IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of applications for resource consent by the Central Plains Water Trust and a notice of requirement for the designation of land by Central Plains Water Limited associated with the construction and operation of the Central Plains Water Scheme

STATEMENT OF EVIDENCE OF COLIN DOUGLAS MEURK ON BEHALF OF THE ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND

INTRODUCTION

1. My name is Colin Douglas Meurk. I am currently a senior scientist at Landcare Research, and was formerly ecological adviser to the Christchurch City Council, and agronomist with Grasslands Division of DSIR, as well as lecturing at Lincoln and Canterbury universities. I have held these positions over a period of 22 years. I have Bachelor of Science (Honours) (Canterbury) and Doctor of Philosophy (Otago) degrees in botanical ecology.

2. I have extensive experience in restoration, land management and conservation ecology in environments throughout New Zealand, Australia, Asia, North America and Europe. Locally I have designed and/or overseen the implementation of major restoration projects, including at Otukaikino, Travis Wetland, the 1990s projects in Christchurch, the Waterway Enhancement Programme (Christchurch), Quail Island, the Queenstown Basin, many school and private projects, and various runanga projects. I have worked closely with iwi throughout the country.

3. I have 15 years' practical experience in preparing restoration plans, overseeing their implementation, and conducting field trials in many locations around Canterbury. I have been a member of the North Canterbury Land Settlement Committee, the North Canterbury Catchment Board and North Canterbury Conservation Board, and have received several national and local awards for work in community-based restoration.

4. I wrote the booklets on native plant restoration referred to by Clare Mulcock in her evidence. (Environment Canterbury and Isaac Centre for Nature Conservation 2005)

5. I surveyed forest and scrub remnants in the Woodstock–Kowai Bush area in the early 1990s, working with Professor David Norton, and then again, in the wider context of the Canterbury Plains Protected Natural Areas Survey, which was conducted during the 1990s. Although this is unpublished, the database has been available to DOC, and local authorities in Canterbury for use when compiling district plans.

6. I wrote the chapter on vegetation of the Canterbury Plains for the *Natural History of Canterbury* (editors Prof. Knox, E Pawson, C Burrows, et al.), which was launched on 29 May 2008. Most recently I have been an expert advisor on Environment Canterbury's Biodiversity Strategy Advisory Panel.

7. In preparing this evidence I have paid special attention to the reports of Craig Bishop, David Norton, Jon Harding et al. (2007), Mark Davis, Philip Grove, Di Lucas, Christopher Glasson, Andrew Craig, and Claire Mulcock. I have consulted DOC and examined personal records and databases from visits to the area of the scheme over the past 23 years. I specifically visited parts of the scheme area during April and May of 2008.

8. I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses. This evidence is within my area of expertise, except where I state that I am relying on facts or information provided by another person. I have not omitted to

consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

9. I have been engaged by the New Zealand Royal Forest and Bird Protection Society to describe and consider the effects of the Central Plains Water (CPW) proposed scheme on terrestrial indigenous habitat and species.

10. My evidence looks at the vegetation, habitats and plant species (terrestrial ecosystems) that are in or adjacent to the CPW scheme footprint. This includes the route of the feeder canals from the Waimakariri and Rakaia rivers to the holding lake in the Waianiwaniwa Valley system, the lake or reservoir itself, with a depth range from about 235 to 280 metres, and the area that will be in the zone irrigated from the reservoir.

11. I shall consider the significance of the sites in a regional context, the likely impact on these from the CPW scheme, and measures planned or designed to avoid, mitigate or remedy these effects. I shall consider each part of the footprint in turn, using common names for plant taxa (see Appendix 1 for scientific names of native species).

HABITATS, VEGETATION AND PLANT SPECIES IN THE CPW SCHEME FOOTPRINT

12. The precise route and associated construction zone of the canals, dams and lakes have not been defined so it is not possible to be absolutely certain of the impacts or the vegetation that will be affected by the scheme. Use is made of the Canterbury Plains Natural Areas Survey Report (CPNAS) by Meurk, Stephens and Cutler. Although this has not been published, the database of sites and values has been available to DOC and local authorities for the past 15 years and accordingly has been used for district plans.

Upper Waimakariri intake

13. The Waimakariri River intake begins in a current channel of the river and runs along the edge of the true right bank of the river. In the riverbed itself there are distinctive communities of indigenous herbaceous plants together with increasing numbers of invasive exotic species, with tree lupin being the most conspicuous at this time. These species are ephemeral and are adapted to the normal disturbances of braided riverbeds, and they form zonation patterns according to the age of the surface or time since the most recent flood (Meurk & Williams 1989). None of these species or associations appears to be specifically in the path of the intake canal, although the canal will restrict the potential area of riverbed available for vegetation.

14. This evidence does not address the effects of water take on the hydrology of the braided river system, or on endemic nesting birds.

15. It is not clear whether there will be any intrusion onto the river bank itself, or the terrace riser above. However, any such intrusion would affect highly significant vegetation on these surfaces – notably, podocarp–beech forest remnants and associated shrublands. These were designated with the highest significance in the CPNAS (Meurk et al. 1996, unpublished).

Traverse to the sediment trap, and tunnel to the proposed lake

16. From the riverbed, the proposed canal continues downstream and up onto a floodplain where a sediment-trapping pond will be established. The floodplain is dominated by introduced species: Scotch broom, gorse, scattered poplars, willow, lupins, and pine. Of indigenous species, there are some individual mature cabbage trees and patches of toetoe and pohuehue. Again, current information about the precise trajectory does not allow comment on which, if any, of the cabbage trees are in the path of the canal or pond.

17. The tunnel beneath and into the south bank of the Kowai river mouth appears to bypass two significant sites of beech forest on steep banks, but may skirt or truncate a wetland of cabbage trees, NZ flax, sedges and ferns (swamp kiokio). This also has an ‘A’ ranking.

Lower Waimakariri intake

18. The main issue here is the tunnel opening and construction into rock below Gorge Hill. There are mixes of prostrate kowhai, korokio, mikimiki, vines and other native shrubs, grasses and small trees in this vicinity. It is unclear if construction of the tunnel entrance will involve removal of overburden on the slopes and cliffs above this point. If so, then associations of native shrubs as listed above will be lost, and will be very difficult to re-establish in shallow, rocky soils.

Traverse of terrace scarp and across the Upper Plains to the dam

19. The traverse of the high terrace scarp or riser is potentially the most damaging part of this section because the earthworks required to achieve an inset into the embankment for the canal will require removal of substantial parts of the scarp face above the entire (several kilometres) length of the canal. A similar length of scarp beneath the canal would be buried in overburden removed from above and settling on the lower slopes. With this will be lost all associated vegetation. The CPNAS identified significant and potentially significant sites along this scarp. It should be noted that the CPNAS was a rapid inventory and reconnaissance that identified broad locations where native vegetation was observed or inferred.

20. There are pockets of native vegetation and some regionally uncommon species (such as kowhai, kanuka, porcupine shrub, mikimiki, prostrate kowhai, mingimingi and grasses) scattered all along these scarps. This is because it is one of the few parts of the landscape that escaped fire, cultivation, browsing and river disturbance. As such they provide discontinuous corridors of native vegetation and habitat for fruit- and nectar-feeding wildlife. Kingfishers are known to nest on these steep cliffs.

