WILLIAMSON
WATER & LAND ADVISORY

Unit 10 | 1 Putaki Drive | Kumeu
Auckland | New Zealand
T +64 21 65 44 22
E jon.williamson@wwla.kiwi
W www.wwla.kiwi

Environment Canterbury Regional Council

Attention: Reuben Herz-Edinger
reuben.herz-edinger@ecan.govt.nz

31 October 2023 WWLA0631

Dear Rueben,

The Point Solar Farm Operational and Construction Phase Stormwater Discharges (CRC240932 - CRC240933) – Response to Further Information Request

This letter has been prepared in response to your letter dated 24 October 2023 requesting further information pursuant to section 92 of the Resource Management Act 1991 (RMA) for the above resource consent. The information requested is shown in *blue* italics, followed by our response, and our numbering corresponds to the numbering set out in your letter.

1. Description of Ecology of the Site

a. Please provide a description of the existing ecology at the site, including (but not limited to) specific descriptions of:

i. Potential lizard habitats within the development area.

ii. Areas surrounding developed pasture, including areas adjacent to scraps/river terraces.

iii. Areas referenced as Channel A and Channel B in the Stormwater Assessment.

iv. Existing ecological values within the proposed landscape amenity planting area.

b. Please provide an assessment of the ecological significance of any areas potentially affected by stormwater runoff against the Canterbury Regional Policy Statement criteria for significance.

c. Please provide a description of any potential effects of the proposal on the ecology of the site.

An Ecological Assessment has been prepared for this proposal and is provided in **Attachment A**.

2. Description of Methodology for Cleaning Solar Panels

There exist a variety of techniques for cleaning solar panels. Some of these techniques include the use of detergents / cleaning chemicals, which would form part of the runoff at the site, and may require further assessment.

a. Please provide a description of the methodology to be used for cleaning solar panel arrays at the site. In this description please include:

i. Description of the expected frequency of cleaning.

ii. Description of materials to be used (e.g., water quantity, detergent use).

iii. Description of any additional discharges generated by cleaning.

The panels will require cleaning infrequently (1-2 times a year at most). This will involve washing the panels with water only and a brush / cloth. No detergent will be used.

b. If cleaning chemicals of any kind are to be used for operation of the solar farm, please provide an assessment of the discharge of these chemicals under Rule 5.98 of the Canterbury Land and Water Regional Plan.

As noted above, no detergents or chemicals will be used to clean the panels.

3. Description of Solar Panel Arrays

Canterbury Regional Council Contaminated Land science advice requested further information on the composition of the solar panel arrays. Further information on the makeup of the solar panels, as well as their support structures, was requested to better understand potential effects of stormwater runoff from these structures.

a. Please provide a description of the construction of the solar arrays, including materials used for the support structures (including the piles and frame supports).

The solar arrays consist of steel structures and each table is attached to the ground by eight steel poles, centralised along its length. The panels are mounted in a single, portrait format (known as 1P), with the pivot in the middle of the 2 m high panel. They will rotate during the day and have positions for high wind and snow events. They will start each day at a relatively low angel (to prevent shading of other panels) and tilt up as the sun rises higher, then once self-shading occurs, they will reduce their angle and be almost flat again at sunset.

The PV solar cells are made of semi-conductor material, such as crystalline-silicon, which is enclosed by a glass laminate encapsulation.

b. Please confirm if the solar panels have glass laminate encapsulation.

Yes, all PV solar panels will be encapsulated with glass laminate.

4. Description of Livestock Grazing

The AEE states that "low scale sheep grazing" would be employed at the site to manage weeds and minimise fire risk. CRC Land Resources advice was that sheep may create high-traffic or 'camping' areas which could increase soil compaction and alter the risks for soil erosion and sediment discharges due to stormwater runoff.

a. Please provide a description of the expected numbers and density of sheep to be grazing within the site.

It is expected that no more than 150-200 sheep will be grazed across the entire site, noting that this is not the primary purpose of the site. Sheep grazing is proposed to maintain grass underneath the panels only, therefore sheep numbers will be low-density.

b. Please provide an assessment of how sheep behaviour may influence soil compaction and erosion potential from stormwater runoff.

As noted above, sheep numbers of the site will be of a low density, across a very large site area. Furthermore, sheep will only be grazing on pasture areas (between the panels) and will be rotated across the site to ensure grass is maintained and to avoid excessive soil compaction and erosion.

On that basis, the risk of soil compaction and erosion potential from stormwater runoff is considered very low.

5. Demonstrate that Farming Activity at the Site is Allowed

The application states that the site currently grazes cows and sheep, and that sheep grazing would be used at the site to control gras and manage fire risks. However, it is not clear to CRC that such farming activity is currently permitted at the site.

a. Please confirm that farming activities at the site are allowed either through a resource consent, or through permitted activity rules in the Waitaki sub-regional rules of Section 15B of the Canterbury Land and Water Regional Plan.

This is a matter for the landowner of the site to address and does not form part of this resource consent application. Any farming activity that is undertaken on the site once the solar farm is operational (i.e. sheep grazing) will be undertaken in accordance with either a permitted activity rule under Section 15B of the CLWRP or additional resource consents will be sought at that point.

6. Description of Expected Contaminants in Discharge

Section 4.3 of the Stormwater Assessment provides details of the expected temperature and E.Coli conditions of the discharge. No further description of contaminants expected in the discharge is provided. CRC Contaminated Land and Groundwater scientists have advised that other contaminants may be present in runoff from solar panel arrays.

a. Please provide a description of expected contaminant concentrations from solar array runoff.

The panels are fully encapsulated by glass laminate, and the piles are constructed of galvanized steel.

Stormwater will hit the panels, then soak to the ground beneath the panels, which will remain vegetated and permeable. On that basis, there is no expected contaminant concentrations from the runoff from the solar arrays.

7. Assessment of Hazardous Substances Stored at Site

The application does not include a description of possible hazardous substances that may be stored on site.

a. Please provide a description of any hazardous substances that may be stored at the site. Please include:

i. Description of any hazardous substances contained within infrastructure at the site, e.g. within any inverter units or transformer units (oils, acids etc).

The solar panels themselves are constructed of inert elements (e.g. silica, steel, glass), that are fully encapsulated. There are no hazardous substances stored on the site or within the invertors.

ii. Description of any hazardous substances stored on site for other reasons (e.g. cleaning chemicals, fuels, etc).

No hazardous substances will be stored on the site. No machinery will be refuelled on the site.

b. If hazardous substances will be stored on the site, please provide an assessment of this under the relevant rules of the LWRP (Rules 5.179-5.184).

As outlined above, there will be no hazardous substances stored on site and therefore Rules 5.179-5.184 of the LWRP are not applicable to this proposal.

Conclusion

We trust that there is now sufficient information available for you to continue processing the application. Please do not hesitate to get in touch if you require further clarification of any aspects of this letter.

Yours sincerely,

Laila Alkamil

Planner | 027 266 8405
Laila.Alkamil@wwla.kiwi | www.wwla.kiwi

ASSESSMENT OF ECOLOGICAL EFFECTS FOR THE PROPOSED ŌHAU C SOLAR FARM BETWEEN THE LOWER REACHES OF THE TEKAPO AND TWIZEL RIVERS, MACKENZIE DISTRICT

providing outstanding ecological services to sustain and improve our environments

Wildlands

R6621c

ASSESSMENT OF ECOLOGICAL EFFECTS FOR THE PROPOSED ŌHAU C SOLAR FARM BETWEEN THE LOWER REACHES OF THE TEKAPO AND TWIZEL RIVERS, MACKENZIE DISTRICT

A nearby induced wetland, off-site.

Contract Report No. 6621c

May 2023

Project Team:
Morgan Tracy – Report author
Rose Stuart – Report author
Justyna Giejsztowt – Report author
Roland Payne - Report author (botany)
Della Bennet – Report author (ornithology)
Fraser Gurney – Report author (ornithology)
Cameron Thorp – Report author (herpetology)
Vikki Smith – Report author (entomology)
William Shaw – Peer review

Prepared for:
Far North Solar Farms Ltd
C/- Williamson Water and Land Advisory
Auckland

CHRISTCHURCH OFFICE: 7A VULCAN PLACE, MIDDLETON, CHRISTCHURCH 8024;
P.O. BOX 9276, TOWER JUNCTION, CHRISTCHURCH 8149; Ph 03-338-4005

HEAD OFFICE: 99 SALA STREET, P.O. BOX 7137, TE NGAE, ROTORUA
Ph 07-343-9017; Fax 07-343-9018, email ecology@wildlands.co.nz, www.wildlands.co.nz

CONTENTS

1. INTRODUCTION 1

2. PROPOSED WORKS 1

3. METHODS 2
   3.1 Desktop assessments 2
   3.2 Field assessments 3
      3.2.1 Vegetation 3
      3.2.2 Avifauna 3
      3.2.3 Lizards 3
      3.2.4 Invertebrates 3

4. ECOLOGICAL CONTEXT 3
   4.1 General overview 3
   4.2 Pukaki Ecological District 4
   4.3 Nearby protected areas 4
   4.4 Nearby sites of natural significance 4
   4.5 Threatened Environment Classification 5
   4.6 Land Cover Database (LCDB) 5
   4.7 Potential natural vegetation 5
   4.8 Important Bird Area 5
   4.9 Braided rivers 5
   4.10 Notable existing environmental modifications 6
   4.11 Statutory context 6
      4.11.1 Ecological significance 6
      4.11.2 Mackenzie District Plan 6
      4.11.3 Wildlife Act 1953 7
      4.11.4 Natural wetlands 7
   4.12 Vegetation and habitats 8

5. FLORA 13
   5.1 Overview 13
   5.2 Threatened, at risk, and locally uncommon species 13
   5.3 Pest plants 14

6. AVIFAUNA 14

7. LIZARDS 15

8. TERRESTRIAL INVERTEBRATES 20

9. ECOLOGICAL VALUES 22

10. STATUTORY ASSESSMENT 23
   10.1 Assessment of ecological significance for vegetation and habitats on-site 23
   10.2 Assessment of ecological significance for vegetation and habitats off-site 24
   10.3 Mackenzie District Plan 25

11. POTENTIAL ECOLOGICAL EFFECTS 25
   11.1 Overview 25

11.2 Vegetation and flora 29
11.3 Avifauna 30
11.4 Lizards 31
11.5 Terrestrial invertebrates 32
11.6 Freshwater 33

12. MANAGEMENT OF POTENTIAL EFFECTS 34
12.1 Spatial design considerations 34
12.2 Vegetation and flora 36
12.3 Avifauna 37
12.4 Lizards 38
12.5 Terrestrial invertebrates 38
12.6 Freshwater fauna 39
12.7 Wildlife management 39
12.8 Ecological Enhancement Plan (EEP) 40
12.8.1 Overview 40
12.8.2 Indigenous revegetation 41
12.8.3 Ongoing maintenance 42
12.8.4 Habitat creation for fauna species 43
12.8.5 Anticipated outcomes of the EEP 44
12.9 Assessment of potential effects following mitigation 45

13. CONCLUSIONS 46

ACKNOWLEDGMENTS 48

REFERENCES 48

APPENDICES

1. Vascular plant species recorded during the field survey 50
2. Evaluation of ecological significance of ecosystems, habitats, and species at the Ōhau C site against the Canterbury RPS Appendix 3 criteria set 52
3. Mackenzie District Plan rules and definitions 55

Reviewed and approved for release by:

W.B. Shaw
Director/Lead Principal Ecologist
Wildland Consultants Ltd

1. INTRODUCTION

Williamson Water and Land Advisory (WWLA), on behalf of Far North Solar Farms Ltd (FNSF), are proposing to establish a new solar farm on a site near Lake Ōhau (hereafter referred to as Ōhau C) in the Mackenzie District, in South Canterbury. WWLA require an assessment of ecological effects for the proposed solar farm and advice on mitigation and ecological enhancement. WWLA also require a long-term management plan for the site.

