BEFORE THE CANTERBURY REGIONAL COUNCIL

***IN THE MATTER OF*:** the Resource Management Act 1991

AND

***IN THE MATTER OF*:** a submission on the Proposed Canterbury Land and Water Regional Plan

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EVIDENCE OF DAVID WILLIAM STEWART

FOR DIRECTOR-GENERAL OF CONSERVATION

Dated 4 February 2013

Director General of Conservation

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STATEMENT OF EVIDENCE OF DAVID WILLIAM STEWART

INTRODUCTION

1. My name is David William Stewart. I am a hydrological consultant and a director of Raineffects Limited.

2. I have a BSc in Physical Geography, Climatology and Mathematics from the University of Otago and 38 years experience in natural resource investigations and hydrology. Between 1974 and 1996 I was employed in various hydrology positions with the Otago Catchment Board and the Otago Regional Council. From 1992 to 1996 I was the Otago Regional Council's Manager of Hydrology. Since 1996 I have worked as an independent hydrological consultant.

3. Since leaving the Council, I have undertaken many water resource assessments and hydrological investigations including impacts of resource development, analysed water plans (Otago Regional Council, Environment Canterbury, draft Waitaki Catchment Water Allocation Regional Plan), analysed major project plans for water use, (Project Aqua, Dunedin City Council water supply, Oceana Gold Taieri River water take) and undertaken many water abstraction permit applications with the largest being the North Otago Irrigation Company/Lower Waitaki Irrigation Company applications to take 10 cumecs from the Waitaki River for irrigation which were subsequently granted. Recently I was Environment Canterbury's hydrologist and S42A report writer for the more than thirty applications to take water in the Upper Waitaki catchment.

4. I have prepared my evidence in compliance with the Code of Conduct for expert witnesses set out in the Environment Court's consolidated practice note dated 1 November 2011. I confirm that my evidence is within my

area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

5. My evidence will deal with the following aspects of the proposed Canterbury Land and Water Regional Plan (pCLWRP):
   - Rule 5:128: Potential impacts of dams in riverbeds
   - Rule 5:129 Condition 1: Extension of the rule to ensure all rivers and streams in the Canterbury area are protected
   - Rule 5:131: Protection of a lake's natural operating regime
   - Rule 5:96: Default minimum flow and allocation limits for waterbodies
   - Rules 5:109-5:111: General review of impacts of forestry in flow sensitive catchments
   - Schedule 9: Correction to description of average daily rate in Table 9.1 for direct connection waterbodies
   - Schedule 13: Correction to average daily rate.

RULE 5.128: POTENTIAL EFFECTS OF DAMMING EXISTING RIVERBEDS

6. The whole width of a riverbed (streambed) is important to the continued efficient functioning of that river or stream. Many rivers in New Zealand now have inefficient stream channels because the riverbeds have been overrun by introduced vegetation such as crack willows, broom and gorse which quickly spreads across the seldom used parts of the river bed. Such obstructions impede flood flows, slow water velocities and reduce sediment loads during floods.

7. The impacts on rivers and streams from in riverbed dams could include:
   - dam and pond size
   - flat-lining of flows;
   - reducing environmental flows;

- increasing days between significant freshes and floods;
- potentially raising flood water levels especially if the structure is permanent; and
- the potential for periods of sediment laden water occurring in the waterbody if excavation of the riverbed for this dam is required.

These impacts are discussed below.

Potential pond areas

8. Rule 5.128 of the Proposed Plan provides that the damming of water in the bed of a river is a permitted activity provided certain conditions are met. These include that "the volume of water impounded is less than 5,000m3". Table 1 shows the various areas that would be occupied in a riverbed if the volume impounded is 4,999m3.

Table 1

Average Depth (m)	Area (m^2)
2.9	1720
2.5	2000
2.0	2500
1.5	3300
1.0	5000
0.5	10000

9. From Table 1, the largest pond extent could be up to 10000 m^2 (1 hectare) but even a pond with an average depth of 1.5m would still occupy an area of 3300 m^3 (one third of a hectare).