21. The densest area of native vegetation is in the “Westwood-Syphon” gully and Bleak House Corner where the canal leaves the scarp and begins its traverse of the plains. It is unclear exactly what earthworks and alignment will be followed here, and therefore what effects there will be on this vegetation.

22. The only significant vegetation sites on the plains before the canals reach the foothills near the proposed dam site are water races. In the reservoir area and possibly in the water races are riparian habitats that are known to harbour mudfish. There are other sites that may be affected by indirect (irrigation) effects.

Proposed lake area

23. There are a number of sites enumerated in reports and from my own investigations that rate from important to significant. These include the following:

24. **The valley below and to the north of Jimmy's Knob – Northeast Malvern Hills Road.** The valley floor and side gullies are dominated by crack willow and other deciduous introduced trees and shrub weeds. The only native canopy plant is pohuehue and cabbage tree. Wet to moist unimproved or weedy pasture grassland is found in clearings and there are associated native rushes. Under the trees and on banks are a number of heavily browsed native ferns – kiokio, kiwakiwa, chain fern, prickly shield fern, and spleenwort. Mikimiki is rare. All sites below the 280-metres-high level of the proposed lake would be extinguished although some are right on the shore line. Those further up the valley and in side gullies would be spared, so long as there was future protection from stock grazing.

25. **Flaxland in the valley west of Jimmy's Knob**. About one hectare of semi-continuous NZ flaxland, which has associated native rushes and sedges, and silver tussock and cabbage trees up the slope. The valley-floor flaxland would be inundated by the upper holding level of the lake. If it was only at this level for short periods of time – say a week – the flax may well survive. There are obvious signs of extensive soil creep and slumping on the adjacent slopes, and this may pose a problem for any lake forming at the foot of these slopes, with the potential for accelerated slumping. Ian Lynn (Landcare Research geomorphologist; personal communication) informs me that any saturation of lower hill slopes with a new water body at their foot may destabilise and mobilise the superficial layers. This, and the risk of earthquakes, was the reason for major grooming of the slopes above the Clyde High Dam.

26. **Shrublands at north-west end of Cairn Ridge**. On the hills to the west of the junction of Waianiwaniwa Road and Malvern Hills Road is a scattering of native small trees and shrubs that are typical of drylands: kowhai, cabbage tree, porcupine shrub, silver tussock, matagouri and probably other species. The toe slope, adjacent to the road, where some of these shrubs occur would be affected by the proposed lake. In places the road is below 280 metres (the maximum stand height of the proposed lake), so any slope near road level will be inundated or destabilised.

27. **Fernlands with shrubs along Malvern Hills Road** (east Cairn Ridge). Along the road embankment are rich communities of native ferns such as bracken, kiokio, prickly shield fern, paesia, spleenwort and pigfern, and the shrubs bidibid, koromiko and *Coprosma rigida*, the latter being a less common species. This is below the Coalgate plantation and it is believed that there is a considerable amount of native vegetation associated with the pine trees.

28. **Wetlands in Coalgate Forest.** A 2006 report from the Selwyn Plantation Board (authored by Professor David Norton) and associated evidence suggests that at least three wetlands within the Board's land will be inundated. These are in Bush Gully, "Tara Stream" and Oyster Gully. The area that would be lost under the proposed lake would be at least seven hectares. These wetland areas are dominated by NZ flax, tussock sedges, toetoe, swamp kiokio, dwarf kiokio, cabbage tree, koromiko and mikimiki. This would only be a partial list. They do have some shrub weeds and exotic grasses in them. Of equal or greater importance is the more than two kilometres of stream habitat that is inhabited by Canterbury mudfish.

29. The KMTE AEE report therefore incorrectly states that "indigenous habitats are all but absent". These are significant wetlands in the Whitecliffs Ecological District.

30. *Olearia rani* has been reported from this catchment, but is unlikely. However, the presence of some other olearia shrub that may have led to this erroneous record would be important.

31. **Raised bog in Bush Gully**. Through the kind auspices of Mr Nelson North, I was able to briefly visit a wetland on his property, just downstream of the border between the Coalgate Plantation land and Mr North's property in Bush Gully. This is an area of one to two hectares on the true-left side of the stream, with water apparently seeping down from the valley hill slope above. This is a rare example in lowland Canterbury of a raised, quaking peat bog. Its presumably lower fertility conditions are apparent in the predominant short vegetation of the localised *Carex tenuiculmis*, bog spike sedge, dwarf kiokio, *Viola cunninghamii*, *Gonocarpus aggregatus*, bog rush/sedge, *Nertera depressa*, *Baumea rubiginosa*, *Triglochin striatum*, *Celmisia graminifolia* agg., NZ bedstraw, manuka and mikimiki. At an elevation of 265 metres, this highly significant wetland would be lost to the proposed lake. This type of wetland cannot with currently known technology be translocated to another site without destroying its unique characteristics.

32. **Mudfish sites.** The report by Harding et al. (2007) demonstrates that all the sampled streams in the proposed lake footprint contain or probably contain Canterbury mudfish. This fish species is classified as Acutely Threatened and Nationally Endangered and this (Waianiwaniwa) river catchment represents the largest known Canterbury mudfish habitat and is substantially larger than any other documented mudfish habitats. A rare combination of conditions makes the Waianiwaniwa River a unique ecosystem and creates an important"whole catchment" refuge for the conservation of this nationally threatened species. It is now difficult to find such unique combinations of characteristics – water quality, flow regime, food, and freedom from predation – so it would be very risky to interfere with this existing balance and endeavour to reinstate the populations elsewhere.

Rakaia intake sites

33. From the PNA rapid inventory, and from aerial photographs provided in the evidence of Glasson and Lucas, it appears that there will be minor disruption to the already disturbed riverbed. It does not look as though there will be any effect on the"Curiosity Shop" vegetation.

There are indicative records of cabbage tree, kowhai, broadleaf, kohuhu, matagouri, pohuehue, mikimiki (possibly *Coprosma ciliata*) and bog rush along the river flats and terrace risers. There are also riverbed species such as mat pohuehue and scabweeds on the riverbed gravels, and possibly other less common and threatened species such as *Luzula celata*. Without a definitive line of the canal/intake route, it is not possible to determine exact effects on these valuable and diminishing species, which provide nectar and fruits to native bush birds such as bellbird and kereru.

Traverse of the terrace scarp

34. As the canal ”climbs” up the terrace wall to the vicinity of Steele’s Road, much of the scarp face will be removed because of cutting above, and filling below, the line of the canal. This will have the effect of removing all vegetation, including indigenous remnants; some woody species will be in excess of a century old. Given that most of the native vegetation of the Upper Plains is now confined to these scarps (and to water races), the removal of these last plains remnants must be taken seriously.

Across the Upper Plains

35. There is almost no remaining native vegetation left on any arable land on the plains. The only native plants will be the occasional cabbage tree on fence lines, those planted around homesteads, some native shrubs and tussocks on road verges (although most of these have been planed off during road tidying in the 1990s) and the water races, which retain some of the last wetland plants on the plains. The effects on water races and any surviving shrubs on road verges are the most serious. I will discuss water races in the next section. Any remaining native shrubs and tussocks on roadsides should be protected, fenced and enhanced by planting with further locally sourced material – to rebuild the critical mass of these diminutive populations.

