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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BRIEF OF EVIDENCE OF STEPHEN GORDON CHILES

BUDDLEFINDLAY
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Qualifications and experience

1. My full name is Dr Stephen Gordon Chiles.

2. I am a Senior Acoustic Engineer with URS New Zealand. I hold a First Class Honours Bachelor of Engineering degree in Electroacoustics from the University of Salford, UK, and a higher degree of Doctor of Philosophy in Acoustics from the University of Bath. I am a Chartered Professional Engineer in New Zealand and a Chartered Engineer in the United Kingdom. I am a full member of the Institute of Acoustics, UK. I have worked in the field of acoustics since 1996. I have worked: as a consultant for the international firms Arup and WSP; as a consultant for the specialist acoustic firms Marshall Day Acoustics and Fleming & Barron; and as a Research Officer at the University of Bath.

3. I have been involved with a large number of environmental noise assessment projects in the United Kingdom, Ireland, Hong Kong, Fiji and New Zealand. I represent the New Zealand Acoustical Society on the Standards New Zealand committee currently responsible for revising the environmental noise standards NZS 6801 and NZS 6802.

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

Scope of evidence

5. On this occasion I have been engaged on behalf of Central Plains Water Limited ("CPW") to assess the potential noise and vibration effects resulting from construction and operation of the intakes, tunnel, dam, headrace, pump stations, distribution network and other structures associated with the Central Plains Water Enhancement Scheme ("the Scheme").

6. The Assessment of Environmental Effects ("AEE") report and many of the submitters have correctly identified that the key issue relating to noise is the construction of the scheme. As a large project with construction spanning several years, particular care will be required to minimise construction noise effects. On the other hand, most parts of the Scheme will be relatively quiet once operational. Noise control measures will be required for pump stations and I will describe in my evidence how this will be achieved using standard constructions.

7. A brief assessment of construction noise was included in the original AEE. In my opinion, that assessment correctly identified the key construction noise issues. The assessment also mentioned some generic noise mitigation and control measures. Selwyn District Council subsequently requested further information regarding potential noise and vibration effects. In response to that request a more detailed noise assessment report dated 24 October 2006 was prepared by Rachel Pirie of URS and Jeremy Phillips of Urbis. Rachel Pirie has since left URS and I have been appointed to review this work and present evidence.

8. My evidence is largely based on the October 2006 noise assessment report by Rachel Pirie and Jeremy Phillips. I have reviewed this report together with the relevant parts of the Proposed Selwyn District Plan. My evidence is also based on my own experience in the assessment and measurement of construction noise for other projects. Where I refer to noise data from the noise assessment report in my evidence, I have verified that it is consistent with data I have used for other projects.

9. For this project I conducted a site visit on Friday 21 June 2007 during which I inspected the sites of the intake structures, headrace, pump stations, tunnelling work site and dam, as far as they could each be observed from public roads. I also inspected sections of the Rangitata Diversion Race near Methven. At the time of this inspection there was water flowing in the main diversion race but not in the irrigation distribution network.

Noise criteria

10. The Proposed Selwyn District Plan contains noise limits which I consider are appropriate for the operational noise of the scheme. However, most people are tolerant of higher noise levels during temporary activities such as construction. It is common in other District Plans for construction noise to be excluded from the general noise limits and instead required to comply with the limits in New Zealand Standard 6803:1999 *"Acoustics – Construction Noise"*. This is a widely used and accepted Standard, and as far as I am aware it has been adopted for the vast majority of recent construction projects throughout New Zealand.

11. I consider that the Proposed Selwyn District Plan is deficient in that it does not specifically exclude construction noise from the general noise limits. I consider that the appropriate basis on which to assess construction noise effects is using New Zealand Standard 6803. I consider that the noise limits

in New Zealand Standard 6803 maintain a reasonable degree of residential amenity during the day. The night-time limits in the Standard result in noise levels inside bedrooms within the World Health Organisation guidelines for avoiding sleep disturbance. The night-time noise limits in the Standard are similar to those in the District Plan.

