BEFORE AN EXPERT PANEL **FTAA-2503-1035**
TEKAPO POWER SCHEME

Under the	FAST-TRACK APPROVALS ACT 2024
In the matter of	an application for replacement resource consents in relation to the Tekapo Power Scheme
By	**GENESIS ENERGY LIMITED** Applicant

STATEMENT OF EVIDENCE OF MICHAEL HARDING
TERRESTRIAL ECOLOGY

18 August 2025

Royal Forest and Bird Protection Society of New Zealand

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List of Abbreviations

CRPS	Canterbury Regional Policy Statement
DOC	Department of Conservation
IBEP	Indigenous Biodiversity Enhancement Programme
MDC	Mackenzie District Council
MDP	Mackenzie District Plan
NPS-IB	National Policy Statement for Indigenous Biodiversity, 2023
PNAP	Protected Natural Areas Programme
PRR	Project River Recovery
SNAs	Significant Natural Areas
SONS	Sites of Natural Significance
TPS	Tekapō Power Scheme
WPS	Waitaki Power Scheme

Introduction

1. My full name is Michael Arthur Coupland Harding.

2. I have been asked by the Royal Forest and Bird Protection Society to provide expert evidence on the terrestrial indigenous vegetation affected by the operation of Genesis Energy Limited's Tekapō Power scheme (**TPS**), in particular the proposed water permits that divert natural flows from the Tekapō River.

Qualifications and Experience

3. I am an independent Environmental Consultant working from offices in Nelson and Dunedin. I have papers in Botany and Geology from Otago University (1980) and a Diploma in Parks and Recreation Management (with Distinction) from Lincoln University (1986). I have seven years' experience in national park management and conservation advocacy, and a subsequent thirty years' experience as an independent ecologist.

4. 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 New Zealand though principally in the South Island. Consultancy work relevant to this consent application includes:

    a) Administration of a riverbed vegetation survey (at 739 sites) throughout the Waitaki Basin (DOC Project River Recovery contract, 2002/2003), an outcome of which is a published report.[1]

    b) Preparation of weed control strategies for the beds of major South Island rivers: Rangitata 2002; Rakaia 2013 & 2018; Upper Waimakariri 2014; Clarence-Waiautoa 2020 (DOC and Environment Canterbury contracts).

[1] Woolmore, C.B.; 2011.The vegetation of braided rivers in the upper Waitaki basin, South Canterbury, New Zealand. *Canterbury Series 0211*. Department of Conservation, Christchurch.

c) Preparation of a national wilding conifer control strategy (DOC contract, 2021).[2]

d) Survey and review of 24 existing Mackenzie District Sites of Natural Significance (SONS) (Appendix I, MDP) and survey of an additional 74 SONS (MDC contracts, 2015-2020), including sites along the Tekapō River.

e) Contribution to scientific research into the distribution and health of threatened dryland cress (*Lepidium*) species in the Mackenzie Basin and Central Otago (2021 to 2023).[3]

f) Review of consent applications for vegetation clearance at sites in the Mackenzie Basin, assessment of those applications against MDP vegetation clearance rules, and assessment of the ecological significance of those sites (independent advice to MDC, 2014 to 2020).

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

h) Preparation of maps of land converted to pasture or crops throughout the Waitaki Basin in 2020 (MDC and WDC contract).

i) Preparation of a Canterbury Land Protection Strategy,[4] which describes the indigenous ecosystems of each ecological district in Canterbury Region, assesses the extent to which each ecosystem is depleted, and identifies priorities for protection.

j) Preparation and presentation of evidence on terrestrial ecology at the Environment Court Hearing for Mackenzie District Plan Change 13 (Eleventh Decision-2017).

k) Preparation and presentation of evidence on terrestrial ecology at the Commissioner Hearing 2020, and at the Environment Court Hearing 2024, for Mackenzie District Plan Change 18.

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[2] Harding M. 2001. South Island wilding conifer strategy. Accessed 25/8/2021 https://www.doc.govt.nz/about-us/sciencepublications/conservation-publications/threats-and-impacts/weeds/south-island-wilding-conifer-strategy/

[3] Walker, S.; Harding, M.A.C.; Loh, G. 2023. The pattern of declines and local extinctions of endemic inland *Lepidium* species in the eastern South Island. NZ Journal of Ecology 47(1): 3547. https://doi.org/10.20417/nzjecol.47.3547

[4] Harding, M.A. 2009. Canterbury Land Protection Strategy. Nature Heritage Fund, Wellington.

Code of Conduct

5. I have read the code of conduct for expert witnesses contained in the Environment Court's Practice Note 2023 (the Code). I have complied with the Code when preparing this written statement of evidence. The data, information, facts, and assumptions I have considered in forming my opinions are set out in my evidence. Unless I state otherwise, this evidence is within my sphere of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope

6. I have been asked by the Royal Forest and Bird Protection Society to provide expert evidence on terrestrial vegetation in response to the application by Genesis Energy Limited for consent to divert natural flows from the Tekapō River through operation of the Tekapō Power Scheme (**TPS**).

7. The principal issues addressed in this evidence are:

    a) The terrestrial vegetation values of the bed and floodplain of the Tekapō River.

    b) The significance of the indigenous vegetation and flora of the floodplain of the Tekapō River.

    c) The physical and ecological processes that sustain those terrestrial vegetation values.

    d) The adverse effects of the loss of natural river flows on terrestrial vegetation values.

    e) The actions required to manage or compensate for the adverse effects of the loss of natural river flows on vegetation and flora of the river floodplain.

Material Considered

8. In preparing this evidence I have read the following documents. Other documents and papers are referenced in footnotes throughout this Evidence.

    a) Genesis Energy Limited – Tekapo Power Scheme Replacement Resource Consents AEE, April 2025.

    b) Kahu Ora – Draft 10-year Strategic Plan (Indigenous Biodiversity Enhancement Programme) 2025.

c) Lewis, D.; Maloney, R. 2020. A costing assessment of potential mitigation actions for hydro-electric activity in the Waitaki River catchment. Department of Conservation.

d) Bramley, G. 2023. Tekapo Power Scheme Reconsenting, Assessment of Effects – Vegetation. Ecological Solutions report to Genesis Energy Limited, May 2023. 58p + appendices.

e) Woolmore, C.B.; 2011. The vegetation of braided rivers in the upper Waitaki basin, South Canterbury, New Zealand. *Canterbury Series 0211*. Department of Conservation, Christchurch.

f) Hoyle, J. 2023. Assessment of Environmental Effects of the Waitaki Power Scheme, River Geomorphology. NIWA.

