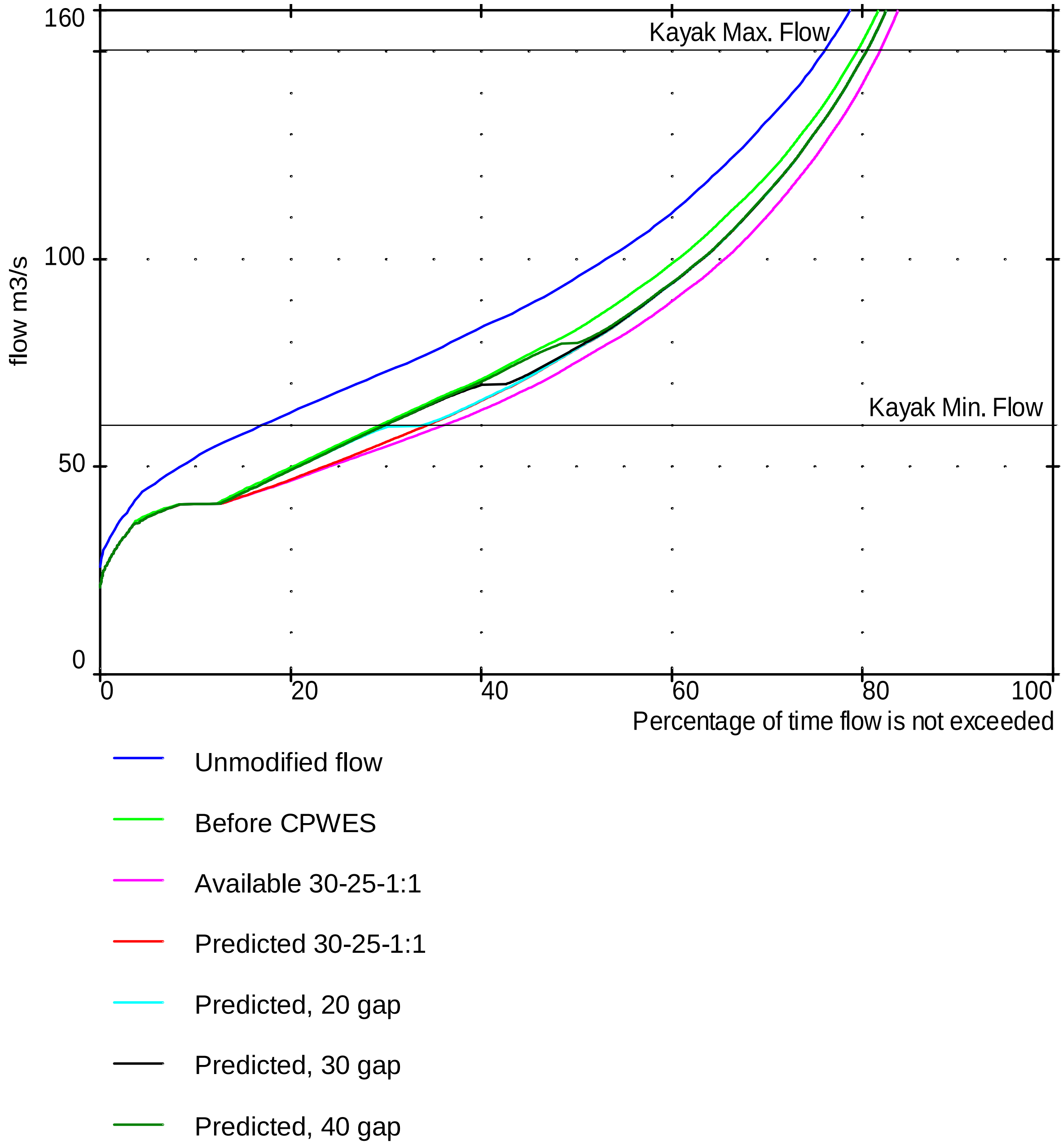

Figure 2. Flow duration curves for the whole year for 1967-2001 showing the flow limits for kayaking and the Predicted flows with gaps of 20, 30 and 40 m^3s^{-1}.