12. Noise limits in New Zealand Standard 6803 apply specifically to dwellings. However, it is noted in the Standard that they may also be used to provide protection for other noise sensitive activities. A specific issue I am aware of is that Windwhistle, Greendale, and Sheffield schools are near to parts of the proposed distribution network. I recommend that the construction noise limits should apply at the schools. Furthermore, although construction work at these locations will only be short-term and relatively small-scale, I recommend liaison with the schools to avoid construction work during any particularly sensitive times.

CONSTRUCTION NOISE

Management plan

13. Several submitters have questioned whether the AEE placed too much emphasis on management plans to control potential effects. In terms of construction noise I consider that it is best practice to use a management plan rather than to include prescriptive noise control measures as consent conditions.

14. In any project, the exact details of the construction methodology cannot be finalised prior to completion of the detailed design and appointment of a contractor. It is generally undesirable to enforce a specific construction methodology at the consent stage as it could prevent normal design development. Also, a particular contractor might subsequently offer more efficient methods of construction which could reduce potential effects. A recent example of this is the construction of Christchurch City Council's ocean outfall. During the initial consent process for that project it was envisaged that substantial excavation and piling through a residential area would be required, but ultimately a far quieter and less disruptive tunnelling method was adopted. During the consent process, I consider that it is important to assess potential construction noise effects from the most likely construction techniques. However, I consider that the most appropriate control is then to implement a construction noise management plan.

Dam construction

15. Construction of the dam is the most substantial part of this project. A wide range of noise sources are anticipated to be in this area over a prolonged period.

16. I understand that dwellings within the footprint of the dam and immediately adjacent will be vacated prior to any construction activity in the area.

17. The main construction staging area will be behind the location of the dam, within the inundation area. I recommend that this staging area should be set back from the dam, to be at least one kilometre from Homebush Road and screened from Coalgate Township by the existing ridgelines. On the basis of the data in the noise assessment report, operations in this staging area would comply with New Zealand Standard 6803 daytime and night-time noise limits within Coalgate.

18. The dam itself is closer to Coalgate and there are numerous dwellings within a few hundred metres of the toe of the dam. However, the dam is relatively long and other parts of the dam are more remote from dwellings. General construction work for the dam will comply with the daytime noise limit from New Zealand Standard 6803 at the nearest dwellings. Night-time works at parts of the dam close to Coalgate would not comply with the noise limits without significant mitigation measures. A buffer distance of approximately one kilometre would be required to enable typical night-time activity. This buffer distance is unachievable at the parts of the dam nearest to Coalgate. Therefore, if twenty-four hour working is essential then night construction equipment operating on these parts of the dam will need to be fitted with extensive noise attenuation devices such as additional exhaust mufflers and attenuated intake grilles. Reversing sirens would need to be disabled and replaced with non-audible warning devices. Where possible, all night operations would be conducted behind temporary local barriers to screen activity from the nearest dwellings. Even with these mitigation measures some equipment would not be able to operate at night and all night operations would have to be subject to strict management procedures.

19. Given the complexity in achieving the night-time noise limits I recommend that the construction noise management plan should contain specific provisions to ensure protection for the residents of Coalgate. In particular, I recommend that for the duration of the dam construction a noise monitoring station should be installed by the contractor between the dam and Coalgate

Township. The contractor should appoint an acoustic consultant to conduct a detailed analysis of noise prior to any proposed night-time operations, and then frequently check the noise monitoring data to verify that noise mitigation measures are working effectively.

20. Regular reports of all relevant data from the noise monitoring station should be provided to residents of Coalgate and to Selwyn District Council. Active dialogue should be maintained between the contractor and local residents. Local residents should be kept well informed of forthcoming construction activity. Should any issues arise, a formal complaints procedure should require the contractor to investigate all complaints within twenty-four hours. Any activity found to be causing an exceedance of the noise limits should be ceased immediately, and should not continue until appropriate noise mitigation is implemented.