Summary

9. The vegetation of floodplains affected by operation of the Waitaki Power Scheme (including Tekapō Power Scheme) has been described by a Protected Natural Areas Programme survey (1984), Project River Recovery survey (2002-2003), and Significant Natural Area surveys (2016-2017).

10. The Tekapō River corridor is dominated by naturally uncommon ecosystems (moraine, outwash gravels and braided riverbeds); it buffers and links other dryland ecosystems and contributes to the most extensive undeveloped depositional landform sequences remaining in the eastern South Island. The river floodplain supports indigenous vegetation, including at least three Threatened and 19 At Risk plant species.

11. Ecological assessments have concluded that the vegetation and habitats of the Tekapō River floodplain are ecologically significant and worthy of protection.

12. Natural vegetation succession on the floodplain of Tekapō River is typically stonefield → mossfield/lichenfield → herbfield → grassland → shrubland. Vegetation succession is influenced by the rate at which the substrate accumulates wind-blown silt and invasion by naturalised (exotic) species. Natural vegetation succession at this climatically harsh location is typically a long slow process, spanning decades.

13. The vegetation of the Tekapō River floodplain is not replicated elsewhere in the Waitaki Basin (except at the Pūkaki and lower Ōhau rivers). The climate at this eastern part of

the basin is drier, warmer, frostier and has a wider temperature range than the climate at river floodplains above the lakes. Accordingly, the vegetation is distinct from that which occurs on braided river floodplains elsewhere in the basin.

14. A naturally functioning braided riverbed system re-sets vegetation succession by periodically creating new floodplain surfaces. This natural functioning has been lost by the dewatering effect of the Tekapō Power Scheme. The long-term outcome will be uninterrupted vegetation succession, resulting in a dominance of grassland, shrubland and forest, and a corresponding loss of stonefield, mossfield/lichenfield and herbfield.

15. The effects of dewatering continue today. The river flow regime exerts a critical influence over the presence of vegetation. Taller – mostly exotic – species will progressively overwhelm the ecologically significant low-stature vegetation associated with the floodplain and will displace the Threatened and At Risk species that rely on those floodplain habitats. These adverse effects are significant.

16. Geomorphological evidence is that maintenance of the naturally-occurring extent of floodplain vegetation and habitat would require – at least – restoration of natural river flows. Flushing flows are unlikely to be sufficient to maintain the extent of floodplain surfaces unless they can replicate the natural variation and duration of flood events.

17. If natural flows are not restored, weed control would provide the most effective mitigation. However, weed control would only slow – not prevent – plant succession on floodplain surfaces. Other actions would be required to compensate for the loss of the ongoing dynamic cycle of creation and loss (through flood events) of floodplain surfaces and thereby the loss of the distinct vegetation they support.

18. The effects management actions proposed by Genesis will not adequately compensate for the loss of floodplain vegetation. The most effective action would be restoration of natural flows. Otherwise, compensation should include more extensive weed control and/or protection of similar vegetation elsewhere in the Waitaki Basin.

Terrestrial Ecology of the Tekapō River Floodplain

19. The indigenous biodiversity values of Waitaki Basin river floodplains affected by operation of the Waitaki Power Scheme (**WPS**) (including the TPS) were described in 1984 in a Protected Natural Areas Programme (PNAP) report.[5] The report recommended formal protection for the beds of the Pūkaki, lower Tekapō, and Ōhau rivers.

20. Vegetation of braided rivers in the upper Waitaki catchment was surveyed during the 2002-2003 summer season. I organised and implemented the field survey, on contract to the Department of Conservation/Project River Recovery (**PRR**). Vegetation and environmental factors were surveyed and assessed at 737 locations (unbounded RECCE plots) in eleven braided river systems upstream of Lake Benmore. The results of that survey were subsequently published.[6]

21. The PRR survey data have limitations for assessing ecological values of the Tekapō River floodplain, as the survey extent was arbitrarily set as the boundaries of Unallocated Crown Land (**UCL**). Therefore, a significant proportion of plots were located on higher older terraces, outside the recent floodplain of the river. However, the survey data do provide useful comparisons between braided riverbed vegetation at different parts of the Waitaki Basin.

22. I surveyed the terrestrial ecology – principally vegetation – of the Tekapō River[7] in 2016 and 2017 as part of a review of Sites of Natural Significance (**SONS**) for Mackenzie District Council. This work comprised approximately 54 hours field survey and resulted in confirmation of the ecological values of SONS 45[8] and descriptions of those values in eight separate reports. The work included survey and provision of herpetofauna advice.

23. The applicant's assessment of the terrestrial ecology (vegetation) of the Tekapō River is presented in a 2023 AEE prepared by Ecological Solutions.[9] The AEE description of

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[5] Espie, P.R.; Hunt, J.E.; Butts, C.A.; Cooper, P.J.; Harrington, W.M.A. 1984. *Mackenzie Ecological Region, New Zealand Protected Natural Areas Programme*. Department of Lands and Survey, Wellington.

[6] Woolmore, C.B.; 2011. The vegetation of braided rivers in the upper Waitaki basin, South Canterbury, New Zealand. *Canterbury Series 0211*. Department of Conservation, Christchurch.

[7] The area of UCL within which lies the Genesis operating easement and which includes higher terraces and terrace risers adjacent to the river floodplain.

[8] The extent of SONS 45 is illustrated in Appendix 3.

[9] Bramley, G. 2023. Tekapo Power Scheme Reconsenting, Assessment of Effects – Vegetation. Ecological Solutions report to Genesis Energy Limited, May 2023. 58p + appendices.

floodplain vegetation is derived from just ten 5m x 5m survey plots and only from the upper reaches of the river (above Grays River confluence). The vegetation survey recorded only six indigenous species at the Tekapō River plots, including only one "herb", an unidentified mat daisy (*Raoulia* species).[10] The vegetation description in the AEE is inadequate and uninformative.

