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

---

SUPPLEMENTARY EVIDENCE OF MARK CHARLES GRACE MABIN IN RESPONSE TO COMMISSIONERS' MINUTE No. 4

BUDDLE FINDLAY
Barristers and Solicitors
Christchurch

Solicitor Acting: **Rachel Dunningham**
Counsel: **Matt Casey Q C**
Tel 64-9-337 0400 Fax 64-9-357 0030 PO Box 317, Shortland Street, Auckland

1. My name is Mark Charles Grace Mabin and my qualifications and experience, and the basis on which I am preparing this brief are set out in my previous brief of evidence prepared for this hearing. I have prepared this supplementary brief of evidence to address questions raised by the Commissioners in their Minute Number 4.

Scope of Evidence

2. In my evidence I will address matters raised in the Commissioners' Minute:

   - Proposed versus existing and consented irrigation at their question number 16.
   - In addition, I will provide further information on the characteristics of the Waimakariri River braiding system at different flow rates

Proposed versus existing and consented irrigation

3. Question 16 of the Commissioners Minute requests clarification of data relating to the scheme area, land area currently irrigated within the scheme area, and land area proposed to be irrigated within the scheme area. This information may have ramifications for economic, groundwater, and nutrient assessments provided by CPWT witnesses.

4. CPWT are proposing to provide this information in two stages. Firstly data is presented below from available sources, mainly ECan databases. As will be apparent, the information contained in the databases does not directly answer the Commissioners questions. The available data must be interpreted in order to develop information that can be used to address the Commissioners' information requests. Different interpreters of the data are likely to give different answers for the questions.

5. In order to address this difficulty, CPWT proposes to undertake a survey of the Central Plains Scheme area in order to determine as nearly as possible how much land is currently being irrigated, from what water source, and whether by scheme or non-scheme shareholders. Other data may also be collected at the same time, including current and proposed land uses. Results of this data collection will constitute the Second Stage of information for the Commissioners and will be available prior to the end of the Hearing.

6. In the meantime, Stage One data is presented below. In the first instance I present the URS synthesis of the available data, and how this has been used

in evidence by various CPWT witnesses. Then I will address each of the eight bullet points at item 16 of the Commissioners' Minute.

7. The Scheme area can be readily determined from the URS GIS databases, and as shown in Mr Tipler's evidence in chief at Figure 1, but excluding a small area northwest of Halkett in the far eastern part of the scheme area near Christchurch that has been removed during the hearing process in order that the CWPT Scheme area does not overlap with the Christchurch Groundwater Recharge Area.

8. The total scheme area is 1,014,078,514 square meters. This may be converted and rounded to 101,408 ha.

9. This area includes all farmed land along with roads, railways, water courses, buildings, reserves, and other land areas that are not farmed and will thus not be directly affected by the Scheme. I have estimated the total area of these non-farming landuses by compiling data from the ECan's website GIS Mapping utility. This allows individual land parcels to be identified, and for each land parcel there is a *property category* coding (alpha codes), and a *land use* coding (numeric codes). ECan has supplied URS with a document that allows identification of the meaning of these alphanumeric codes (*Draft Ratings Valuations Rules Version 3.0, pp 50-51, and pp 60-66*). From these it has been possible to identify the following non-agricultural lands:

- Roads and rivers (These cannot be separated in the land parcel database, but the length of roads can be determined from the roads layer of the GIS, and assuming a 20 m road reserve width, the total area of roads can be estimated)
- Residential land uses
- Commercial land uses
- Industrial land uses
- Parks and reserves
- Utilities
- Transport and storage facilities

10. The total land area in the Scheme area that I was able to measure from the ECan web GIS was 95,966 ha, which is 5,442 ha less than the area derived from the URS GIS database. I consider this difference related to the level of

accuracy possible in determining the scheme boundary in the ECan web-based GIS environment. For this reason I consider that the URS GIS database measurement is likely to be more reliable. I have therefore calculated areas of the land use types based on the relative proportions of each in the ECan web GIS database and applied this to the 101,408 ha area measured from the URS GIS database. These land use areas are shown in Table 1.

Table 1: Present land use in CPWT Scheme area

LAND USE	AREA	% SCHEME AREA
Farming	86,543 ha	85.3 %
Roads	2,072 ha	2.0 %
Streams/rivers	7,218 ha	7.1 %
Commercial, industrial, transport, storage, utilities, parks and reserves	465 ha	0.5 %
Residential	442 ha	0.4 %
Other (railway, vacant, unclassified)	4,668 ha	4.6 %
TOTAL	101,406 ha	

11. The 86,543 ha is not all potentially irrigable as there will be buildings, lanes, trees, and other structures that should not be included. Mr Macfarlane in his evidence has estimated that this non-irrigable land would amount to 10,000 ha. Therefore I estimate that the potentially irrigable land area within the CPWT Scheme boundary is about 76,000 ha.