10. While it is acknowledged that not all dams in riverbeds will be so big, it does show the potential size of a dam in a riverbed. Dams situated in a riverbed need professional advice to ensure they are constructed

properly and are sited in a riverbed such that they do not impinge on the natural processes of the river.

Flow Flat Lining

11. Any abstraction from a river, whether it be for some consumptive use such as irrigation or non consumptive use such as dam filling, can potentially affect the natural flow regime including flat lining flows. Flow flat lining is unlikely to be an issue for a 5000 m^3 dam in a large river. But the filling or topping up of a 1000-5000m^3 dam in a small river or stream could have implications on the flow regime. For example, in a stream which had a 400l/s mean flow and 300l/s median flow, a constant abstraction from the dam for ongoing irrigation could result in flows being flat lined for significant periods of time. This would be due to continuous topping up of the riverbed dam from the stream especially at times of low flow assuming the dam was the first step in an irrigation abstraction process. Farmers are known to create dams in streams/rivers to provide a good depth of water at the pumping site so that the pump can be in deep water the whole time it is pumping.

Environmental flows

12. Floods are an important part of a river regime. They act as cleaners of river beds by removing periphyton and fine sediment, turning over rocks in the riverbed and generally refreshing the river. Sediment load and velocity are important to the clearing of periphyton and refreshing the river. Floods are also important in channel forming so braided rivers continue to be a dynamic mobile system and rivers in general shift their channels within the riverbed. Therefore the entire natural riverbed is important to the river even if parts of it are seldom used. Impediments to flood flows are to be discouraged or if that is not possible, carefully managed.

13. Environmental flows are smaller freshes and calculated using the median flow in the stream. Clauson and Biggs (Reference 1) found that a flow equivalent to about three times the median flow was generally required to remove algal growth and move sediment and stones in the streambed. Such freshes are a part of a natural stream flow regime and reducing the frequency of these freshes can be very detrimental to any stream and especially one which has significant algal growth problem. Environment Canterbury in its Proposed Hurunui and Waiau Regional Plan (October 2011) on page7, identified the flows equivalent to 1.5 and 2 times median flows were also important in the overall health of the river/stream. None of these are large flood flows.

14. Using the example in the previous section of a stream with a median flow of 300 l/s and a mean flow of 400 l/s, it can be seen that freshes equivalent to 450 l/s (1.5 times median), 600 l/s (2 times median) and 900 l/s (3 times median) are the important flows. If a dam of 5000m^3 is empty when the fresh occurs, then it could easily abstract much of this fresh and reduce the flow to much less than the environmental flow and reduce or negate its effectiveness.

Increase in number of days between significant freshes

15. As a result of removing some of the environmental flows, the days between freshes will increase and in summertime this could be detrimental to the health of the stream and result in greater weed growth smothering the streambed.

Raising Flood Levels

16. Structures in river/streambeds could cause flood levels to be higher, especially if the structure is permanent. Temporary structures such as gravel/rock dams are not so critical in relation to raising flood levels even a small flood will remove the dam and it will need to be reconstructed after the flood. However, a permanent structure that could withstand

the flood is likely to cause flood levels to be higher than under natural conditions. These permanent structures may also collect debris similar to bridge piers which could also cause higher water levels. Impacts of these higher water levels could range from nil to severe bank erosion or bank overtopping.

Impact of Excavation

17. If a 5000 m^3 dam is constructed in the riverbed, it may also include excavation of the riverbed which may result in sediment laden water occurring in the river/stream while the excavation occurs.

Summary

18. There are many potential issues resulting from the impounding of water in a dam in a riverbed and in my opinion such a construction should have expert input, oversight and approval from the consenting authority to ensure these potential problems are avoided or mitigated on a case by case basis.