24. A fuller description of the vegetation of the Tekapō River floodplain is described below and illustrated in Appendix 1. This description is based on data collected during the 2016/2017 SONS surveys. Vegetation most affected by dewatering of the TPS rivers is that on recent floodplain surfaces, corresponding with early floodplain development stages.[11]

25. Young (frequently disturbed) floodplain surfaces are dominated by bare ground (cobbles, stones and gravel). Typical colonising indigenous species, often sparsely and patchily distributed, are crustose lichens, willowherbs (*Epilobium melanocaulon* and *E. rostratum*), mat daisies (*Raoulia* species), creeping pohuehue (*Muehlenbeckia axillaris*) and mosses, notably *Racomitrium* species and wire moss (*Polytrichum juniperinum*).

26. Abandoned (less frequently disturbed) floodplain surfaces are then colonised by low-growing indigenous species, including leafless pohuehue (*Muehlenbeckia ephedroides*), *Helichrysum depressum*, harebell (*Wahlenbergia albomarginata*), *Convolvulus verecundus*, patotara (*Leucopogon fraseri*), *Pimelea sericeo-villosa* subsp. *pulvinaris*, woodrush (*Luzula rufa* var. *albicomans*), *Carex breviculmis*, *Colobanthus brevisepalus*, *Scleranthus uniflorus*, *Poa lindsayii*, *Lachnagrostis lyallii* and lichens, notably *Xanthoparmelia* and *Cladia* species. Many other – less common – indigenous species may be present and there is considerable variation in vegetation composition, depending on physical factors and disturbance.

27. Ubiquitous naturalised (exotic) species on floodplain surfaces include sheep's sorrel (*Rumex acetosella*), lotus (*Lotus pedunculatus*), viper's bugloss (*Echium vulgare*), mouse-ear hawkweed* (*Pilosella officinarum*), St John's wort (*Hypericum perforatum*), Yorkshire fog (*Holcus lanatus*) and sweet vernal (*Anthoxanthum odoratum*). Other locally common exotic species include stonecrop (*Sedum acre*), Russell lupin (*Lupinus polyphyllus*), sweet brier (*Rosa rubiginosa*), poplar (*Populus* species) and willow (*Salix* species).

[10] Bramley, 2023, page 41.
[11] Vegetation at stages of floodplain development is illustrated in Appendix 1 of this Evidence.

28. Stable surfaces, undisturbed by flood flows, are progressively colonised by both indigenous and exotic species, including pines* (*Pinus* species), silver birch* (*Betula pendula*), sweet brier*, gorse* (*Ulex europaeus*), Scotch broom (*Cytisus scoparius*), matagouri (*Discaria toumatou*), mikimiki (*Coprosma propinqua*), native broom (*Carmichaelia petriei*), tree daisy (*Olearia odorata*), porcupine shrub (*Melictyus alpinus* agg.), scrub pohuehue (*Muehlenbeckia complexa*) and fescue tussock (*Festuca novae-zelandiae*).

29. The AEE lists only one Threatened plant species (*Carmichaelia corrugata*), observed in tussock grassland near the Tekapō Canal, and nine At Risk plant species, most of which were observed in grassland habitats near the canal.[12] The list of Threatened and At Risk plant species in the AEE is incomplete and inadequate, especially for the purpose of assessing ecological significance of the floodplain. I observed three Threatened and 19 At Risk plant species during my surveys of the Tekapō River floodplain (listed below in paragraphs 33 & 34; some species are illustrated in Appendix 2).

Significance of Terrestrial Ecology

30. The Tekapō River corridor comprises fluvioglacial landforms (moraine, inland outwash gravels and braided riverbeds), which are classified as naturally uncommon ecosystems.[13] Indigenous vegetation or habitat of indigenous fauna occurring on naturally uncommon ecosystems are ecologically significant when assessed against criteria in the Canterbury Regional Policy Statement (**CRPS**) and National Policy Statement for Indigenous Biodiversity (**NPS-IB**).

31. The Tekapō River corridor buffers and links other indigenous vegetation and habitat of the intermontane Waitaki Basin, contributing to the most extensive undeveloped indigenous ecosystems on depositional landforms remaining in the eastern South Island. The river corridor is part of extensive intact sequences that are not replicated at this scale elsewhere in the country; those sequences are nationally significant.[14]

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[12] Bramley, 2023, page 48.
[13] Williams, P.A.; Wiser, S.; Clarkson, B.; Stanley, M.C. 2007. New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. *NZ Journal of Ecology 31*: 119-128.
[14] Statement of Evidence, Dr Susan Walker, Mackenzie District Plan Change 18, June 2024 (ENV-2021-CHC-94), para 14.

32. The river floodplain supports stonefield, mossfield-lichenfield, herbfield, grassland and shrubland vegetation.[15] This vegetation is commonly present as a mosaic of vegetation types, depending on the characteristics and age of the substrate. Exotic plant species are present and in places dominant. Nevertheless, the vegetation at most parts of the river corridor meets the Mackenzie District Plan (**MDP**) and NPS-IB definitions for 'indigenous vegetation' and is typical and characteristic (representative) of the vegetation of the Mackenzie Ecological Region.

