IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications by Central Plains Water Trust to: Canterbury Regional Council for resource consents to take and use water from the Waimakariri and Rakaia Rivers and for all associated consents required for the construction and operation of the Central Plains Water Enhancement Scheme Selwyn District Council for resource consents to construct and operate the Central Plains Water Enhancement Scheme
AND	
IN THE MATTER OF	a notice of requirement by Central Plains Water Limited to: Selwyn District Council for the designation of land for works associated with the construction and operation of the Central Plains Water Enhancement Scheme

---

BRIEF OF EVIDENCE OF MURRAY DOUGLAS GILLON

BUDDLE FINDLAY
Barristers and Solicitors
Christchurch

Solicitor Acting: **Rachel Dunningham**
Counsel: **Dr E D Wylie Q C**
Tel 64-3-379 1747 Fax 64-3-379 5659 PO Box 322 DX WP20307 Christchurch

QUALIFICATIONS AND EXPERIENCE

1. My full name is Murray Douglas Gillon.

2. I have Bachelors and Masters degrees in civil engineering from the University of Canterbury graduating in 1968 and 1971 respectively. I am a Fellow of the Institution of Professional Engineers New Zealand and a Chartered Professional Engineer.

3. I have worked as a civil engineer predominantly in the investigation, design, construction, operation, safety assessment and rehabilitation of dams since 1970. I am presently the Managing Director of Damwatch Services Limited, a speciality dam engineering consulting company. I have carried out safety reviews on over 40 dams in New Zealand, Australia, China, Fiji and the Philippines and been involved in major remedial works on over 25 dams.

4. I have been active in both the New Zealand and international dam engineering societies and a contributor to the Australian society. In New Zealand, I was a member of the New Zealand Society of Large Dams management committee for 14 years. In the international society, the International Commission on Large Dams, I was a member of the technical committee on materials for fill dams from 1990 to 1994 and chairman of the technical committee on reservoir landslides from 1994 to 2000. In this latter role I was the primary author of the first international guidelines for the management of reservoir landslide hazards. In 2002 I was the international peer reviewer for the Australian Committee on Large Dams' Guidelines on Dam Safety Management. I have authored or co-authored over 50 technical papers on a wide variety of dam engineering subjects. In 2007 I presented keynote addresses at dam safety conferences held in Turkey and the Philippines. In Turkey my addresses were titled "Dam Safety Management Practices in New Zealand' and 'Dams and Earthquakes in New Zealand'. In the Philippines my addresses were "Key Principles of Dam Safety Management' and 'Key Practices in Dam Safety Management'.

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

Scope of Evidence

6. URS New Zealand Limited (URS) acting for Central Plains Water (CPW) engaged the company I work for, Damwatch Services Limited (Damwatch) to

undertake a peer review of the URS investigations and conceptual design for the proposed Waianiwaniwa Dam that forms part of the Central Plains Water Enhancement Scheme. As stated by URS, the essential question to be answered by the peer review was whether CPW can have confidence that it will be possible to build the dam to the high standards of safety indicated in the URS dam safety assurance report. I have undertaken the review.

The Proposed Dam

7. The proposed Waianiwaniwa dam site is at the mouth of the Waianiwaniwa valley where the Waianiwaniwa River emerges from the Malvern Hills. The dam would be a zoned earthfill embankment up to 55m high and with a crest length of about 2000 metres. An outlet conduit and spillway would be located on the left or eastern side of the valley. The reservoir is an off-river storage to which water would be conveyed through either a canal discharging into the reservoir or water pumped from a lower level canal.

8. The New Zealand Society of Large Dams (NZSOLD) Dam Safety Guidelines 2000 classify dams according to the potential impacts that would result in the event of dam failure. Where fatalities are likely in the event of dam failure, the dam is classified as having a 'High' potential impact category (PIC). The proposed Waianiwaniwa dam is expected to have a 'High' PIC.

Information Relied On

9. My peer review has been based on information supplied by URS, a site visit and a workshop with URS to discuss my preliminary findings. The initial information supplied by URS consisted of two reports: *Preliminary Geotechnical Report for the Proposed Waianiwaniwa Water Storage Dam*, URS, 18 June 2007 (the URS geotechnical report) and *Central Plains Water Enhancement Scheme Dam Safety Assurance Report*, URS, 30 March 2006 (the URS dam safety report) At the workshop I requested supplementary information in regard to flood hydrology, flood passage and spillway and conduit type and locations. This information was supplied.

10. The URS geotechnical and dam safety reports make it clear the geotechnical assessment of the dam site and the safety assessment of the dam are at the conceptual or pre-feasibility level. Pre-feasibility level studies are used to assess whether the project is viable or realistic. I concur with URS that the reports are at a conceptual or pre-feasibility level.

Peer Review Methodology

11. My peer review methodology centred around answering two questions. The first was *is an embankment dam viable at the site ?* The second question was *can the proposed design deliver a dam that will confidently satisfy public safety requirements ?* The first question primarily relates to the URS geotechnical report and the second question primarily relates to the URS dam safety report.