RULE 5:129 CONDITION 1: EXTENSION OF THE RULE TO ENSURE ALL RIVERS AND STREAMS IN THE CANTERBURY AREA ARE PROTECTED

19. I note that the Director-General of Conservation has submitted on this Rule seeking an additional condition to protect in-stream values by ensuring limits set in sections 6-15 of the pCLWRP are met or, where applicable, the default rules on minimum flows in 5.96 will apply.

20. Currently Condition 1 of this Rule requires that "The damming of water does not cause water flow to fail to meet any limits set in Section 6-15". As worded the Condition fails to ensure all flows are protected in all rivers and streams since those that are not included in Sections 6-15 have the default limits as set in Rule 5:96(2) which states "....if no limits are set in Sections 6-15 for that surface water body, the take, both singularly and in addition to all existing resource consented takes meets a flow regime

with a minimum flow of 50% of the 7-day mean annual low flow (7 DMALF) as calculated by the CRC and an allocation limit of 20% of the 7 DMALF: and ...."

21. Rule 5.96(2) is a default minimum flow and allocation regime for all rivers and streams not included in Sections 6-15 and these default limits are equally as important in these rivers and streams as are those set in the rivers and streams in Sections 6-15. Therefore Rule 5.129 needs to include reference to the default limits for rivers and streams not included in Sections 6-15. I agree with the Director-General's view that the condition should read:

> "The damming of water does not cause water flow to fail to meet any limits set in Sections 6-15 or, where applicable, the default rules on minimum flows and allocation limits in Rule 5:96(2) apply".

22. I discuss Rule 5.96(2) further below.

RULE 5:131: PROTECTION OF A LAKE'S NATURAL OPERATING REGIME

23. Rule 5.131 in the pCLWRP "The constructing of a new dam and the damming of the water in the bed of a river or lake that results in the natural operating regime or level of a natural lake being altered is a non-complying activity."

24. The pCLWRP does not define the term "natural operating regime or level" and the section 42A report response to the Director-General's submission to do so was rejected since the term is "self-explanatory". I do not agree that the term is self-explanatory.

25. There are two parts to the clause that makes it not self-explanatory and in need of a definition. Firstly the clause can be the "natural operating regime" and the second be the "natural operating level". Both can be entirely different so definition is required.

26. The flow regime of a river as defined by Duncan and Woods (Reference 2) can be adapted to apply to lakes. In this case, the definition of the lake's "natural operating regime" would be:

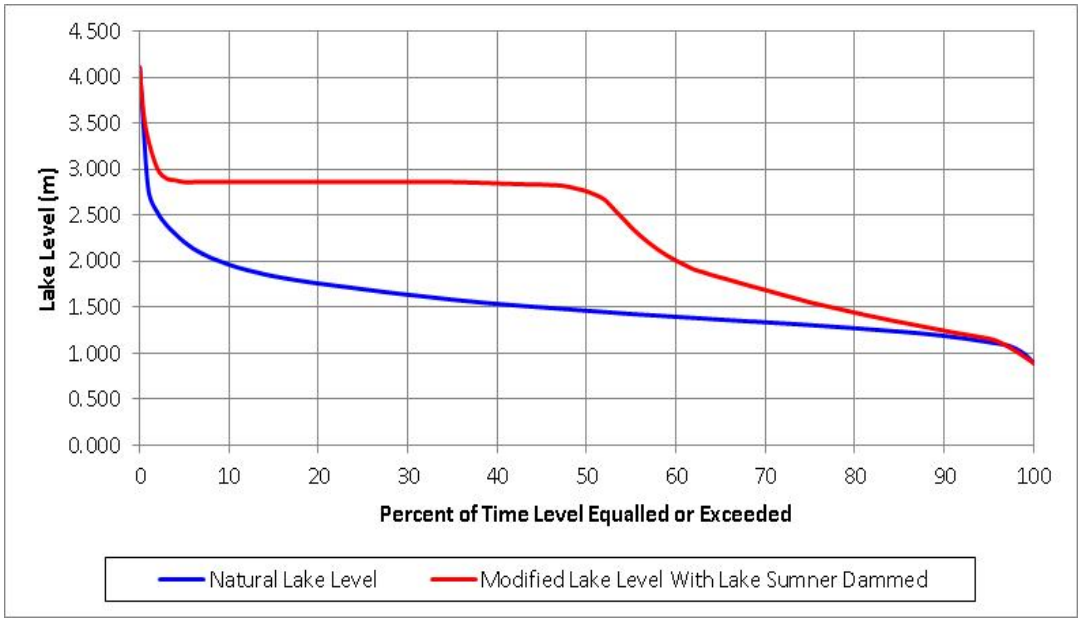
> "The level regime (or hydrologic regime) of a natural lake is the unique way that its level changes from day to day, season to season and from one year to another under completely natural conditions".