Ōhau C is located between the Tekapo and Twizel Rivers. It is a flat site, with farmland to the north and rivers on the eastern and western boundaries. The Twizel River flows along the western side of the site and the Tekapo River flows along the eastern side. The site is approximately 10 kilometres to the southeast of Twizel township, and is currently used for farming and livestock grazing.

This report provides the findings of an ecological assessment for the proposed project. Mitigation measures, including ecological enhancement, are also provided.

2. PROPOSED WORKS

FNSF intend to install 736,866 solar panels across the site, with a four metre gap between each panel. Installation will require trenching (approximately half a metre in width) for electrical cables, which will run under the roads within the site. The panels will be installed using mounting trackers with driven piles for legs, which will minimise requirements for earthworks. The panels will be on an angle, with the highest end being 2.1 metres off the ground, and the lower end one metre off the ground. The panels will rotate approximately 45° degrees.

Forty-one six metre long inverters will be installed across the site, as well as 25 4.5 × 3.5 metre water tanks. One large control room will be built on site (dimensions to be determined).

Access roads will need to be developed for machinery for access to and around the site. Once installation is complete, solar panels will cover approximately 60% of the site.

FNSF have a strong interest in improving the local environment in addition to solar farm development. The site will have rabbit and hare-proof fencing surrounding the property. They intend to include indigenous plantings, weed control, and control of mammalian browsers in their long-term management of the site. Weed control methods around the solar panels are still being developed.

3. METHODS

3.1 Desktop assessments

Ecological Context and Databases

Desktop assessments were undertaken to determine the ecological values of the site. This included assessment of recent and historical aerial imagery and reviewing database records including Land Environments New Zealand (LENZ)[1], Land Cover Database (LCDB, v5.0)[2], the New Zealand Plant Conservation Network (NZPCN)[3], and iNaturalist (accessed December 2022)[4].

Original Vegetation

Potential natural vegetation, as mapped by Manaaki Whenua Landcare Research, has also been reviewed for the site. This describes the type of indigenous vegetation that would be expected to be present in the absence of human modifications and provides an indicator of what the pre-human ecological state may have been.

Avifauna

The eBird database[5] (maintained by Cornell University) was searched for bird records within a five-kilometre radius of the proposed site (January 2021 to January 2023) and in the surrounding area.

Lizards

The Department of Conservation Bioweb Herpetofauna database[6] (accessed May 2022) was checked for lizard records within a 20 kilometre radius of the site.

Terrestrial Invertebrates

The Global Biodiversity Information Facility[7] was searched for invertebrate records within five kilometres of the site, to see if any notable invertebrates (short-range endemics, protected species, species believed to be declining, or species listed as Threatened or At Risk) had been recorded nearby. Satellite photography was then examined to assess the likelihood of any notable invertebrate habitats being present on-site.

[1] https://www.landcareresearch.co.nz/tools-and-resources/mapping/lenz/
[2] https://ourenvironment.scinfo.org.nz/
[3] https://www.nzpcn.org.nz/
[4] https://www.inaturalist.org/
[5] https://ebird.org/atlasnz/home
[6] https://www.doc.govt.nz/our-work/reptiles-and-frogs-distribution/atlas/
[7] GBIF.org

3.2 Field assessments

3.2.1 Vegetation

Terrestrial vegetation was surveyed on 12 December 2022. Vegetation and associated habitat types were mapped and described following the structural classes of Atkinson (1985). Field mapping was digitised onto aerial imagery using ArcGIS 10.8. All vascular plant species observed are listed in Appendix 1.

3.2.2 Avifauna

An avifauna survey was undertaken on 14 December 2022. Three discrete continuous transects were walked to ensure all habitat types were visited and to maximise area coverage because of the site's large size. All bird species seen and heard were recorded, and any additional species detected while travelling between the transects were noted as incidental counts. The locations of Threatened and At Risk species were recorded with GPS waypoints.

3.2.3 Lizards

The site was visited on 13 December 2022 to determine habitats and potential species present. The walk-through lizard habitat assessment included assessing the quality of the habitat for lizards, visually surveying for active lizards, and handsearching of ground cover potential lizard habitat (e.g. rocks, pieces of wood). Weather conditions during the site visit were hot and sunny with intermittent cloud cover.

Targeted intensive surveys for lizards, using live-trapping methods, were not undertaken.

3.2.4 Invertebrates

A walk-through survey of invertebrates and their habitats was undertaken on 2 February 2023, with the primary aim of searching for notable invertebrates identified in the desktop assessment and their habitat on-site. Hand-searching involved looking on the ground and in vegetation and debris, and using a sweep-net to catch flying and jumping insects.

4. ECOLOGICAL CONTEXT

4.1 General overview

As noted in Section 1 above, the site is located between the lowest reaches of the Tekapo and Twizel Rivers. The Tekapo River discharges into the head of Lake Benmore, a human-made hydro lake, immediately adjacent to (to the east) of where the Ōhau River also discharges into the lake. The Twizel River flows into the Ōhau River about one kilometre upstream from the lake.

The site is low-lying largely flat land, *c.*400 metres above sea level, comprising the low interfluve between the Tekapo and Twizel Rivers. As such, the site is underlain by

alluvial gravels. The lower reaches of the Tekapo and Twizel Rivers are both braided systems, with a line of low eroded cliffs on the edges of the river channels.

Almost the entire site is grazed farmland and part of it is cultivated and cropped seasonally. A centre-pivot irrigator (diameter 1.5 kilometres) is present in the northwestern part of the site.

4.2 Pukaki Ecological District

The site is located in the Pukaki Ecological District and the following description is adapted from McEwen (1987).

Pukaki Ecological District is characterised by dry outwash plains between Lakes Tekapo and Benmore, mostly below 600 metres above sea level. The geology is fluvioglacial outwash deposits, with isolated greywacke and argillite hills. The climate is semi-arid to sub-humid with cold winters, warm summers and 600-1,600 mm of rainfall annually. Soils are moderately fertile but prone to drought in summer, they are easily erodible in steep areas with bare screes being common.

This Ecological District was historically typified by extensive red tussockland (*Chionochloa rubra*), replaced at altitude by snow tussock (*Chionochloa rigida*). Tussocklands had some kettlehole tarns and associated wetlands; some areas of hard tussock (*Festuca novae-zelandiae*) and scattered blue tussock (*Poa colensoi*). Some prostrate mat plants, e.g. *Coprosma petriei*, *Raoulia subsericea* as well as some scrub, including tūmatakuru/matagouri (*Discaria toumatou*) with mingimingi (*Coprosma propinqua*) were scattered throughout.

Pasture now occupies much of this Ecological District, with some tussocklands and areas of scrub (tūmatakuru, *Coprosma* spp., kōwhai (*Sophora* spp. and *Corokia*) remaining. Grazing by sheep and rabbits has significantly affected grasslands.

Braided riverbeds provide important habitat to a number of bird species, there are also several notable rare insects in the area.

4.3 Nearby protected areas

Lake Ruataniwha Conservation Area is adjacent to the proposed Ōhau C site, and it is made up of several separated sections. One of these sections primarily lies along the Twizel River, on the western side of the proposed solar farm property. The Ben Ōhau Conservation Area and adjacent Pukaki Flats Conservation Area is located seven kilometres north of the Ōhau C site. There are hard tussock (*Festuca novae-zelandiae*) grasslands to the east of Twizel. There is also the Glenbrook Conservation Area approximately eight kilometres to the southwest of Ōhau C.

4.4 Nearby sites of natural significance

The entirety of the Ōhau River has been identified as a Site of Natural Significance in the Mackenzie District Plan. It is recognised primarily for its avifauna habitat values, as well as areas of wetland. It extends along the Ōhau river from Lake Benmore into,

and including, areas of Lake Ruataniwha. This area overlaps with the north-eastern boundary of the proposed Ōhau C solar farm site.

4.5 Threatened Environment Classification

The Ōhau C site is classified entirely as a 'critically underprotected' land environment, with more than 30% indigenous vegetation left and less than 10% indigenous vegetation protected (Cieraad *et al.* 2015).

4.6 Land Cover Database (LCDB)

Two land cover types are mapped in the LCDB, with most of the site mapped as depleted grassland. An area of high producing exotic grassland is mapped where the centre pivot irrigator is located in the northwestern part of the property.

4.7 Potential natural vegetation

The site is identified as an area that would have historically been scrub, shrubland and tussock-grassland below the treeline.

4.8 Important Bird Area

The site is immediately adjacent to an Important Bird Area (IBA)[1] which includes the Ōhau, Pukaki, Twizel, and Tekapo Rivers. The site is in the wedge that forms the Ōhau-Tekapo Delta, where the Ōhau and Tekapo Rivers enter Lake Benmore. The full suite of endemic braided river birds is found in braided river habitat at the Delta, including kakī/black stilt (*Himantopus novaezelandiae*, Threatened-Nationally Critical).

This area is part of the Department of Conservation's Project River Recovery programme.

4.9 Braided rivers

Braided rivers and their associated gravel beds have been identified as a historically rare ecosystem type and are naturally uncommon on a national basis (Williams *et al.* 2007). Braided river ecosystems are therefore classified as Threatened-Endangered (Holdaway *et al.* 2012). Sixty-four percent of Aotearoa New Zealand's braided rivers occur in Canterbury. The braided rivers of the Mackenzie Basin drain into the Waitaki River and braided rivers and wetlands of the upper Waitaki Basin are under active restoration as part of "Project River Recovery" The programme is run by the Department of Conservation and funded by Meridian Energy and Genesis Energy under a compensatory agreement that recognises the impact of hydroelectric power development on these rivers and wetlands (DOC 2020).

[1] Forest & Bird 2016*:* New Zealand Seabirds - Sites on Land, Rivers, estuaries, coastal lagoons & harbours*. The Royal Forest & Bird Protection Society of New Zealand*, Wellington. 177 p.

4.10 Notable existing environmental modifications

The site has been named due to its proximity to the Ōhau C hydro power station on the Ōhau canal network, which is part of the larger Waitaki hydro scheme. This scheme comprises of five hydro-generation stations in the Upper Waitaki and three in the Lower Waitaki as well as a series of dams and canals to optimise generation potential. The Ōhau canal network runs from Lake Ōhau down through Lake Ruataniwha and into Lake Benmore. It is also fed by the Pukaki Canal, which brings water from Lakes Tekapo and Pukaki. Development of this hydro scheme has caused notable modifications to the surrounding environment through the construction of dams, formation of lakes (e.g. Lake Benmore), and diversion of water, and has drastically altered the hydrological regimes of the rivers in the Mackenzie basin.