25. Only the Predicted gap options are illustrated in Figure 2 for clarity. The Available gap options are shown in Figure 3. All gap options increase the time flows are suitable for kayaks by a small amount. The two larger gaps increase the time in the optimum zone and the smallest gap increases the time at the lowest acceptable flow. For the

Predicted 30-25-1:1 scenario, flows are suitable for kayaking for 56.6% of the year and for the Predicted gap scenarios 59.5% of the year. Thus there is a 2.9% (mean of 10.6 days per year) difference in the duration of the preferred flow range for kayaks between the 30-25-1:1 and the Predicted gap options.

26. Figure 3 is similar to Figure 2 except it shows the gap options where all the Available water is taken. For the Predicted 30-25-1:1 scenario flows are suitable for kayaking for 56.6% of the time and for the Available gap scenarios 60.9% of the time. Thus there is a 4.3% (mean of 15.7 days per year) difference in the duration of the preferred flow range for kayaks between the Predicted 30-25-1:1 and the Available gap options.

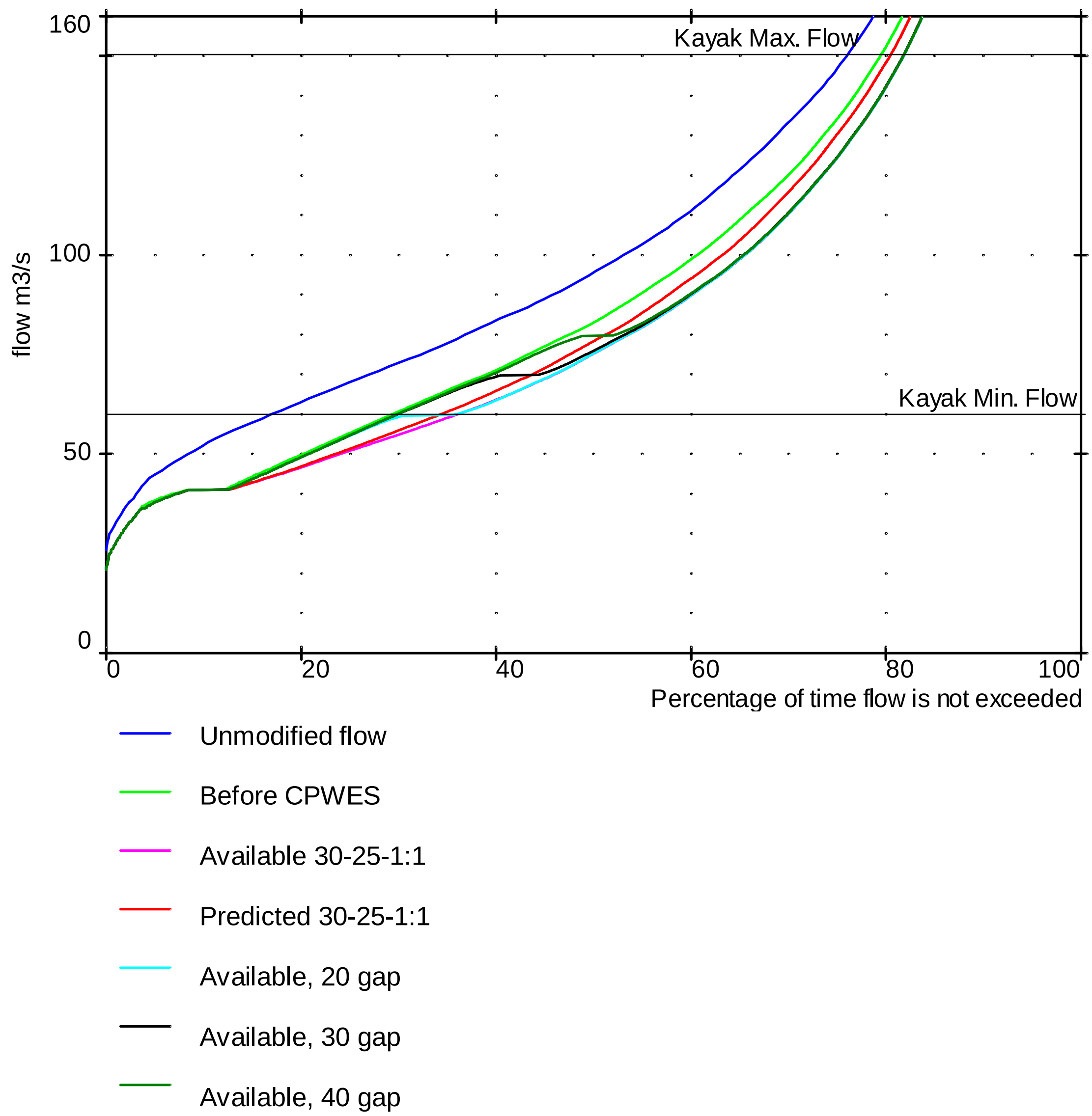

Figure 3. Flow duration curves for the whole year for 1967-2001 showing the flow limits for kayaking and the Available flows with gaps of 20, 30 and 40 m^3s^{-1}.

Jet boats

27. Figure 4 shows December to March flow duration curves for the Predicted gap scenarios and the flow limits for jet boats from the lower limit of adequate flows to the upper limit of optimal flows (Paragraph 9.24 of Minute 9). The Available gap scenario lines, if shown, would move to the right at the flat lining to cover the Available 30-25-1:1 line at flows higher than the flat lining as they do in Figure 3.