27. The definition of the lake's "natural operating level" can be quite different to its operating regime. Major modification can be made to the lake's operating regime but the lake will still remain within its natural operating levels. The difference is explained below.

28. The solution is that the above definition for a natural operating regime be included in the definitions section of the pCLWRP and the words "or level" be deleted from Rule 131. The natural operating regime of any lake includes levels.

29. It is important to reinforce that the natural operating regime of a lake does not include just the level range from lowest to highest but also includes all levels in between these ranges. Figure 1 on the next page shows the natural operating regime of the Hurunui catchment's Lake Sumner (blue line) and this curve is typical of natural lakes.

Figure 1. Natural and Modified Level Duration Curves For Lake Sumner



30. In a lake, modification of levels is the major issue. Lake levels fluctuate naturally and when major rainstorms occur, the levels will become high and flood the lake surrounds. In lakes like Lake Sumner, floods affect the lake surrounds including native bush, roads and some properties. In lakes like Lakes Wanaka and Wakatipu, floods can be devastating to people and property as occurred in November 1999 but the highest levels recede very quickly under natural conditions once the heavy rainfall eases or stops. They seldom naturally stay in the flood range for more than a few days or at maximum one to two weeks at any one time. At times of little rain, lake levels can become very low and large areas of the lake bed can become exposed which can result in significant dust storms and lake access can become very difficult for recreationists and water users from the lake. Therefore holding lakes at low levels for abnormal periods of time can again be a significant problem for people and property. Such an event occurred in Lake Hawea in 1976/77 and there were major problems with dunes of silt from the lakebed building up and encroaching on properties and dust storms every time the wind was strong enough.

Therefore, it is possible to manipulate lake levels such that the level range is unchanged but the natural operating range is significantly altered.

31. A recent example of such potential modification of a lake's operation regime was the application by Hurunui Water Project to dam the completely natural Lake Sumner in the Hurunui catchment. This lake currently has a natural measured level range of between 0.896m and 4.108m and a mean level of 1.538m that is currently equalled or exceeded 40% of the time. Levels are less than 1.538m for 60% of the time.

32. The Hurunui Water Project proposal is for a control structure which will hold the lake level 2.86m above the minimum recorded level of 0.896m between 1 August and 30 April each year, about 1.3m higher than its current mean level and at a level that is naturally equalled or exceeded less than 1% of the time. This is the flood range and the proposal would see the lake level held in the flood range for more than 50% of the time (about 183 days per year on average) compared with less than 1% of time (about 3 days per year on average) under natural conditions. Figure 1 (above) shows the natural and modified level duration curves and while the levels are being kept within the natural range, the proportion of time spent at flood level and lower level are completely different.

33. The effects of holding lakes at flood level or at abnormally low levels for long periods of time are likely to be very significant so it is important that natural lake operating regimes are not significantly altered. Downstream effects of damming include holding rivers at lower flows than would normally occur while the dam is filling, potentially eliminating low flows in summer if the river is used as the means of conveyance for irrigation water to the abstraction point, and the reduction in environmental flows for flushing the river while the dam is filling or being topped up. Such

changes to levels should be scrutinised carefully through a consenting regime but, in my understanding, would not necessarily trigger Rule 5.131 of the pCLWRP.