4.11 Statutory context

4.11.1 Ecological significance

Areas of ecological significance in Canterbury are areas or habitats that meet one or more of the criteria listed in Appendix 3 of the Canterbury Regional Policy Statement (CRPS; see Appendix 2). This criteria set is provided for the evaluation of the significance of indigenous vegetation and habitat of indigenous fauna against 10 criteria within four categories:

- Representativeness
- Rarity or distinctive features
- Diversity and pattern
- Ecological context

The Mackenzie District Plan (MDP) defers to the CRPS for assessments of ecological significance. Each vegetation and habitat type at the site was assessed against these criteria.

4.11.2 Mackenzie District Plan

Relevant rules and definitions provided in the operative Mackenzie District Plan which relate to indigenous vegetation and vegetation clearance are summarised in Appendix 3. Vegetation and habitat types present at the site were assessed against the definition of indigenous vegetation and the definition of improved pasture, to assess whether they are subject to vegetation clearance rules. The Mackenzie District Plan also stipulates limits on activities adjacent to wetlands. The site was also assessed in relation to these rules.

Various Mackenzie District Plan provisions apply to the site:

- This site is zoned as Rural Zone.
- Mackenzie Basin Subzone applies across the entire site. This identifies the site as an Outstanding Natural Landscape.
- Sites of Natural Significance have been identified in proximity to the site, around the margins of Lake Benmore, and including the braided beds of Tekapo and Ōhau Rivers.

- The entire site is located within an area identified as being of High Visual Vulnerability[1].
- A hydro-electricity inundation hazard area has been identified along the river braid plains on both the eastern and western sides of the site, merging in the south where the rivers flow into Lake Benmore.

4.11.3 Wildlife Act 1953

All indigenous lizards and birds, and some indigenous invertebrates, are protected under the Wildlife Act (1953). It is an offence to disturb or destroy protected wildlife without a Wildlife Act Authorisation (WAA; also known as a wildlife permit) from the Department of Conservation. A permit must be obtained from the Department of Conservation before any protected wildlife (and/or their habitats) can be disturbed, handled, translocated or killed. Also, if an activity is likely to disturb or kill protected avifauna or their eggs, then a Wildlife Act Authority (permit) is needed from the Department of Conservation.

4.11.4 Natural wetlands

Natural wetlands were assessed using definitions in the Resource Management Act (RMA; 1991) and the National Policy Statement for Freshwater Management (NPS-FM; 2020). The RMA defines wetlands as "permanently or intermittently wet areas, shallow water, and land/water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions". The NPS-FM excludes the following situations from the RMA definition:

- A wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or
- A geothermal wetland; or
- Any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain derived water pooling.

Rule 8 of the Mackenzie District Councils Vegetation Clearance Rules specifies that clearance may not occur within 100 metres of an ecologically significant wetland or with 50 metres of all other wetlands. Vegetation and habitats on the site and within 100 metres of its boundaries were evaluated for wetland status.

[1] Landscape features and views sensitive to change and how their visual quality can be compromised by the individual or cumulative effects of land use and development activities which are not in harmony with the natural appearance of the landscape.

4.12 Vegetation and habitats

Vegetation cover at the Ōhau C site is predominantly grazed exotic grassland and cropland, with some small remnants of indigenous dryland and shrubland communities around the margins. There are no wetlands on the site, but there are a number of wetlands within 100 metres of the site boundary (Figure 1). Including the off-site wetlands, six vegetation and habitat types were identified:

1. Sweet briar-matagouri shrubland.
2. Cocksfoot grassland.
3. Brassica cropland.
4. Brome-hawkweed-sheep's sorrel grassland/herbfield.
5. Stonefield drylands.
6. Wetlands (offsite only)

1. Sweet briar-matagouri shrubland

This type is confined to two small patches in shallow gullies on the eastern edge of the site. Vegetation in these areas is dominated by exotic sweet briar (*Rosa rubiginosa*) with indigenous tūmatakuru/matagouri (At Risk – Declining), porcupine shrub (*Melicytus alpinus*) and mingimingi (Plate 1). Scattered exotic pines (mostly *Pinus contorta*) are emergent in places above the shrubs. There are also open areas, rocky ground, and exotic weeds, including mouse-ear hawkweed (*Pilosella officinarum*) and haresfoot trefoil (*Trifolium arvense*). Indigenous hard tussock and creeping pōhuehue (*Muehlenbeckia axillaris*) are also locally common.

Plate 1: Sweet briar-matagouri shrubland.

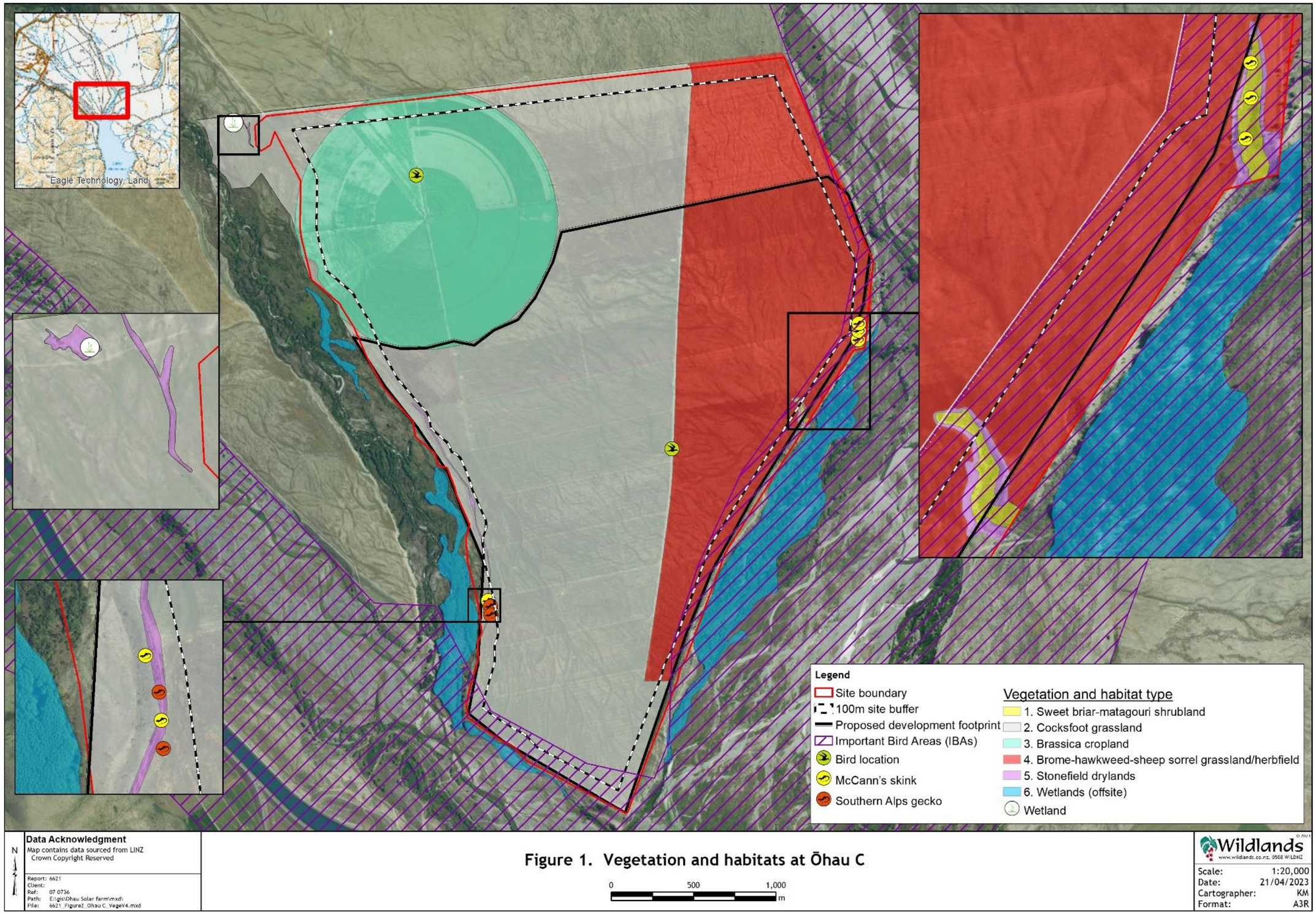

Figure 1. Vegetation and habitats at Ōhau C

2. Cocksfoot grassland

Cocksfoot (*Dactylis glomerata*) grassland is the most extensive vegetation type on the site and appears to have been sown mostly for hay and baleage production (Plate 2). The type is dominated by exotic species. It varies in height and composition across the site, in some paddocks the grass is over one metre tall where it is dominated by cocksfoot. In other areas it is shorter and comprises a mixture of exotics such as clovers (mostly *Trifolium repens and T. pratense*), lucerne (*Medicago sativa*) and other grasses including ryegrass (*Lolium perenne*) sweet vernal (*Anthoxanthum odoratum*) and red fescue (*Festuca rubra*). Around the margins, haresfoot trefoil and sheep's sorrel (*Rumex acetosella*) are also abundant and there are occasional patches where sweet briar is common.

Plate 2: Cocksfoot-dominant grassland, which covers much of the site.

3. Brassica cropland

In the northwest corner of the site there is a circular area of cropland under a centre-pivot irrigator which, at the time of the survey, was planted with a brassica crop. Little else appeared to be growing in this area. Stones and bare ground were abundant between crop plants (Plate 3).

4. Brome-hawkweed-sheep's sorrel grassland/herbfield

On the eastern side of the site there are numerous paddocks with exotics such as mouse-ear hawkweed, sheep's sorrel, and brome grasses (*Bromus tectorum* and *B. hordeaceus*) that are dominant (Plate 4). These areas appear to have been cultivated in the past but have not been resown recently. Cocksfoot, ryegrass, sweet vernal, clovers, and lucerne are all common exotics, along with herbaceous weeds such as haresfoot trefoil, viper's bugloss (*Echium vulgare*), and chicory (*Cichorium intybus*).

Plate 3: Irrigated brassica cropland, in the northern part of the site.

Plate 4: Brome-hawkweed-sheep's sorrel grassland/herbfield, which covers an extensive part of the site.

5. Stonefield drylands

Areas of stonefield and indigenous dryland vegetation are confined to the tops of old river terraces on the margins of the site. These areas are generally dominated by exotic weeds and grasses with mouse-ear hawkweed and haresfoot trefoil both abundant. However, local pockets of indigenous dryland vegetation persist on stony ground (Plate 5). Indigenous species observed in these areas included

creeping pōhuehue, maikaika/onion orchid (*Microtis unifolia*), blue wheatgrass (*Anthosachne solandri*) scabweed (*Raoulia hookeri*), and NZ harebell (*Wahlenbergia albomarginata*). Two At Risk - Declining species, mat daisy (*Raoulia australis*) and stout dwarf broom (*Carmichaelia monroi*), and Maniototo Cress (*Lepidium solandri* Threatened – Nationally Critical), were recorded just outside the site boundary.

