Mackenzie District Plan

Proposed Plan Change 18 - Indigenous Biodiversity

Section 42A Hearings Report - Ecology

10 December 2020

Technical Report - Ecology

Evidence of

Mike Harding

Environmental Consultant

Contents

List of Abbreviations

CRPS	Canterbury Regional Policy Statement
DOC	Department of Conservation
ESW	Ecologically Significant Wetland
MDC	Mackenzie District Council
MDP	Mackenzie District Plan
MWLR	Manaaki Whenua-Landcare Research
NPSFM	National Policy Statement for Freshwater Management 2020
NPSIB	Proposed National Policy Statement for Indigenous Biodiversity
ONL	Outstanding Natural Landscape (Mackenzie Basin)
OSTD	Over-sowing and Topdressing
PC13	Plan Change 13
PC18	Proposed Plan Change 18
RMA	Resource Management Act 1991
SNAs	Significant Natural Areas
SONS	Sites of Natural Significance
WPS	Waitaki Power Scheme

List of Submitters and Abbreviations Referred to in this Evidence

Submitter Number	Full Submitter Name	Abbreviation
8	Canterbury Regional Council	CRC
9	Environmental Defence Society	EDS
11	Genesis Energy Limited	Genesis
13	Meridian Energy Limited	Meridian
16	Mt Gerald Station Limited	Mt Gerald

Introduction

1. My full name is Michael Arthur Coupland Harding. I am an independent Environmental Consultant based at Arthur's Pass, Canterbury. I hold a Diploma in Parks and Recreation Management (with Distinction) from Lincoln University (1986) and papers in Botany and Geology from Otago University (1980). I have seven years' experience in national park management and conservation advocacy, and a subsequent twenty-seven years' experience as an independent ecologist.

2. My work as an independent ecologist has included field surveys of indigenous vegetation and habitat, assessments of ecological significance, assessments of priorities for protection of indigenous ecosystems, and advice on management of indigenous ecosystems, throughout the South Island. Consultancy work of particular relevance to PC18 is:

    a. Survey of vegetation and/or collation of specialists' survey reports on high country pastoral leases, including six Mackenzie Basin properties, for the Pastoral Lease Tenure Review Programme (DOC contracts, 1994 to 2015);

    b. Administration of a riverbed vegetation survey (at 739 sites) throughout the Mackenzie Basin (Project River Recovery contract, 2002/2003);

    c. Survey and review of 24 existing Mackenzie District SONS (Appendix 1, MDP), and survey of an additional 74 SONS/SNAs for MDC between 2015 and 2020;

    d. Survey of vegetation at consent application sites or vegetation clearance sites in the Mackenzie Basin, assessment of that vegetation against MDP vegetation clearance rules, and assessment of the ecological significance of those sites (MDC contracts, December 2014 to June 2020);

    e. Survey and assessment of SNAs at more than 800 sites in the adjacent Timaru and Waitaki districts (2005 to 2020); and

    f. Preparation and presentation of evidence at the Environment Court hearing for MDC Plan Change 13 (PC13-Eleventh Decision-2017), on behalf of MDC.

3. I have been engaged by Mackenzie District Council (MDC) to provide evidence on the ecological matters raised in submissions on proposed Plan Change 18, as requested by Mrs White (author of the s42A report). I was not involved with the preparation of

proposed Plan Change 18, nor have I provided advice to any submitters on the plan change.

4. Although this is a Council hearing, I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. I have complied with it in preparing this evidence and I agree to comply with it in presenting evidence at this hearing. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise, except where I state that I am relying on the evidence of another person.

5. With respect to the Code of Conduct, I advise the Hearing Panel that I have been engaged over the past seven years (and continue to be engaged) by Mackenzie District Council to provide ecological advice on Sites of Natural Significance, vegetation clearance, and the protection of indigenous biodiversity generally in Mackenzie District.

6. In preparing this evidence I have been aware of and viewed the following material:

    - PC13 Eleventh Decision, 2017 (Decision No. [2017] NZEnvC 53).
    - Canterbury Regional Policy Statement
    - MDC Proposed Plan Change 18
    - Submissions received by MDC on proposed Plan Change 18
    - Proposed National Policy Statement for Indigenous Biodiversity

Scope of Evidence

7. This evidence is prepared in accordance with s42A of the Resource Management Act 1991 (RMA). It provides technical information, assessment and, where relevant, recommendations to the Hearing Panel on ecological matters raised by submitters to proposed Plan Change 18 (PC18) to the Mackenzie District Plan. A planning report has been prepared by Liz White, which provides a full assessment of the submissions and further submission on PC18. As my evidence provides the technical basis for some of the recommendations made in her report, these documents should be read together.

8. In this evidence, I specifically comment on:

    - Sites of Natural Significance (SONS): review and mapping

- Wetlands
- Contributors to the decline in Indigenous Biodiversity
- Vegetation Clearance Rules
- Waitaki Power Scheme Operating Easement Areas
- Definitions for Indigenous Vegetation and Vegetation Clearance
- The Definition of Improved Pasture
- Mapping of Converted Land (Improved Pasture)

Summary

9. The Mackenzie District includes a diverse range of landforms and ecosystems, stretching from the main divide of the Southern Alps in the west to lowland basins, hills and valleys at Albury in the east. Lower-altitude eastern parts of the Mackenzie District are substantially modified and are dominated by developed farmland. Important indigenous biodiversity is present in steeper valleys, on outcropping limestone, and at poorly-drained locations (wetlands). Indigenous biodiversity is more intact in ecosystems on the higher slopes and mountain ranges.

10. The western part of Mackenzie District is dominated by the Southern Alps and the Mackenzie Basin. The basin has a distinct combination of landforms and climate, characteristic of an eastern (rain-shadow) inter-montane basin. The wider basin (including the part within Waitaki District) is the largest of the country's inter-montane basins and contains extensive contiguous glacial and fluvio-glacial landforms, which support distinct indigenous ecosystems not replicated to this extent anywhere else in the country.

11. Mackenzie Basin ecosystems on these depositional landforms are often degraded, though still support a diverse range of indigenous species, including 91 Threatened or At Risk plant species. These ecosystems also provide habitats for notable fauna species, including banded dotterel, black stilt, Mackenzie Basin spotted skink and robust grasshopper.

12. There has been widespread loss of indigenous biodiversity in Mackenzie District, from the effects of human settlement and land development. Important causes of this loss have been fire, grazing, cultivation, plant and animal pests and hydro development. Many of the activities that have caused the degradation of indigenous ecosystems and loss of indigenous biodiversity in the Mackenzie District continue today.

13. Sites of Natural Significance (SONS) are listed in the MDP (Appendix 1). This list is inadequate, dated and incomplete. Notably, most undeveloped (un-converted) land on depositional landforms in the Mackenzie Basin has significant ecological values, but only a proportion of that land has been identified as SONS. A review of these SONS, and identification of additional SONS/SNAs, is underway but far from complete.