12. The question then arises, how much land is currently irrigated in the CPWT Scheme area? Mr Stephen Douglass of URS has provided an estimate of this. His methodology and calculations are provided in a memo that I have attached to my supplementary evidence.

13. From an examination of ECan consent records Mr Douglass estimates that a total of 38,188 ha is currently irrigated or is likely to be irrigated in the near future. The breakdown of groundwater and surface water, existing in proposed is shown in Table 2.

14. It can be seen that ~50 % of the potentially irrigable land is already irrigated in the Scheme area.

15. The total area under irrigation estimated by Mr Douglass may be compared to the previous 30,000 ha estimated as at June 2006 that was used in evidence by CPWT witnesses. The 8,188 ha difference may be assumed to be due in part to a real increase in the area irrigated between June 2006 and

June 2008, and bearing in mind that some 1,685 ha of this increase is actually still being decided through the resource consent application process.

16. It may also be due in part to limitations in the ECan consents database as described in Mr Douglass's memo. These limitations will be addressed by CPWT as noted in Paragraph 5 above. In particular, the database does not recognise the performance of wells. Anecdotal evidence indicates that at least some wells cannot deliver the volume of water indicated in the database, and hence the area indicated in Mr Douglass's memo is likely to be an overestimate.

Table 2: Present and likely future irrigation in CPWT Scheme area

LAND USE	AREA	% FARMING AREA
Farming	86,543 ha	
Non-irrigable land in farming area (lanes, trees, buildings, water races etc)	10,000 ha	11.6 %
Irrigable land in Scheme area	76,543 ha	88.4 %
		% IRRIGABLE AREA
Area currently irrigated from groundwater	32,938 ha	43.0 %
Area currently irrigated from surface water	3,565 ha	4.7 %
Total area currently irrigated	36,503 ha	47.7 %
Area likely to be irrigated in the near future (16 % from surface water, 84 % from groundwater)	1,685 ha	2.2 %
Total area currently and likely to be irrigated in Scheme area	38,188 ha	49.9 %
Area associated with the Selwyn-Waimakariri GW Hearing	1,161 ha	

17. Mr Douglass has also been able to estimate the area of land currently irrigated by CPW shareholders. Some 151 groundwater and 8 surface water consents are owned by CPW shareholders. Thus, some 45 % of groundwater consents are owned by CPW shareholders.

18. These consent holders irrigate an estimated 22,898 ha from groundwater and 2,420 ha from surface water, for a total of 25,318 ha. These data are shown in Table 3.

Table 3: Land areas currently irrigated by CPW shareholders

Total Scheme area associated with CPW shareholders	65,574 ha	
Area currently irrigated from groundwater by CPW shareholders	22,898 ha	
Area currently irrigated from surface water by CPW shareholders	2,420 ha	
Total Scheme area irrigated by CPW shareholders	25,318 ha	38.6 % of CPW shareholders' land is irrigated

19. It will be recalled that CPWT witnesses assessing economic, groundwater, and nutrient effects have assumed that if the Scheme goes ahead, the total area of land irrigated will be 75,000 ha, comprising 60,000 ha of shareholders' land irrigated from surface water, and 15,000 ha of non-CPW shareholders' land irrigated from groundwater. The 75,000 ha of irrigated land has been assumed to represent an increase of 45,000 ha over the currently irrigated land area.

20. It can be seen from Table 2 that there is estimated to be 76,000 ha of irrigable land within the Scheme area, thus the proposed 75,000 ha of irrigation can be accommodated.

21. The assumed increase in irrigated land of 45,000 ha added to the existing 38,188 ha of currently irrigated land would bring the total irrigated area to 83,188 ha. This is 6,645 ha more than the land area estimated to be available. The discrepancy is likely to be related to the increased irrigated land area that has occurred since the estimates were originally compiled in 2006. However, it is also important to realise that the estimate of 38,188 ha of currently irrigated land is an interim figure and this is likely to be an overestimate.

Commissioners' Requests for Further Information

22. The following provides answers to the Commissioners' questions raised at item 16 in their Minute #4. I have provided the original text of their questions, and answers that are available at present. It should be borne in mind that CPWT is proposing to obtain more detailed information in the near future. Some of the information present here may therefore be subject to change.