Plate 5: Indigenous dryland vegetation with mat daisies (left) and scabweed (right) growing in stonefield dryland habitat on the margins on the site.

6. Wetlands

No wetlands are present on the subject site.

There is one small induced wetland within 100 metres outside of the northwest border of this site. It is located at the bottom of a small depression that appears to have been created by historic gravel extraction. Water pools in one corner of the gravel pit and exotic facultative wetland plants including crack willow (*Salix ×fragilis*), jointed rush (*Juncus articulatus*) and soft rush (*Juncus conglomeratus*) are growing here (Plate 4). Several other tree species are also present, including necklace poplar (*Populus deltoides*) and lodgepole pine. However, the surrounding area, including most of the old gravel pit, is dry and rocky, and supports multiple indigenous dryland species.

Other wetland habitats exist outside of the site along the floodplains of the both Tekapo and Twizel Rivers (Plate 6). Distance from the site varies but in both river beds there are wetlands within 100 metre of the site boundary. The largest and most extensive wetlands are in the Takapō/Tekapo River to the east of the site. However, both rivers have a similar network of riverine wetland habitats with shallow water, fens, swamps, and seepages. Considerable catchment modification has taken place in both of these rivers, which may have induced some of these wetlands through reduced water flow. Some wetlands have also been induced by vehicle tracks criss-crossing water channels.

Wetlands in both rivers are dominated by an exotic canopy of crack willow and alder (*Alnus glutinosa*) trees, but indigenous sedges and rushes are common beneath the canopy and around the margins of open water. Indigenous species observed in these areas include rautahi (*Carex maorica*), raupō (*Typha orientalis*), sedge (*Carex diandra*), spike sedge (*Eleocharis acuta*), and pūkio (*Carex secta*). Although no Threatened or At Risk species were observed,

extensive surveys of these wetlands were not undertaken as they were outside of the development site.

Another induced wetland was also recorded in an old gravel pit just to the northwest of the site (Figure 1). In this area, water pooling has allowed several crack willow and poplar (*Populus nigra*) trees to establish above weedy jointed rush and soft rush.

Plate 6: Wetland habitats within 100 metres of the site boundary. Large swamp wetland on margins of the Takapō River to the east of the site (left) and a small seepage wetland in the Twizel River, to west of the site (right).

5. FLORA

5.1 Overview

Fifteen indigenous and 42 exotic vascular plant species were recorded during the survey of the Ōhau C site (Appendix 1).

5.2 Threatened, at risk, and locally uncommon species

Only one species with a national threat ranking (de Lange *et al.* 2018) was recorded on the site: tūmatakuru/matagouri, classified as At Risk-Declining.

The national threat ranking is largely based on its restricted status in the North Island and matagouri is common in the South Island and the Mackenzie Basin. It was only recorded in shallow gullies on the eastern side of the site.

Four species with national threat rankings (de Lange *et al.* 2018) were recorded within 100 metres of the site boundary:

- Maniototo peppercress: Threatened – Nationally Critical.
- Stout dwarf broom: At Risk – Declining.
- Desert broom (*Carmichaelia petriei*): At Risk – Declining.
- Common mat daisy: At Risk – Declining.

Due to the proximity of Threatened and At Risk species to the property boundary, it is possible that individuals of these species would also be detected within the property in more detailed surveys.

Plate 7: Stout dwarf broom (At Risk – Declining) (left) and Maniototo peppercress (Threatened – Nationally Critical) (right).

5.3 Pest plants

Five plant species recorded at the site are listed as either 'pest' or 'Organisms of Interest' (OOI) in Environment Canterbury Regional Pest Management Plan (CRPMP; 2018-2038; Table 1).

Table 1: Pest plants and Organisms of Interest (PEST, OOL), listed in CRPMP, recorded at the Ōhau A site.

Scientific Name	Common Name(s)	Growth Form	Pest Status
Cytisus scoparius	Broom	Shrub	PEST
Echium vulgare	Vipers' bugloss	Herb	OOI
Hypericum perforatum	St John's wort	Herb	OOI
Pinus contorta *Pseudotsuga menziesii*	Wilding conifers	Tree	PEST

6. AVIFAUNA

The desktop assessment found records of 47 species (and two hybrid taxa) between January 2021 and January 2023 within five kilometres of the Ōhau C site. Of the 49 taxa, 33 are classified as indigenous and 16 as exotic. Records of seven Threatened species were found in the desktop assessment, including Nationally Critical kakī/black stilt (*Himantopus novaezelandiae*) and kotuku/white heron (*Ardea alba modesta*), Nationally Endangered tarapirohe/black-fronted tern, Nationally Vulnerable pūteketeke/Australasian crested grebe, taranui/Caspian tern (*Hydroprogne caspia*) and pārera/grey duck, and Nationally Increasing ngutu pare/wrybill (*Anarhynchus frontalis*).

Eight At Risk species were recorded, including: Declining pohowera/banded dotterel, tarāpuka/black-billed gull, kotoreke/marsh crake, pīhoihoi/New Zealand pipit and tōrea/South Island pied oystercatcher (*Haematopus finschi*), Relict māpunga/black shag and kawaupaka/little shag, and Naturally Uncommon Australian coot (*Fulica atra australis*).

Thirty bird species were recorded during the field survey (Table 2). Of these, 15 are indigenous and 15 exotic. One Threatened species (tarapirohe/black-fronted tern, Nationally Endangered) and four At Risk species (Declining pohowera/banded dotterel and tarāpuka/black-billed gull, and Relict māpunga/black shag and kawaupaka/little shag) were detected. Exotic passerines were the most common birds at the site, with skylarks (*Alauda arvensis*) being especially abundant. All species recorded during the field survey were also recorded in the desktop assessment.

Tarapirohe/black-fronted tern and pohowera/banded dotterel were observed during the field survey. Both species use the site for foraging and breed in or directly adjacent to the site. The site provides potential foraging and breeding habitat for kakī/black stilt and several other Threatened or At Risk species.

The stonefield dryland areas provide suitable habitat for pohowera/banded dotterel and South Island pied oystercatcher (*Haematopus finschi*, At Risk - Declining) to forage and breed, and may also be utilised by pihoihoi/New Zealand pipit. Banded dotterel were observed feeding in the cocksfoot grassland, brome-hawkweed-sheep sorrel grassland/herbfield, and brassica cropland, and they could use these habitats for breeding.

Wetlands adjacent to the site provide habitat suitable for matuku-hūrepo/Australasian bittern (Threatened-Nationally Critical) and kotoreke/marsh crake (At Risk-Declining). The *Carex* sp. and *Juncus* sp. provide suitable foraging areas and may provide breeding habitats. Neither of these species were detected during the site visit as these are highly cryptic species.

7. LIZARDS

Species recorded within a 20 kilometre radius of the Ōhau C site are listed in Table 3. Closest records and the likelihood of each species being found on-site are set out in Table 3.

Two lizard species were found during the field visit. McCann's skink (*Oligosoma maccanni;* Not Threatened) and Southern Alps gecko (*Woodworthia* "Southern Alps"; At Risk – Declining) were observed in stonefield dryland habitat (Figure 1). Two individuals of each species were found in rock piles at the base of a west-facing terrace slope in the southwestern part of the site (Plate 6). Three McCann's skinks were also found among rock piles in a gully in the northeastern part of the site.

Indigenous lizards are most often found where there is sufficient complex ground cover, such as dense vegetation (including rank exotic grass) and rock piles, which provides refuges from predators and inclement weather. High-quality habitat for most species of lizards inhabiting the Mackenzie District includes undeveloped outwash plains, dry river cobbles and talus slopes, especially where interspersed with indigenous shrubland, along with contiguous tracts of indigenous shrubland.

Table 2: Bird species records found in the desktop assessment and during the field survey at the Ōhau C site. Common names, scientific names, and threat classification are from Robertson *et al.* 2021.

Common Name(s)	Scientific Name	Threat Classification 2021	Likelihood of Presence at Site
Indigenous Species			
Australasian bittern/matuku-hūrepo	*Botaurus poiciloptilus*	Threatened-Nationally Critical	Possible
Black stilt/kakī	*Himantopus novaezelandiae*	Threatened-Nationally Critical	Highly likely
White heron/kōtuku	*Ardea alba modesta*	Threatened-Nationally Critical	Possible
Black-fronted tern/tarapirohe	*Chlidonias albostriatus*	Threatened-Nationally Endangered	Seen during visit
Australasian crested grebe/pūteketeke	*Podiceps cristatus australis*	Threatened-Nationally Vulnerable	Unlikely
Caspian tern/taranui	*Hydroprogne caspia*	Threatened-Nationally Vulnerable	Highly likely
Grey Duck/pārera	*Anas superciliosa*	Threatened-Nationally Vulnerable	Likely
Wrybill/ngutu pare	*Anarhynchus frontalis*	Threatened-Nationally Increasing	Likely
Banded dotterel/pohowera	*Charadrius bicinctus bicinctus*	At Risk-Declining	Seen during visit
Black-billed gull/tarāpuka	*Chroicocephalus bulleri*	At Risk-Declining	Seen during visit
Marsh crake/kotoreke	*Zapornia pusilla affinis*	At Risk-Declining	Likely
New Zealand pipit/pīhoihoi	*Anthus novaeseelandiae novaeseelandiae*	At Risk-Declining	Likely
South Island pied oystercatcher/tōrea	*Haematopus finschi*	At Risk-Declining	Likely
Black shag/māpunga	*Phalacrocorax carbo novaehollandiae*	At Risk-Relict	Seen during visit
Little shag/kawaupaka	*Microcarbo melanoleucos brevirostris*	At Risk-Relict	Seen during visit
Australian coot	*Fulica atra australis*	At Risk-Naturally Uncommon	Unlikely
Australasian shoveler/kuruwhengi	*Spatula rhynchotis*	Not Threatened	Highly likely
Black swan/kakīānau	*Cygnus atratus*	Not Threatened	Seen during visit
Grey duck – mallard hybrid	*Anas superciliosa × platyrhynchos*	Not Threatened	Seen during visit
Grey teal/tētē-moroiti	*Anas gracilis*	Not Threatened	Highly likely
Grey warbler/riroriro	*Gerygone igata*	Not Threatened	Seen during visit
Marsh crake/kotoreke	*Zapornia pusilla affinis*	At Risk-Declining	Possible
New Zealand scaup/pāpango	*Aythya novaeseelandiae*	Not Threatened	Highly unlikely
Paradise shelduck/pūtangitangi	*Tadorna variegate*	Not Threatened	Seen during visit
Pied stilt/poaka	*Himantopus himantopus leucocephalus*	Not Threatened	Seen during visit
Pied stilt x black stilt hybrid	*Himantopus himanoptus x novaezelandiae*	Not Threatened	Likely
Pūkeko	*Porphyrio melanotus melanotus*	Not Threatened	Unlikely
Shining cuckoo/pīpīwharauroa	*Chrysococcyx lucidus lucidus*	Not Threatened	Seen during visit
Silvereye/tauhou	*Zosterops lateralis lateralis*	Not Threatened	Seen during visit
South Island fantail/pīwakawaka	*Rhipidura fuliginosa fuliginosa*	Not Threatened	Seen during visit
Southern black-backed gull/karoro	*Larus dominicanus dominicanus*	Not Threatened	Seen during visit
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened	Highly likely
Swamp harrier/kāhu	*Circus approximans*	Not Threatened	Seen during visit
Welcome swallow/warou	*Hirundo neoxena neoxena*	Not Threatened	Seen during visit