14. In response to the need to more efficiently identify remaining SONS/SNAs, land on depositional landforms in the Mackenzie Basin that has not been 'converted' or 'partially-converted' (from indigenous to exotic vegetation) has been mapped. That mapped area

depicts the location and extent of vegetation that is potentially significant indigenous vegetation. It will inform MDC and landowners/landholders, and guide further field survey work.

15. Wetlands have also been mapped in Mackenzie District from high resolution aerial photography by Environment Canterbury. Some wetlands have been ground surveyed, and some mapped as SONS. Most wetlands are ecologically significant. Some highly modified or induced (artificial) wetlands may not be ecologically significant.

16. Some parties to PC18 have submitted on the causes of biodiversity decline. The main contemporary causes of decline in indigenous biodiversity in Mackenzie District are land-use change (especially vegetation clearance and cultivation), grazing, and plant and animal pests.

17. PC18 contains provisions relating to biodiversity offsets. Biodiversity offsets are complex, due to the difficulty of measuring/quantifying indigenous biodiversity, the irreplaceability of indigenous ecosystems, and the challenges of monitoring the outcomes.

18. In the Mackenzie Basin, the only ecosystems that could readily be replaced (like for like) are those on very recently-formed land surfaces. Ecosystems in other parts of Mackenzie District, such as montane forest, may more likely be replaced. It is unlikely that a biodiversity offsetting proposal in the Mackenzie Basin would be able to meet the CRPS Policy 9.3.6 criteria.

19. The vegetation clearance permitted by Conditions 1-6 of Rule 1.1.1 would generally exclude clearance of significant indigenous vegetation, except that permitted under Conditions 1 and 5. Clearance for maintenance and repair of fence lines, vehicle tracks and roads, and clearance for plant pest control, would need to be constrained by appropriate conditions to avoid clearance of significant indigenous vegetation.

20. Some parts of the Waitaki Power Scheme (WPS) core sites and, to a greater extent, areas covered by operating easements are ecologically significant. The operating easement areas support intact (undeveloped) landforms with remnant (though degraded) indigenous vegetation. They provide habitat for many At Risk and Threatened plant and animal species.

21. Clearance of vegetation within the WPS operating easement areas is very likely to have adverse effects on indigenous vegetation and habitat, and especially at those parts

identified as SONS. The ecological effects of refurbishment (upgrade and renewal) will likely be greater than the ecological effects of maintenance and operation, because any new works may remove or disturb additional areas of significant indigenous vegetation or habitat.

22. I have reviewed the proposed definition of indigenous vegetation, and the submissions made on that definition. Taking into account the submissions, the definitions used in other district plans and the one that is proposed in the NPSIB, my suggested definition for 'indigenous vegetation' is: *Means a community of vascular plants, mosses and/or lichens that includes species native to the ecological district. The community may include exotic species.*

23. I have reviewed the proposed definition of vegetation clearance, and the submissions made on that definition. I support the inclusion of activities such as artificial drainage, overplanting, OSTD, and irrigation in that definition.

24. I have reviewed the proposed definition of improved pasture, and the submissions made on that definition. I discuss three main issues raised by submitters: ambiguity; inadequate protection for indigenous vegetation; and, mapping. My suggested definition for Improved Pasture is: *Means an area where indigenous vegetation has been fully removed and the vegetation converted to exotic pasture or crops.* I suggest that the date at which this definition applies is May 2020.

25. Areas of converted (fully developed) land in the Mackenzie Basin have been mapped (May 2020). I suggest that this map is included in the MDP to define areas of improved pasture. The map has yet to be finalised through consultation and further field survey.

Ecological Context

26. The Mackenzie District includes a diverse range of landforms and ecosystems, stretching from the main divide of the Southern Alps to lowland basins, hills and valleys in the catchments of the Opuha, Opihi and Tengawai rivers. There are two distinct parts to the Mackenzie District: the high-altitude western mountains (Southern Alps) and Mackenzie Basin; and the lower-altitude eastern ranges and valleys. These parts are separated by the Two Thumb, Rollesby and Dalgety ranges.

27. Lower-altitude areas at eastern parts of the Mackenzie District are substantially modified and are dominated by developed farmland. Important indigenous biodiversity is present in steeper valleys, on outcropping limestone, and at poorly-drained locations (wetlands). Indigenous biodiversity is more intact in ecosystems on the higher slopes and mountain ranges, notably the Two Thumb and Tara Haoa (Mt Peel) ranges.

28. Most of the issues raised by submitters on which I have been asked to provide evidence relate to the Mackenzie Basin. So, the technical advice provided in this evidence relates primarily to the Mackenzie Basin part of the Mackenzie District, except where indicated otherwise.

29. The Mackenzie Basin has a distinct combination of landforms and climate, characteristic of an eastern (rain-shadow) inter-montane basin. The wider basin (including the part within Waitaki District) is the largest of the country's inter-montane basins and supports extensive montane glacial and fluvio-glacial landforms (moraines, outwash terraces, and riverbeds). These landforms are contiguous, forming largely uninterrupted sequences from the wetter and higher western parts of the basin, to the drier and lower eastern parts. They support distinct indigenous ecosystems, which are not replicated to this extent anywhere else in the country.

30. These ecosystems and the indigenous biodiversity they support were well documented in evidence (and decisions) for PC13[1]. Most important are the ecosystems that lie on depositional landforms. Several of these are naturally uncommon ecosystems which are nationally threatened[2], including: outwash gravels; ephemeral wetlands; braided riverbeds; and moraine.

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[1] Dr S Walker, Evidence in Chief PC13, 9 September 2016, paras 14-30; N J Head, Evidence in Chief PC13, 9 September 2016, p15-22; M A C Harding, Evidence in Chief PC13, 15 July 2016, paras 10-20.

[2] Holdaway, R.J.; Wiser, S.K.; Williams, P.A. 2012. Status assessment of New Zealand's naturally uncommon ecosystems. *Conservation Biology 26*: 619-629.

31. The indigenous plant communities of these ecosystems include scrub, shrubland, tall tussockland, short tussockland, herbfield, mossfield, lichenfield, stonefield and loamfield. Many of these ecosystems and their plant communities are degraded, though they still support a diverse range of indigenous plant and animal species. For many of these species, the Mackenzie Basin is their stronghold. The distinctiveness and vulnerability of the Mackenzie Basin flora is indicated by the inclusion of 91 of these plant species in the latest threatened plant list[3].