Upper and Lower Plains indirect effects

36. Apart from the direct effects of the CPW scheme of earthworks, canals, dams and reservoirs, there are the consequences of the main purpose of the scheme – which is to irrigate large areas of the dry plains.

37. I understand this will turn any remaining dryland plant communities into permanently moist pasture (or crops), will locally raise the water table, will result in some streams running more reliably, and will lead to stronger groundwater flow into Te Waihora (Lake Ellesmere).

38. It is not clear how water races will be affected because the CPW scheme proposal does not explicitly indicate whether these will continue. No provision appears to be made for canals crossing or being crossed by water races.

39. However, it should be noted that the Selwyn District Council has been debating their decommissioning.

40. Dry plains grasslands once occupied at least one-tenth of the entire Canterbury Plains and inter-montane basins but are now one of the rarest plant communities in the country. There are several substantial areas of these on the fringes of the scheme, especially in the east of the scheme area and along the scarps or risers of the Rakaia and Waimakariri rivers, and on some dry floodplains.

41. Experience at Bankside Reserve, Eyrewell and McLeans Island has shown that irrigation close to even protected remnants causes more competitive exotic grasses to invade and take over the local indigenous species; in essence adjacent irrigation is not compatible with dryland nature conservation.

42. It has been suggested that extra water will benefit natural values, but this is only from the perspective of improving already common often eutrophic aquatic habitats favouring exotic plants and wildlife (for instance, mallards and trout) at the expense of rare native plant and animal communities.

43. I can only speculate about potential effects on Te Waihora, and these have been dealt with in other evidence. It is a complex

environment of many habitats ranging from salt marsh to dense raupo swamps, and the fourth largest lake in the country. I have not seen details of the hydrological modelling nor how they may apply to the range of environments around the shoreline and in relation to spatial variables. The dynamic equilibrium of these various communities may however be altered, with some habitats expanding in places while contracting in others, while complementary (or opposite) changes in other associated vegetation occurs.

ANALYSIS

44. Here I will describe the overall significance of terrestrial vegetation and habitat in the CPW scheme area , provide a summary of overall effects, and discuss both disputed and supported matters raised by other experts.

Significance of vegetation on a wider regional scale

45. The significance of vegetation remnants must be considered in the context of the Canterbury Region LENZ analysis, and also in the context of eco-social sustainability (see Appendix 2).

46. There has been a steady attrition of natural habitat in lowland Canterbury over the past 15 years, that is, despite the ‘protection’ of the RMA.

47. This has occurred despite laws (RMA), district plans, policies and documents such as the national (1998) and regional (2008) biodiversity strategies; a report from the Ministerial Advisory Committee in 2000 titled *Bio-what?*; and a report from the Parliamentary Commissioner for the Environment in 2001 titled *Weaving Resilience into our Working Lands.*

48. All of these documents suggest the need to draw the line to prevent ongoing cumulative effects, and to urgently recognise the significance of remaining areas of native vegetation, habitats and wildlife.

49. Appendix 2 explains how people’s environmental ‘expectations’ reflect what they see around them. If a type of nature becomes

dominant and visible, people become familiar with it, whatever it is. They eventually identify with it, and become protective towards it. This reinforces the acceptance of that style of nature, even if it is degraded. If that nature is largely exotic, as it is in lowland Canterbury, then that is what will be perpetuated and accentuated. Incremental acceptance of biodiversity loss is a subtle, cumulative effect with serious consequences. To break that cycle involves remedying past effects resulting from the systematic removal of natural ecosystems.

Summary of effects

50. The main effects on the terrestrial vegetation are as follows:

- disruption to braided riverbed plants,
- removal of mature kowhai and cabbage trees to make way for the intake structures, canals and sediment ponds on the floodplains of the Rakaia and Waimakariri rivers.
- removal of established native trees and shrubs on the terrace scarps above and below the canal traverse
- uncertain disruption to water races and wetlands on the Upper Plains
- loss of significant wetlands, shrublands, fern communities and Canterbury mudfish habitat in the proposed reservoir footprint
- indirect effects on remnant dryland plant and invertebrate communities, especially towards the east of the proposed irrigation footprint.
- accelerated, post-irrigation loss of indigenous vegetation and biodiversity as a direct result of currently permitted farm practices. There is no mechanism to control the effects of rapidly intensified agriculture while district planning lags far behind current best practice. Modern farming methods now recognise the need to protect and enhance biodiversity, but this has not filtered through to district plans.

51. The remaining native trees and shrubs along the terrace scarps and on the river floodplains are the only food resources for bellbirds and kereru utilising the river corridors from foothills to the sea.

Discussion of matters raised in other evidence

Craig Bishop's evidence

52. Bishop's general account of the state of the CPW footprint area is accurate and he has consulted the key information sources. The impression is accurately created that there is very little indigenous habitat or rare species present, and that the Canterbury Plains and Foothills, whether analysed by ecological district, vegetative cover or LENZ categories, are the most degraded and therefore among the most threatened environments in the country – in terms of representative and sustainable natural ecosystems.

53. However, I believe this has led to some erroneous conclusions. Firstly, that the effects of the CPW scheme are "less than minor", when I would suggest that a more appropriate interpretation is that the amount of affected vegetation is small. The second presumption is that because so little indigenous vegetation remains, further loss is not "significant".

54. The conclusion— that the effect of the scheme on indigenous vegetation and habitats is minor—contradicts urgent efforts currently being made globally, nationally, and regionally, to reverse the decline in biodiversity.

55. Although the message has been slow to percolate, it is now widely recognised that the less biodiversity we have, the more strenuous the effort needed to maintain and enhance what is left. The dairy industry is realising that there are also very good commercial reasons for this, as perceptions about food sources impact directly on the marketing and sale of primary produce.

56. It isn't logical to suggest that restoration of decimated and degraded landscapes (from a natural character perspective) should begin by first allowing the loss of further (and almost all remaining) primary habitat.

57. (Primary habitat is that which, even if degraded, has a continuous history back to a past primeval ecosystem. These primary habitats are our only living benchmarks and seed sources for knowledge and restoration of former natural history.)

58. A set of graphs (such as the graph in Appendix 3) prepared for a report for MfE in the 1990s demonstrate that “significance” must be assessed in the context of how much or little indigenous vegetation remains. Conventional approaches are typically to discern and rank ”significance” in areas well endowed with high-quality remnants, as has been the case with PNA analyses in mountainous or high-rainfall hilly areas, where one is choosing the best of the best.

59. When one has an abundance of riches it is easy to rank sites, lose some, and not seriously affect the integrity of the natural ecosystems remaining. When one has little, then one can’t afford to lose more.

60. In degraded areas, ”significance” must be perceived in a different light. In Canterbury and other areas with almost no remaining native vegetation and habitat, essentially everything that remains is of national significance. Walker et al. (2007) suggest a threshold of 10% (even 20%) of land area as a minimum area or critical mass for biodiversity sustainability. That is, when the proportion of indigenous cover remaining in the environment falls below 10–20%, there is an exponential increase in risks to and accompanying losses of biodiversity.