21. The location of the noise monitoring station will require careful selection. This should minimise the contribution of road traffic and other existing noise sources, whilst also representing the exposure of houses to construction noise. I consider that the optimum location for the monitoring station cannot be determined until full details of the construction programme and methodology are known. I recommend that the location for the monitoring station be determined by the contractor's acoustic consultant in liaison with Selwyn District Council.

22. In summary, normal daytime dam construction and twenty-four hour activity at the staging area will comply with the noise limits from New Zealand Standard 6803. However, night-time dam construction will require significant noise mitigation measures. To ensure adequate noise mitigation is provided I recommend close community liaison and continuous noise monitoring during construction.

Tunnel construction

23. It is proposed that the tunnelling operation would be based beside Malvern Hills Road. There will be no intermediate access shafts to the tunnel and the construction would continue from this site to the Waimakariri portal. The tunnelling would be a continuous twenty-four hour operation. There are three houses near the junction of Waianiwaniwa Road and Malvern Hills Road which would be within one kilometre of the tunnel work site. These three houses are in the reservoir inundation area and therefore would ultimately be

vacated. One option to avoid tunnelling noise effects would be for these three houses to be vacated before tunnelling commences.

24. There are two dwellings relatively near to the Waimakariri tunnel portal. The dwelling at the bottom of the terrace is in the order of 500 metres from the portal and the dwelling at the top of the terrace is in the order of 300 to 400 metres from the portal. Given these separation distances and on the basis of the data in the noise assessment report, daytime construction work at the portal will comply with the noise limits from New Zealand Standard 6803. Night-time working at this location would only be possible if mitigation is provided.

Intake construction

25. From my site visit and from inspection of aerial photographs I am not aware of any dwellings within one kilometre of the intake structures. Furthermore, most of the nearest dwellings are partially screened from the sites by river terraces. On the basis of the data in the noise assessment report and with standard noise control measures, construction at the intake sites will comply with both the daytime and night-time noise limits from New Zealand Standard 6803.

Headrace construction

26. I understand that the headrace will be constructed in sections each in the order of a few kilometres in length. The headrace will be aligned so as to balance cut and fill and thereby minimise the amount of material required to be hauled. It is not envisaged that there will be any significant haulage between different sections of the headrace. The avoidance of significant haulage is a major factor that will minimise noise during the headrace construction.

27. Given the relatively short construction lengths of the headrace, and that the headrace corridor will not be used as a major haul road, I consider that the typical duration noise limits from New Zealand Standard 6803 are applicable. Furthermore, I understand that the headrace construction will only be conducted during daytime hours.

28. The noise assessment report suggests that at a distance of approximately 75 metres, the headrace construction activities will comply with the daytime noise limits. My own assessment from another similar construction project suggests that a more conservative 150 metres separation would be required.

From inspection of the headrace maps and aerial photographs, there appear to be only a limited number of dwellings that could be within 150 metres of the headrace. Once the final alignment is confirmed, if any houses are within 150 metres of the headrace, mitigation measures should be implemented as required to maintain compliance with the construction noise limits. In some instances this may simply be a case of minimising the time equipment is near a particular dwelling. This might be achieved by careful location of the temporary staging areas used for each section of the headrace. In other cases it may be possible to liaise with residents so that work can be conducted during times when the dwelling is unoccupied. If other mitigation is not practical then temporary noise barriers may be required. I recommend that the process of identifying houses and establishing the required mitigation should be detailed in the construction noise management plan.

29. There are three siphons and numerous bridges to be constructed along the headrace alignment. From my own assessment for another similar construction project, I consider that a buffer of approximately 250 metres is required from these construction sites to achieve compliance with the daytime noise limits. The siphon under the Selwyn River and several of the road bridges appear to have dwellings closer than 250 metres. In these cases, I recommend the same mitigation options that I have just detailed for dwellings near the headrace.

Distribution network construction

30. I understand that the distribution network will be constructed in a similar style to the main headrace, but it is of a smaller scale and will utilise smaller construction equipment. Again, construction of the distribution network would be limited to the daytime hours defined in New Zealand Standard 6803. In this instance I consider that the 75 metre buffer distance from dwellings, proposed in the noise assessment report, is appropriate to ensure noise limits are achieved. There are a significant number of dwellings likely to be within this buffer distance. The construction noise management plan should specify that all of these dwellings be identified and appropriate mitigation implemented. In some instances it might be demonstrated that due to the nature of construction at a certain location, the noise limits will be achieved at a shorter distance than 75 metres with no noise control measures required. At other locations where mitigation is required the options detailed for dwellings near the headrace are applicable.

