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

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EVIDENCE IN REPLY
CLIVE ANDERSON

BUDDLE FINDLAY
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Solicitor Acting: **Rachel Dunningham**
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Qualifications and experience

1. My full name is Clive Kenneth Anderson

2. My tertiary education qualifications comprise: New Zealand Certificate of Engineering (Civil), Bachelor of Engineering in Civil Engineering (Hons) from the University of Canterbury, Master of Soil Mechanics and Engineering Seismology (Distinction) from Imperial College from the University of London and Graduate Diploma of Management (Technology Management) from Deakin University, Melbourne. Additionally I am qualified as a Chartered Professional Engineer (CPEng) and as an International Professional Engineer. I have twenty six years post graduate experience in the field of Civil and Geotechnical Engineering in New Zealand, Australia, Singapore, Fiji and Indonesia. My work experience has encompassed land subdivision planning and design, landslide stabilisation projects, tunnels, highways, mining, structure foundations, and dam design. Work in these broad fields has often required the design of major earthworks calling on my specialist geotechnical engineering skills. I am a member of the New Zealand Geotechnical Society, New Zealand Society for Earthquake Engineering, and I am the current president of the New Zealand Minerals Industry Association.

3. 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

4. My evidence addresses the stability of the terrace race below the Waimakariri Gorge Bridge.

5. Central Plains Water (CPW) has applied to build a canal below its proposed Waimakariri Gorge Bridge intake, sidling along the face of the terrace on the true right bank of the river, for some 5 km from Riverview Farm to Redmonds Road. I understand that throughout the hearing the Commissioners and some submitters have questioned the stability of the terrace face and therefore the viability of the proposed canal. That has included drawing attention to reconstruction and tunnelling needed to maintain the Selwyn District Council stockwater race that follows closely the proposed CPW canal route.

6. The intake system will comprise an intake tunnel below the true right abutment of the Waimakariri Gorge Bridge leading into the canal heading downstream across flat ground before traversing along the gravel river terrace to emerge onto the plains near Redmonds Road. The canal gradient will be horizontal for part of this length.

7. Where the canal traverses the river terrace it will follow approximately the bench formed to support the Selwyn District Council stock water race. The topography of the terrace edge slope is that of steep ground with, in some locations, a cut bench that supports the existing stock water race and an access track. Grasses, trees and shrubs are growing on the bench and surrounding slopes.

Sources of Evidence

8. I have relied on the following sources of information in preparing my evidence:

8.1 A site walkover of a portion of the site on 22nd Aug 2008 to check on my expectations of the local topography and soil types.

8.2 A description of the site geology prepared by Mr Tim McMorran.

8.3 Examination of two typical cross-sections of the canal where it traverses the terrace edge slope.

8.4 Discussions with Mr Lewthwaite of URS NZ Ltd on the current design concept for the canal cross-section and past instability of a section of the stock water race.

8.5 I have not carried out any specific stability analyses at this stage. This could be readily carried out as part of the design process at the detailed design stage. As explained later in my evidence my observations of the site geotechnical conditions and the proposed canal design features inform me that it will be practicable technically to design the proposed canal so that it has an acceptably low probability of failure.[

My Observations

9. During my site visit I made the following observations:

9.1 I observed that the local geotechnical materials exposed in the river terrace comprised silty-sandy gravels typical of the materials underlying the Canterbury Plains in this area. It is reasonable to conclude that they will

form the materials that would be exposed in any cuts constructed for the canal.

9.2 The bench cut into the river terrace that supports the existing stock water race appears to have been excavated from the natural river terrace. It has produced a steep cut batter above the race and a more shallow sloping batter below the race. I did not measure the batter angles but I surmise from my observations that the cut batter is steeper than 1V:1H and that the lower batter is about 1V:1.5 - 2H.