33. Threatened and At Risk species[16] recorded from SONS surveys of the alluvial terraces (wider floodplain) of Tekapō River include:

Anthosachne falcis ..... At Risk (declining)
Carex resectans ..... At Risk (declining)
Carmichaelia nana ..... Threatened (nationally vulnerable)
Colobanthus brevisepalus ..... At Risk (declining)
Convolvulus verecundus ..... At Risk (declining)
Coprosma brunnea ..... At Risk (declining)
Lepidium solandri ..... Threatened (nationally critical)
Luzula ulophylla ..... At Risk (declining)
Muehlenbeckia ephedroides ..... At Risk (declining)
Pimelea sericeovillosa subsp. *pulvinaris* ..... Threatened (nationally vulnerable)
Poa maniototo ..... At Risk (declining)
Raoulia australis ..... At Risk (declining)
Raoulia beauverdii ..... At Risk (declining)
Raoulia monroi ..... At Risk (declining)
Raoulia parkii ..... At Risk (declining)
Xanthoparmelia semiviridis ..... At Risk (declining)

34. Additional notable species on older terrace surfaces are:

Acaena buchananii ..... At Risk (declining)
Carmichaelia petriei ..... At Risk (declining)
Carmichaelia vexillata ..... At Risk (declining)
Leucopogon nanum ..... At Risk (declining)
Olearia odorata ..... At Risk (declining)
Rytidosperma exiguum ..... At Risk (declining)

[15] Vegetation structural classes follow the method proposed by: Atkinson, I.E.A. 1985. Derivation of mapping units for an ecological survey of Tongariro National Park, North Island, New Zealand. *NZ Journal of Botany 23*: 361-378.

[16] As listed by de Lange, P.J; Gosden, J.; Courtney, S.P; Fergus, A.J.; Barkla, J.W; Beadel, S.M.; Champion, P.D; Hindmarsh-Walls, R.; Makan, T.; Michel, P. 2024. Conservation status of vascular plants in Aotearoa New Zealand, 2023. *New Zealand Threat Classification Series 43.* Department of Conservation, Wellington, New Zealand; & de Lange, P.J.; Blanchon, D.; Knight, A.; Elix, J.; Lücking, R.; Frogley, K.; Harris, A.; Cooper, J.; Rolfe, J.R. 2018. Conservation status of New Zealand indigenous lichens and lichenicolous fungi, 2018. *New Zealand Threat Classification Series 27.* Department of Conservation, Wellington, New Zealand.

35. The ecological value of vegetation and habitat of the Pūkaki, lower Tekapō, and Ōhau river corridors was recognised by the PNAP survey in the early 1980s, which listed the beds of those rivers as Recommended Area for Protection (RAP) P-15.[17] The Tekapō River was listed as SONS 45 in the MDP in the 1990s and remains scheduled in Appendix I of the operative MDP. The location of the scheduled Tekapō River SONS is illustrated in Appendix 3 of this Evidence.

36. The AEE describes the vegetation of the Tekapō River floodplain as "of low ecological quality and low ecological value" and states that the only ecologically significant vegetation is "grey shrubland" which "is scattered along the Tekapo River in patches of varying size and integrity".[18] The AEE ecological significance assessment does not represent best ecological practice, is inconsistent with application of the CRPS,[19] and conflicts with the MDP.

37. The 2016/2017 SONS surveys confirmed that vegetation and/or habitat of most parts of the Tekapō River corridor are ecologically significant when assessed against the CRPS criteria. It is likely that a contemporary assessment against the NPS-IB criteria would identify areas that are larger and more contiguous as ecologically significant.

38. Further, the vegetation of the Tekapō River floodplain is distinctive; it is not replicated elsewhere in the Waitaki Basin (except at the Pūkaki and lower Ōhau rivers). The climate at this part of the basin is drier, warmer, frostier and has a wider temperature range than the climate at river tributaries above the lakes.[20] Accordingly, vegetation of the Tekapō River (and Pūkaki and lower Ōhau rivers) is distinct from that which occurs on braided riverbeds elsewhere in the Waitaki Basin.

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[17] Espie, P.R.; Hunt, J.E.; Butts, C.A.; Cooper, P.J.; Harrington, W.M.A. 1984. *Mackenzie Ecological Region, New Zealand Protected Natural Areas Programme*. Department of Lands and Survey, Wellington.

[18] Bramley, 2023, pages 43 & 45.

[19] The AEE makes no reference to published guidance for application of the CRPS (Wildlands. 2013. Guidelines for the application of ecological significance criteria for indigenous vegetation and habitats of indigenous fauna in Canterbury Region. *Contract Report 2289i*. Environment Canterbury, Christchurch).

[20] Woolmore, C.B.; 2011. The vegetation of braided rivers in the upper Waitaki basin, South Canterbury, New Zealand. *Canterbury Series 0211*. Department of Conservation, Christchurch, Table 2.

Physical and Ecological Processes Affecting the Tekapō River Floodplain

39. My expertise in the physical processes affecting river floodplains is from geology education (Otago University) and extensive field survey of riverbeds throughout the eastern South Island. For details of the geomorphology of the WPS river floodplains I rely on – and provide references to – the advice of other experts, notably that provided for the lower Tekapō, Pūkaki and Ōhau river floodplains.[21]

40. The geomorphology evidence is that the WPS river floodplains (including the Tekapō River floodplain) are on a long-term trajectory of degradation (down-cutting) as the rivers incise into the fluvio-glacial outwash sediments, leaving the rivers confined between higher terraces.[22] Geomorphic processes affecting the present floodplains of the WPS rivers are largely influenced by flood flows, as flood flows drive bedrock transport, bank erosion, and vegetation removal.[23]

41. The WPS alters the flow regime and supply of sediment to the rivers. It has impacted – and continues to impact – the geomorphic forms of the rivers. The WPS buffers the effects of high inflows when storage is available in the system (hydro lakes) and thereby reduces the effectiveness of flood events.[24] The geomorphology of the Pūkaki and lower Tekapō rivers has been "extremely stable" since the commissioning of the Pūkaki control structure in 1978.[25] The impacts of the TPS on the Tekapō River are similar.

42. The vegetation present on the Tekapō River floodplain is determined principally by the age and characteristics of the floodplain surface and the proximity of other vegetation (propagules/seed sources). I am familiar with the stages of vegetation succession on river floodplains from my extensive experience surveying indigenous vegetation and infestations of naturalised (weed) species on eastern South Island riverbeds.

43. The natural succession on early stage floodplain surfaces is generally stonefield → mossfield/lichenfield → herbfield → grassland → shrubland. Vegetation succession is influenced initially by the substrate (particle size) and subsequently by the rate at which the substrate accumulates wind-blown silt (loess) and the presence of seed sources.

