IN THE MATTER	of submissions on a regional plan under clause 6 of the First Schedule to the Resource Management Act 1991 ("the RMA")
AND	
IN THE MATTER	of the proposed Canterbury Natural Resources Regional Plan (the PNRRP)
AND	
IN THE MATTER	of submissions relating to Chapter 5 : Water Quantity
BETWEEN	**SELWYN PLANTATION BOARD LIMITED, BLAKELY PACIFIC LIMITED** and **MATARIKI FOREST** (formerly Carter Holt Harvey Limited) hereafter referred to as the Joint Forestry Submitters

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EVIDENCE IN REPLY OF DR TIM DAVIE

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PART A: REPLY TO NIWA REPORT – VEGETATION CHANGE AND WATER YIELD: AN ANALYSIS OF THE LFPA APPROACH

BACKGROUND

1. In evidence submitted to the hearing commission for the Environment Canterbury Proposed Natural Resources Regional Plan (PNRRP) the joint Forestry Submitters (JFS) proposed the Low Flow Producing Area (LFPA) rule for the regulation of forestry activity in flow sensitive catchments.

2. The LFPA rule would restrict forestry in areas of flow sensitive catchments that are important for producing low flows.

3. On 30/10/07 I received a copy of the report "Vegetation change and water yield: an analysis of the LFPA approach" in which Environment Canterbury had sub-contracted NIWA to analyse the effects of the LFPA rule on flows in a variety of Canterbury flow-sensitive catchments.

4. The following is my response to reading this report. I do this on the same basis as in my previous evidence to the hearing commission; as an expert witness commissioned by the "Joint Forestry Submitters" to provide written evidence concerning the Canterbury Provisional Natural Resources Regional Plan (PNRRP).

SCOPE AND GENERAL COMMENTS

5. In this evidence I will provide my interpretation of the analysis of the LFPA rule. Rather than direct my evidence to each paragraph of the NIWA report, I will address the following matters:

   - The scenarios used to simulate the LFPA rule
   - The various simulated impacts of the LFPA rule shown in the Figures 1- 37. I have divided this part of my evidence into the categories shown in the NIWA report figures: 7 -d MALF flow, mean flow and reliability of supply. I also provide some comment on the analysis of where the forest is planted within LFPA restricted area.
   - Practicality of LFPA approach, and
   - My summary comments on the NIWA analysis.

6. The approach used to analyse the LFPA rule is essentially the same as that used to determine the rule proposed in the Chapter 5 of the PNRRP. There has been a small adjustment down in the percentage reduction on water yield following afforestation but no change in the ratio of total water yield to low flows.

7. In paragraphs 130-158 of my original evidence I was critical of this approach. I stand by these criticisms which in summary are: that the analysis of the affects of afforestation on water yield in flow sensitive catchments used in the PNRRP is overly harsh in its treatment of both total water yield and low flows and that the suggested impact threshold is set too high.

8. At paragraphs 58-129 of my original evidence I discussed the use of the LFPA rule to as a better method to protect low flows. For the reasons discussed below the NIWA report has not altered my support for the LFPA rule. It remains my opinion that the LFPA rule is preferable to the current rule in the PNRRP.

9. Whilst it is reasonable and sensible to use the same methodology to assess both rules (i.e. LFPA and the current PNRRP rule), I believe the methodology is extremely cautious in its treatment of forestry and overstates the impact of forestry on low flows in particular. It is therefore unsurprising that application of the same methodology leads to the outcome that Mr Duncan does not support the LFPA rule.

INTERPRETATION OF THE LFPA RULE

10. The NIWA report uses three different scenarios to simulate an LFPA rule. These are that forestry would be restricted to 20% of the catchment area where:

    - S1 – The proportion of MALF is greater than the proportion of area contributing to the MALF. In figure 9 of the NIWA report this can be summarised as any situation where the green bar is greater than or equal to the red bar.
    - S2 – The proportion of MALF is greater than or close to the proportion of area contributing to the MALF. In figure 9 of the NIWA report this can be summarised as any situation where the green bar is greater than or close to the red bar.
    - S3 – There is any low flow production. In figure 9 of the NIWA report this can be summarised as all of the areas where the green bar is greater than zero. For the Selwyn this is all of the total catchment; for the Waipara it is approximately 25% of the total catchment.