61. Specifically Bishop (paras 18, 55, 123, 160 et al.) has discounted the importance of water races as recent ephemeral planted weedy environments, whereas they are actually century-old, naturally colonised habitats, rich in plant and animal life. As such they represent the largest single remaining continuous (wetland) habitat on the Canterbury Plains. Although initially formed artificially, they are now as natural as any wetland on the plains.

62. While new canals may provide new opportunities for riparian habitat, this is not equivalent to more than century-old ecosystems (many established in the 1870s and 1880s: Stephen Wright, Selwyn District Council, personal communication) because of the progressive

maturing and build-up of complex webs of microbes, invertebrates and species diversity.

63. Bishop (para 30) discounts values of remnants in the Waianiwaniwa Valley – but he did not have the opportunity to visit a highly significant raised bog wetland in Bushy Valley (see my para 32).

64. Bishop's discussion of highly modified environments having low terrestrial habitat values (para 61) is perhaps a perspective founded in generally wetter or hillier country, where there has been substantial retention of species-rich forest patches. Without a local context and baseline, there is a tendency to "see" forest and extensive wetlands, whereas degraded smaller remnants become invisible. This, however, does not diminish their objective value.

65. Bishop's statement that the sites referred to (Riccarton Bush, Travis Wetland, etc.) have low terrestrial value, and that no dryland sites are listed, is hard to fathom. The very high values and many sites on the north-western boundary of Christchurch were documented by Meurk et al. (1993).

66. Although Bishop dismisses the existing habitat value of the Waianiwaniwa catchment to kereru, tui and bellbirds (para 91), it should be noted that NZ flax, kowhai and cabbage tree are important to bellbird (and tui) and kereru, and these plants occur in scattered and large stands throughout the area.

67. Bishop (para 98) appears to dismiss the importance of dryland, especially dry woodland, shrubland and grassland species on the terrace scarps. He appears not to have considered the impact of the several kilometres of canal sidling along the scarp faces, involving cutting above and filling below (see Lucas evidence, and profiles), which will eliminate much of the extant vegetation of the faces. There are indications of kowhai, cabbage tree, kanuka, matagouri, mikimiki, pohuehue and grassland species on these faces, and these are significant remnants or corridors for native wildlife.

68. Using the plains CPNAS data, there are over 10 significant dryland sites listed in this vicinity, remembering that these sites represent large discontinuous associations of species. Further investigation

once precise canal footprints are available would be needed to quantify the effects, or used as a reference to avoid them.

69. Bishop's contention that losses of wetland will be offset by natural regeneration around lakes, and that there will be monitoring around the works, and that effects will be addressed at the time (paras 111, 115), seems to gloss over the complexity of true mitigation or restoration.

70. Much of Bishop's assumptions about restoring wetlands and the beneficial effects of more water being available (e.g., paras 140, 141, 187, 215, 226) glosses over the very real difference between natural or very long established wetlands in particular, and recently restored wetlands.

71. Zedler and Callaway (1999) and others in the US have long criticised the role of "mitigation" as a means of compensating for loss of natural wetlands. Evidence shows generally that natural, species-rich, low-fertility systems are replaced by poor monocultures in eutrophic conditions. They note that "…regulators should always strive to prevent damages to critical ecosystems rather than to permit losses, and hope for compensation." Basically it takes much longer than expected. "Higher ratios (than 10:1) [for offsetting] should become standard for replacing ecosystems that require longer development periods, or that have not been [successfully] replaced in previous restoration efforts."

72. Larger lakes and areas of open water will probably increase common birds such as mallards and Canada geese. But, we can't use recreation as an argument for the lakes and more water – water does not equal wet *lands*. There are plenty of existing lakes and water bodies in the vicinity. What we have less of is natural habitat.

73. Bishop's proposed monitoring via Mulcock's sustainable management plan is desirable (para 171), but it would be too late for saving primary habitat. Reliance on management plans which, furthermore, are voluntary does little to allay concerns about the future of natural habitat in the region.

Craig Bishop's Section 42 response evidence

74. Again there is the view expressed (para 6) that indigenous ecosystems make up as little as 0.3% of the entire CPW irrigation area, as though this means that it is therefore not worth worrying about. The reverse is true — the risk of disruption is not low, but very high, for those remnants. Bishop supports the view himself, that the highly modified nature of the Plains renders any remnants as likely to be ecologically significant: See his Section 42 response at para 49.

75. Bishop suggests (para 8) "Careful survey prior to construction" for vegetation at the intake structure and terrace riser canal sites. But this will hardly be of use if something valuable is discovered. By this stage it will be too late.

76. At para 11 in his response to s42 reports, Bishop suggests CPWT will support the implementation of the draft *Biodiversity Strategy for the Canterbury Region* (Environment Canterbury 2008). This strategy has now been finalised and published, with its top three goals as follows: (*Canterbury Biodiversity Strategy* at page 5)

- *Goal 1: Protect and maintain the health of all significant habitats and ecosystems*
- *Goal 2: Restore the natural character of degraded indigenous habitats and ecosystems*
- *Goal 3: Increase the integration and sustainable use of indigenous species in modified environments (eg farm, urban, lifestyle blocks)*

77. Several of the main parties at this hearing are members of the Biodiversity Strategy Advisory Group (Ecan, the Selwyn District Council, Forest & Bird), as are groups closely associated with the applicant, such as Fonterra and Federated Farmers. Agreement on conditions related to biodiversity should not therefore be difficult.

78. Targets 1 and 2 of the *Canterbury Biodiversity Strategy* (linked to Goals 1 and 2), are as follows:

- *Target 1: There is no further loss of significant habitats and ecosystems from 2010.*

- *Target 2: There is an on-going increase in the number, quality and effectiveness of ecosystem–based restoration projects and initiatives, particularly in areas where less than 30% indigenous cover remains.*

79. At page 33 of the *Canterbury Biodiversity Strategy*, the Canterbury Plains are identified as a top priority, being an area with less than 10% indigenous cover remaining. As explained in para 75 above, the situation in the CPW irrigation area is much worse than that, with indigenous ecosystems making up as little as 0.3%.

80. Based on my figure in Appendix 3 and my evidence at paras 146-150, I believe that in this context, significant indigenous biodiversity now means all natural (spontaneous) populations of native plants and animals, with the possible exception of occasional cabbage trees, bracken fern, pohuehue and scrambling pohuehue, rushes, some sedges, and NZ flax (individuals not large stands).

81. Bishop appears to be confusing (see for example at para 12, response evidence) the relationship between the amount of vegetation affected, and the level of risk perceived. The overwhelming dominance of houses and gardens in Fendalton, for example, does not make the tiny area of Riccarton Bush less significant, but much **more** significant. When habitat is extremely valuable (significant), then the threat to natural values is very high, not low, as implied.

82. And the RMA is blind to the **type** of vegetation – if it is rare, representative or species-rich, it does not matter whether it is short dry grassland or rainforest.

83. Bishop acknowledges that reduction of shelterbelts will result in a decline in bird habitat (para 14). Even pine plantations, that were formerly common on the Plains, supported insectivorous native birds such as grey warblers, fantails and occasional bellbirds, as well as mosses, lichens, poroporo, ferns and sometimes a few other native understorey plants (Meurk 2008). This added diversity to the plains, which diversity will now be reduced by removal of these forests (even if exotic) and their replacement by irrigated pasture.