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[21] Hoyle, J. 2023. Assessment of Environmental Effects of the Waitaki Power Scheme, River Geomorphology. NIWA.
[22] Statement of Evidence, J. Hoyle, 25 May 2025, para 74.
[23] ibid, para 19.
[24] ibid, para 18-19.
[25] ibid, para 75.

Natural indigenous vegetation succession on river floodplains – especially at this climatically harsh location – is typically a long slow process, spanning decades.

44. In May 2025 I surveyed vegetation at locations on the Pūkaki and Ōhau river floodplains at which I had surveyed vegetation during the 2017/2018 SONS surveys. At two GPS-referenced locations I repeated the survey method (unbounded RECCE plot)[26] undertaken during that earlier survey. The survey results confirm that vegetation succession is still occurring – albeit very slowly – at locations unaffected by flood flows. I expect that the results of resurveying locations on the Tekapō River would be similar.

45. The suite of vegetation types – and successional stages – on the river floodplains are maintained by disturbance. The mosaic of vegetation types is dynamic; that dynamism is driven by flood scour, changing river channels, and newly deposited floodplain surfaces. The distinct vegetation and the populations of Threatened and At Risk species are maintained by these physical processes.

Adverse Effects of the Tekapō Power Scheme

46. The main effect of water extraction (dewatering) on terrestrial vegetation associated with the TPS has been the stabilisation of floodplain[27] surfaces of the Tekapō River. The geomorphology of the river is now stable, and the river form is fixed, due to flow diversion and limited spill releases.

47. The reduction in frequency and scale of flood flows has halted the natural floodplain development processes of the river system. Previously, the river meandered across a wider bed, alternately eroding (removing) and creating river terraces. Now, the geomorphology of the Tekapō River is extremely stable.

48. Prior to the TPS, flood flows were mitigated by Lake Tekapō, but not to the extent which prevented the maintenance of a meandering channel across a wider braided river floodplain. The historic meander and wider floodplain of the Tekapō River are evident in pre-TPS aerial images. The TPS has further mitigated/dampened the effects of flood flows, the results of which are the stabilisation and channelisation of the Tekapō River.

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[26] Hurst, J.M.; Allen, R.B.; Fergus, A.J. 2022. The Recce Method for describing New Zealand vegetation – expanded manual, Version 5. Landcare Research-Manaaki Whenua, Lincoln, New Zealand.

[27] The term 'floodplain' is defined as the extensive horizontally bedded alluvial landform occurring within or adjacent to the unvegetated active riverbed. (Reinfelds, I.; Nanson, G. 1993. Formation of braided river floodplains, Waimakariri River, New Zealand. *Sedimentology 40*: 1113-1127.)

49. Dewatering reduces the power of the rivers to change course/meander and reduces their ability to mobilise and transport riverbed sediment. The effect is a stabilised – and increasingly armoured – river channel which is less likely to meander across the floodplain.[28]

50. A naturally functioning braided river system re-sets vegetation succession by periodically creating new floodplain surfaces. The natural functioning of the Tekapō River has been lost through dewatering. The long-term outcome will be the eventual dominance of grassland, shrubland, and then exotic forest vegetation, on floodplain surfaces. The extent of mossfield-lichenfield-herbfield vegetation will be much reduced – or eventually disappear – because no new floodplain surfaces will be created.

51. The Applicant's vegetation AEE is consistent with this conclusion. It states that dewatering of the Tekapō River has "reduced the natural process of erosion – deposition – aggradation within those sections of the braided river, which will in turn have created a more stable environment for vegetation, altering the frequency of disturbance and allowing species composition to change". The AEE further states that "maintaining the low flows in the Tekapo River will maintain the current vegetation which over time has developed vegetation typical of stable river edges (i.e., a higher proportion of long-lived woody species adapted to stable environments)".[29]

52. The effects of dewatering continue today. The river flow regime exerts a critical influence over the presence of vegetation.[30] Riverbed surfaces that would have been previously re-worked by flood flows are now being colonised by species – many of which are exotic – that favour stable substrates. This succession to vegetation dominated by exotic grasses and woody species (shrubs and trees) will continue to overwhelm the ecologically significant low-stature floodplain vegetation and will displace the Threatened and At Risk plant species that rely on those floodplain habitats.

53. The adverse effects of the operation of the TPS (dewatering of rivers) on floodplain vegetation are significant. The loss of natural flows from the river has altered ecological processes, notably the disturbance upon which the long-term persistence of floodplain

[28] Hoyle, J. 2023. Assessment of Environmental Effects of the Waitaki Power Scheme, River Geomorphology. NIWA.
[29] Bramley, 2023, page 45.
[30] Stecca, G.; Hicks, D.M.; Measures, R.; Henderson, R. 2023. Numerical modelling prediction of vegetation trajectories under different flow regimes in New Zealand braided rivers. *Journal of Geophysical Research: Earth Surface 128*.

vegetation relies. The eventual outcome will be the loss of this ecologically significant and distinctive vegetation.

54. In addition, naturalised (exotic) plant species exert considerable influence over the composition of floodplain communities, including those species planted for flood protection purposes.

Management of Adverse Effects

55. Maintenance of the full range and extent of floodplain indigenous vegetation and habitat would require the ongoing erosion (loss) and deposition (creation) of floodplain surfaces. Flushing flows are unlikely to be sufficient to restore and maintain floodplain surfaces unless they can replicate the natural variation and duration of flood events.[31] Restoration of natural flows to the Tekapō River is required to maintain the natural dynamic functioning of its river floodplain.

56. Restoration of a naturally functioning river floodplain may require more than a cessation of water extraction. It may also require modification of the existing armoured channel of the river to allow the river to meander across its former floodplain.

57. Maintenance of indigenous vegetation/habitat would also require control of naturalised (exotic) plants throughout the river system. Wider landscape-scale control of invasive weeds (especially seed sources of species such as wilding conifers) would increase the sustainability – and ultimately reduce the costs – of floodplain weed control.

58. However, weed control (removal of colonising exotic plant species from floodplain surfaces) would not prevent vegetation succession on stable floodplain surfaces. Natural vegetation succession and other factors, notably deposition of wind-blown silt and subsequent soil development, would eventually lead to the demise of the early stage floodplain vegetation. The natural extent of floodplain vegetation can only be maintained by the continued creation of new floodplain surfaces, as would occur on the floodplain of a naturally functioning river.