11. All three scenarios are possible representations of the LFPA rule. Because the LFPA rule was derived from looking at the Waipara catchment (for reasons oulined in my previous evidence) my original thoughts had been based on scenario 3 (S3).

12. However, on looking at how the LFPA rules applies to other flow sensitive catchments in Canterbury I would personally favour scenario 1 (S1) as it detects the really important low flow producing zones of a catchment and provides protection in these areas. In hydrological terms this protects the significant low flow producing areas of a catchment.

13. In the interpretation here I rely heavily on figures 10-13 in the NIWA report (i.e. for the Selwyn catchment). This is because the Selwyn presents a more complex case than the Waipara (figures 3-5) which formed the thinking around the original LFPA rule.

SIMULATED IMPACTS OF THE LFPA RULE ON LOW FLOWS

14. The top diagram of figure 10 in the NIWA report shows the simulated impact of forestry using the LFPA rule on the MALF7 statistic.

15. Under the most extreme scenario (20% afforestation in the restricted zone and all of the rest the catchment completely afforested – shown on the right hand side of the top diagram of figure 10) there is what looks like an 8.9% decrease in the MALF7.

16. I have four comments to make about this:

    - This is a relatively small change in low flow and could easily be swallowed up by consideration of methodological and measurement error. As presented in my earlier evidence, in my opinion the current methodology over calculates the impact of forestry on low flows and therefore a change of 8.9% using this methodology may not be large. I also presented my

view that measurement error on permanent flow gauging may not be able to detect changes less than 7%.

- The scenario is an extreme one. Although it is a possibility, it is highly unlikely that all of the remaining catchment would be afforested.
- If accepted that the analysis is correct the difference between a simulated change of 5% (current PNRRP rule) and the possible change of 8.9% is not large in the context of the extra benefits of having forestry in catchments (water quality, economic, etc as outlined in previous JFS evidence).
- In other catchments the MALF7 decrease is less. For example the Waipara catchment (top diagram in Figure 4) shows only 6.7 % reduction. This is only 1.7% above the PNRRP threshold. Whilst the Waipara was not specifically selected for this reason, the NIWA analysis would appear to support use of LFPA rule in this catchment.

17. Of the catchments analysed the Selwyn and Te Ngawai (Figure 28 in NIWA report) are the most extreme examples. In the case of the Te Ngawai the simulated decrease of low flow under the most extreme condition is around 11%.

18. It is worth bearing in mind the level of this change compared to the calculated effect willows have on low flows (approximately 100% in the Waipara – see earlier evidence)

19. Overall I am pleased to see that under the NIWA analysis (which I consider to overstate the effects of forestry on low flows) the LFPA rule allows forestry to take place in catchments while not having an overly large impact on low flows, even under the worst case senario.

SIMULATED IMPACTS OF THE LFPA RULE ON MEAN FLOWS

20. The bottom diagram of figure 10 in the NIWA report shows the simulated impact of forestry using the LFPA rule on the mean flow of the Selwyn river.

21. Under the most extreme scenario (20% afforestation in the restricted zone and all of the rest the catchment completely afforested – shown on the right hand side of the bottom diagram of figure 10) there is an 18% decrease in the mean flow.

22. Although this change appears more dramatic it must be remembered that mean flow is influenced by high flows. As presented in my earlier evidence (paragraphs 42-44) forestry has a large effect on small floods and autumn freshes which will heavily influence the mean flow figure.

23. A change of 18% of mean flow is most likely to occur through reduction in these small floods, particularly in the autumn and early winter. Therefore I would contend that this change is not likely to be significant in water resource or ecological terms (n.b. large floods will still occur).

IMPACT OF WHERE THE TREES ARE PLANTED WITHIN THE RESTRICTED ZONE

24. In the top diagram of figure 11, in the NIWA report the analysis is extended to look at a possible scenario where the 20% planting within a low flow zone is placed in the area which produces the greatest low flow (i.e. not evenly distributed).