OPERATIONAL NOISE

31. There will be up to five main pump stations associated with the scheme. As the pump stations could operate at any time, they should comply with the night-time noise limits from the District Plan. For all locations the controlling noise limit is 45 dBA L_{10} at the notional boundary of rural dwellings.

32. The District Plan noise limits are intended for permitted activities. In this particular rural area the noise of farm irrigation pumps is commonly encountered. Although such pumps are generally of a smaller scale to those proposed for this project, the essential noise character is the same. Therefore, I consider that water pump noise in compliance with the District Plan noise limits is something that could reasonably be expected within this area. I consider that if the pump stations comply with the night-time District Plan noise limits the noise effects will be no more than minor.

33. Four of the pump stations are a moderate size ranging from approximately 2 MW to 3.5 MW maximum pumping capacities. These pump stations are referred to as Upper Waimakariri, Lower Waimakariri, and Rakaia, which includes two stations. On the basis of an empirical formula for pump noise, I estimate the pumps required at these stations would have a sound pressure level of up to approximately 97 dBA at a distance of one metre from the pump. I have assumed that if there are no additional acoustic requirements, the pumps will be housed in a simple enclosure comprising corrugated steel walls and roof; as commonly observed for recent farm irrigation pump sheds throughout Canterbury. With such an enclosure I calculate that noise emissions would comply with the 45 dBA L_{10} noise limit within 150 metres of the pump stations. From my site visit and from inspection of aerial photographs, I understand that the indicative locations of these four moderate sized pump stations are at least 150 metres from the nearest dwellings. On this basis, no further noise mitigation would be required to comply with the District Plan noise limits. The same will apply to any smaller auxiliary pump stations.

34. My analysis of the pump stations is based on estimated pump noise data. When the detailed design of the pump stations is conducted the actual noise emissions of the selected pumps should be used to verify my calculations. As my calculations are conservative, it is unlikely that the pumps would have significantly higher noise emissions. If there is any adverse discrepancy or if the required 150 metres separation distance cannot be maintained, then the 45 dBA L_{10} noise limit will still be achieved, by improving the sound insulation

of the pump station enclosures. Generally, this would simply require a plywood, cement particle board, or similar lining to the inside of the walls and roofs. However, even if significantly greater attenuation were required a heavier construction such as concrete could be used to ensure compliance with the District Plan noise limits.

35. The main pump station associated with the scheme is the possible pump station near Coalgate. This pump station would be used to fill the reservoir from the headrace. This would be a significant pump station with up to approximately 13.8 MW pumping capacity. I understand that the pump station would probably be embedded into the front of the dam at the east end, beside the headrace. The nearest dwelling to this approximate location is in the order of 150 to 200 metres away on the south of Homebush Road. On the basis of estimated pump noise emissions, to achieve the 45 dBA L_{10} noise limit at this location will require enhanced pump station sound insulation. This will necessitate a heavy construction such as concrete or concrete block. The doors to the pump station will need to be acoustically rated. Any ventilation openings should be orientated away from neighbouring properties as far as practicable and fitted with appropriate attenuators or acoustic louvres. With these sound insulation measures the Coalgate pump station will comply with the District Plan noise limits.

36. Apart from the pump stations, most elements of the scheme will produce only limited if any noise emissions. However, some noise may be generated where there is turbulent water. I observed at the Rangitata Diversion Race that smooth water movement in the main race was essentially inaudible. Water movement at a siphon was just audible, but not disturbing and was at a noise level well below the District Plan noise limits. Weirs and drop structures were not in operation during my observation of the Rangitata Diversion Race.