RULE 5.96 TAKE AND USE SURFACE WATER

34. Rule 5.96 of the pCLWRP states:

> "The taking and use of surface water from a river or lake is a restricted discretionary activity, provided the following conditions are met:
>
> (2) Unless the proposed take is the replacement of a lawfully established take affected by the provisions of section 124 of the RMA, if no limits are set in Sections 6-15 for that surface water body, the take, both singularly and in addition to all existing resource consented takes meets a flow regime with a minimum flow of 50% of the 7-day mean annual low flow (7DMALF) as calculated by the CRC and an allocation limit of 20% of the 3DMALF: and ...."

35. The section 42A report (page 276) now states:

> (2) Unless the proposed take is the replacement of a lawfully established take affected by the provisions of section 124 of the RMA, if no limits are set in Sections 6-15 for that surface water body, the take, both singularly and in addition to all existing resource consented takes complies with the following flow regime:
>
> (a) For rivers with mean flows less than or equal to 5 m3/s, a minimum flow of 90% of the7-day mean annual low flow (7DMALF) as calculated by the Canterbury Regional Council and an allocation limit of 30% of the 7DMALF; and
>
> (b) For rivers with mean flows greater than 5 m3/s, a minimum flow of 80% of the 7DMALFas calculated by the Canterbury Regional Council and an allocation limit of 50% of the7DMALF; and

36. The section 42A report offers no explanation for the change but this same change from the original Rule 5:96(2) is included in the final recommended wording for this rule.

37. Rule 5.96 was discussed earlier in my evidence. The issue here is the size of the default minimum flows and allocation limit set in this rule.

38. I agree with the amendments proposed in the section 42A report. The amendments are virtually identical to those set out in the proposed National Environmental Standard (NES) on ecological flows which was released for public comment in February 2009.

39. From a hydrology point of view, for catchments that have not had in-depth analyses on them to determine an appropriate minimum flow and allocation regime, the proposed NES and the section 42A report is to be preferred over Rule 5:96(2) in the pCLWRP in terms of minimum flows. It recognises that catchments with larger flows are not as affected by abstractions and minimum flows as small catchments are. A minimum flow of 50% of MALF would equate to a flow with about a 10% annual exceedence probability (AEP) (10 year return period).

40. The section 42A report and the proposed NES has minimum flows set as 80% of MALF for rivers with mean flows greater than 5 cumecs and 90% of MALF for rivers with mean flows less than 5 cumecs. In general, 80% of MALF has an AEP of about 20% (5 year return period) while 90% of MALF has an AEP of about 50% (2 return period). The original rule had the minimum flow at 50% of 7DMALF (AEP of about 10%). Since these are interim minimum flows, they should be conservative because the minimum flow can always be lowered should in-depth studies reveal that a lower minimum flow is possible. However if the flow is set too low initially, then it will be very difficult to later raise if water has been allocated because the abstractor(s) will have developed their schemes with the lower minimum flow expectation and raising the minimum flow could compromise the schemes. Therefore the proposed minimum flows in the S42 report are the much better option.

RULE 5:109-5:111: GENERAL REVIEW OF IMPACTS OF FORESTRY IN FLOW SENSITIVE CATCHMENTS

41. I understand the Director-General's submission supports the general approach in the pCLWRP. Research investigating the impacts of landuse change on water yields from flow sensitive catchments shows that replacing tussock or exotic grassland with forestry reduces flows in flow sensitive streams and rivers significantly. It has been found that the conversion of tussock grassland to pine forest can reduce runoff yield from that land area by 20-30% and the conversion of exotic grassland to pine forest can reduce runoff yield from that land area by 50% or more.