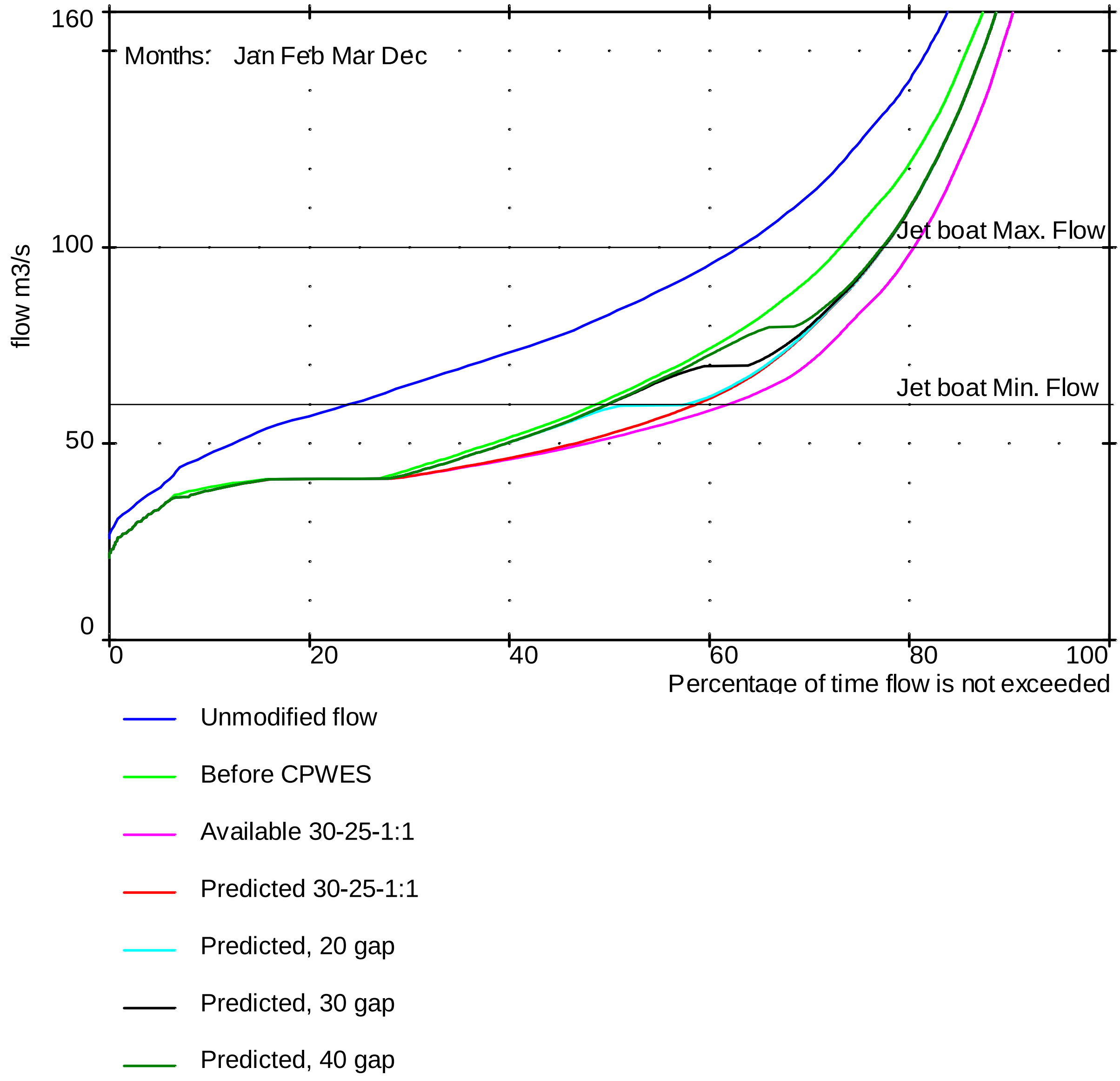

Figure 4. Flow duration curves for December to March for 1967-2001 for the Predicted gap options showing the flow limits for jet boating.

28. The Predicted 30-25-1:1 scenario flows are suitable for jet boating for 29.9% of the time and for the Predicted gap scenarios 37.0% of the time. Thus there is a 7.1% (mean of 8.6 days/season) difference in the duration of the preferred flow range for

kayaks between the 30-25-1:1 and the Predicted gap options. For the Available gap scenarios flows are suitable for jet boating for 39.9% of the time. Thus there is a 10% (mean of 12.1 days/season) difference in the duration of the preferred flow range for jet boats between the Predicted 30-25-1:1 and the Available gap options.

Salmon angling

29. Figure 5 shows December to March flow duration curves for the abstraction scenarios and the flow limits for salmon angling from the preferred flows according to Dr Hayes (Paragraph 9.47 of Minute 9).