Common Name(s)	Scientific Name	Threat Classification 2021	Likelihood of Presence at Site
White-faced heron/matuku moana	*Egretta novaehollandiae*	Not Threatened	Highly likely
Exotic Species			
Australian magpie	*Gymnorhina tibicen*	Introduced and Naturalised	Seen during visit
California quail	*Callipepla californica*	Introduced and Naturalised	Seen during visit
Canada goose	*Branta Canadensis*	Introduced and Naturalised	Seen during visit
Chaffinch	*Fringilla coelebs*	Introduced and Naturalised	Seen during visit
Common redpoll	*Acanthis flammea*	Introduced and Naturalised	Seen during visit
Dunnock	*Prunella modularis*	Introduced and Naturalised	Seen during visit
Eurasian blackbird	*Turdus merula*	Introduced and Naturalised	Seen during visit
Goldfinch	*Carduelis carduelis*	Introduced and Naturalised	Seen during visit
Greenfinch	*Chloris chloris*	Introduced and Naturalised	Seen during visit
House sparrow	*Passer domesticus*	Introduced and Naturalised	Seen during visit
Mallard	*Anas platyrhynchos*	Introduced and Naturalised	Likely
Passerine sp.	*Passeriformes* sp.	Introduced and Naturalised	Seen during visit
Rock pigeon	*Columba livia*	Introduced and Naturalised	Seen during visit
Skylark	*Alauda arvensis*	Introduced and Naturalised	Seen during visit
Song thrush	*Turdus philomelos*	Introduced and Naturalised	Seen during visit
Starling	*Sturnus vulgaris*	Introduced and Naturalised	Seen during visit
Yellowhammer	*Emberiza citronella*	Introduced and Naturalised	Seen during visit

Table 3: Lizard records from a Department of Conservation Bioweb Herpetofauna database search within a 20 kilometre radius of Ōhau C and an assessment of the likelihood of the presence of these species at the site. Conservation status is as per Hitchmough *et al.* 2021. The likelihood of occurrence for each species is based on their known habitat preferences and distribution in the general area.

Common Name	Scientific Name	Threat Classification	Recorded Distance from Ōhau C	Habitat Preference	Likelihood of Presence on Site
Lakes skink	*Oligosoma* aff. *chloronoton* "West Otago"	Threatened – Nationally Vulnerable	2.7 km	Scrubland, tussockland, rocky areas, scree, herbfield, fellfield, stony riverbeds and terraces.	Possible: potential habitat (rocky terraces) available on-site.
Southern grass skink	*Oligosoma* aff. *polychroma* Clade 5	At Risk – Declining	3.2 km	Prefers damp or well vegetated habitats such as rank grasslands, wetlands, stream/river edges, and gullies. Widespread from Banks Peninsula south to Stewart Island.	Possible: a widespread and commonly encountered species which may be confused with McCann's skink but is generally found in damper areas/areas with dense grass.
McCann's skink	*Oligosoma maccanni*	Not Threatened	On site	Open habitats – dry rocky environments such as rock outcrops and montane grassland.	Confirmed as present on-site during the habitat assessment.
Scree skink	*Oligosoma waimatense*	Threatened – Nationally Vulnerable	2.7 km	Creviced rock bluffs, alluvial outwash plains, dry river cobbles and terraces, talus slopes, boulderfield and scree (from lowland to alpine areas, <1,500m).	Possible: potential habitat (rocky terraces) available on-site.
Jewelled gecko	*Naultinus gemmeus*	At Risk – Declining	15.6 km	Scrubland, forest and tussockland. Often trees and shrubs like beech, mānuka, kānuka, mingimingi, matagouri, snow tussock and other dense vegetation.	Unlikely: minimal appropriate habitat (indigenous shrubland) available on-site.
Southern Alps gecko	*Woodworthia* "Southern Alps"	At Risk – Declining	1.1 km	Rocky scrubland, talus, boulderfield, scree, stony river terraces and creviced rock outcrops (from lowland and montane valleys to alpine areas, <1,900m).	Confirmed present on-site during habitat assessment.

Confirmed and potential lizard habitat was present in the following vegetation types:

- Sweet briar-matagouri shrubland.
- Cocksfoot grassland.
- Brome-hawkweed-sheep's sorrel grassland/herbfield.
- Stonefield drylands.

Areas of high quality lizard habitat are present on the site. These include the areas of stonefield dryland and sweet briar-matagouri shrubland, particularly where there are relatively deep rock piles amongst indigenous shrubland vegetation (i.e. embedded cobbles at the bottom of talus slopes). These areas could potentially support Threatened species (i.e. Lakes skink and/or scree skink), which are known from similar habitat in the Mackenzie Basin.

It is likely that lizards are present in both gullies in the northeastern part of the site and in other areas of stonefield dryland in the western part of the site. Due to time constraints, the western part of the site was not surveyed during the walk-over assessment.

Plate 8: Stonefield dryland and sweet briar-matagouri shrubland on the Ōhau C site, in the western part of the site where lizards were detected (left) and in a gully in the northeastern part of the site (right).

Areas of medium quality lizard habitat may be present on the site, including terrace slopes within cocksfoot grassland in the west of the site.

Most of the site, including the brassica cropland, brome-hawkweed-sheep's sorrel grassland/herbfield, and most of the cocksfoot grassland across the central plateau of the site is considered to comprise potential lizard habitat that is only of low to negligible

quality. McCann's skink may be in present in low densities in brome-hawkweed-sheep's sorrel grassland/ herbfield and cocksfoot grassland.

8. TERRESTRIAL INVERTEBRATES

The desktop survey revealed that four notable invertebrate species have been recorded within a five kilometre radius of the site (Table 4).

Table 5 lists the invertebrate species found during the field survey.

In general, habitat was lacking or was of low-quality for indigenous invertebrates. The invertebrate fauna was generally found to be lacking in diversity, though the hot weather is likely to have suppressed activity.

Table 5: Invertebrate species found in the field survey at the Ōhau C site.

Species	Common Name	Threat Status	Habitat	Species of interest?
Orocrambus vitellus	Grass moth	Not assessed	Indigenous and exotic grassland.	No.
Uropetala sp.	Giant dragonfly	Not Threatened	Damp banks (larvae); shrubland, treeland, and bush (adults).	No.
Bombus spp.	Bumblebee	Introduced and naturalised	Meadow with exotic flowers.	No.
Pieris rapae	Cabbage white butterfly	Introduced pest	Open fields with brassica plants for larval food.	No.
Zizina oxleyi	New Zealand blue butterfly	Not Threatened	Open, sunny, rocky areas; leguminous vegetation needed for larval food source.	Yes. Despite their Not Threatened status, they are declining.[1]

The field survey was carried out during hot, sunny, windy weather, when most invertebrates are unlikely to be active but butterflies and grasshoppers are active. However, robust grasshopper and minute grasshopper are more active in December and January. No robust grasshoppers or minute grasshoppers were found, but this is unsurprising given the lateness of the season when field surveys were carried out.

One New Zealand blue butterfly was seen in the grassland where there was clover present. Clovers are one of the potential exotic larval food plants for this species.

Robust grasshopper populations, if present, will be confined to the braided river margins off-site, in particular the eastern margin. Minute grasshopper and short-horned grasshopper may also be present in the open stonefield and herbfield habitat at the eastern margin of the site (Figure 1), though due to time and weather constraints this part of the site was not investigated. Some patches of relatively open ground – currently thickly overgrown with exotic herbs - could become habitat for indigenous grasshoppers if restored.

[1] Patrick B. and Patrick H. 2012: Butterflies of the South Pacific. Otago University Press and Otago Museum. ISBN 978 1 877578 04 5.

Table 4: Records of invertebrate species of interest found in the desktop evaluation within a five kilometre radius of the Ōhau C site.

Species	Common Name	Threat Status	Habitat	Reason for Designation as a Species of Interest	Likelihood of Occurrence on Site
Brachaspis robustus	Robust grasshopper	Threatened-Nationally Endangered (Trewick *et al.* 2022)	Open rocky areas on braided river beds.	Threatened by introduced predators and habitat loss.	Possible: potential habitat present at edge of site.
Sigaus minutus	Minute grasshopper	Threatened-Nationally Vulnerable (Trewick *et al.* 2022)	Open rocky areas.	Threatened by introduced predators and habitat loss.	Possible: potential habitat present on-site.
Phaulacridium otagoense	Short-horned grasshopper	At Risk-Declining	Open rocky areas and herbfields	Threatened by genetic incursion by *P. marginale*.	Possible: potential habitat present on-site.
Zizina oxleyi	New Zealand blue butterfly	Not Threatened (Hoare *et al.* 2017)	Stony areas with leguminous plants and shelter nearby.	In decline due to displacement by invasive common blue butterfly (*Zizina labradus*[1]).	Possible: habitat present on-site.

[1] Patrick B. and Patrick H. 2012. Butterflies of the South Pacific. Otago University Press and Otago Museum. ISBN 978 1 877578 04 5.

Tekapo ground wētā may also be present in dry, open areas of the site; their range and distribution are not well-known. A dragonfly in the common and widespread genus *Uropetala* was observed. Introduced insects were common: primarily cabbage white butterfly (*Pieris rapae*) and bumblebees (*Bombus* spp).

9. ECOLOGICAL VALUES

Descriptions of ecological values are set out below for:

- Indigenous vegetation.
- Avifauna.
- Lizards.
- Terrestrial invertebrates.

Indigenous Vegetation

Indigenous vegetation on the site is mostly confined to small pockets and scattered individual plants. The only At Risk plant species observed within the site is tūmatakuru, which is present in the stonefield drylands. This vegetation and habitat type is considered to be ecologically significant.

Avifauna

Black-fronted tern and banded dotterel feed within the Ōhau C site, with banded dotterel possibly breeding on-site as well. Pihoihoi/New Zealand pipit and South Island pied oystercatcher may also forage and breed within the Ōhau C site.

The key ecological avifauna values at Ōhau C are associated with the rivers, wetlands, and delta that are adjacent to the site. These areas are breeding and foraging habitats for multiple Threatened and At Risk species, most notably the Threatened – Nationally Critical kakī/black stilt. Wetland areas (off-site) provide foraging and potential breeding habitat for Australasian bittern (Threatened – Nationally Critical) and marsh crake (At Risk- Declining).

The river deltas bordering the southern edge of the site are particularly important in this regard. Multiple Threatened and At Risk species use the braided rivers and deltas to the south of the proposed solar farm site for foraging, roosting, and breeding.