37. To provide an indication of water noise level on a weir or drop structure, I conducted measurements at the Antigua Boat Shed weir on the River Avon in Christchurch following a day and night of heavy rainfall. Whilst this weir is different to the structures that would be used for this project, the noise generating mechanisms are the same. The noise level at 5 metres from the weir was 69 dBA L_{10}. This noise would reduce with distance and the level would be less than the District Plan night-time limit of 45 dBA L_{10} at 100 metres. Weirs and drop structures for the project are likely to benefit from at least partial screening by surrounding embankments. Even if the project structures generate slightly more water noise than the River Avon

weir, this should be compensated for by the partial screening. I understand that all weirs and drop structures for the project will be located at least 100 metres from the nearest dwellings. With this separation distance I predict that the water noise will comply with the District Plan noise limits.

38. There will be infrequent routine inspections and maintenance activity for most parts of the scheme. Generally, I am not aware of any significant noise sources associated with this activity. One possible exception is the dredging of the river channels by the intake structures. However, I do not consider that there will be any adverse noise effects, as this is an infrequent, short-duration activity, which I understand is at least one kilometre from any houses.

39. A small number of submitters have raised concerns about potential noise disturbance from recreational motor boats using the new reservoir. I understand that possible water sports envisaged at the reservoir include yachting, windsurfing and kayaking, all of which are relatively quiet. Any recreational use of the reservoir would first be subject to local community consultation. I consider that this will provide an appropriate mechanism to determine controls and restrictions required for motor boats.

VIBRATION

40. The District Plan makes reference to three standards for the assessment of vibration: Australian Standard 2187-2:1993 for blasting; New Zealand Standard 2631/1-3:1985-1989 for other vibration sources; and ISO 2631 for human exposure to vibration. New Zealand Standard 2631 has been withdrawn by Standards New Zealand. In addition to the standards referenced by the District Plan, German Standard DIN 4150-3:1999 forms the basis for most assessments of vibration affecting buildings.

41. With respect to construction vibration, I consider that the main issue is the prevention of building damage. The most stringent limit proposed by DIN 4150-3 and AS 2187-2 is a maximum peak particle velocity of 2 mm/s to protect historical, ancient buildings, ruins and monuments. The limit for standard dwellings is 5 mm/s.

42. I have considered four categories of activity using vibration data from previous assessments. For general earth moving equipment such as trucks and bulldozers the 2 mm/s vibration limit will be achieved beyond a relatively short distance of approximately 25 metres. For compaction equipment vibration levels will generally be within the 2 mm/s criterion beyond

approximately 100 metres. Based on these two activities, I therefore propose a conservative buffer of 150 m to achieve the vibration criteria for general construction. Vibration from piling and blasting can vary significantly and I recommend a buffer of 250 metres and 500 metres respectively to achieve the criteria.

43. Generally there are few houses within the vibration buffer distances. My assessment is based on the most delicate structures and it is unlikely that building damage would occur for a standard dwelling even if it was inside these buffer distances. Where any dwelling is within the buffer distances, I recommend that an independent pre- and post-construction structural check of the building should be undertaken. The checks should be signed off by the property owner. Structural 'tell-tales' should be installed on any cracks identified during the pre-construction check, and visual inspections should be undertaken at intervals of one month when construction activity is occurring within the buffer distance. The process of identifying dwellings within the buffer distances and conducting these checks should be incorporated into a combined construction noise and vibration management plan.

44. The pump stations are the only potential operational vibration sources. Control of vibration from pumps will be achieved with standard installation practices such as an appropriate mounting base, spring or rubber isolators, and flexible couplings to all pipes.

CONCLUSIONS

45. I consider that construction noise for this project should be assessed in accordance with New Zealand Standard 6803:1999 *"Acoustics – Construction Noise".* I have described noise mitigation measures that are likely to be required for each of the major elements of the project to comply with this Standard.

46. I consider that operational noise from the scheme should be designed to comply with the noise limits in the Proposed Selwyn District Plan. For pump stations this can be achieved through the design of the pump station enclosures, and for weirs and drop structures this can be achieved by maintaining an appropriate separation distance from nearby dwellings.