32. The Mackenzie Basin also provides habitat for a diverse range of indigenous birds, lizards and invertebrates. Notable habitats are braided riverbeds, wetlands, outwash terraces, moraines and screes. Notable threatened species for which the Mackenzie Basin provides critical habitat are banded dotterel (*Charadrius bicinctus*), black stilt (*Himantopus novaezelandiae*), Mackenzie Basin spotted skink (*Oligosoma* aff. *lineoocellatum* "Mackenzie Basin") and robust grasshopper (*Brachaspis robustus*).

33. These ecological values are what remains following extensive loss or degradation since human settlement. The most widespread causes of this loss/degradation have been activities and effects related to settlement and farming, such as fire, grazing, animal pests (notably rabbits), plant pests (weeds), over-sowing, topdressing, application of herbicides, vegetation clearance, direct drilling, cultivation, soil loss, irrigation, draining, road/track construction, and tree planting (especially exotic conifers). Other localised activities that have contributed to this loss/degradation are earthworks associated with the Waitaki Power Scheme, quarrying, and flood protection works.

34. This loss has manifested itself in the loss of ecosystem health and a reduction in ecosystem extent. Ecosystem health includes the diversity of indigenous species, the size of those species' populations, the health of individuals of those populations, and the intactness of the ecological processes which link and sustain those species. Ecosystem extent is the area occupied by that ecosystem.

35. The reduction in size/health of many remaining plant species' populations is indicated by the fact that 91 Mackenzie Basin plant species are presently (2018) ranked as Data Deficient, Threatened or At Risk[4]. This is an increase from the 83 species ranked[5] in

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[3] de Lange, P.J; Rolfe, J.R; Barkla, J.W; Courtney, S.P; Champion, P.D; Perrie, L.R.; Beadel, S.M.; Ford, K.A.; Breitweiser, I.; Schönberger, I.; Hindmarsh-Walls, R.; Heenan, P.B; Ladley, K. 2018. *Conservation status of New Zealand indigenous vascular plants, 2017*. Department of Conservation, Wellington, New Zealand.

[4] de Lange, P.J; Rolfe, J.R; Barkla, J.W; Courtney, S.P; Champion, P.D; Perrie, L.R.; Beadel, S.M.; Ford, K.A.; Breitweiser, I.; Schönberger, I.; Hindmarsh-Walls, R.; Heenan, P.B; Ladley, K. 2018. *Conservation status of New Zealand indigenous vascular plants, 2017*. Department of Conservation, Wellington, New Zealand.

2013[6]. Notable changes are increases in the number of plant species listed as Threatened, from 29 in 2013 to 36 in 2018, and in the number of plant species listed as At Risk Declining from 26 in 2013 to 38 in 2018 (Attachment 1).

36. The intactness of the ecological processes which link and sustain these indigenous plant and animal species has been compromised by fragmentation of habitat through land development, grazing, competition from naturalised (exotic) species, predation and browsing. Other, more complex, factors are the off-site (edge) effects of land development[7], such as increased moisture (from irrigation), spread of propagules and nutrients (from fertilising), and the introduction of pathogens.

37. The reduction in ecosystem extent is also difficult to quantify, because the reduction ranges from complete loss (conversion) to varying degrees of modification/degradation (no Mackenzie Basin ecosystems are completely pristine). Land on depositional landforms (moraines, outwash terraces, and riverbeds) in the wider Mackenzie Basin (including that within Waitaki District) that has been either fully converted or partially converted to exotic vegetation in 2019/2020 was recently mapped[8].

38. Much of the complete loss (conversion) of ecosystems has occurred in recent years, largely due to the increase in irrigated land. The extent of indigenous vegetation that had been completely replaced with exotic vegetation in the Tekapo and Pukaki ecological districts[9] (i.e. within the Mackenzie District part of the Mackenzie Basin) between 2011 and 2016 is estimated to be between 15,600ha and 20,400ha[10].

39. Many of the activities that have caused the degradation of indigenous ecosystems and loss of indigenous biodiversity in the Mackenzie Basin continue today. The existing stressors were summarised in 2017[11] as “fire, pests, weeds, application of herbicides, oversowing, topdressing, cultivation, direct drilling and irrigation”. Other stressors, the effects of which are more difficult to quantify, are climate change (especially fire risk),

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[5] de Lange, P.J; Rolfe, J.R; Champion, P.D; Courtney, S.P; Heenan, P.B; Barkla, J.W; Cameron, E.K; Norton, D.A; Hitchmough, R.A. 2013. *Conservation status of New Zealand indigenous vacular plants, 2012*. Department of Conservation, Wellington, New Zealand. 70p.
[6] N J Head, Evidence in Chief PC13, 9 September 2016, Appendix 1.
[7] For example: Walker, S. Measured edge effects on indigenous grassland and shrubland vegetation on low-relief topography in Canterbury. Contract Report LC3866. Manaaki Whenua-Landcare Research.
[8] Maps were prepared from analysis of 8 satellite images (dated between October 2019 and May 2020) by Manaaki Whenua-Landcare Research. See paragraphs 117-124 of this Evidence.
[9] As defined by: McEwen, W.M. (editor) 1987. Ecological regions and districts of New Zealand, third revised edition (Sheet 4). *New Zealand Biological Resources Centre Publication No.5.* Department of Conservation, Wellington, 1987.
[10] PC13 Decision-Eleventh Decision-2017, para 93.
[11] PC13 Decision-Eleventh Decision-2017, para 119.

local/regional climate effects from increased irrigation (increased humidity and soil moisture), and the introduction or naturalisation of new exotic species (including pathogens).

Sites of Natural Significance

40. The current provisions contained in the MDP relating to indigenous biodiversity are set out in Mrs White's report. In this part of my evidence I have been asked to comment more specifically on the Sites of Natural Significance (SONS) listed in Appendix 1 of the Mackenzie District Plan.

41. The SONS listed in Appendix 1 were identified in the 1990s. These sites appear to have been selected through desk-top analysis and review of existing protection proposals, such as Significant Sites of Wildlife Importance (SSWIs) identified by the Wildlife Service, and areas recommended for protection by the Department of Conservation's Protected Natural Areas Programme (RAPs).

42. The MDP Appendix 1 list of SONS is inadequate and incomplete. The SONS were not selected through a fit-for-purpose or comprehensive field survey. The listed SONS are each described in only one or two sentences. There appears to have been no deliberate assessment of the significance of each site against criteria relevant to Section 6(c) RMA.

43. The MDP Appendix 1 list of SONS is now approximately 25 years old. In that time, ecological values have been lost or degraded throughout the Mackenzie District, including at many SONS. And, the significance (rarity) of many indigenous species and habitats has increased[12]. Also during that time, our understanding of ecological significance has improved, and has been better defined by research and case law. Criteria for the assessment of ecological significance have evolved, from the MDP criteria, to the CRPS Appendix 3 criteria (2013), and to the proposed NPSIB criteria (2020).