42. Currently there are pine plantations in many flow sensitive catchments. At some stage, these pines will be harvested and when that occurs, there will be an increase in runoff yield from that previously forested area. If the same area is replanted in pines, runoff yield from that area will steadily reduce until the forest canopy closes again and at that stage, yields will be reduced by 50% or more again from that area. Given the significant reduction in yield that conversion of tussock or exotic grassland to pine forest has on water yields, then any increase in forestry plantation in flow sensitive catchments will be detrimental to runoff yields. Current yields from the flow sensitive catchment will be those measured up until now and will have the yield reduction from any forestry conversion as part of its current hydrology. Such catchments should not have their yields further reduced through increased forestry conversion.

SCHEDULE 9 – ASSESSMENT OF STREAM DEPLETION EFFECT

43. Table 1 in Schedule 9 includes the direct stream depletion effect to be included in the surface and groundwater allocations. Under the column "Amount to be included in the surface water allocation limit" it states

that for direct stream depletion effects it is the "average daily rate of take". That term is then explained in brackets.

44. Despite the explanation, the term "average daily rate of take" is still open to mis-interpretation. The average daily rate of take is the average of all the takes on that particular day and they may not be taking at their maximum rate and therefore may not take all they are allowed for that day. To clarify, it should be amended to state "Average daily rate of take to abstract maximum daily volume". The existing bracketed explanation should be retained.

SCHEDULE 13– REQUIREMENTS FOR IMPLEMENTATION OF WATER ALLOCATION REGIMES

45. In Schedule 13 the surface water allocation regime is calculated using average daily rates. However, with surface water abstraction, the effects are instantaneous when the pump is switched on or the diversion is opened. The river sees the abstraction as instant and not an average during a 24 hour period.

46. It is normal practice to set allocation limits based on peak rates of take (e.g. Regional Plan: Water for Otago, Waitaki Catchment Water Allocation Regional Plan). Many water permits are not fully exercised at present but with the increasing awareness of the value of the water and increased dairying, more water permits are now fully utilised compared with in the past, so average daily rates of take are not indicative of the actual effects on the river or stream.

47. The Director-General's submission sought that the reference to "average daily rate" be amended to "maximum daily rate". For the reasons discussed above I agree this amendment should be made.

CONCLUSION

48. To summarise:

- In Rule 5:128(2), dams constructed in river and streambeds need professional oversight to ensure their impacts on the river and its flows are minimised.

- Rule 5:129 Condition 1 needs to be extended to cover all rivers and streams in Canterbury by including the words "…or, where applicable, the default rules on minimum flows and allocation limits in Rule 5:96(2) apply" after the words "…Sections 6-15".

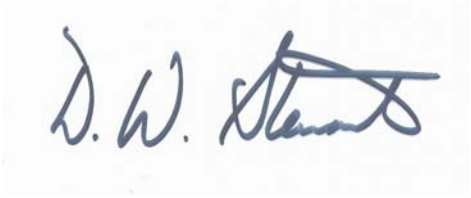
- In Rule 5:131, a clear definition of a natural lake's operating regime needs to be provided and a slight modification to the Rule by removing the words "or level" be undertaken to ensure the lake operating regime is not compromised by allowing developments to alter the lake operating regime but remain within natural lake levels.

- The default minimum flows and allocation limits in the S42 report are to be preferred to that proposed in Rule 5:96(2) of the pCLWRP.

- Forested areas in flow sensitive catchments should not be permitted to be extended beyond their current extent (Rules 5:109-5:111).

- Further explanation of the term "average daily rate" is needed in Schedule 9 Table 9.1.

- When calculating allocation limits for rivers and streams in Schedule 13, the maximum consented rate needs to be included for direct abstraction from a river and not the average daily rate.



Dave Stewart

4 February 2013

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2. Duncan, M.J.; Woods, R.A. 2004. Chapter 7 Flow regimes. Freshwaters of New Zealand: 7.1-7.14