84. Although Bishop is confident that wetlands will be enhanced by greater flows of water (para 19), it will take a long time for the natural values of century-old water races to be re-formed. This effect is too easily discounted. Of course, any riparian protection and planting is worthwhile but it is not mitigation for natural wetlands and riparian vegetation (cf. Zedler & Callaway 1999).

85. The statement that “increased ground water levels are not expected to affect ‘dryland” (para 21) cannot be supported when considering the degradation of dryland vegetation at the Bankside Reserve, as a consequence of adjacent irrigation. Similar consequences can be seen, due to increased stocking rates, larger stock, rotational grazing and irrigation in and around dryland vegetation on McLeans Island, and along field boundaries at Orari. Substantial buffers between natural areas, and irrigation and intensive stocking, will be needed to avoid similar effects on remaining dryland vegetation.

86. Bishop supports the idea of monitoring riverbeds to detect new weeds (para 35). It is to be noted that there is already a new weed in the Waimakariri catchment – *Myrica germanica*. If this is not controlled soon, it will be impossible to eradicate. As it is wind dispersed, new earthworks and disturbances in the riverbeds could provide another node for establishment.

87. Bishop appears to support the greater use of indigenous trees (para 42). A question arises as to what the style and status of the planting will be – which is further addressed under Glasson’s evidence. Firstly, any planting should maximise the opportunities for native trees, shrubs and wetland species. This planting should include a natural proportion of large (noble podocarp) trees, which should be protected by covenant so that they are safe in perpetuity.

88. Bishop accepts that management plans need to be monitored if they are to work (para 47). Monitoring of conditions will need rigorous checking by a trained person. ”Retraining” will also be required every time there is a change of ownership of properties.

89. I agree with many of the other points made in the evidence presented in paras 51–62.

90. I agree with Bishop (para 64) that there have been advances in knowledge about ecological restoration, but the full cost of replacing all the complexity of natural ecosystems and their specific association with unmodified soils would be exorbitant and almost unknowable. In particular, low-fertility wetlands and dry grasslands are extremely difficult to restore because the mere act of planting causes disturbance, mobilisation of nutrients, and increased competition from exotic species.

91. As Zedler and Callaway (1999) conclude, avoidance is much to be preferred over mitigation when there is uncertainty about end results. Of course, restoration in its own right (to remedy past effects) is to be applauded, and is highly desirable in terms of re-establishing natural character and ecological integrity in the landscape.

Chris Glasson's landscape evidence

92. Chris Glasson at para 72 says: "the lake edge ecology could be enriched and made more diverse for wildlife". While any planting of (native) trees will enhance tree-inhabiting indigenous wildlife, and this is a desirable thing to do regardless of this scheme, it is important to dispel the commonly held notion that water equates with wetland.

93. The RMA does not provide that boating/water skiing and the like can be used to mitigate biodiversity loss.

94. Many significant wetlands have been destroyed and replaced with ponds with a few flaxes, pampas grasses and willows or alders around the shore, in the mistaken belief that the environment was being enhanced. From ecological, representativeness and rarity criteria, this is most certainly not true. Notions of "enhancing" the lake are similarly flawed from an ecological perspective.

95. Much store has been placed on the beautification of the Opuha Dam. The views of Fraser Ross (April, *2008),* a careful observer from South Canterbury, are as follows in paragraphs 74 to77:

96. *A head-high-tall tussock grassland was flooded, which to me was highly significant…I asked that some at least be transferred for landscaping around the new lake at suitable locations. As far as I know this was not*

done…And there were other areas of interesting native shrublands and plant life…

97. *The river above the dam which was flooded had some interesting rocky reaches through which the river flowed. Just below the dam site, the river was a very pleasant reach, with a deepish swimming hole and lovely stretches of river environment for some distance. And, although I did not survey the riverbed edges, there was remnant native grassland and shrubland vegetation.*

98. *The dam collapse caused significant damage throughout the Opuha Gorge – if it has recovered I have not been back to check, but expect it has got very weedy. So, the flooding caused by the Opuha Dam did have some significant impacts on native vegetation and landscape values – never mitigated. The loss of the tall tussock grasslands was the only such stand that I saw in the area. There are some very small remnants, but nothing to compare with that which has been lost.*

99. *Not only biodiversity was affected, but also the loss of water quality, to such an extent that drinking water sourced from the river waters was so impaired that a replacement source had to be found.*

100. Glasson (para 132) says that the planting of the Waianiwaniwa Dam "will take some considerable time if the landscape is to be compatible with its existing state – i.e. deciduous and coniferous exotic trees." The notion of mitigating effects by replacing "like with like" appears appealing, but I am of the view that with the knowledge we now have, "like with like" mitigation is nowhere near good enough. If biodiversity strategies for the country and the Canterbury region are to ever mean anything, then much more has to be done.

101. If the scheme goes ahead as planned, with almost no consideration given to environmental effects, it will be a clearly identifiable trigger for serious loss of biodiversity in Canterbury.

Cultural disjunction

102. In relation to proposed landscaping, there seems little point in planting more exotic trees, other than through habit, when we have lost so much of our natural heritage. By the time these new trees are established and matured, most of the residents of the Coalgate area will have departed. Future generations of New Zealanders will be

searching to locate and preserve their unique heritage, and will depend on landscape decisions made today.

103. Instead of exotic conifers and deciduous English trees that will begin to seed into the surrounding landscape, we should begin now by at least mixing a substantial proportion of New Zealand's noble trees; that is, those grand indigenous species that will endure beyond the life of most exotics. Such trees contribute as carbon banks, and to the natural character of the landscape. They act as wildlife refuges and are important food sources, unlike the exotic trees that provide almost no food for native honey eaters and frugivorous birds. The trees will provide seeds for regeneration across the landscape, but also eventually a high-quality, harvestable crop (Meurk & Hall 2006).

104. Regarding Glasson's recommended use of exotic trees (para 160-163): in my opinion, this will perpetuate an ecological disjunction and thereby a cultural disjunction – of people from nature. Indeed the very existence of this scheme and the failure of the scheme experts to "see" significant native vegetation is symptomatic of this disjunction. If it is maintained, this disjunction will invariably lead to further attrition, as per the Meurk & Swaffield model (2000) (Appendix 2).

105. If shade trees are required, then lowland ribbonwood, NZ beech, wineberry, totara, kahikatea, pokaka, lemonwood and longer-term matai should be used. Glasson's para 162a list contains species that we must begin to do away with if we are to avoid serious weed risk in the future – specifically birch, willow, poplar and elm. The only reason willows and poplars don't spread far at present is because most are single-sex clones. But fertile populations are potentially moving through the country, and when this happens, our poplar and willow stands will explode uncontrollably across the landscape, like grey willow does in wetlands today.

106. Glasson's para 162b list is fine, but should be supplemented with those native noble trees referred to above. Otherwise we perpetuate the notion that we can replace big exotics with small natives and that the"real" plantings will be with grand exotic trees, while the natives will continue to be a kind of decoration around the edge.