47. I have assessed vibration in terms of buffer distances around different types of construction activity. I recommend that any houses within these buffer distances should be subject to structural checks.

48. If consent were to be granted for this scheme, I recommend that conditions be imposed to ensure that construction and operational noise are controlled. I suggest that the following conditions would be appropriate:

- *All construction activity shall be conducted so that noise emissions do not exceed the noise limits in the following table. Sound levels shall be measured and assessed in accordance with the provisions of NZS 6803:1999 "Acoustics – Construction Noise". These limits shall apply at all occupied residential units and at Windwhistle, Greendale, and Sheffield schools. The consent holder shall liaise with each of the schools and avoid construction work during any particularly sensitive times.*

Time of week	*Time period*	*Duration of work*					
		Typical duration (dBA)		*Short-term duration (dBA)*		*Long-term duration (dBA)*	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekdays	*0630-0730*	*60*	*75*	*65*	*75*	*55*	*75*
	0730-1800	*75*	*90*	*80*	*95*	*70*	*85*
	1800-2000	*70*	*85*	*75*	*90*	*65*	*80*
	2000-0630	*45*	*75*	*45*	*75*	*45*	*75*
Saturdays	*0630-0730*	*45*	*75*	*45*	*75*	*45*	*75*
	0730-1800	*75*	*90*	*80*	*95*	*70*	*85*
	1800-2000	*45*	*75*	*45*	*75*	*45*	*75*
	2000-0630	*45*	*75*	*45*	*75*	*45*	*75*
Sundays and public holidays	*0630-0730*	*45*	*75*	*45*	*75*	*45*	*75*
	0730-1800	*55*	*85*	*55*	*85*	*55*	*85*
	1800-2000	*45*	*75*	*45*	*75*	*45*	*75*
	2000-0630	*45*	*75*	*45*	*75*	*45*	*75*

- *The consent holder shall prepare and adopt a Construction Noise and Vibration Management Plan. The consent holder shall appoint an appropriately qualified acoustic engineer to oversee this process. No construction activity shall commence until the Plan has been approved by Selwyn District Council. The Plan shall: include all applicable noise limits; define procedures for identifying dwellings within 150 metres of the headrace, 250 metres of bridges/siphons/piling, 75 metres of the distribution network, and 500 metres of any blasting; detail mitigation options that will be adopted as required to comply with the noise limits; detail procedures to be followed for monitoring of noise during construction works; detail procedures for conducting pre and post construction structural checks for building within the vibration buffer distances; and detail liaison and complaint procedures. The complaint procedure shall require investigation of complaints within*

twenty-four hours, and immediate cessation of any construction activity found to be breaching the noise limits.

- *During dam construction works the consent holder shall install and maintain a noise monitoring station between the dam and Coalgate Township. The station shall be configured to record the $L_{Aeq(1\ hour)}$ and L_{AFmax} values for every hour throughout the entire dam construction period. Results from the noise monitoring station shall be provided monthly to Selwyn District Council and residents of Coalgate. The location of the noise monitoring station shall be approved by Selwyn District Council prior to installation.*

- *All operational noise from the scheme shall comply with the following noise limits when measured in accordance with NZS 6801:1991 "Measurement of Sound" and assessed in accordance with NZS 6802:1991 "Assessment of Environmental Sound":*

  Within the notional boundary of any dwelling, rest home, hospital, or classroom in any educational facility, except where that dwelling, rest home, hospital or classroom is located within a Living Zone:

0730 to 2000 hrs	*60 dBA L_{10}*
2000 to 0730 hrs	*45 dBA L_{10}, 70 dBA L_{AFmax}*

  Within any site boundary in a Living Zone:

0730 to 2000 hrs	*55 dBA L_{10}*
2000 to 0730 hrs	*40 dBA L_{10}, 70 dBA L_{AFmax}*

49. In my evidence I have described how it is practical and realistic for the Scheme to comply with the relevant noise and vibration limits. With appropriate controls in place, such as those I have suggested as consent conditions, I consider that the construction and operational noise and vibration effects of the scheme will be no more than minor.

Dr Stephen Chiles