59. In other words, control of invasive species would only partially mitigate the loss of floodplain vegetation, if natural flows are not restored. Weed control alone – regardless

[31] Stecca, G.; Hicks, D.M.; Measures, R.; Henderson, R. 2023. Numerical modelling prediction of vegetation trajectories under different flow regimes in New Zealand braided rivers. *Journal of Geophysical Research: Earth Surface 128*, page 20.

of scale – will not maintain the natural extent of floodplain vegetation in the Tekapō River corridor. Further compensation is required to address that loss.

60. The eventual outcome of dewatering of the Tekapō River and inadequate weed control will be the loss of a distinctive and ecologically significant vegetation type, and a suite of Threatened and At Risk species' populations, both of which are not replicated elsewhere.

Proposed Compensation

61. Genesis proposes compensation by way of an Indigenous Biodiversity Enhancement Programme (**IBEP**), the objective of which is "Improve the condition, resilience, biodiversity, ecological processes and other values of representative examples of the following features within the Waitaki Catchment" including "Braided rivers (both aquatic, within the braid plain) and their margins".[32]

62. Parts of the vision that are relevant to vegetation are to increase habitat availability for indigenous flora and fauna through weed control, and to increase populations of some threatened species through browser control.[33] Proposed priority actions for Tekapō River are "weed and predator management" in the "upper reach of the Takapō River which has relatively low infestations of woody weeds and moderate levels of residual populations of key threatened species".[34]

63. In my assessment, the principal compensation proposed for the Tekapō River (weed management) will not compensate for the loss of terrestrial vegetation values because it does nothing to prompt the ongoing creation of new floodplain surfaces. Further, restricting weed management to the upper reaches (including Fork Stream) means that the terrestrial ecological values of the other parts (most) of the remaining stabilised Tekapō River floodplain surfaces will progressively decline.

[32] Genesis Energy Limited – Tekapo Power Scheme Replacement Resource Consents AEE, April 2025, pages 178-179.
[33] ibid, pages 183-184.
[34] Kahu Ora – Draft 10-year Strategic Plan (Indigenous Biodiversity Enhancement Programme) 2025, page 34.

Appropriate Compensation

64. The magnitude of the compensation required to adequately address the adverse effects of the TPS on floodplain vegetation of the Tekapō River is difficult to calculate. The Department of Conservation costed five scenarios for managing the effects of the WPS (including effects on the Tekapō River system). The estimated cost of Scenario A (all biodiversity values are managed at all places) is $658 million, or $18 million per year for 35 years. [35]

65. Costs were calculated for each "work plan" for a 35-year consent period. The total cost of weed control across all rivers in the Waitaki catchment was calculated to be $5.5 million per year.[36] The cost of comprehensive weed control on the floodplain of the Tekapō River does not appear to have been calculated separately.

66. Historic expenditure, through Project River Recovery is not informative, as the objective of PRR weed control was principally to maintain open (sparsely vegetated) habitats for riverbed birds, rather than to maintain the vegetation typical of floodplain surfaces. It appears that maintenance of the distinct floodplain vegetation of the Tekapō River was not actively considered during the development of PRR.[37]

67. Evidence of this objective is the weed control methods employed. My observations of the Pūkaki and lower Tekapō rivers indicate that weed control is typically boom-spraying of the existing floodway (open riverbed), not the wider floodplain. A weed control programme that provides compensation for the effects of the TPS on the Tekapō River would include all floodplain surfaces and would employ selective weed control methods which avoid the loss of indigenous plant species.

68. If natural flows are not restored to the Tekapō River, additional compensation would be necessary to adequately compensate for the adverse effects of the activity. This is because weed control alone will not maintain the ecological values of the floodplain vegetation. A more appropriate level of compensation could be wider-scale weed control and/or the protection of similar vegetation elsewhere in the Waitaki Basin.

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[35] Lewis, D.; Maloney, R. 2020. A costing assessment of potential mitigation actions for hydro-electric activity in the Waitaki River catchment. Department of Conservation, page 18.
[36] ibid, page 13.
[37] Statement of Evidence, K Hughey, 28 May 2025, para 106.

69. A key threat to floodplain vegetation, and to other parts of the river corridor within the Genesis operating easement, is the spread of wilding conifers. Wilding conifer control is the type of programme that would benefit from an ongoing funding commitment. Long-term funding would help ensure that wilding conifer control is sustainable, as funds would be secure for ongoing control following the removal of seed sources.

70. There is a Mackenzie Wilding Conifer Strategy, of which Genesis Energy is listed as a key participant.[38] Full implementation of the strategy requires a substantial increase in funding and continued annual funding. The Strategy estimated that – in 2016 – an additional $28 million would be required to remove all existing wilding conifers across the 129,000ha infestation area. It estimated that, with an annual expenditure of between $4 and $5 million, the total additional investment required would be $40-$50 million.[39]

71. Follow-up control is necessary to sustain the initial control effort. For example, for one of the four Mackenzie Basin subzones (4-West) it will take nearly 14 years to achieve wilding conifer control at an initial cost of $15 million and follow-up cost of $2 million annually.[40]

72. A contribution to wilding conifer control, by way of compensatory funding from Genesis, could make the difference between sustainably managing wilding conifer infestations in the Waitaki Basin or the continued widespread loss of ecological and farming values.

73. Compensation through protection of similar vegetation would be more difficult to achieve, as the floodplain vegetation of the Tekapō River is not replicated elsewhere. However, components of that vegetation, such as many of the At Risk and Threatened species, are present at other undeveloped – and unprotected – dryland sites in the Waitaki Basin.

74. The most important remaining undeveloped dryland ecosystem in the Waitaki Basin is the fluvioglacial outwash plain of the Tekapō River. Most parts of this ecosystem lie within Crown Pastoral Lease and are not formally protected. Ecological values of this

[38] Mackenzie Wilding Conifer Strategy, Te Manahuna Consulting, 2016, page 40.
[39] ibid, pages 11-12.
[40] ibid, pages 42-43.

area are threatened by plant and animal pests and potentially threatened by land-use change.