9.3 In the area that I visited the steep cut slopes above the stock water race were free of any significant instability of the cut slopes. This is a key characteristic of the high river terraces that flank the Waimakariri River. The main source of erosion of these terraces is related to small scale shallow failures of the face where plant growth has been unable to become established. This erosion results in a build up of small amounts of talus debris at the base of the slope. The plant growth assists with stability of the cut face by providing some protection from the direct impacts of the erosive forces of wind and rain but does not provide significant stability improvements to the global or large scale stability of the whole slope

9.4 I observed a portion of the stock water race length below the cut bench that supports it. It was concealed by dense scrub so that I could not observe the slope batter directly. I assume that given the time the stock water race was constructed (late 1800s) the material that was cut from the slope above the bench was most likely disposed of by tipping it over the side onto the slope below. Consequently much of this slope may comprise loose cut to waste material. This could be confirmed through geotechnical investigations at the detailed design stage.

9.5 With respect to the cause of the reported stock water race instability Mr Lewthwaite reported to me the content of conversations he had with Mr Alan Stevens, former Engineer to the Malvern County Council, who has written a history of the stockwater race, and Mr Mark Bull who has lived on a nearby farm since the early 1960's. Their view apparently is that the old water race, installed in the late 1800s, was closed in the early 1900s primarily because of loss of water from the race. There were also difficulties keeping the intake tunnel at the Gorge Bridge clear of sediments, and there had been some instability in the terrace caused by seepage from the water race. There is also an opinion that the race was overtopped in several places due to the raceman not closing the intake when a large flood

passed down the Waimakariri River. I also understand from this conversation that since the race was reconstructed around 1960 there have been no significant maintenance problems on the terrace face and only minor repair work has been required.

10. Based on my discussions with Mr Lewthwaite I understand that the concept design proposed for the canal along the terrace face comprises the following:

    (a) A trapezoidal section about 6 m deep and about 35 m wide at the top. It will be constructed by cutting into the insitu gravel materials on the river terrace edge or by building a platform out from the terrace edge.

    (b) The canal invert slope will be on a flat gradient for most of the length of the terrace race so that the maximum water velocity will be about 0.5 m/s.

    (c) The canal will be lined around its perimeter by a lining material to minimise leakage loss from the canal. The liner will have an insitu permeability of about 1×10^{-7} m/s or less, which will be lower than the mass permeability of the underlying insitu material. The impact of this lining is to prevent the build up of piezometric pressures in the underlying slope that could lead to instability.

11. Discussion of Instability Potential

    (a) The terrace edge slopes were observed to be stable during the site visit despite recent heavy and persistent rain over the recent winter months (2008). Erosion of the steep cliff faces in the area I visited was minor. This indicates to me that the existing slopes along the proposed canal alignment have a high degree of natural stability provided by the effective strength of the terrace forming materials and their inherent good drainage properties.

    (b) Excessive leakage from the proposed intake canal has the potential to create slope instability if the piezometric pressures within the slope became too high and reduced the effective shear strength of the slope materials to a level that resulted in slope failure.

    (c) One effective measure to prevent excess leakage from the canal is to line it with a low permeability lining material such as compacted earthen materials. The proposed lining if designed and constructed to modern engineering standards should in my opinion prevent excessive piezometric pressures from occurring within the slope. This provides a

barrier to leakage flow that restricts the entry of water into the underlying insitu terrace materials.

(d) The leakage flows that do enter the gravels are readily conducted away by the naturally free draining (relative to the proposed lining material) terrace materials. In those areas where the terrace gravels are not as free draining as required e.g. where silty layers are present then a purpose built drainage layer can be placed between the liner and natural materials to provide the free drainage required. Geotechnical studies at the time of final design will show whether or not this is needed. This will prevent the build-up of high piezometric pressures within the downhill batter slope.

(e) Above the canal the cut slope would be constructed at an angle that can be supported by the natural insitu strength of the materials. As I observed during my site visit these batters may be capable of being adequately stable at a batter of 1V:1H or steeper. The design batter will be determined at the final design stage taking into account geotechnical, economic and material balance considerations.

12. My conclusion with respect to the ability to construct a stable intake canal is as follows:

12.1 I believe that it will be technically possible to design and construct a stable intake canal traversing the natural river terraces downstream of the proposed Waimakariri River intake at the Gorge Bridge which has an acceptably low probability of failure.

Clive Kenneth Anderson