44. I agree with the view expressed by submitters that not all significant sites are included in MDP Appendix 1 as SONS. Most undeveloped (un-converted) land on depositional landforms in the Mackenzie Basin has significant ecological values. The MDP Appendix 1 SONS cover only a small proportion of that undeveloped land.

45. This view is consistent with that of the Environment Court, which concluded that much of the ONL (i.e. the Mackenzie Basin) "meets the area of significant vegetation criterion,

[12] See paragraph 35 of this Evidence.

notwithstanding the presence of introduced plants or weeds"[13], and that "consequently the ONL is a significant natural area under Policy 9.3.1[14] of the CRPS"[15].

Mapping Significant Natural Areas

46. Separate to the PC18 process, I have been reviewing the Mackenzie District SONS on behalf of Mackenzie District Council since 2015. The primary purpose of that review is to determine whether the ecological values for which each SONS was identified are still present, and to more accurately define the boundaries of each SONS. Ecological values at SONS are assessed against the CRPS criteria. 24 of the 82 MDP Appendix 1 SONS have been reviewed. 74 additional SONS/SNAs have been identified during this review. The review is ongoing.

47. The principal components of the review of each SONS are: obtaining permission for access from the landowner/landholder for a field survey; field survey of ecological values; research to identify other known ecological values; assessment of the recorded ecological values against the CRPS significance criteria; electronic (GIS) mapping of the extent of the significant ecological values; preparation of a written report; discussion of the report with the landowner/landholder; and, provision of the final report to the landowner/landholder and MDC.

48. More recently, in response to the need to more efficiently identify remaining SONS/SNAs, land on depositional landforms in the Mackenzie Basin that has not been 'converted' or 'partially-converted' (from indigenous to exotic vegetation) has been mapped[16]. That mapped area depicts the location and extent of vegetation that is potentially significant indigenous vegetation. It will inform MDC and landowners/landholders, and guide further field survey work.

49. Additional research and survey will likely be required to identify other areas that provide significant habitat for indigenous fauna; i.e. those habitats that are not already assessed as areas of significant indigenous vegetation.

50. Completion of SONS/SNA surveys depends primarily on access to properties and the availability of ecological expertise. It may also be affected by the NPSIB, if that policy is

[13] PC13 Decision-Eleventh Decision-2017, para 236
[14] The pertinent part of CRPS Policy 9.3.1 is the "Rarity/Distinctiveness" criterion: "Indigenous vegetation or habitat of indigenous fauna that supports an indigenous species that is threatened, at risk, or uncommon, nationally or within the relevant ecological district".
[15] PC13 Decision-Eleventh Decision-2017, para 237.
[16] Maps were prepared from analysis of 8 satellite images (dated between October 2019 and May 2020) by Manaaki Whenua-Landcare Research (see paragraphs 117-124 of this Evidence).

formally adopted. The timeframe for completion of SONS/SNA surveys is therefore unclear. It is very unlikely that it will be completed prior to the MDP review. However, the NPSIB will require regular (at least two-yearly) plan reviews to include additional SNAs (SONS). The identification of SONS/SNAs can be an ongoing project.

51. Meanwhile, to avoid further loss of indigenous biodiversity in Mackenzie District, it is necessary to provide protection for significant indigenous vegetation and significant habitats of indigenous fauna that have not already been formally identified as SONS/SNAs.

Wetlands

52. In relation to wetlands, I have been asked to comment on the extent to which they are mapped in the Mackenzie District. The only broad-scale analysis of wetlands in the Mackenzie District of which I am aware is Environment Canterbury's Wetlands GIS layer which maps the location and extent of wetlands throughout the Canterbury Region[17]. The Mackenzie District wetlands are mapped on the GIS layer from high resolution aerial photography; a small number have also been ground surveyed.

53. The accuracy of the Canterbury Wetlands GIS layer is constrained by the limited field check (ground-survey). Also, it does not appear to systematically apply the Canterbury Land and Water Regional Plan definition of a 'wetland'[18]. However, those wetlands that have been ground-surveyed have been determined as wetlands against nationally recognised criteria, and their ecological values assessed against the CRPS (Appendix 3) criteria. Also, some Mackenzie District wetlands have been ground-surveyed as part of MDC's SONS review programme and are described and assessed in SONS reports.

54. PC18 includes provisions that apply to 'ecologically significant wetlands' (ESW), but ESW are not defined. There is however a definition of ESW in the CRPS[19]. In my view, this definition is problematic, as the words "predominately pasture and dominated by exotic species" create uncertainty, and will likely lead to considerable debate amongst ecologists. This uncertainty increases the risk that not all ecologically significant wetlands in Mackenzie District will be protected through application of this definition.

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[17] https://ecan.maps.arcgis.com/apps/Minimalist/index.html?appid=f74fea07a54148bb953ab35195e6d5da

[18] Data Interpretation and Limitations, Canterbury Wetlands GIS Layer, Environment Canterbury.

[19] "Ecologically significant wetland": means a wetland that meets one or more of the criteria in Appendix 3 of the Canterbury Regional Policy Statement, but "do not include areas that are both predominately pasture and dominated by exotic plant species and where they are not significant habitats of indigenous fauna." (CRPS 9.3.5).

55. A more appropriate method to select ecologically significant wetlands would be to apply the CRPS Appendix 3 criteria, without the "predominately pasture and dominated by exotic species" condition.

56. I have been asked to comment on whether all wetlands in Mackenzie District are ecologically significant. I think it unlikely that all Mackenzie District wetlands are ecologically significant. If the CRPS Appendix 3 criteria are used (as suggested in para 55 above), any relatively unmodified wetland will be ecologically significant. Highly modified or induced (i.e. artificial) wetlands may not be ecologically significant.

Contributors to Biodiversity Decline

57. One party (Mt Gerald) has submitted that natural processes such as soil erosion, climate change, nutrient depletion and the introduction of weeds and pests are arguably the main contributors to a decline in biodiversity and that land development activities should not be singled out.

58. Factors other than "land development" do contribute to a decline in indigenous biodiversity in the Mackenzie District. The most important of these are grazing, animal pests (especially rabbits and wallabies) and plant pests (especially wilding conifers). I am unaware of any evidence that soil erosion, climate change or nutrient depletion are the "main contributors to a decline in biodiversity".

59. Soil erosion is an important process in the Mackenzie Basin but is a significant contributor to a decline in indigenous biodiversity only at sites where vegetation cover has been degraded or removed. The most common causes of vegetation loss are grazing, browsing (e.g. rabbits) or deliberate clearance (such as burning or cultivation). Deposits of wind-blown glacial silt (loess) are present throughout the Mackenzie District and are an important natural component of many Mackenzie Basin landforms, notably the glacial outwash terraces. Movement of soil (erosion and deposition) is a natural and ongoing process in the Mackenzie District, although the quantity of soil moved has increased as a result of the depletion of vegetation cover.