25. I have two comments to make about this analysis:

- This is again an unlikely scenario. The highest low flow producing areas are normally at the highest altitudes (e.g. the Waipara) or areas of extensive wetland (e.g. the Selwyn). In the case of altitude, it is my understanding that commercial forestry does not normally take place in these areas due to poor growth rates and snow damage to the trees. In the case of wetlands there would be a requirement for extensive drainage which would require resource consent under most district plans and/or the relevant regional plan, which I understand would discourage commercial forestry.
- There is an assumption in the methodology that vegetation change of less than 20% in area will cause a detectable change in streamflow. Because this is inherent in the methodology it is unsurprising that the results show it to be so. As outlined in my previous evidence (paragraph 118-129) I do not agree with the underlying assumption. This is part of my view that the current analysis is overstating the effect that forestry has on flows in general, and low flows in particular.

26. Overall the impact of planting trees in the most sensitive parts of the catchment is greater than when spread evenly throughout the LFPA. However as outlined above I believe it to be an unlikely scenario that overstates the effect on low and mean flows.

RELIABILITY OF SUPPLY

27. In figures 12 & 13 of the NIWA report the previous analyses are repeated to investigate the effect on reliability of supply at both the MALF-7 and median flow values.

28. This analysis is based on assumed relationships between the flow reductions and flow duration curves for rivers. Due to the nature of the assumptions the graphs of reliabilities follow very similar patterns to the flow graphs (described above).

29. When the days of increased restriction at the MALF-7 level are considered (top of figure 12 for the Selwyn) there is a small increase, possibly up to 4 days more per year under the most extreme scenario (scenario 1 in figure 12). This equates to 1.1% of the time with increased restriction at the MALF7 level.

30. It is difficult to see this as having a significant effect on ecology and as per earlier arguments the effect could easily be a factor of methodological and/or measurement error.

31. In terms of the effect of afforestation on reliability of supply at the median flow level (bottom half of figure 12); this appears dramatic (up to 20 days of reduced supply) but the question needs asking: are these rivers fully allocated up to the median flow level? (i.e. does it matter that there is reduced reliability iof supply at the median level?)

32. In the case of the Waipara (I do not have statistics for the Selwyn) the median flow at Teviotdale is 1459 l/s while the amount of direct surface water take (without storage) is 120 l/s (Chater, 2002).

33. The amount of total surface water allocation in the Waipara is 1358 l/s but the majority of this is for abstraction to storage during periods of high flow (Chater, 2002).

34. In my opinion, in the case of the Waipara reliability of supply at the median level is not a significant water resource issue. This is based on the evidence that at median flow there is still ample water for surface water supply.

Equally there will still be plenty of water available above the median for storage takes.

35. In the NIWA report, the reduction in reliability of supply at the median level for the Selwyn (30 days under the most extreme scenario) appears dramatic but is likely to still allow enough water for users.

PRACTICALITY OF LFPA APPROACH

36. The NIWA report raises the issue of defining the isohyds within a plan and whether this would be contentious.

37. I am not a planning expert so cannot comment authoritatively on this but I would have thought it is no different from any line drawn on a planning map. If a forestry proposal was assessed to be partially within the permitted area and partially inside the LFPA rule area then consent would be required if the proposal exceeded the 20% threshold and the application would be considered on its merits. Presumably if a consent applicant can show that there is minimal impact in "crossing the line" then it would be acceptable. This would not require redrawing, or disputing, of the line.

SUMMARY COMMENTS ON ANALYSIS OF LFPA APPROACH

38. My overall impression of the analysis shown in the NIWA report is that the changes in low flow due to the LFPA approach are not large and increases from the current PNRRP policy can easily be accounted for by the methodology used. The analysis supports adoption of the LFPA rule and the reasons for the rule discussed in my earlier evidence.

39. Under the most extreme forestry scenario there are larger differences in the mean flows caused by afforestation, however I do not agree with the assumption in the NIWA report that the increases materially affect the reliability of supply at the median flow.

40. In my opinion, for both the mean and median flow statistics the use of the LFPA rule is not likely to be significant in water resource or aquatic ecology terms. This is because:

    - For the mean flow statistic the reduction is likely to be caused by a reduction in small floods which are not important for water resources or stream ecology (N.B. there are still floods occurring);
    - For the median flow statistic the projected reduction should not be significant as there should still be plenty for abstractors unless the river is severely over-allocated.

41. In summary I believe that the LFPA is a feasible approach to regulate forestry in flow sensitive catchments in Canterbury. The demonstrated effects on low flows are small and on mean & median flows not significant.