Lizards

Two indigenous lizard species - McCann's skink and Southern Alps gecko - have been found on the site. There are limited areas of high and medium-quality lizard habitat on-site, including areas where lizards were detected and areas where lizards are considered likely to be present but were not detected during the walk-over assessment. Areas of high- and moderate-quality lizard habitat on-site include:

- Sweet briar-matagouri shrubland.
- Stonefield dryland.
- Possibly areas of cocksfoot grassland where there are terrace slopes in the western part of the site.

Threatened lizard species (i.e. lakes skink and/or scree skink) may be present on-site; most likely in areas of sweet briar-matagouri shrubland and stonefield dryland with relatively embedded rock and dry river cobbles.

Terrestrial Invertebrates

Most of the Ōhau C site is not good quality habitat for indigenous invertebrates. Some limited areas of open, dry habitat with short vegetation, particularly at the eastern margins of the site, may harbour Threatened or At Risk grasshopper and/or wētā species. New Zealand blue butterfly is also present and may be using the clover crop as larval hosts, although the indigenous broom may also provide suitable food sources.

Summary

Ecological features and values adjacent to the site, associated with the rivers and their margins, are extremely high.

Ecological values on-site vary considerably subject to the character of the vegetation and habitat types that are present. Most of the site has a cover of exotic pasture and part of it is irrigated and cropped. These areas have low value for indigenous plants but are nevertheless utilised by Threatened or At Risk indigenous birds and it is possible that lizards may also be present, albeit these types are unlikely to provide significant habitat for lizards. Undeveloped gullies on the margins of the site are important habitat for indigenous plants, avifauna, lizards, and invertebrates.

10. STATUTORY ASSESSMENT

10.1 Assessment of ecological significance for vegetation and habitats on-site

Each vegetation and habitat type within the site has been assessed against the ecological significance criteria in Environment Canterbury's Regional Policy Statement (Appendix 2), as set out below.

Cocksfoot grassland

Cocksfoot grassland areas are dominated by introduced pasture grasses and weedy herb species, which is the dominant vegetation type across the project site. Indigenous plants were present, but in low abundances. This vegetation type provides habitat for banded dotterel (At Risk – Declining), and breeding and foraging habitat for South Island pied oystercatcher and pihoihoi/New Zealand pipit (both At Risk – Declining). In addition, this vegetation type may also provide habitat for indigenous lizard populations. A targeted lizard survey is required to confirm whether lizards are present, the species, and their relative abundances. This type is considered to be ecologically significant as it meets the CRPS criteria for **rarity/distinctiveness** and **ecological context**.

Brassica cropland

The "brassica cropland" vegetation type was dominated by cultivated brassica, likely grown for stock feed, with low floral diversity. This vegetation type can provide foraging and breeding habitat for pihoihoi/New Zealand pipit, South Island pied oystercatcher, and banded dotterel. No ecologically significant habitat was identified for invertebrates, or lizards within this area, but targeted lizard surveys will determine if the vegetation type provides any suitable habitat. The area is considered to be ecologically significant, meeting the criteria for **rarity/distinctiveness** and **ecological context**.

Brome-hawkweed-sheep sorrel grassland/herbfield

This vegetation type is characterised by brome grasses and low-growing exotic herbs. No significant indigenous vegetation was identified in this area. However, the exotic grass may provide an important habitat for indigenous lizard species and may support foraging for banded dotterels. A targeted lizard survey is required to confirm whether lizards are present. The exotic clover in this area supports larval development for the New Zealand blue butterfly (At Risk - Declining). Therefore, this habitat meets the definition of ecologically significant for two criteria: **rarity/distinctiveness** and **ecological context**.

Sweet Briar – Matagouri Shrubland

This habitat is dominated by a mix of exotic sweet briar and indigenous tūmatakuru/matagouri which is classified as At Risk - Declining. This vegetation type provides habitat for indigenous lizards, and it is likely that At Risk lizard species are present. Therefore, this vegetation type meets the CRPS criteria for **rarity/ distinctiveness** and **ecological context**.

Stonefield drylands

Drylands on this site primarily have a cover of exotic herbs, but they also support patches of indigenous vegetation. This vegetation type provides habitat for indigenous lizards such as McCann's skink and Southern Alps gecko (At Risk - Declining). It also provides habitat for the minute grasshopper (At Risk - Declining), and foraging and breeding habitat for banded dotterels, South Island pied oystercatcher, and pihoihoi/ New Zealand pipit. This habitat type meets the definition of ecologically significant for **rarity/distinctiveness** and **ecological context.**

10.2 Assessment of ecological significance for vegetation and habitats off-site

Vegetation and habitats off-site were not formally assessed against the CRPS criteria. However, off-site wetlands and braided rivers directly adjacent to the site are ecologically significant.

Various indigenous and exotic plants, such as *Carex* spp. and *Juncus* spp, characterise off-site wetlands. Vegetation in these wetlands provides foraging habitat for Australasian bittern (Threatened – Nationally Critical) and marsh crake (At Risk – Declining).

The off-site braided river delta to the southeast of this site is a release location and breeding ground for kakī/black stilt (Threatened – Nationally Critical). The braided rivers also provides habitat for robust grasshopper (Threatened - Nationally Endangered).

10.3 Mackenzie District Plan

Two vegetation habitat types present at the site meet the definition of indigenous vegetation in the Mackenzie District Plan (Table 6), and are therefore subject to rules relating to the clearance of indigenous vegetation.

Table 6: Vegetation and habitat types at the Ōhau C site and Mackenzie District Plan definitions.

Vegetation Habitat Type	Status	Improved Pasture	Natural Wetland
Sweet briar-matagouri shrubland	Indigenous	**Yes**	No
Cocksfoot grassland	Exotic	**Yes**	No
Brassica cropland	Exotic	**Yes**	No
Brome-hawkweed-sheep's sorrel grassland/herbfield	Exotic	**Yes**	No
Stonefield drylands	Indigenous	**Yes**	No
Wetlands (offsite)	Indigenous	No	**Yes**

Five vegetation and habitat types within the site meet the definition of improved pasture which excludes these habitats from the definition of indigenous vegetation (although the two are not mutually exclusive) and therefore are not subject to indigenous vegetation clearance rules (Figure 2).

No wetlands are present on the site. However, significant natural wetlands occur adjacent to the site. Rule 8 of the Mackenzie District Councils Vegetation Clearance Rules specifies that clearance may not occur within 100 metres of an ecologically significant wetland or within 50 metres of all other wetlands. Off-site wetlands meet the ecological significance criteria.

11. POTENTIAL ECOLOGICAL EFFECTS

11.1 Overview

The works proposed will involve the following activities:

- Minor earthworks.
- Shading.
- Trenching.
- Introduction of new surfaces.
- Machinery movement around site.
- Auxiliary construction, such as buildings, pylons, service roads or fences required for solar farm functioning.
- Long-term weed control.
- Rabbit and hare control.
- Native plantings or other offsets on-site.

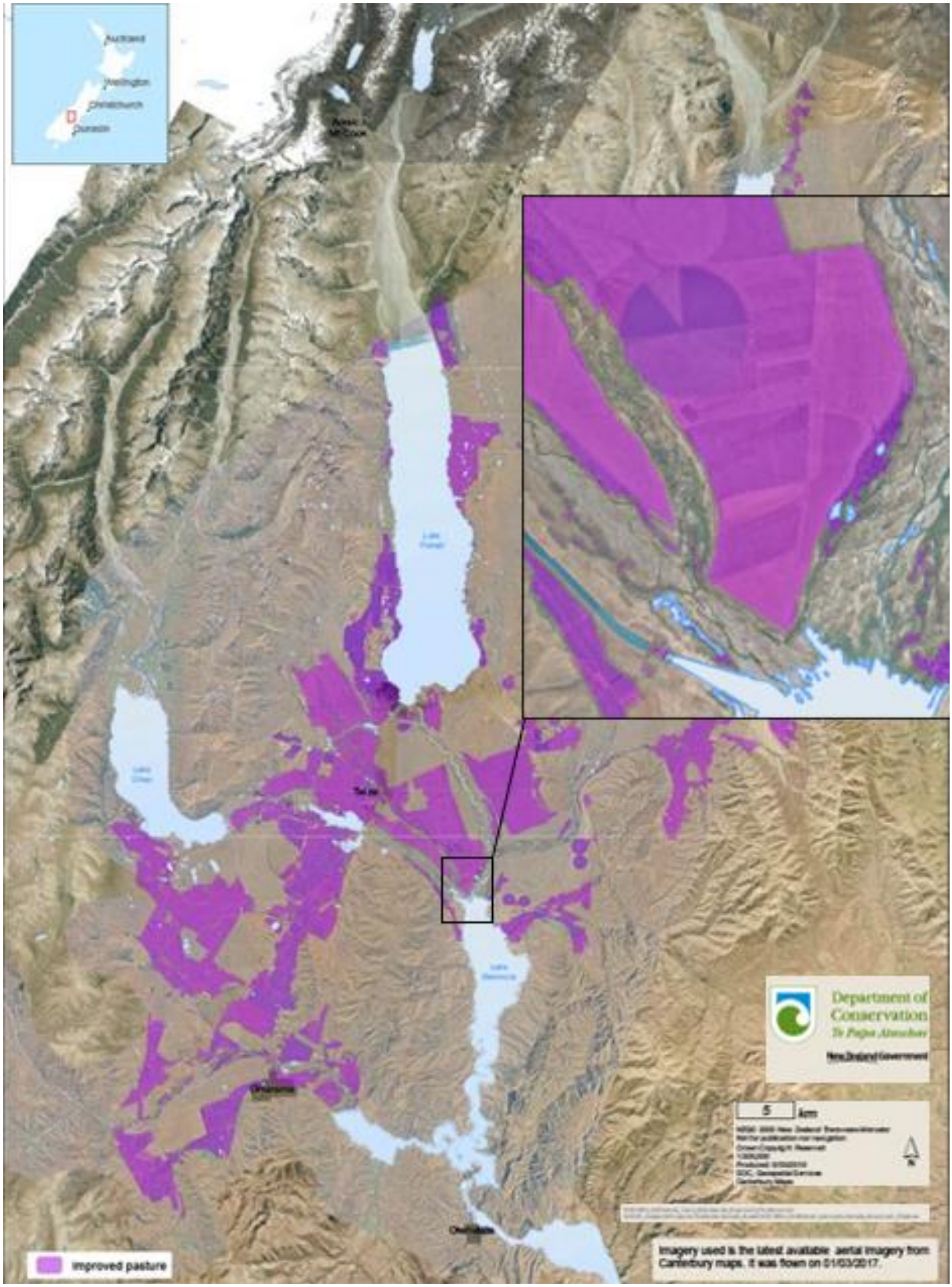

Figure 2: Areas of improved pasture within the Mackenzie Basin as identified by the Department of Conservation in 2018. All of the Ōhau C site is classified as improved pasture.