60. Climate change may contribute to a decline in indigenous biodiversity in the Mackenzie District. However, the rate and extent of any decline in response to climate-induced change is unclear. It will likely depend on factors such as land-use (especially cropping and irrigation), protected area design, pest control, and fire control. Climate change is

an important long-term issue, though is not presently a “main contributor” to the decline in indigenous biodiversity.

61. I am not aware of any evidence that nutrient depletion is a main contributor to a decline in indigenous biodiversity in the Mackenzie District. A more important contributor is nutrient enhancement, such as the addition of nutrients through application of fertiliser, or movement of nutrients by grazing/browsing animals (such as deposition of dung at stock camps).

62. In the Mackenzie Basin, increased fertility generally favours naturalised (exotic) plant species, which then outcompete and smother most low-growing indigenous species. Rank growth of exotic grasses is a significant threat to populations of many of the Threatened and At Risk plant species in the Mackenzie Basin. Some taller indigenous species may benefit from the application of fertiliser, such as matagouri, silver tussock, and probably tall tussock (*Chionochloa* species).

63. Pests are a main contributor to the decline in indigenous biodiversity in the Mackenzie District. Notable pests are rabbits (*Oryctolagus cuniculus*), wallabies (*Macropus rufogriseus*), wilding conifers (*Pinus* spp.), willows (*Salix* spp.), sweet brier (*Rosa rubiginosa*), broom (*Cytisus scoparius*) and Russell lupin (*Lupinus polyphyllus*).

64. Land use change (development) is an important contributor (in addition to grazing and pests) to a decline in indigenous biodiversity in the Mackenzie District. It is also the contributor that can be most effectively addressed by plan rules. The soil erosion, climate change and nutrient depletion contributors would be most effectively addressed through restrictions on vegetation clearance, removal of grazing, fire suppression, control of pests, and conservation management.

Offsetting

65. PC18 includes provisions relating to off-setting, as required by the CRPS. I have been asked to comment on the ecological implications of off-setting in the Mackenzie District.

66. Biodiversity offsets are complex and fraught, due to the difficulty of measuring/quantifying indigenous biodiversity, the irreplaceability of indigenous ecosystems, and the challenges of monitoring the outcomes.

67. In the Mackenzie Basin, the only ecosystems that could readily be replaced (like for like) are those on very recently-formed land surfaces. Here, indigenous species will quickly recolonise, and plant succession could be managed so that the eventual plant

community/habitat is very similar to that which has been lost elsewhere. But, unless the new community/habitat is created and colonised before the existing one is destroyed, there will be interim net loss of habitat for indigenous plant and animal species. This may have a significant effect on sedentary species such as lizards or robust grasshopper, or migratory bird species if they are faithful to breeding sites.

68. Other Mackenzie Basin ecosystems, such as outwash terraces and moraines, support older more complex plant communities with more intricate plant-soil-climate relationships. These would be very difficult to re-establish or replicate. This difficulty is accentuated in the Mackenzie Basin by the altitude, climate, and exotic plant and animal pest threats.

69. Considerable ecological expertise would likely be required to adequately monitor the conditions and outcomes of a biodiversity offset programme. And, those outcomes are likely to be difficult to measure or quantify.

70. Ecosystems in other parts of Mackenzie District, such as montane forest, may more likely be replaced (like for like). However, the difficulties of interim net loss and monitoring still apply.

71. In my view, it is unlikely that a biodiversity offsetting proposal in the Mackenzie Basin would be able to meet the CRPS Policy 9.3.6 criteria.

Permitted Vegetation Clearance

72. I have been asked to consider whether the vegetation clearance that is proposed to be permitted under conditions 1-6 of Rule 1.1.1 would allow for clearance of significant indigenous vegetation.

73. The vegetation clearance permitted by Conditions 1-6 of Rule 1.1.1 would generally exclude clearance of significant indigenous vegetation, except that permitted under Conditions 1 and 5. I discuss these in turn below.

74. Some fence lines, vehicle tracks and roads (Condition 1) have been constructed with small (or no) machinery, whereas modern maintenance and repair is often undertaken with larger machinery (such as bulldozers or diggers). Repair of vehicle tracks commonly results in upgrading, such as excavation of drains and resurfacing with metal (gravel). In these situations there could be adverse effects on adjacent indigenous vegetation or habitat. For Condition 1, appropriate parameters would be restrictions on the extent of

vegetation clearance, such as within 2m of an existing fence line or the edge of an existing road, and on the placement of new culverts or drains.

75. Plant pest control (Condition 5) frequently includes application of broad spectrum herbicides which may also kill sensitive indigenous species. Furthermore, removal of wilding conifers has been used in the Mackenzie Basin (and elsewhere) as a proxy for land development. For example, many hectares of wilding conifers on otherwise undeveloped outwash terraces in the Mackenzie Basin have been removed with heavy machinery and the remnant indigenous vegetation (including wetlands) cultivated. For Condition 5, appropriate parameters would be restrictions on soil disturbance and control methods. The method of plant pest control should be subject to and determined by an ecological assessment of surrounding vegetation prior to control.

76. I have also been asked to comment on the ecological effects of: extending the permitted activity conditions to include replacement (in addition to maintenance and repair); including additional activities (as sought by submitters) in the list of permitted activities; and extending the conditions to apply to new activities.

77. Extension of the conditions to include replacement (in addition to maintenance and repair) increases the likelihood of adverse effects on indigenous vegetation. This could be avoided by restricting this activity to like-for-like replacement using the same methods.

78. Additional activities suggested that may have only minor adverse ecological effects are stock tracks and stock crossings, within the parameters suggested above. The net ecological effects of some types of new infrastructure, such as fences along waterways (within parameters), may be positive.

79. I have been asked to comment on clearance of indigenous vegetation within Farm Base Areas. I surveyed (field-checked) vegetation within the proposed Farm Base Areas for PC13. The boundaries of those Farm Base Areas were subsequently adjusted to exclude areas of significant indigenous vegetation. The effects of vegetation clearance on indigenous biodiversity within Farm Base Areas will therefore be minor.

Waitaki Power Scheme

80. PC18 includes rules that apply to the Waitaki Power Scheme (WPS), and more specifically to: the existing footprint of the WPS; core sites associated with the WPS; and areas covered by an operating easement associated with the WPS[20]. I have been

asked to comment on the significance of indigenous vegetation and habitat in these areas.

81. Some parts of the WPS core sites and, to a greater extent, areas covered by operating easements are ecologically significant. The main river corridors (Tekapo, Pukaki and Ohau) are listed as existing SONS. These SONS have been reviewed and confirmed, and additional adjacent SONS described. Most parts of these SONS support significant indigenous vegetation; other parts provide significant habitats for indigenous fauna.