75. A contribution to formal protection and long-term management of the terrestrial ecological values of the Tekapō outwash ecosystem, by way of compensatory funding from Genesis, could make the difference between survival of this nationally threatened dryland ecosystem or its gradual decline and eventual loss. Further investigation – including consultation with affected parties – would be required to estimate the likely costs of that type of compensation.

76. In summary, the effects management proposed in the Kahu Ora Strategic Plan (IBEP) will not compensate for the loss of floodplain vegetation on the Tekapō River. Further compensation, such as that described above, is required to address those adverse effects.

Mike Harding
18 August 2024

Appendix 1: Floodplain Development Stages

Photo 1: Sparsely vegetated active riverbed, with At Risk mat daisy (*Raoulia australis*).

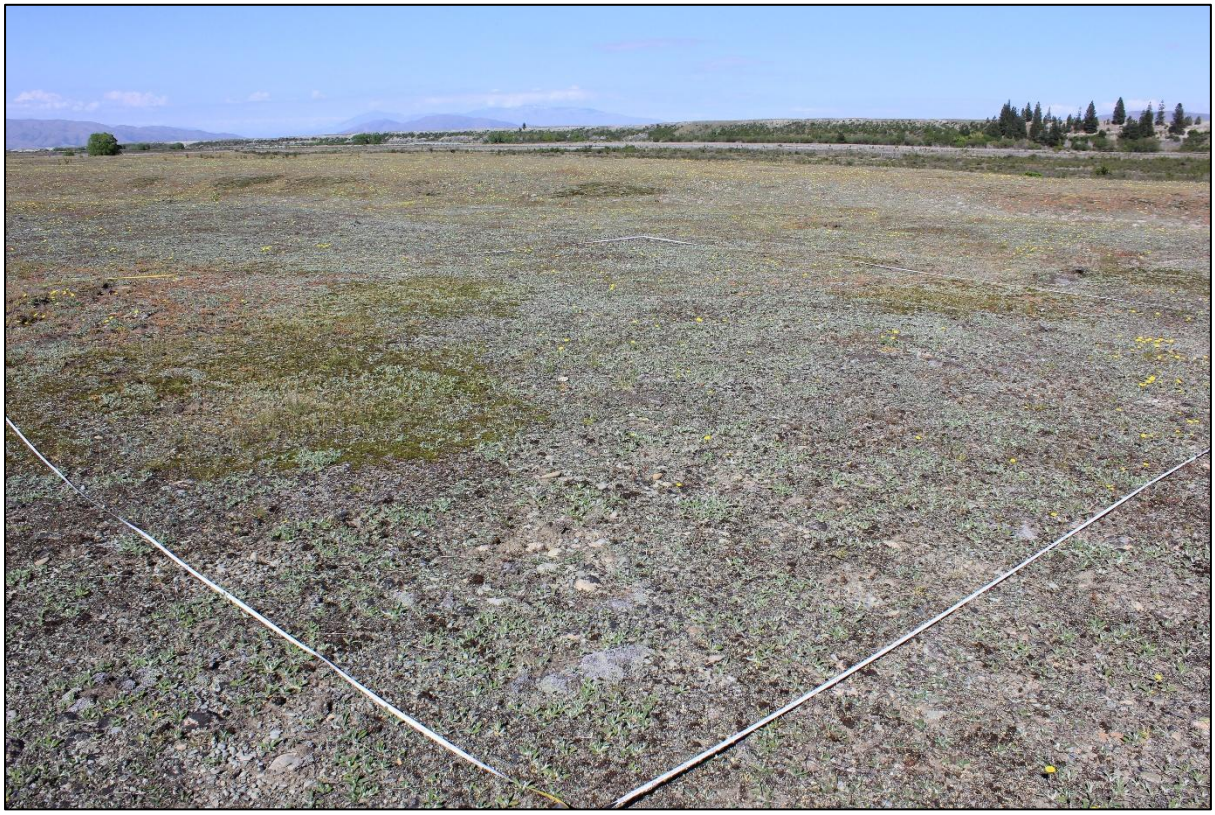


Photo 2: Stabilised riverbed/young floodplain surface.