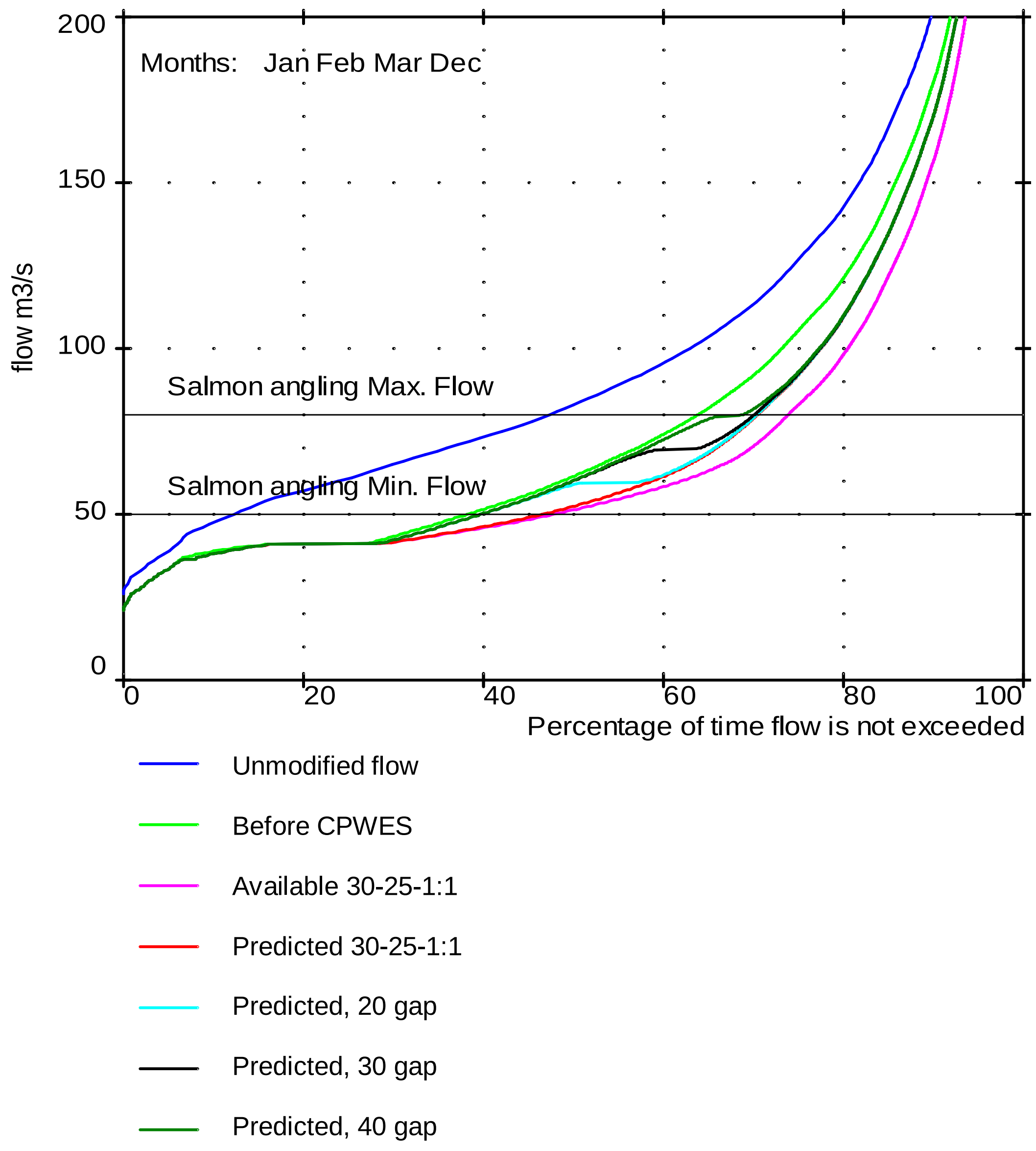

Figure 5. Flow duration curves for the December to March for 1967-2001 showing the flow limits for salmon angling.

30. Any gap size from 10 to 40 m^3s^{-1} would increase the available time for salmon angling above time for the Predicted 30-25-1:1. For the Predicted 30-25-1:1 scenario, flows are suitable for salmon for 22.9% of the time and for the Predicted gap scenarios 30.0% of the time. Thus there is a 7.1% (mean of 8.6 days/season) difference in the duration of the preferred flow range for salmon angling between the 30-25-1:1 and the Predicted gap options. For the Available gap scenarios, flows are suitable for salmon angling for 33.8% of the time. Thus there is a 10.9% difference (mean of 13.2 days/season) in the duration of the preferred flow range for salmon angling between the Predicted 30-25-1:1 and the Available gap options.

River bed nesting birds

31. Figure 6 shows September to December flow duration curves for the abstraction scenarios and the optimal flow limits for river bed nesting birds (Paragraph 9.100 of Minute 9).

32. Once again any of the gap options increase the time in the referred flow range over that provided by the unmodified flow regime, the current takes and that proposed by CPWES. For the Predicted 30-25-1:1 scenario, flows are suitable for riverbed-bird nesting for 20.9% of the time and for the Predicted 30 gap scenario 29.9% of the time. Thus there is a 9% (mean of 11.0 days/breeding season) difference in the duration of the preferred flow range for riverbed-bird nesting between the 30-25-1:1 and the Predicted 30 gap option. For the Available 30 gap scenario, flows are suitable for riverbed-bird nesting for 34.7% of the time. Thus there is a 14.7% (mean of 17.9 days/breeding season) difference in the duration of the preferred flow range for riverbed-bird nesting between the Predicted 30-25-1:1 and the Available gap options.

Invertebrates

33. The Commissioners in their Minute 9, paragraph 9.108, invited comment on the effect of the various flow regimes on invertebrate production. I have used the preliminary model described in my earlier evidence to explore the relative invertebrate productivity of the proposed 30-25-1:1 and 30 gap flow regimes. I explored linear and ñSò shaped colonisation curves and 10 and 20 day durations to full colonisation. The example, shown in Figure 7, is for a linear increase to full productivity over 10 days. The results for the other colonisation rates and times looked very similar to Figure 7. These plots are also similar to those in my earlier evidence and show that there is little difference in invertebrate productivity between the flow regimes. The model was run from 1 December 1989 to 31 May 1990 chosen because that was the critical time

for an average year. Differences between flow regimes appear to be greatest during an average year.