82. Most areas covered by the operating easements will be ecologically significant. Substantial parts of the operating easement areas are intact (undeveloped) landforms with remnant (though degraded) indigenous vegetation. The terraces and terrace risers support a number of notable plant species. For example SONS on the west side of the Pukaki River support populations of 15 plant species ranked[21] as Threatened or At Risk. There are very few plant communities elsewhere in the country that support this number of threatened or at risk plant species.

83. The terrace risers provide habitat for Threatened and At Risk lizard species, such as Lakes skink (*Oligosoma* aff. *chloronoton* "West Otago") and Mackenzie Basin spotted skink (*Oligosoma* aff. *lineoocellatum* "Mackenzie Basin"). The terraces and riverbeds provide habitat for Threatened and At Risk bird species, such as banded dotterel (*Charadrius bicinctus*), black-fronted tern (*Chlidonias albostriatus*) and South Island pied oystercatcher (*Haematopus finschi*). The invertebrate values of these landforms/habitats are less well-known but Threatened species are present, such as robust grasshopper (*Brachaspis robustus*).

84. MDC Appendix 1 SONS within operating easement areas associated with the WPS support populations of at least 19 Threatened or At Risk plant species[22]. These operating easement areas also provide habitat for a number of Threatened or At Risk bird, lizard and invertebrate species.

85. Clearance of vegetation within the WPS core sites is unlikely to have major adverse effects on indigenous vegetation and habitat, except at those areas identified as SONS. Clearance of vegetation within the wider operating easement areas is very likely to have

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[20] Core sites are mapped in MDP Section 7 Rural Zone Schedules (Schedule A); I understand the Operating Easement Areas to be the areas of Crown Land along the Tekapo, Pukaki and Ohau rivers.
[21] de Lange, P.J; Rolfe, J.R; Barkla, J.W; Courtney, S.P; Champion, P.D; Perrie, L.R.; Beadel, S.M.; Ford, K.A.; Breitweiser, I.; Schönberger, I.; Hindmarsh-Walls, R.; Heenan, P.B; Ladley, K. 2018. *Conservation status of New Zealand indigenous vascular plants, 2017*. Department of Conservation, Wellington, New Zealand.
[22] See Attachment 2.

adverse effects on indigenous vegetation and habitat, and especially at those parts identified as SONS.

86. The ecological effects of refurbishment (upgrade and renewal) will likely be greater than the ecological effects of maintenance and operation, because any new works will likely remove or disturb additional areas of significant indigenous vegetation or habitat.

Definition of Indigenous Vegetation

87. I have reviewed the proposed definition of indigenous vegetation, and the submissions made on that definition. A summary of the submissions is provided in Mrs White's report. My brief comments on these submissions are listed below:

a) I agree that exemptions that provide for clearance of indigenous vegetation should be included within the rules, rather than sitting within the definition, because the exemptions define the use or purpose of the vegetation, not its characteristics.

b) I agree with the CRC submission that the definition should specify that species are native to the district. However, I don't agree that examples should be listed, as it risks the exclusion of other legitimate examples. A simple inclusive definition is preferable.

c) I agree with the intent of the EDS definition to acknowledge the presence of exotic species in a plant community, but think the proposed EDS definition is unnecessarily complex.

d) I consider that indigenous species' cover of 66%, as proposed by Genesis and Meridian, would not be ecologically appropriate. There are very few indigenous plant communities on depositional landforms in the Mackenzie Basin where indigenous species form more than 66% cover. Most basin-floor plant communities are degraded and include a high component of exotic species, and may naturally include a substantial proportion of bare ground (e.g. soil, stones, and/or rocks).

e) I would describe the definition (and my recommended alternative) as inclusive, rather than 'broad'. The definition will include vegetation at most remaining undeveloped areas in the Mackenzie Basin, and most undeveloped areas elsewhere in the Mackenzie District. That is appropriate, as most undeveloped areas still support indigenous vegetation, most of which is ecologically significant.

f) The presence (and dominance) of exotic species and bare ground is typical of indigenous vegetation in rain-shadow (dryland) parts of an inter-montane basin such as the Mackenzie Basin. Restricting the definition to vegetation which includes only a 'minor element' of exotic species is not appropriate; that definition would exclude large areas of ecologically significant indigenous vegetation.

88. Taking into account the submissions, the definitions used in other district plans and what is proposed in the NPSIB, my suggested definition for 'indigenous vegetation' is:

Means a community of vascular plants, mosses and/or lichens that includes species native to the ecological district. The community may include exotic species.

89. Ecologically this definition is preferable because:

a) A "community" means that it cannot be a single native plant species in exotic vegetation.

b) "Vascular plants, mosses and/or lichens" ensures that the definition includes non-vascular plant species (such as mosses) and lichens. Mosses and lichens are an important component of indigenous plant communities in the Mackenzie Basin. At some sites, lichens form the dominant vegetative cover.

c) "Native to the ecological district" means that the plant species must be native to the area. It excludes indigenous plant species that are not naturally found in the area. This is important because some indigenous species are weedy outside their natural range. 'Ecological Districts' are already defined and mapped[23].

d) Inclusion of "exotic species" in the definition is not essential, but is important in the context of the Mackenzie Basin because the low-growing (non-woody) indigenous plant communities of the Mackenzie Basin typically include a high proportion of exotic plant species.

Definition of Vegetation Clearance

90. I have reviewed the proposed definition of vegetation clearance, and the submissions made on that definition. A summary of the submissions is provided in Mrs White's report. The additional activities that submitters seek to include in the definition can lead to

[23] McEwen, W.M. (editor) 1987. Ecological regions and districts of New Zealand, third revised edition (Sheet 4). *New Zealand Biological Resources Centre Publication No.5.* Department of Conservation, Wellington, 1987.

modification of vegetation, so are relevant. The ecological effects of these activities are discussed in turn below.

91. Grazing modifies vegetation and has adverse effects on indigenous species. Intensive grazing (such as mob-stocking) can completely remove indigenous vegetation, and is intentionally used for that purpose. The effects of intensive grazing on indigenous vegetation were acknowledged in PC13[24].

92. A change in land use from sheep grazing to cattle grazing, or sheep grazing to deer grazing, would most likely have adverse ecological effects on indigenous vegetation. Cattle are larger heavier animals that are more likely to cause trampling and pugging, tear or break vegetation, and damage wetlands. Deer are more likely than sheep to damage wetlands.

93. Artificial drainage may also result in the clearance or modification of vegetation. Drainage of a wetland will invariably lead to the replacement of wetland species (e.g. sedges and rushes) with exotic grasses.

94. Overplanting frequently results in clearance of vegetation. A good example is tree planting, which is particularly relevant at present with Government support for tree planting (the Billion Trees and Jobs for Nature projects). Many Mackenzie Basin ecosystems support low-growing non-woody indigenous vegetation which would be completely eliminated by overplanting with taller species such as conifers (*Pinus* species) or Russell lupin (*Lupinus polyphyllus*).