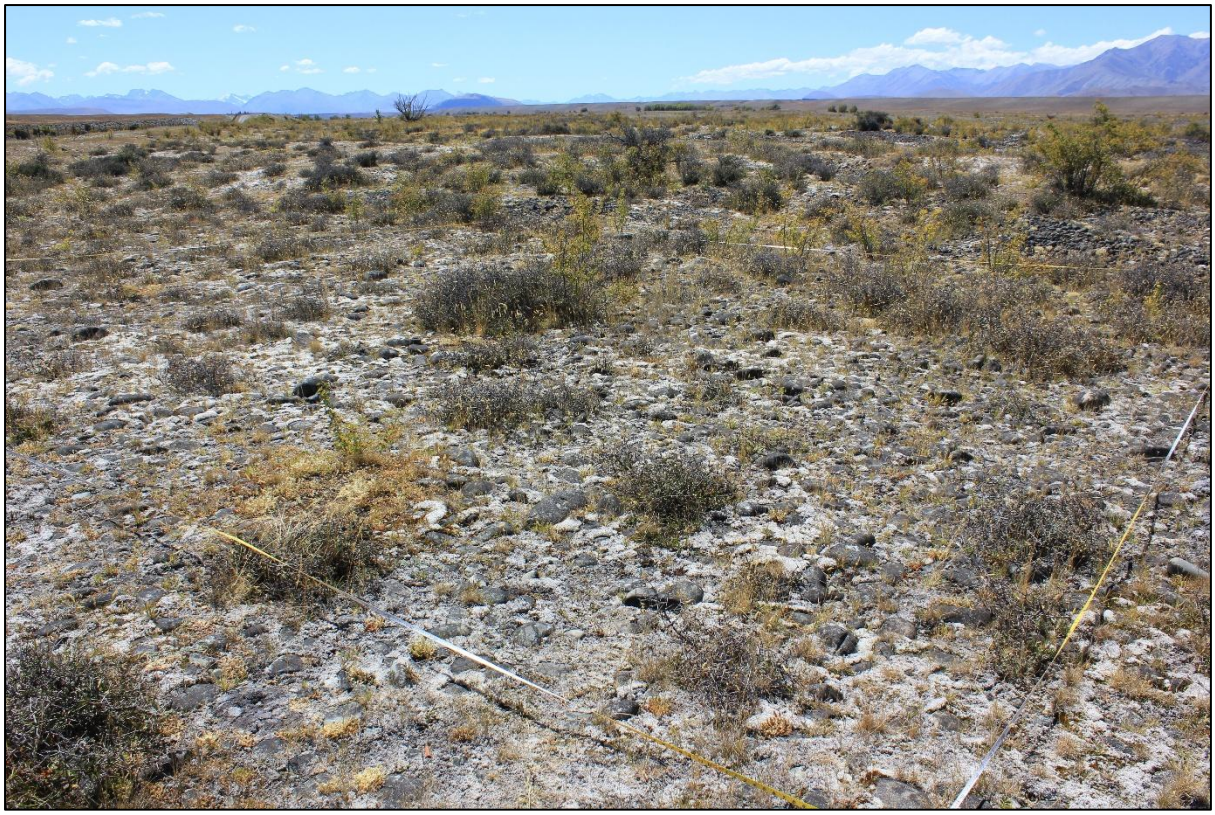


Photo 3: Abandoned riverbed/older floodplain surface.

Photo 4: Old/mature floodplain surface.

Appendix 2: Examples of Threatened and At Risk Plant Species

Photo 5: Threatened (nationally critical) dryland cress (*Lepidium solandri*).

Photo 6: At Risk (declining) *Colobanthus brevisepalus*.

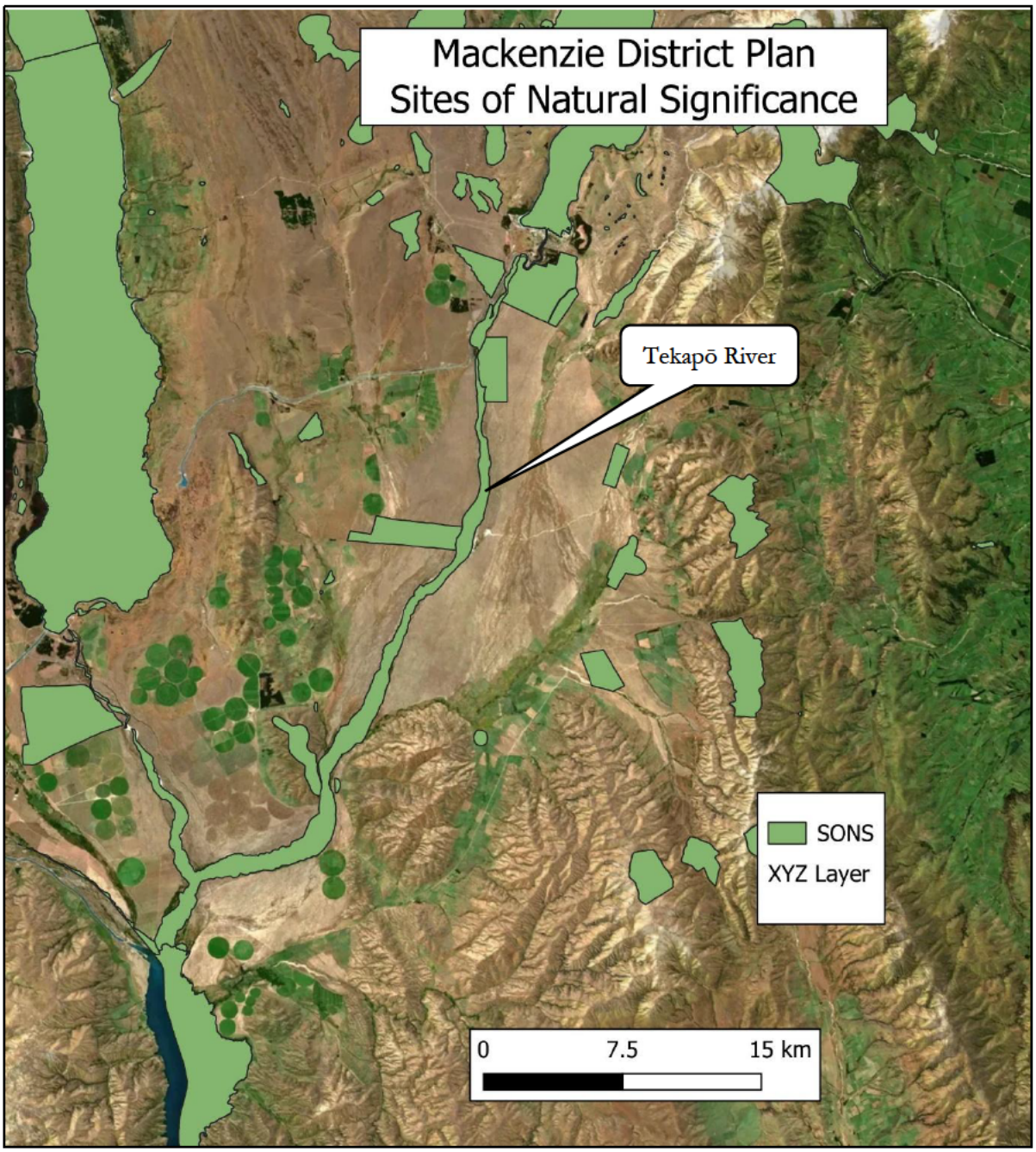
Photo 7: At Risk (declining) native convolvulus (*Convolvulus verecundus*).

Photo 8: Threatened (nationally vulnerable) native broom (*Carmichaelia nana*), with *Colobanthus brevisepalus* (centre).

Photo 9: At Risk (declining) daisy (*Raoulia monroi*).

Photo 10: Threatened (nationally vulnerable) *Pimelea sericeovillosa* subsp. *pulvinaris*.

Appendix 3: MDP Sites of Natural Significance (SONS)



Sites of Natural Significance (SONS/aka SNAs) in Mackenzie District Plan, Appendix I.