PART B: REPLY TO COMMENTS BY MR DUNCAN ON THE EVIDNECE BY DR TIM DAVIE

BACKGROUND

42. Mr Duncan has provided a series of comments on the evidence that I presented to the Hearings Commission on Chapter 5 of the Proposed Natural Resources Regional Plan (PNRRP).

43. I do not intend to go through the comments individually, unless there are specific clarifications required. This is because I believe the dispute we have over data and interpretation of data reinforces the point that the science in this area of research is not absolute and precise.

44. We both agree that the introduction of tall vegetation in a catchment area reduces the amount of flow in the river draining the catchment. We disagree on how large that change is and the degree of effect of the vegetation change on low flows.

45. My opinion is that the analysis and opinions presented by Mr Duncan overstate the influence of forestry on river flows.

46. Having read Mr Duncan's comments, and the NIWA report on the Low Flow Producing Area (LFPA) approach I maintain my original position that the LFPA approach will provide adequate protection of river flows for instream values and downstream users while enabling a greater level of forestry than that proposed in the PNRRP within Canterbury.

SPECIFIC POINTS

47. In paragraph 3, Mr Duncan queries the depth of root zone analysed (both through modelling and measurement) under pines and pasture. The model does not "assume an equal rooting depth under pasture and pines", it presents data based on neutron probe tubes (a soil moisture measuring device) that reached the underlying Moutere Gravel formation under both pasture and pines. This is the effective rooting depth of both vegetation covers. The scale shown is the total water held in the soil, not a total soil depth.

48. Paragraph 6 (above) clarifies figure 1 of my evidence and does not alter my interpretation of the figure.

49. In paragraph 10 Mr Duncan states that the NIWA report shows that the "LFPA rule does hasten the onset, and increases the duration, frequency & severity of low flows". I cannot see any analysis beyond looking at average year mean and low flows and the reliability of supply at MALF-7 and median flows. This is not an analysis of onset (i.e. time of year), frequency (how often it occurs) or severity (how low the flow actually goes). I accept that there has been some analysis of duration (length of time with reduced flow which is partially covered by reliability). I would dispute Mr Duncan's conclusion that all four elements of low flow have been analysed and I have not seen this done in any of the Environment Canterbury analysis.

50. In paragraph 14 Mr Duncan raises the issue of difference in flow between the two Pakuratahi study catchments. He is correct to point out that the figure does not appear in the Pakuratahi report. The 28% figure of change I quoted is through my own analysis of the Pakuratahi data based on the period after logging compared to pre-logging (i.e. the same catchment, rather than using the comparison of catchments for flow). This does not alter my conclusions from the Pakuratahi study.

51. In paragraph 20 Mr Duncan discusses the choice of the Waipara catchment by the JFS. The multiple reasons for choosing the Waipara as a case study are outlined in paragraph 194-198 of my primary evidence. The Waipara was selected as a suitable case study for many reasons and the fact that it is the driest of the flow sensitive catchment was not a consideration. In short the LFPA rule was derived from analysis of the Waipara catchment rather than fitted to the Waipara situation.

52. As described in paragraph 12 above regarding the NIWA report, after having the opportunity to see how the LFPA rule might apply in other flow sensitive catchments I believe that scenario 1 is a hydrologically effective representation of the LFPA rule. Using this scenario the Waipara catchment is not such an extreme example (as suggested in paragraph 20 of Mr Duncan's reply). Under scenario 1 the Waipara would have 76%, the Waitohi 75%, the Te Moana 58% and the Okuku 48% of their catchments without forestry restrictions.

53. Later in paragraph 20 Mr Duncan states that the LFPA rule does not protect the low flows adequately because "the area outside the defined low producing area is contributing significantly to the 7-day MALF".

54. As stated previously, my overall impression of the analysis shown in the NIWA report is that the changes in low flow due to the LFPA approach are not large and increases from the current PNRRP policy can easily be accounted for by the methodology used. Therefore I stand by my assertion at paragraph 200 of my original evidence that the LFPA rule does "achieve the stated aims of protecting the flow requirements for instream values and the reliability of supply for existing abstractors for irrigation purposes in flow sensitive catchments from the effects of a change in vegetation cover from short to tall vegetation".