The works proposed (Figure 3) could potentially have the following effects of the ecology of the site:

- Clearance of indigenous vegetation.
- Clearance of At Risk or Threatened plants.
- Microclimate changes beneath solar panels resulting in changes to vegetation.
- Microclimatic effects on At Risk flora.
- Risk of introduction of pest plants.
- Disturbance (including death, displacement and injury) and harm to lizards.
- Loss of indigenous lizard habitat, and habitat reduction through panel shading.
- Fragmentation of lizard habitat.
- Disturbance of lizards during earthworks.
- Breeding failure/avoidance of lizards.
- Disturbance (including death or injury) of avifauna during construction.
- Ongoing disturbance to lizards.
- Reduction in invertebrate habitat.
- Mortality of Threatened or At Risk invertebrates.
- Disturbance to invertebrates during construction.
- Reduction of habitat quality due to shading.
- Ongoing disturbance to invertebrates.
- Loss of avifauna habitat.
- Disturbance of breeding avifauna.
- Death or injury of avifauna during construction.
- Ongoing disturbance.
- Risk of bird strike.
- Sedimentation of nearby rivers

The scope of this assessment does not include a comprehensive evaluation of the impact of ongoing weed control. It is considered likely that ongoing solar generation will require the control of vegetation within the development footprint to ensure that panels are not shaded. However, insufficient information is available to adequately assess the impacts of vegetation control. The magnitude of effects associated with vegetation control around the development will depend on many factors, including how often vegetation is managed, how vegetation responds to altered microclimatic conditions, which species thrive at the site over time, and which weed management techniques are used. Weeds could be managed mechanically, chemically, or through the use of grazing animals. These techniques will vary in the effects to which they affect biodiversity. Some of these techniques may have impacts on all of the biodiversity present at the site.

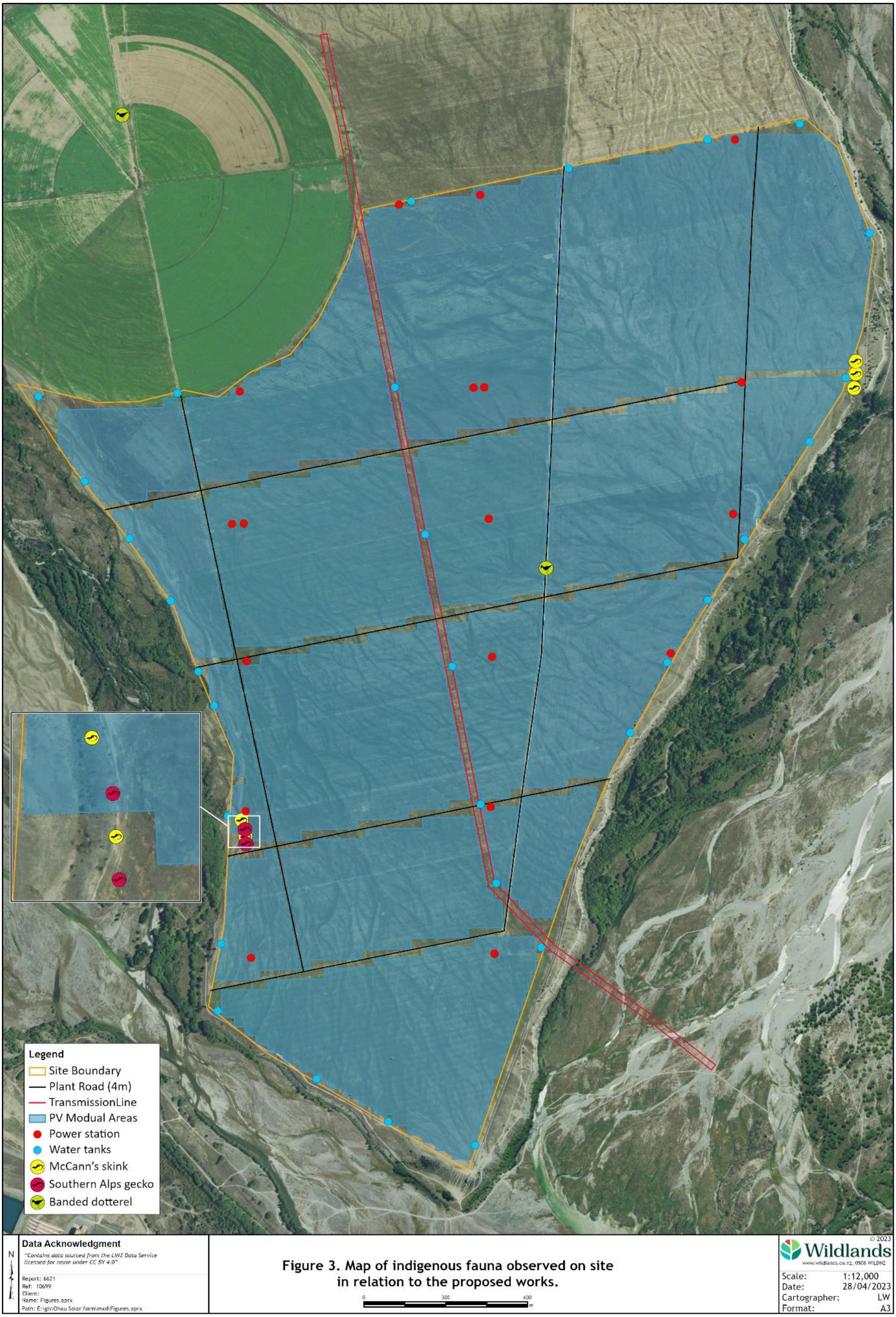

Figure 3. Map of indigenous fauna observed on site in relation to the proposed works.

11.2 Vegetation and flora

General

The vegetation at the site is predominantly grazed exotic grasses with relatively small pockets of indigenous vegetation. There is potential risk to indigenous vegetation during the construction and ongoing operations of the solar farm, including destruction of At Risk plants, clearance of indigenous vegetation, microclimate changes beneath the solar panels, and changes to the site's overall floristic composition.

Clearance of Indigenous Vegetation

The proposed works will require vegetation clearance for access roads, trenching, and pole installation. Most of the onsite vegetation is exotic grassland. Vegetation clearance will have a **negligible** effect on indigenous vegetation.

Clearance of At Risk Plants

The sweet briar-matagouri shrubland supports matagouri (At Risk – Declining), and the stonefield drylands support populations of mat daisy and stout dwarf broom (both At Risk – Declining). Development of the solar farm could result in some individuals of these species being removed. Installation of the solar panels requires relatively little earthworks (poles will be primarily inserted into the ground), but depending on the placement, this may cause harm to plant species.

As heavy machinery moves around the site during construction, this could result in damage to At Risk plant species.

However, most of the site is dominated by exotic vegetation species, and indigenous species are confined to small pockets of suitable habitat, or are individual plants. These areas could be avoided during development. It is therefore considered that these project impacts will have a **minor** or **less than minor** adverse effect on indigenous plants.

Microclimate Changes Beneath Solar Panels, Resulting in Changes to Vegetation

Changes in the microclimate beneath solar panels is likely to affect the floristic composition of the site. Most of the site is exotic grassland, and species native to the Mackenzie Basin typically thrive in full sun. Therefore, species that thrive in shade, slightly lower temperatures, and increased soil moisture are likely to colonise the spaces underneath the solar panels. These species are likely to be non-native, which will have a **less than minor** adverse effect on the floristic composition of the site.

Microclimate Effects on At Risk Plants

At Risk plant species could be shaded out due to the presence of the solar panels. The solar panels will rotate as well, which will limit the height of larger At Risk shrub species, or exclude them from being within the rotational range of each solar panel. These project impacts could have a **minor** adverse effect on At Risk plants if these are not avoided.

Risk of Introduction of Pest Plants

If the works require the importation of metal, soil, or fill for contruction, there is the potential that these materials will be contaminated with seeds of pest plants and ecological weeds which are not already present at the site. This, combined with clearence of exisitng vegetation could acceleate the estblishment of undesirable species at the site, which would have a **more than minor** adverse effect, depending on the species introduced.

11.3 Avifauna

Overview

There are five potential effects on avifauna: permanent habitat modification/loss (e.g. South Island pied oystercatcher breeding on farmland), displacement resulting from construction disturbance (especially along the Ōhau and Twizel Rivers and within the Department of Conservation black-stilt breeding centre), impacts on breeding birds (e.g. death or injury if breeding on-site), ongoing disturbance to birds during operation and impact trauma (bird strike) with panel arrays.

Habitat Modification or Loss

Although plans for the site have not been finalised, the development of the solar farm will affect species such as banded dotterel, pihoihoi/New Zealand pipit, and South Island pied oystercatcher which will lose foraging (and potentially breeding) habitat within the open grassland areas, and black-fronted tern will lose foraging habitat for large insects within open short grass areas. Without mitigation, this effect is likely to be **minor**.

Displacement of Breeding Avifauna

Disturbance from construction activities includes noise, vibration, machinery and human activity. This disturbance is likely to cause birds the change their behaviour and abandon or temporarily avoid the site (and surrounding area) during the breeding season. This leads to behavioural and physiological responses which are presumed to be costly, and can lead to changes in habitat use, parental care, reproductive failure and may have long-lasting effects on populations (c.f. Weston *et al.* 2012). There is a high risk that the disturbance from construction activities will displace a number of Threatened and At Risk species in the Ōhau and Twizel Rivers and nearby wetlands. Without mitigation, this effect is likely to be **more than minor**.

Death or Injury During Construction

If birds are breeding within the construction site, these birds will not only be subject to construction disturbance but also adults, chicks or eggs maybe injured or killed by ground clearance and machinery. Without mitigation, this effect is likely to be **more than minor**.

Ongoing Disturbance

This can occur through the placement of roads, maintenance tracks and yards. If an accessway brings vehicles in close proximity to the Ōhau or Twizel riverbeds and the wetland areas, this will provide ongoing disturbance to breeding, roosting and foraging birds. Without mitigation, this effect is likely to be **more than minor**.

Risk of Bird Strike

There is currently no information available on the solar array layout at the proposed solar farm. As such, more information and further investigations is required to determine direct affects at the site regarding the risk of bird strike with solar array panels. The level of effect has been determined at a conservative level and may change based on final plans. Without mitigation, this effect is likely to be **more than minor**.

11.4 Lizards

Overview

As the plans for the site has not been finalised and targeted surveys have not yet been undertaken, effects on lizards have been determined based on the habitats observed during the site visit and both species recorded and likely to be present on the site. The level of effect has been determined at a conservative level and may change based on final plans and the types and level of disturbance proposed. Final plans for the solar farm construction require targeted surveys to determine direct effects to lizards at the site, and ultimately inform a Lizard Management Plan.