12. In answering both questions I considered the primary failure modes that are applicable to embankment dams. These are failure by overtopping, failure due to internal erosion or piping and, to a much lesser extent, breaching due to slope failure. Although failure due to earthquakes is very uncommon, I also gave this serious consideration due to the presence of active faults in the area.

Question 1. Is an embankment dam viable at the site?

13. Viability in the context of this question is about technical viability. This means that the geotechnical features of the site are sufficiently well understood so that a robust dam could be built by conventional means using well established methodologies and without resorting to extraordinary means or measures. It also means that areas of uncertainty or risk are identified so that they can be addressed in the subsequent feasibility and detailed design stages of the project and, that either these uncertainties are sufficiently unlikely that they are not expected to eventuate as the project develops or, that they can be readily accommodated by design changes.

14. In my opinion the investigations reported in the URS geotechnical report are a sufficient basis to conclude that an embankment dam is viable at the site. The foundation conditions are able to be treated by the conventional means of excavation, stripping unsuitable surficial materials and construction of a cut-off trench. There are suitable conditions on the eastern side of the valley to found the spillway and outlet conduit on rock.

15. The URS geotechnical report identifies several active faults that pass within 30 km of the dam site and a fault that crosses the upper reservoir that is inferred to be active. The controlling maximum earthquake source for the dam design is expected to be the Hororata Fault about 2.5 km from the dam. Well designed and constructed embankment dams on non-liquefiable foundations have an excellent performance record in strong earthquakes and

the defensive measures available to ensure this have been incorporated into the proposed dam design.

16. Further stages of investigation will be required to define the extent of potentially liquefiable materials present upstream of the dam footprint. In the event that these intrude into the footprint the dam axis can be shifted downstream to avoid them or the materials can be treated. While there is no evidence in the investigations to date to suggest that there is active faulting within the dam foundation, this will need to be confirmed in any future feasibility, design and construction phases.

17. Although the materials available for dam construction have not been evaluated in detail, it is clear from the general geology and the experience of similar materials in other New Zealand dam construction that there are suitable materials available for construction of an embankment dam in the area.

18. In my opinion an embankment dam as proposed is viable at the mouth of the Waianiwaniwa valley.

Question 2. Can the proposed design deliver a dam that will confidently satisfy public safety requirements?

19. The URS dam safety report provides a comprehensive evaluation of the safety of the proposed Waianiwaniwa dam in relation to the proposed design features of the dam, spillway and outlet conduit. While the concept level design in the report does not provide details of the design, the report makes it clear what measures would be incorporated into the design to reduce life safety risks to acceptably low levels. The report also discusses the maximum earthquake and flood loads that would be applicable to the dam under the NZSOLD Dam Safety Guidelines (2000).

20. The dam safety report also presents a quantitative assessment of the risk of dam failure. This considers the applicable failure modes, outlines the mitigation measures to be incorporated into the dam design and provides a quantitative assessment of both the likelihood and loss of life associated with these failure modes for the proposed dam design. As the NZSOLD Dam Safety Guidelines do not provide quantitative guidelines for the acceptability of risk, the report evaluates the results against the Australian Committee on Large Dams (ANCOLD) 2003 Guidelines on Risk Assessment and demonstrates that the proposed design reduces life safety risks to acceptably low levels against the ANCOLD guidelines.

21. The risk reduction measures proposed in the dam design are measures that are widely accepted as good industry practice and I consider them to be both appropriate and necessary. Although no details are given in relation to the spillway and outlet conduit, the intention is to found both structures on rock. There are suitable locations where this can occur. It is also intended to provide spillway and freeboard capacity to safely pass the probable maximum flood and for the dam to be stable under the various effects of the maximum design earthquake.

22. On the basis of the current understanding of the site, I consider that the proposed design can deliver a dam that will satisfy both the NZSOLD Dam Safety Guidelines and the public safety requirements of the ANCOLD 2003 tolerable risk guidelines for new dams. In the event that future investigations find that there is active faulting within the dam footprint, the public safety risks will need to be re-evaluated for this new condition and a potentially revised dam design.

CONCLUSIONS

23. My peer review methodology centred around answering the following two questions:

    (a) Is an embankment dam viable at the site?

    (b) Can the proposed design deliver a dam that will confidently satisfy public safety requirements?

24. The result of my peer review is summarised in the following two conclusions, the answers to my two questions.

    (a) In my opinion an embankment dam as proposed is viable at the mouth of the Waianiwaniwa valley.

    (b) On the basis of the current understanding of the site, I consider that the proposed design can deliver a dam that will satisfy both the NZSOLD Dam Safety Guidelines and the public safety requirements of the ANCOLD 2003 tolerable risk guidelines for new dams. In the event that future investigations find that there is active faulting within the dam footprint, the public safety risks will need to be re-evaluated for this new condition and a potentially revised dam design.

Murray Douglas Gillon