107. This approach does nothing to resurrect our unique biodiversity, as envisaged in documents such as the *NZ Biodiversity Strategy,* and in the (Parliamentary Commissioner for the Environment) report, *Weaving resilience into our working lands*; in *Biowhat?,* and in the *Canterbury Biodiversity Strategy*. The proposed mitigations are generally valuable (with the qualifications above), but they are not compensation for loss of significant values in the form of primary habitat.

108. NZ cultural landscapes may be viewed in evolutionary terms as comparable to countryside in Europe a millennium ago. To many, the ”Englishness” of some of our countryside is valued. What is not appreciated is that indigenous nature (or biodiversity) underpins this pleasant scene in Europe, whereas in New Zealand, it is a pale imitation of something from the other side of the world. New Zealand countryside does not have the rich diversity of a European meadow, hedgerow, woodlot, road verge etc. but is occupied by a subset of English (and other foreign) species. These in many cases represent biosecurity threats, and have certainly usurped the presence of what was once a vast landscape of indigenous plants and co-dependent wildlife.

109. The intensification of agriculture as proposed here will escalate the removal of biodiversity by creating a pastoral monoculture, with planned removal of shelterbelts and plantations, and replacement of mixed pastures with two or three main species of grass and clover.

Philip Grove’s Report

110. Overall I agree with Grove’s comments; e.g. para 21 - that the canals and intakes are likely to affect cushion-herbfield, riparian wetlands, dry shrublands, open cabbage tree and kowhai treeland – but probably not beech–podocarp forest. Although there are some very important stands of the latter near the Waimakariri intake, it appears that the works will avoid this. Certainly, this must be ensured.

111. I agree (Grove para 24) that the footprint of intakes, sedimentation ponds, canals, tunnels and the lake should be inspected further by an expert botanist (as well as ornithologist, entomologist and

herpetologist) – and including the zone of associated works and staging.

112. Grove suggests (para 29) that modal flow will be affected by abstraction, but as I recall, abstraction will only occur at high flows.

113. I especially support para 41 (that “many remnant native vegetation and wetland habitats, some supporting nationally-threatened species, are likely to be affected by the scheme’s water use”) and I note the likelihood that adjacent irrigation will have a major effect.

114. My discovery of a highly significant wetland in Bush Gully adds weight to the notion that survey of the Waianiwaniwa is inadequate (para 52) to make definitive statements about the presence of valuable habitat.

Evidence of Mark Davis

115. I generally agree with most of Davis’ comments— that there are inadequacies in the existing information, and therefore the ability to properly evaluate effects, and that the proposed mitigation measures fall short because effects are under-estimated.

116. Davis notes (para 3.10) that sites from the (presumably) Plains PNA database are centres of broad swathes of vegetation with scattered native plants through them. This confirms my view that the canals will have effects on native vegetation which Bishop doesn’t address.

117. Most of the districts in question would be lucky to have 1% native vegetation cover (cf para 3.17) and would fall way short of achieving the threshold level suggested as a minimum for viable ecosystems. (see Appendix 3)

118. Davis (para 3.22) had a similar experience to mine from a one-day field check – that is, discovery of wetland and other native plant populations along the edge of the proposed lake/reservoir, hitherto undetected as part of the consideration of effects. It is accepted that the A-rated site of beech–podocarp forest near the Waimakariri upper intake should not be affected. However, this needs to be absolutely ensured.

119. In greater danger are the shrublands and woodlands containing native species on the steep river risers/scarps (para 3.22). The “Old Curiosity Shop” limestone area on the Rakaia side likewise should not be affected, but this needs to be verified. Is the tributary valley referred to below 340 metres? The beech and kowhai groves and other species mentioned by Davis must be regarded very highly.

120. The red tussock Leyden Swamp (Para 3.22 continued) is highly significant – red tussock grows nowhere else on the plains.

121. Further support for the role of water races (para 4.14) is indicated from O’Brien and Dunn (2006).

122. I am not sure what effort has been made to locate the *Melicytus flexuosus* and *Juncus holoschoenus* (para 4.17). This should be done to verify whether or not they are actually present and what their situation is. Importantly, adding or subtracting of water to existing habitats cannot be glibly stated to improve conditions for species present, as these have co-existed with the current environment (unless it has deteriorated recently) and are in balance with the present hydrological regime. A change in any direction could upset this balance.

123. Any uncultivated examples of zonal soils (representative of the regional climate and parent material) should be preserved as benchmarks for change before any further intensification in the district is contemplated – especially cultivation (paras 4.20-4.21). Too little attention has been paid to this requirement and any future monitoring will be meaningless if there is no control or standard baseline against which to compare change.

124. It is hard to see how canal alignment adjustments could mitigate losses of native plant populations and vegetation on the terrace scarps/risers since the entire face will be eliminated by cutting above and filling beneath the canal (para 5.10). Thus movement of the canal position on the face will not change that; and translocation of mature shrubs and trees is impracticable and unworkable (see photo from Omarama – Appendix 4).

125. The original premise, of Bishop, is flawed (para 5.11).

126. It is unclear if successful translocation of mudfish has ever been undertaken before (see para 5.12). Adding water to wetlands does not necessarily enhance them, as existing species and associations are adapted to the regime the way it is, and more water may merely homogenise all wetland to one common eutrophic type.

127. Davis correctly notes (paras 5.13-5.18) that there is inadequate or incorrect information on the natural values and effects and the general impression regarding mitigation seems to be ”trust us, we know what we are doing”. The restoration experience and prowess of Bishop is not in question, but some of what would be required has not been successfully carried out before – translocation of sensitive fish and low-fertility wetlands.

128. Davis’ sections 6.1, 6.2 & 6.3 are absolutely correct; no-one seems to be taking responsibility. The catchword in RMA terminology is ”significant”. As Grove and I have pointed out – when indigenous vegetation drops below 10–20% then *all* that remains is significant within the ecological district framework (as Davis has also pointed out). The applicant repeatedly says that effects will be less than minor and that mitigation will be carried out, but little detail is provided other than to rely on Bishop’s expertise – which is not generally in dispute

129. Davis’ discussion of the Selwyn District Plan (paras within section 6.3) is very instructive and demonstrates very effectively how not only this scheme, but many others, fail to live up to the often impressive aspirations of the District Plan.

<u>Intent of the RMA</u>

130. My reading of the Act is that it sets out to protect values that are precious to New Zealanders. Yet there has been much ongoing loss of primary habitat and associated species in lowland Canterbury.

131. This is borne out by the status of all but our commonest bird species – with the exception of the bellbird, they are all declining slowly, or quickly, or are threatened. This reflects the general crisis facing New Zealand’s biodiversity – it is under threat and declining almost

everywhere. This is the context in which further losses must be considered.

132. Allowing further attrition will clearly be contrary to the spirit and intent of all the Acts, policies, regional and district plans, and other carefully researched reports dealing with the environment. They all support representativeness, integrity of ecosystems, preventing further loss, and protecting and enhancing biodiversity.

AVOIDANCE, MITIGATION AND REMEDY OPTIONS

133. Mitigations such as tree planting are beneficial, but do not address primary habitat loss.

134. Tree planting can, however, assist with rebuilding New Zealand's indigenous ecosystems if it is carried out with predominantly indigenous species. In particular, many large trees (podocarps) should be incorporated in any planting programme, rather than planting only small shrubs and tussocks, which are ephemeral and only a partial solution.