95. Over-sowing and topdressing (OSTD) modifies vegetation and has adverse effects on most indigenous plant communities. Those adverse effects were considered at length during PC13[25]. The Environment Court concluded that the evidence supported management of pastoral intensification (including OSTD)[26].

96. Planting of non-site specific plants presumably means the introduction of non-native species. This would be covered by the inclusion of 'overplanting'.

97. Irrigation is an important, if not essential, activity to effectively convert indigenous vegetation to exotic pasture or crops, especially in the drier eastern part of the Mackenzie Basin. Other activities, such as OSTD and direct drilling, will introduce exotic pasture or crop species but will not necessarily displace all indigenous species. And,

[24] PC13 Decision-Eleventh Decision-2017, paras 254-256.
[25] PC13 Decision-Eleventh Decision-2017, paras 134-138.
[26] PC13 Decision-Eleventh Decision-2017, para 414.

land subject to these activities will frequently still provide habitat for indigenous fauna. Often, the application of water is required to complete the conversion.

98. An important consideration is that many land development activities, notably cultivation, sowing of crops, fertilising and irrigation have adverse effects on indigenous vegetation beyond the location of the activity. The distance from the activity at which indigenous vegetation is affected by these off-site (or "edge") effects may be greater than 336m[27]. Furthermore, activities such as irrigation have cumulative effects which, for example, may lead to local or regional climate change[28].

Improved Pasture

99. I have reviewed the proposed definition of improved pasture, the submissions made on that definition, and the related rule permitting clearance of indigenous vegetation within areas of improved pasture. A summary of the submissions is provided in Mrs White's report.

100. Three main issues are raised by submitters: ambiguity; inadequate protection for indigenous vegetation; and, mapping. I discuss the ecological components of each of these in turn below.

Ambiguity

101. The ambiguity of the definition will risk clearance of indigenous vegetation and further loss of indigenous biodiversity. Some submitters note that it would be difficult for a farmer to apply the definition without assistance from an ecologist. I concur with the concerns raised by submitters.

102. I have assessed vegetation at sites in the Mackenzie Basin to determine whether it meets the PC18 definition of Improved Pasture. The definition is poorly worded and difficult to apply. It requires an assessor to determine whether:

- species growth and composition have been modified or enhanced for livestock grazing within the previous 15 years;
- exotic pasture species have been deliberately introduced; and
- indigenous vegetation growing at the site is less than 15 years old.

[27] Walker, S. Measured edge effects on indigenous grassland and shrubland vegetation on low-relief topography in Canterbury. Contract Report LC3866. Manaaki Whenua-Landcare Research.
[28] Marwan, K.; Peyman, Z. 2019. *Locally Induced Climate of Simons Pass Irrigation Project*. Department of Geography, University of Canterbury, report. 20pp.

103. These determinations are difficult, if not impossible, because usually there are no reliable and/or comparable data for vegetation at the site 15 years ago (i.e. the baseline), or what has happened to that vegetation over those 15 years.

104. It is not usually possible to determine when or if modification or enhancement for livestock grazing has occurred. The person who could provide that information is usually the person who is applying for consent to clear vegetation (the landowner/manager). Records of modification or enhancement (such as GPS tracks of tractor work, or flight records of OSTD) may be available. However, it may be difficult for the consent authority, or any other party, to verify those records.

105. Similarly, it is difficult for an ecologist, at a single point in time, to determine with certainty whether exotic pasture species have been deliberately introduced. Many exotic (naturalised) plant species found in pasture in the Mackenzie District (especially herbs and grasses) are ubiquitous and will readily colonise areas, especially disturbed ground, without human assistance. Providing a list of "exotic pasture species" that are usually sown would not solve this problem.

106. A further difficulty is determining the age of indigenous vegetation at a site. It may be possible to estimate the age of indigenous shrubs, although those estimates are unlikely to be accurate and opinions will differ. It is much more difficult, if not impossible, to determine the age of non-woody species. For example, tussocks are long-lived but lose and replace tillers (lateral shoots) annually.

Inadequate Protection for Indigenous Vegetation

107. It is likely that the definition will not adequately protect indigenous vegetation from clearance. For example, some areas that would meet the definition, such as vegetation that has been OSTD, still support ecologically important indigenous vegetation. Therefore, the definition would not prevent the continued loss of indigenous vegetation in the Mackenzie District.

108. The definition permits clearance of indigenous species. The only way that this clearance can avoid continued loss of indigenous biodiversity is if there is an equivalent gain in indigenous vegetation elsewhere in the district. There is no evidence that there is a net increase of indigenous biodiversity (or indigenous vegetation generally) in the Mackenzie District. To the contrary, the Environment Court agreed with evidence that, in the Mackenzie Basin part of the district, there has been ongoing loss of indigenous vegetation[29].

Mapping of Improved pasture

109. Three submitters proposed that land which has been fully cultivated and converted to exotic pasture should be mapped as improved pasture, so that it is clear which areas are subject to Rule 1.1.1 (6). Other submitters support the mapping of significant natural areas (SONS/SNAs).

110. Defining the location and extent of improved pasture on a map would avoid the need to reassess vegetation against a definition each time vegetation clearance is proposed. It would provide clarity and certainty to landowners/landholders and Council. Farmers could continue to maintain developed land without the need to assess vegetation or apply for resource consent. Council would be reassured that such modification and enhancement is not leading to further loss of indigenous vegetation.

111. I have had experience assessing vegetation (and vegetation clearance) against definitions of Improved Pasture. In my view two actions are required to provide greater certainty that indigenous biodiversity of the Mackenzie District will be maintained. First, a clearer simpler definition of improved pasture and, second, identification of existing areas of improved pasture in the MDP. These two actions are discussed below.

Definition of Improved Pasture

112. I have provided advice on other definitions of improved pasture, including earlier drafts of the NPSIB. I am aware that it is difficult to provide a definition that provides certainty and has universal application. Based on this experience, my suggested definition for Improved Pasture is:

Means an area where indigenous vegetation has been fully removed and the vegetation converted to exotic pasture or crops.

113. Ecologically this definition is preferable because:

a) It is simple. This is possible in this context because it applies to one defined area: the Mackenzie District. This avoids the challenges posed by applying a definition to a wider range of ecosystems, as is necessary for a regional or national definition.

b) It acknowledges that most areas in the Mackenzie District that have not been fully developed (converted) still support remnant indigenous vegetation (and habitat) and are frequently ecologically significant.