23. *Question 16, bullet point 1.* Clarification of the relative land areas in existing and consented irrigation within the scheme area, versus the areas and volumes proposed to be irrigated by CPWT and in particular the overlap

between the two (a map showing existing and consented irrigated land within the CPWT command area would be of assistance).

23.1 Tables 2 and 3 above allow an understanding of the current state of knowledge of irrigated and potentially irrigated land in the Scheme area. About 50 % of the irrigable land area is currently irrigated, and this would rise to ~100 % if the Scheme goes ahead.

24. *Question 16, bullet point 2.* How much land would be irrigated by CP if it proceeds, which is not currently irrigated and which will not be irrigated in the reasonably foreseeable future?

24.1 CPWT has assumed that 45,000 ha of currently non-irrigated land would be irrigated after the scheme. If the scheme does not proceed it is unlikely there would be significant increase in the area currently irrigated from groundwater beyond the 1,685 ha identified in Table 2. ECan has listed the whole Central Plains area as being in a Red Zone for groundwater allocation purposes. This means ECan considers the groundwater resource is already fully allocated.

25. How much land would be irrigated which is already irrigated?

25.1 CWPT has assumed that all land currently irrigated would continue to be irrigated under the scheme. Therefore, from Table 2 it can be seen that 38,188 ha of land that is already irrigated will continue to be irrigated if the Scheme goes ahead.

26. In estimating economic benefits, ground water mounding effects and nutrient effects what assumptions have been made regarding the replacement of existing consented groundwater takes?

26.1 CWPT witnesses in the areas of economic effects, groundwater effects, and nutrient effects have assumed that there will be a total of 75,000 ha of irrigated land in the CPWT command area, comprising 60,000 ha of CPWT shareholders irrigating surface water, and 15,000 ha of non-CPWT farmers irrigating groundwater. Therefore, CPWT was expecting the present groundwater-derived irrigation area to be halved. The effects of this on economic returns will be able to be addressed by Mr Macfarlane and Mr Donnelly later in the hearing.

27. For example, in estimating economic benefits have the recent groundwater consents for Rakaia Selwyn, been discounted in terms of increased production?

27.1 Mr Macfarlane advises that his economic analysis was undertaken before the Rakaia Selwyn groundwater consents had been decided. Therefore the economic benefits arising from increased production in this area have not been discounted in the CPWT economic analysis. It is expected that half of the land that will be irrigated as a result of these consents will convert to surface water under the CPWT scheme.

28. If those consents and the proposed areas covered by the Waimakariri/Selwyn consent applications are included as irrigated land, how much unirrigated production land remains in the command area?

28.1 38,355 ha (calculated from the total irrigable area minus the total area irrigated)

29. What area of land within the command area, will be irrigated by the Synlait Rakaia takes if those retain priority?

29.1 The Synlait consent is to take 6 m^3/s. Assuming this will be used to irrigate at 0.5L/s/ha, the total irrigation area would be 12,000 ha.

30. Should the land to be irrigated by Ngai Tahu Properties Ltd, be taken into account in the economic analysis? (Production from Waimakariri River water displaced by CPWT if it proceeds).

30.1 This irrigation area has not been taken into account in the economic analysis.

Characteristics of the Waimakariri River braid system

31. In oral questioning of various witnesses, the Commissioners have sought information on the characteristics of river braids at different flow levels in the Waimakariri River and how the braids may change as discharge drops to low flows.

32. To illustrate these issues I have selected a 2 km reach of the Waimakariri River at Crossbank, which is 5.5 km northwest of Christchurch International Airport. I have chosen this reach because it is reasonably well known from studies carried out over many years by NIWA and other international earth scientists interested in braided gravel river sediment transport processes. Also of relevance for selecting this reach is there was a time lapse video camera mounted on a power pylon here and this has provided a useful series of images looking downstream as will be discussed below.

33. In Figure 1, I have compiled a series of six vertical aerial photographs of part of the Crossbank reach. These were obtained from New Zealand Aerial Mapping Ltd, and represent all of the available imagery from that company covering the 1967 – 2001 period used for flow modelling by CPWT.

34. The images show the braided river patterns at a variety of flows from 250 m^3/s to 37 m^3/s. The 1975 (228 m^3/s) and 1994 (250 m^3/s)images show flows a little less than the FRE3 "fresh" flow (284 m^3/s); the 1979 (89 m^3/s), 1984 (75 m^3/s), and 2000 (95 m^3/s) images show flows at or somewhat below the median flow (96 m^3/s); while the 2001 (37 m^3/s) image shows a flow condition a little below the mean annual 7-day low flow (40 m^3/s).