135. It is important to appreciate the difference between simply tree planting, and protecting complex primary habitat (benchmarks, models and seed sources) with its intrinsic natural heritage values. Full restoration is very expensive. The Happy Valley (West Coast) restoration, for example, involves digging, storing and returning tussocks, and a whole range of inter-tussock and shrub plants, and snails to the same environmental site.

136. Restoration would not be easy on the Central Plains, as new locations will be different and more elevated than existing locations, with subtle and unpredictable differences in rainfall, drainage, runoff, abundance of weeds in close proximity and in the soil, and fertility. Raised fertility will be seized on by exotic grasses already present in the system at low density. While planting and re-establishing of new habitat, however simplified, is worthwhile in its own right, it is not the equivalent of the original habitat.

137. The first and soundest option for diminishing effects is non-disturbance of significant habitats and species by avoidance. Only when all avoidance options are exhausted, and development is of national importance, should remedying and mitigation be considered. The current attitude to this is the concept of offsets. In this case, one has to determine what is the appropriate ratio of compensated area for lost habitat?

138. One approach to calculating this is in terms of the age or maturity of systems. For example, the loss of a 600-year-old tree might be in some sense compensated for by planting two hundred, 3-year-old trees of the same species through to establishment. Likewise, the loss of 100-year-old water race wetland vegetation might involve establishing an area 20 times the size, of 5-year-old riparian/wetland vegetation, with the same range of species as in the model.

139. Another approach is to consider what is the minimum viable habitat and population sizes, and allow no losses below this threshold or rebuilding up to that figure. In this case, the 10-20% cover of indigenous vegetation in the district is the target. As the area is so far beneath this at present, it would be unrealistic to expect that the district will attain that level of cover any time soon. Nevertheless, it is a desirable goal in the long term and much can be done to integrate nature with production in working landscapes (see Meurk & Hall 2006).

Cost of restoration

140. The establishment of trees, shrubs and tussocks does not compensate for the biodiversity of natural (even degraded) ecosystems. We can only imagine the complexity of such systems — from microbes to teeming invertebrate life, and upwards.

141. I estimate that at full market rates, it would take $100 000 per hectare to establish the structural components of a forest ecosystem. And it would take centuries for it to approximate a natural ecosystem in terms of age structure.

142. With free labour and much community goodwill, this could be reduced considerably, but to re-establish all of the ecosystem

components (microbes, invertebrates, ground layer plants, understorey plants, vines, epiphytes, parasites, etc.) I estimate would probably cost ten times the raw cost of materials.

143. My estimate of costs for dry environments are made up of a per plant cost of $2 to $5, with a 1 metre spacing, site preparation, planting, watering in the first year, and maintenance and pest control for up to 5 years or until canopy closure is attained.

144. Establishing a small selection of dominant species and wide spacings with volunteer labour will cost much less, however success of establishment may also be less. Jorge Santos of the Motukarara Nursery on Banks Peninsula, has estimated that restoring a hectare of land could cost around $37,000*; and double this amount if larger grade plants (PB3 or PB5) were used. He suggests community groups that rely on volunteer labour for most of the plantings and maintenance could restore the same hectare of land for less.

145. The (Santos) cost estimate covers pre-planting spraying, planting (spaced at 1.5m), spray releases and replacement plantings, plant stock and labour, but does not include stock fencing, pest protection and mulching—essentials that can add a considerable amount of money and labour to the overall project.

146. Santos cautions that land to be restored is often infested with weeds and vulnerable to pests such as rabbits, hares and possums, requiring a dedicated and costly weed and pest control before planting, a careful planting process and a long-term ongoing commitment to pest and weed control.

CONCLUSION

147. The concept of water harvesting and irrigation and improved efficiency of agriculture is supported in principle, if it is sustainable and does not destroy other values that are also significant to New Zealand.

148. The natural ecology of New Zealand and Canterbury has to be one of the most important issues facing us now – if we are to maintain

integrity, sense of place, and (commercially) an authentic clean green image.

149. My opinion is that there is nationally and regionally significant vegetation and wildlife habitat in the footprint of the CPW scheme which will be destroyed by proposed infrastructure, associated works, and downstream activities.

150. While the precise nature and location of this has not been provided, nevertheless, one can see that there will be considerable destructive effects on remaining natural values, within the context of an already decimated natural landscape.

151. In the context of ongoing attrition of similar habitat over the past few decades in Canterbury, the predicted losses of further primary habitat will amount to unacceptable cumulative loss of indigenous vegetation and habitat.

152. I believe there might be a compromise, but only if major measures of avoidance of the most serious environmental breaches occur, and there is genuine offsetting as part of the requirements. The true cost of this would need to be factored in by Central Plains as a significant cost in the overall project.

Suggested conditions:

153. A thorough survey of natural values in the scheme footprint is required. (This is also recommended in Action 1.1 at page 56 of the *Canterbury Biodiversity Strategy: Identify and prioritise specific sites requiring urgent protection)*

154. Major replanting of indigenous species using best restoration practice and rigorous pest control along the Rakaia and Waimakariri corridors affected by the canal works. This is a possible case for offsetting.

155. Cut and fill on scarps would need to apply avoidance/minimisation wherever possible, including in the construction envelope as well as the canal footprint. Conditions needed around soil removal and restoration planting.

156. In order to preserve and enhance significant wetlands, mudfish habitat and other remnant communities of native plants in the Waianiwaniwa valley complex, avoidance is essential. The only realistic way to do this is to lower the maximum design level of the lake. A minimum lowering from the current design level of 280 metres would be down to 255 metres (or less). This would avoid substantial fish habitat and the valuable spring bog in Bush Valley.

157. The water race network needs to be maintained and enhanced on the plains. On-going weed control will be required, especially of blackberry, kaffir lily and gorse. Where losses of water race habitat occur, it is possible to quantify offsets with reference to the age of the vegetation.

158. The predominant landscape planting should be indigenous, including large ”noble” trees such as podocarps. Again the age of what is being displaced should be factored into the offset ratio.

Colin Douglas Meurk

4 June 2008

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APPENDICES

APPENDIX 1

Common and scientific names of plant species used in evidence

Bidibid	*Acaena* spp.
Bog spike sedge	*Eleocharis gracilis*
Bog rush/sedge	*Schoenus pauciflorus*
Bracken fern	*Pteridium esculentum*
Broadleaf	*Griselinia littoralis*
Cabbage tree	*Cordyline australis*
Chain fern	*Asplenium flabellifolium*
Dwarf kiokio	*Blechnum penna-marina*
Kanuka	*Kunzea ericoides*
Kiokio	*Blechnum novae-zelandiae*
Kiwakiwa	*Blechnum fluviatile*
Kohuhu	*Pittosporum tenuifolium*
Korokio	*Corokia cotoneaster*
Koromiko	*Hebe salicifolia*
Kowhai	*Sophora microphylla*
Manuka	*Leptospermum scoparium*
Matagouri	*Discaria toumatou*
Mat pohuehue	Muehlenbeckia axillaris
Mikimiki	small-leaved coprosmas (*C. propinqua*, *C. crassifolia*, *C. rigida*, *C. ciliata*)
Mingimingi	*Cyathodes juniperina*
NZ bedstraw	*Galium propinquum* and other species