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[29] PC13 Decision-Eleventh Decision-2017, paras 83-93.

c) The words “where indigenous vegetation has been fully removed” are critical. It means the area must have been developed/converted so that the extant indigenous vegetation has been removed or displaced.

d) It allows continued maintenance/development of converted land which indigenous species have colonised, because the original indigenous vegetation has been “fully removed”.

e) The words “vegetation converted” are also critical. This means that the area must have been developed. This is compatible with the District Plan definition of ‘agricultural conversion’.

f) The definition avoids identifying the method of conversion. Most commonly it would have been cultivation or burning. If cultivation or burning was specified in the definition, assessments would require evidence of the conversion method, which could be difficult and open to challenge.

g) Avoiding reference to the method of conversion makes the definition compatible with the mapped ‘converted land’, which was selected by assessing the existing vegetation (exotic pasture or crops) rather than from evidence of cultivation.

114. This definition means that vegetation clearance at other areas would not meet the permitted standard. That is ecologically appropriate, because direct clearance of extant indigenous vegetation risks further loss of indigenous biodiversity.

115. An important issue is the need to define the point or period in time at which indigenous vegetation was fully removed and converted to exotic pasture or crops. The ecologically appropriate time for the definition to apply is the date of the satellite images upon which the draft maps of ‘converted’ and ‘partially converted’ land in the Mackenzie Basin are based. That date is May 2020[30]. For consistency, that date should also apply to other parts of the Mackenzie District.

Maps of Improved Pasture (Mackenzie Basin)

116. As discussed earlier[31], maps of potential SONS/SNAs in the Mackenzie Basin have been prepared for MDC. Preparation of these maps included the identification of areas of “converted” and “partially converted” land. These are draft maps, subject to confirmation through more detailed checking. The map data are held by MDC as A3 hard copy maps

[30] paras 117-124 of this Evidence
[31] para 48 of this Evidence

and as electronic files (GIS shape files). A broad-scale image of the mapped data is presented in Attachment 3. The mapping method is outlined below.

117. The maps were drafted by Stella Bellis, Manaaki Whenua-Landcare Research (MWLR), Lincoln. Three layers (categories) were mapped: depositional landforms; fully and very obviously converted (developed) land; and developed land where full conversion is not obvious or certain.

118. The depositional landform layer was mapped from the 1:1,000,000 GNS Geological Map of NZ, which maps depositional landforms as six separate layers:

- IQa Late Quaternary glacial outwash deposits
- IQa Late Quaternary alluvium and colluvium
- Q1 Late Quaternary till deposits
- Q1 Middle Quaternary till deposits
- mQa Middle Quaternary alluvium and colluvium
- Qk Late Quaternary lake deposits

119. Converted and partially converted land were mapped from Sentinel-2 satellite images. Sentinel-2 is a wide, high-resolution, multispectral imaging mission run by the European Space Agency. MWLR downloaded the Sentinel imagery and processed[32] them to produce analysis-ready data by:

- Re-projection to the New Zealand Transverse Mercator map grid as 10m pixels.
- A local correlation sharpening technique to render the 20m resolution bands to 10m resolution.
- Radiometric and atmospheric calibration.

120. The converted and partially converted map layers were generated from visual inspection of a series of satellite images from the spring 2019 to winter 2020 period. Eight suitable cloud-free images were used. These were taken on[33]:

- 29 October 2019
- 3 November 2019
- 22 November 2019

[32] The MWLR method is documented fully in "Brief notes on converted and partially converted land mapping in the Mackenzie and Waitaki Districts" Stella Bellis, Manaaki Whenua-Landcare Research, October 2020, 9pp.
[33] These dates are UT; the local (NZST) date is one day later.

- 22 January 2020
- 26 February 2020
- 17 March 2020
- 1 April 2020 (used as the background image for the maps)
- 26 May 2020

121. Areas of converted land and partially-converted land were mapped as polygons. I received hard copies of the draft maps in early August 2020 and field-checked the mapped polygons over a six day period between 20th and 25th August 2020. That field check was undertaken from public roads and other locations accessible to the public.

122. Maps edits arising from that field check were provided to Stella Bellis, in person at MWLR Lincoln office in early September 2020. I received hard copies (and electronic shape files) of the edited maps in early October 2020. I then edited the mapped polygons at a finer scale, to adjust the polygon boundaries to paddock edges and land parcel boundaries, and to 'snap' polygon boundaries to one another.

123. During that final edit, the mapped converted land and partially-converted land layers were checked against Google Earth images (mostly from March 2019). Additional areas of converted or partially converted land were added to the maps, where such conversion was obvious on the Google images.

124. Map changes arising from these edits were provided to Stella Bellis as edited shape files. MWLR then produced the final copy of the maps. For the purposes of identifying potential SONS/SNAs (which was the main purpose of the mapping exercise) these maps include the following additional data:

    - Farm Base Areas
    - Existing SONS
    - Surveyed (reviewed and new) SONS
    - Three Land Cover Data Base-5 (LCDB-5) land cover classes: exotic forest; deciduous hardwoods; and built-up (urban) areas.

125. These maps provide guidance for the ongoing MDC SONS/SNA survey programme in the Mackenzie Basin. The maps also provide a point-in-time record of the location and extent of 'converted' and 'partially-converted' land on depositional landforms in the Mackenzie Basin. The mapped areas of converted and partially-converted land are

based on satellite, and at some locations Google Earth, images. They need to be confirmed at a finer scale.

126. Confirmation of converted and partially-converted land, in consultation with landowners/landholders, is a planned part of the mapping exercise. For that exercise, copies of the maps can be produced at a more detailed scale for each property, for the landowner/landholder and to guide the confirmation exercise.

127. The timing of and process by which the confirmation and final map edit occur are yet to be determined. The process could be similar to that undertaken previously by MDC to finalise Farm Base Areas for PC13.

128. It is particularly important that mapped areas of 'partially-converted' land are checked at a finer scale, as these are areas where the extent of conversion is unclear. Many are likely to be re-mapped as 'converted' land following a more thorough field check.

129. Meanwhile, the occurrence of any later (post-May 2020) land development (conversion) can be detected by checking later Sentinel-2 satellite images against the images used to create the maps. In other words, the maps and satellite images can be used to monitor land-use change, from a baseline of May 2020. It is therefore appropriate that the date at which the Improved Pasture definition should apply is May 2020.

130. If the maps are included in the MDP to define areas of improved pasture in the Mackenzie Basin, the definition of improved pasture becomes largely redundant for the basin, because all such areas will have been mapped. However, the definition should be retained so that new areas of improved pasture (resulting from newly-consented activities) can be defined as such until the time at which they are included in the MDP (by updating the converted land map through a plan change/review).

131. Areas of improved pasture elsewhere in Mackenzie District could also be mapped, using the same satellite images. Otherwise, areas of improved pasture could be determined by the definition, and land-use change monitored by viewing satellite images. Retention of the definition will be required for those parts of Mackenzie District where improved pasture has not been mapped.

Mike Harding

10 December 2020