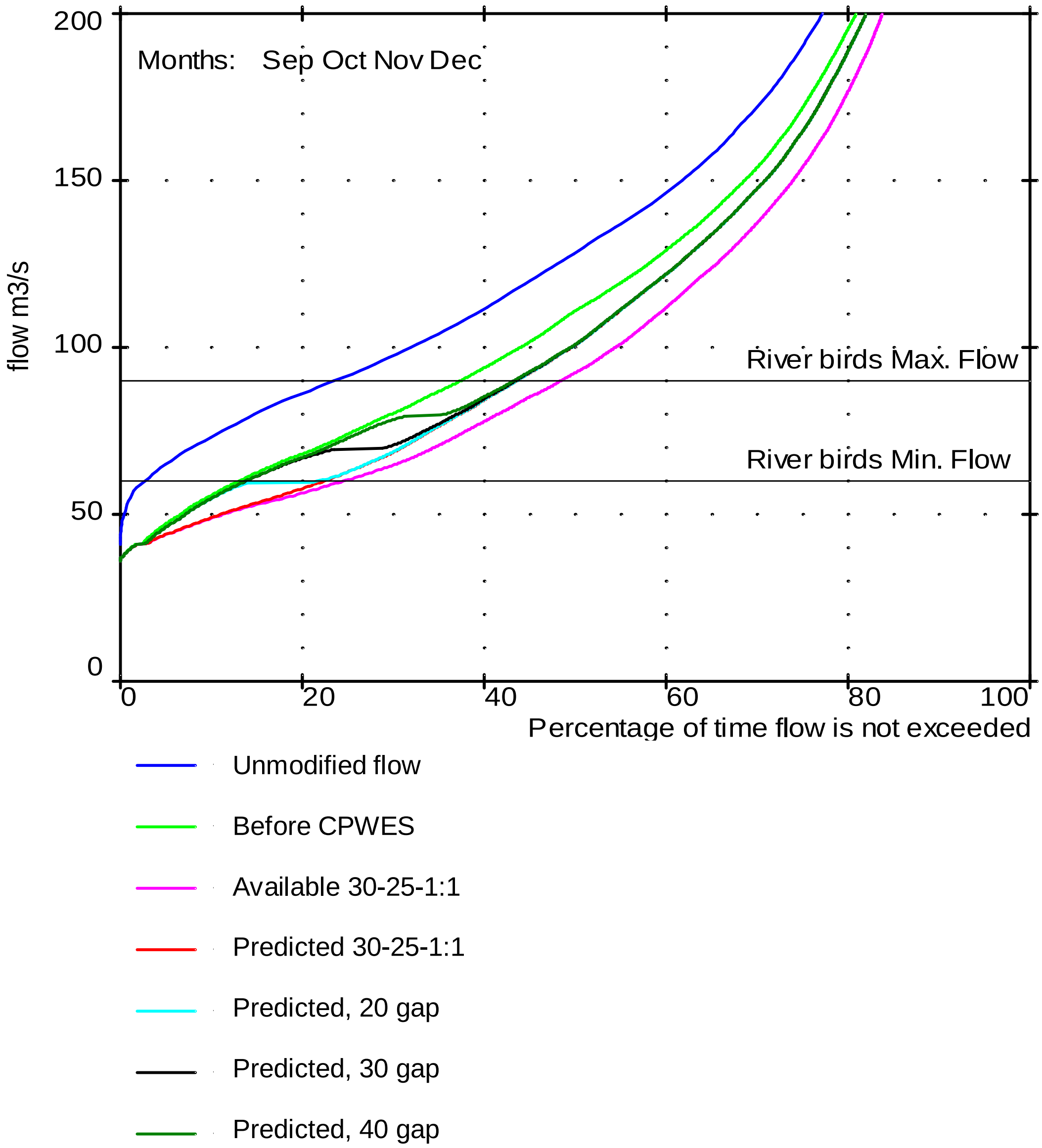

Figure 6. Flow duration curves for September to December for 1967-2001 showing the optimal flow limits for river bed nesting birds.

34. After about 2 weeks after a 550 m^3s^{-1} flood in the Waimakariri River I was able to find mayfly nymphs anywhere in the river I could wade. So it appears that invertebrate numbers can recover rapidly after floods. I believe that invertebrate production is unlikely to be limiting for fish and birds.