NZ flax	*Phormium tenax*
Paesia	*Paesia scaberula*
Pig fern	*Hypolepis* spp.
Pohuehue	*Muehlenbeckia australis*
Porcupine shrub	*Melicytus alpinus*
Prickly shield fern	*Polystichum vestitum*
Prostrate kowhai	*Sophora prostrata*
Rushes	*Juncus* spp. (native – *J. edgariae*, *J. distegus*)
Scabweeds	*Raoulia* spp.
Scrambling pohuehue	*Muehlenbeckia complexa*
Silver tussock	*Poa cita*
Spleenworts	*Asplenium* ferns
Swamp kiokio	*Blechnum minus*
Toetoe	*Cortaderia richardii*
Tussock sedges/pukio	*Carex secta, C. virgata* (also called purei in some reports)

APPENDIX 2

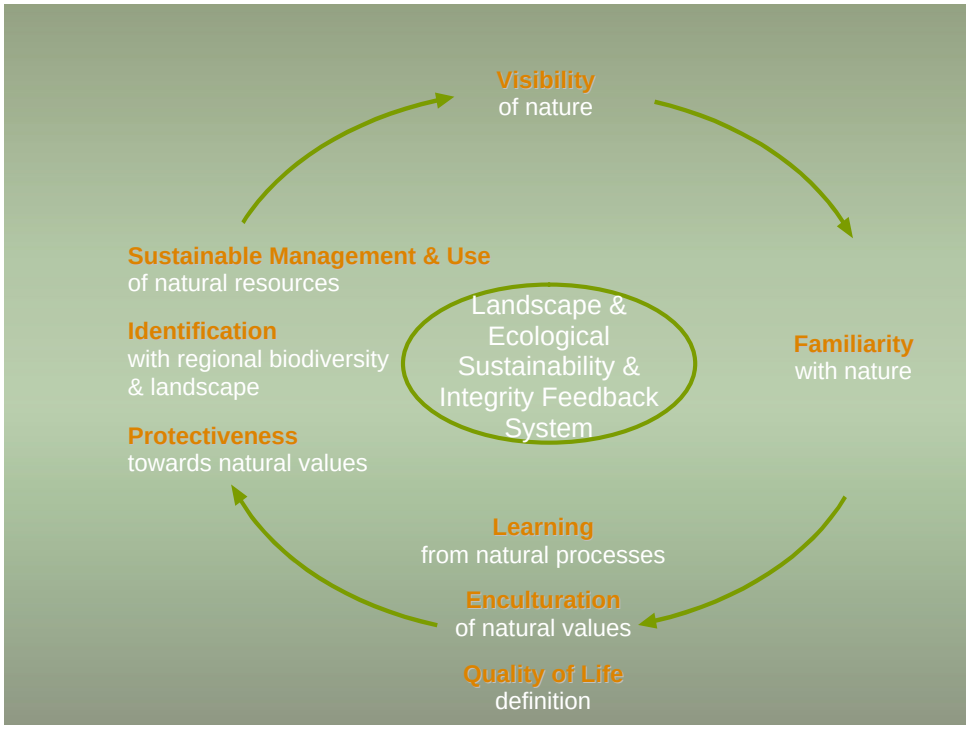
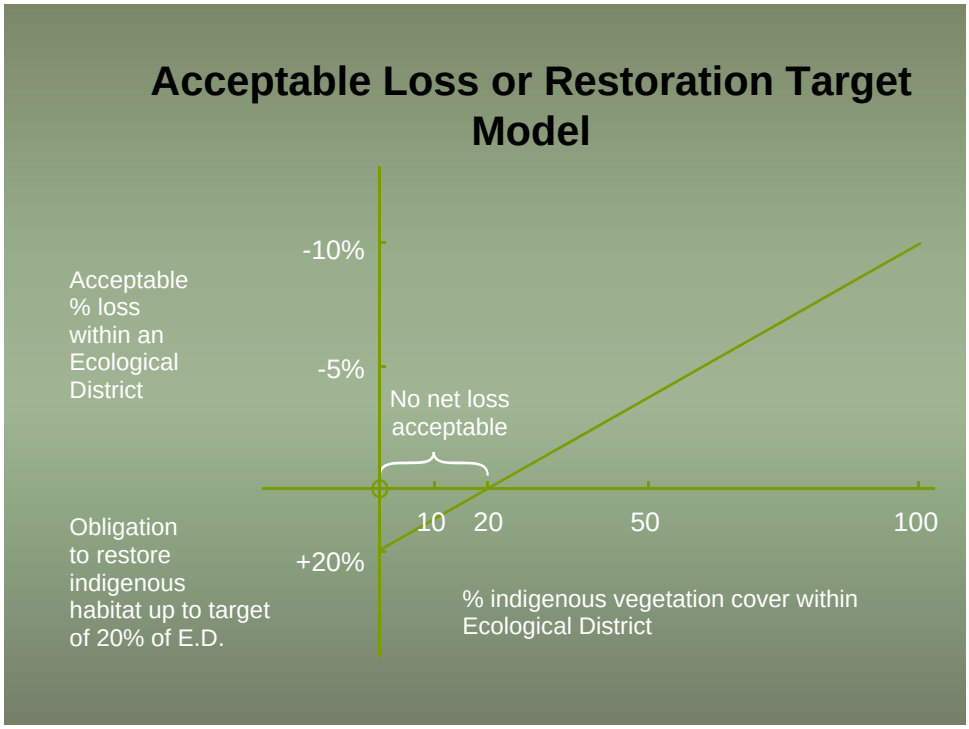


Diagram from Meurk & Swaffield (2000).

Visibility of a type of nature leads to familiarity and ultimately identification and protectiveness towards it, which acts to retain that style of nature. If that nature is largely exotic, as it is in lowland Canterbury, then that is what will be perpetuated and accentuated. That is a type of cumulative effect. To break that cycle involves remedying past effects resulting from the systematic removal of natural ecosystems.

APPENDIX 3



From Meurk (1998): *Perspectives on natural significance and a strategy for implementing nature conservation under the RMA.* Unpublished report prepared for Ministry for the Environment.

When there is ample indigenous vegetative cover, we can accept trade-offs and some loss of that vegetation, without affecting the ecological integrity of the system or the viability of biological populations. So at, say 100% cover, we might accept a loss of say 10% (−10% on graph). But as the portion of the landscape in natural habitat declines to around 10–20% cover, there is a dramatic loss of biodiversity (Walker et al. 2007). So every remaining area of primary and even semi-natural areas (such as pine forests with a regenerating under storey of native plants) becomes significant. At that point there is no further acceptable loss. If the landscape now has less than this threshold of 10–20% natural habitat, then the deficit represents a target for ecological restoration.

APPENDIX 4

Failed attempt at transplanting mature nature shrubs of matagouri, porcupine shrub, and small-leaved coprosmas in a development at Omarama, despite the sprinkler irrigation (2007). All these woody plants have died. There is a common belief that one can move mature dryland woody plants without realising that such plants may be decades, even a century, old and have deep roots which sustain them through drought. Severing these roots destroys this lifeline to deep moisture. So not only has the landscaping attempt failed, but the donor site has also been needlessly stripped of a decades-old association of fruit-bearing plants, lizards, birds and insects.