35. I have measured various characteristics of the visible braids on 3 x enlargements of these images at 5 regularly spaced transects across the fairway. Each of the five transects was located in the same position on the successive photographs. I measured the width of each braid and calculated characteristics of the braids as shown in Table 4.

Table 4: Characteristics of Waimakariri River braids at Crossbank

Year	Flow (m^3/s)	# braids	Mean braid width (m)	% wet fairway	# 800 m^3/s floods in previous 5 years
1975	228	11.6	40	43.0%	8
1979	89	10.8	26	28.5%	4
1984	75	12.6	25	29.4%	6
1994	250	6.6	59	36.3%	6
2000	95	6.2	29	19.7%	7
2001	37	5.0	25	13.8%	5
	800			100.0%	

36. There are systematic variations with the different flow levels. With higher flows the braids are wider and they cover a greater proportion of the fairway. Hicks (*et al* 2001) report that the fairway here is fully covered with water at a flow of 800 m^3/s, which is a little less than the mean annual flood (1,016 m^3/s)

37. On Figure 1, I have depicted a scatter plot of the relationship between flow and proportion of fairway inundated. This shows a consistent relationship such that as flow drops by 10 m^3/sec, the wetted proportion of the fairway drops by 1.1 %. The number of braids is also likely to drop, although the relationship is not as regular. However, it can be seen that for the 2000 and 2001 images when the flow declined from 95 m^3/s to 37 m^3/s the number of braids dropped by about one.

38. Also shown on Figure 1 is the mean daily flow series for the 1967 – 2001 periods, with a line marking the 800 m^3/s flow level. Flows above this are likely to re-organise the arrangement of braids across the whole fairway, and it can be seen that they occur on average about once per year (34 floods in 35 years).

39. The two colour images from 2000 and 2001 were taken only 3 months apart. A 387 m^3/s flood event had occurred between these two dates, and it can be seen that most of the small braids had changed positions, and a 1 km length of a main braid had also been significantly re-arranged. I interpret this to suggest that braid patterns can change significantly with flows of around 500 m^3/s. From the je Joux Waimakariri flow series I calculate that these floods occur on average 3.5 times per year, and thus the braid patterns in the Waimakariri are likely to persist for only about three to four months.

40. On Figure 2, I show oblique aerial photographs of part of the Waimakariri River taken within about one minute of each other from a helicopter on 30th May 2007. The mean daily discharge on that day was 64 m^3/s. In the foreground of image # 2 lobes of gravel can be seen spreading out onto the inter-braid bars. This shows the typical sheet-like pattern of movement that the gravel takes as it is moved downstream in pulse-like waves.

41. I have also attached to my supplementary evidence a CD containing files provided by Dr Burrell of Golder Associates. There are three files as follows.

41.1 A PowerPoint presentation that shows 2-D plots of depth vs flow at the Crossbank site.

41.2 A video taken from a web cam NIWA had installed at the Crossbank site. The video features an animated series of daily photographs of the river from 1 April to 2 May 2000. The time series includes mean daily river flows ranging from 58 m^3/s to >600 m^3/s, including two high flow events (686 m^3/s and 321 m^3/s), and their flow recessions to discharges below 100 m^3/s.

41.3 An EXCEL spreadsheet showing the mean daily discharges for the 1 April – 2 May 2000 period.

42. The Powerpoint slides show a braid modelling exercise with flows at 20 m3/s, 40 m3/s, 60 m3/s, 80 m3/s, and 100 m3/s. The original work was carried out by NIWA scientists.

43. The video shows the same section of the Waimakariri River (looking downstream) as I have depicted in the right side of Figure 1. The sequence of images clearly shows river width, braiding intensity and water clarity changing with the various flow levels. I also draw your attention to the following.

43.1 There is a ~700 m^3/s flood on 7th April, and the fairway is almost entirely covered with turbid river water. This is consistent with the expectation that the fairway is 100 % covered at a flow of 800 m^3/s.

43.2 Observing the braid patterns before and after this event, it can be seen that this flood caused a significant re-organisation of the fairway.

44. The flood on the 20-21st April reached ~ 300 m^3/s. Note the large lobe of gravel that appears in the left foreground of the image as the flood water level declines. This shows that bedload transport had occurred during this event, consistent with the information I presented in my evidence in chief that in the Waimakariri River bedload transport movement is likely to be occurring by the time flow reaches about 280 m^3/s.

M.C.G. Mabin
4th July 2008