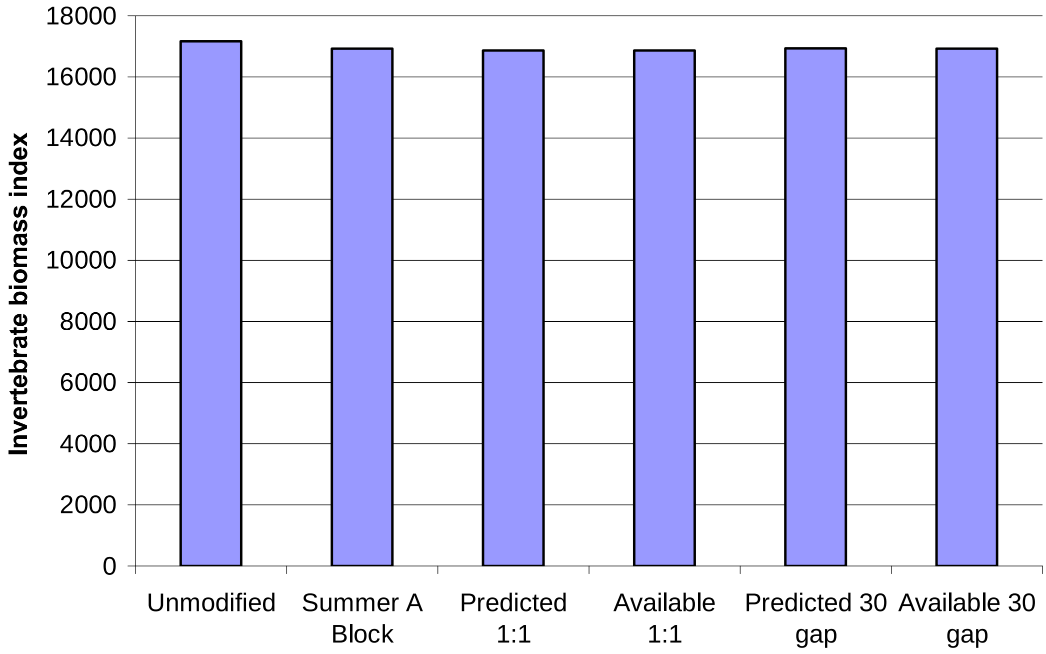

Figure 7. Invertebrate biomass index for December 1989 to May 1990, for the various flow regimes.

Summary

35. CPWES propose to abstract a maximum of 25 m^3s^{-1} with 24 m^3s^{-1} to be taken above current B Permit takes on a 1:1 sharing basis. Their revised scheme requires no winter take and a reduced summer take.

36. The 1:1 sharing of the B Permit water prevents any additional flat lining of the flow at any level.

37. Flow duration curves for the CPWES proposal and various gap options have been produced for the periods critical to a range of recreational and environmental values.

38. The flow duration curves show that gaps of 20 to 40 m^3s^{-1} above the current B permit minimum flow of 63 m^3s^{-1} increase the time that flow remains within the preferred range for various activities above that of the 1:1 sharing regime proposed. The cost of this extra time in the preferred range is a reduced volume and reliability of take.

39. A gap of 30 m^3s^{-1} appears optimum, but a gap of 20 m^3s^{-1} would increase the time within the preferred flow range, but for some activities the flows would be sub-optimal. A gap of 20 m^3s^{-1} would allow an increased volume and reliability of take over schemes with larger gaps.

40. Having made those comments, the differences in time in the preferred flow ranges between the proposed 1:1 scenarios and the current A Block takes are relatively small in terms of days per year (less than ± 4.5 days/year on average) for most cases.

41. The difference in time available in the preferred flow ranges between the proposed Predicted 1:1 flow sharing and the Predicted 30 gap regimes ranges from 8.6 days per season for jet boating and salmon angling to 11 days/breeding season for riverbed-nesting birds.

42. The difference in time available in the preferred flow ranges between the proposed Predicted 1:1 flow sharing and the Available 30 gap regimes ranges from 12.1 days per season for jet boating to 14.7 days/breeding season for riverbed-nesting birds.

43. Results from a preliminary invertebrate time series model indicate there is no material difference in invertebrate productivity between the proposed abstraction regimes and the 30 gap regime.