Injury/Death/Displacement

Vehicle strikes are likely to cause injury and death to indigenous lizards during solar panel installation. Trenching and minor earthworks may (fatally) injure lizards present at the site. The proposed solar farm will likely result in the permanent displacement, injury and death of individual lizards within the proposed development footprint. This effect is likely to be **more than minor.**

Habitat Loss and Reduction of Habitat Quality

Lizard habitat has been identified within the proposed solar farm footprint. Habitat loss may occur due to trenching and the development of access roads. Habitats may also be reduced in quality where panels are constructed. Reduction of habitat quality can displace lizards into habitats that may already likely be at carrying capacity, increasing competition and breeding avoidance. If lizard habitat loss cannot be avoided, the proposed development will result in permanent and cumulative ongoing habitat loss for indigenous lizards at this site. This effect is likely to be **more than minor.**

Fragmentation

The proposed solar farm may result in the potential local extirpation or fragmentation of an unknown sized lizard population. Ongoing cumulative fragmentation of lizard

habitats within the Canterbury Region may result in the eventual localised extinction of lizard species without mitigation. This effect is likely to be **more than minor.**

Disturbance During Earthworks

Disturbance during earthworks for trenching wires includes effects to lizards such as dust, vibration, and noise. This disturbance is likely to disrupt normal behaviour, including social dynamics in lizard populations adjacent to the earthwork footprint as a result of construction activity. Across the site, this effect is likely to be **more than minor.**

Breeding Failure/Avoidance

The proposed solar farm and associated earthworks may lead to affected behaviour of lizards and/or social interactions, increase in stress, leading to reduced population functionality, such as poor breeding and low population recruitment. This effect is likely to occur through panel shading, altering habitat composition and quality and earthworks. Without mitigation, this effect is likely to be **more than minor**.

Reduction of High Quality Habitats Due to Shading

High quality habitats within the site could be shaded out due to the construction of the panels, resulting in the gradual shift in vegetation and species composition. This could displace more habitat specific lizard species (such as Lakes skink, if present) and reduce population abundance of more common lizards such as southern grass and McCann's skink. Without mitigation, this effect is likely to be **more than minor**.

Ongoing Disturbance

Vehicle strikes, noise and dust may affect lizard populations along newly-formed roads and vehicle accessways especially in areas where new tracks are created with cobbles, which provides refugia and basking opportunities for lizards. While there is limited published literature about the impacts of dust on lizards, it is likely that lizards would avoid this habitat if there was heavy dust deposition. Without mitigation, this effect is likely to be **minor**.

11.5 Terrestrial invertebrates

General

The presence of notable orthopteran species (Tekapo ground wētā, minute grasshopper, and robust grasshopper) on-site is possible but unconfirmed. Therefore, in predicting ecological effects on terrestrial invertebrates, it is necessary to be conservative and assume that notable species are present.

Reduction in Invertebrate Habitat

Habitat for notable invertebrates (Table 3) has been identified within the proposed development footprint. The proposed development will result in habitat loss for invertebrates at this site. This effect is likely to be **more than minor.**

Mortality of Invertebrates

All earthworks, including for the placement of trenching and the cut-fill earthworks for establishing contours, will cause the removal and destruction of any notable invertebrates present on the surface of the ground during works. Vehicle strikes will also cause the death of invertebrates. This effect is likely to be **more than minor**.

Disturbance During Works

Dust and vibrations associated with earthworks are likely to disturb insects and affect their behaviour. Little has been published on the effects of dust on invertebrates, but dust settling on insect bodies may cause injury from abrasion and/or blocking external breathing apparatus. This effect is likely to be **more than minor**.

Reduction of Habitat Quality Due to Shading

High quality habitats within the site could be shaded out due to the solar panels. Shading has the double-edged effect of both reducing habitat quality through a gradual shift in vegetation composition and structure, and reducing sunlight availability for basking species such as robust and minute grasshoppers. The creation of shaded areas is likely to benefit the New Zealand blue butterfly, but overall this effect is likely to be **more than minor**.

Ongoing Disturbance

Vehicle strikes, vibration, and dust from ongoing works may affect invertebrate populations near newly-formed roads and vehicle accessways, particularly if they approach the river bed. This effect is likely to be **more than minor**.

Creation of Concrete and Cobbled Areas

Concrete provides basking opportunities for indigenous invertebrates, including New Zealand blue butterfly. This effect is likely to result in a **net gain.**

Note: The proposed solar farm site is immediately adjacent to two rivers, which provide habitat for many freshwater invertebrates. International studies have shown that solar farm proximity can be detrimental to freshwater invertebrates. Adverse impacts are therefore likely from the development and ongoing operations of this solar farm on local indigenous freshwater invertebrates and thereby nearby rivers. An assessment of effects on freshwater invertebrates was beyond the scope of this assessment.

11.6 Freshwater

While there are no waterways within the site, consideration of the surrounding waterways remains important. Works will result in the disturbance of sediment, which has the potential to enter waterways through overland flows, this can have a number of negative effects on freshwater fauna species. Small galaxiids and bullies, as well as many macroinvertebrate species utilise hard surfaces and interstitial spaces for

foraging, spawning and shelter, an increase in fine sediment within the waterways they inhabit would result in loss of this habitat (Ryan 1991; Jowett and Boustead 2001).

Sedimentation of a waterway can cause a decrease in the survival rate of fish eggs as it can reduce both space and oxygen availability within the interstitial spaces of the substrate (Ryan 1991), impacting the recruitment rates of fish that spawn in the area. Sedimentation can also lead to an increase in invertebrate drift as habitat becomes less suitable, this can result in a change in the community composition, diversity and abundance (Mathers *et al.* 2022; Davis *et al.* 2022). Changes in macroinvertebrate community will cause follow on impacts for the fish species that feed on them. Finally, sedimentation can also reduce the availability of refuges within the substrate for small indigenous fish species, which can increase the likelihood of negative interactions with introduced salmonids (Coughlan 2022; Sowersby *et al.* 2015).

The impact of sediment in surrounding waterways could be **minor**.

12. MANAGEMENT OF POTENTIAL EFFECTS

12.1 Spatial design considerations

Two vegetation types on the site are considered low value, despite meeting the criteria for ecological significance. Cocksfoot grassland and brome-hawkweed-sheep sorrel herbfield comprise most of the proposed solar farm footprint. These habitats potentially provide foraging and breeding habitat for various indigenous bird and lizard species, and a New Zealand Blue Butterfly was observed in the brome-hawkweed-sheep sorrel herbfield. However, there are no At Risk or Threatened plant species in these vegetation types. However, these two types extend beyond the solar farm boundary within the property. Therefore, while this type of habitat would be reduced by the development, it would not be removed completely from the wider ecosystem.

Higher value vegetation and habitats are also present on the site, primarily along the property boundaries. These include the stonefield drylands and sweet briar-matagouri shrublands. These types should be excluded completely from development, as they already exist in small patches, and support populations of protected indigenous lizard species.

To ensure that higher value habitats are protected from solar farm development, the proposed development footprint should be adjusted (Figure 4). This would thereby exclude the high value habitats, and provide a buffer region for avifauna on the offsite braided rivers and wetlands.

Stonefield drylands and sweet briar-matagouri shrubland would benefit from protection and enhancement. These habitats include areas of indigenous and ecologically significant vegetation as well as important habitats of Threatened and At Risk plants, invertebrates, lizards, and birds. Additionally, a buffer of 100 metres around waterways and wetlands should be implemented, to ensure that avifauna, wetlands, and the adjacent braided river systems are not adversely affected by the proposed works.

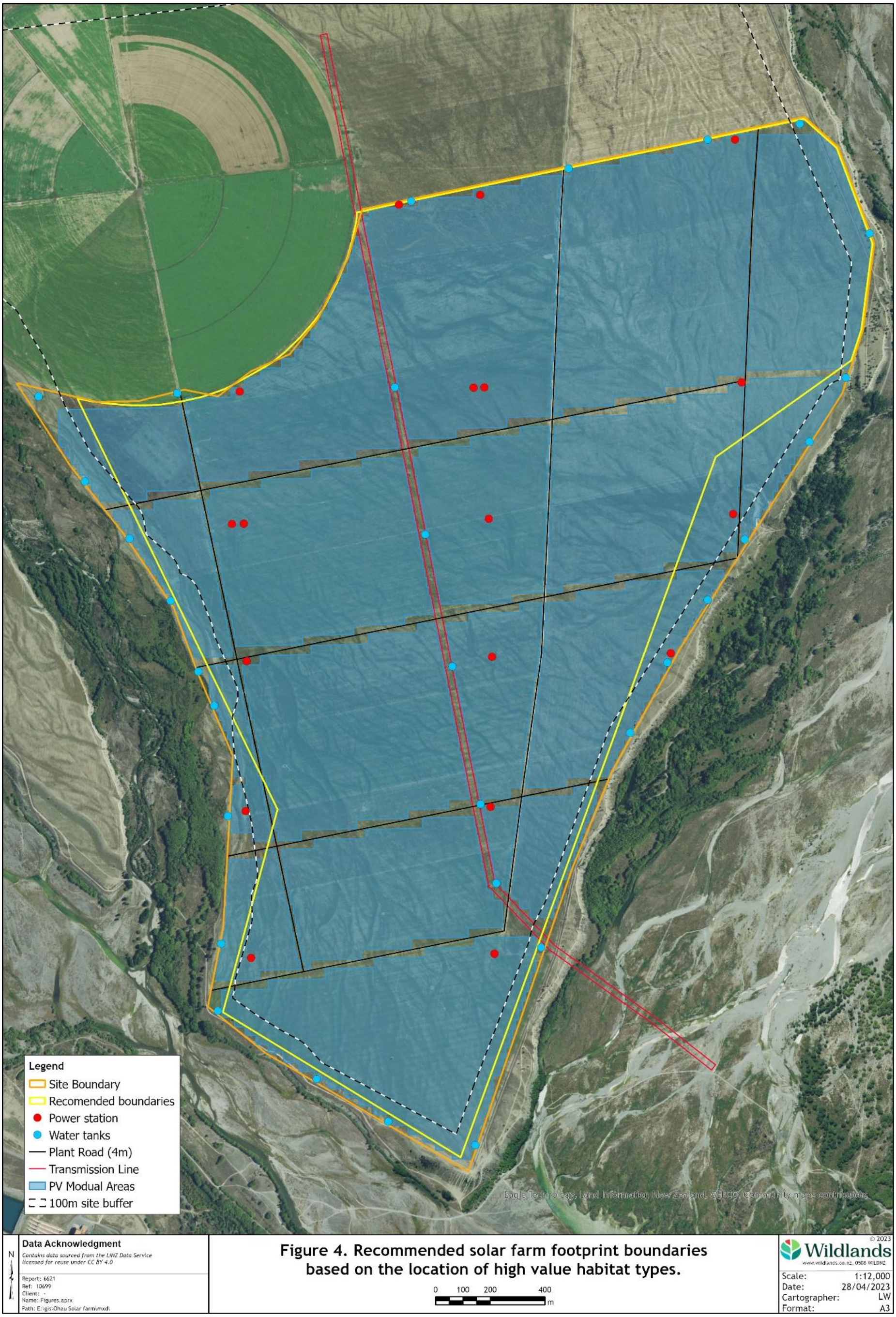

Figure 4. Recommended solar farm footprint boundaries based on the location of high value habitat types.

Furthermore, any land on the property not utilised for solar farm operations would benefit from protection and enhancement as well. 'Unused' land would benefit from indigenous plantings, habitat creation for indigenous lizards and invertebrates, and protection from lagomorph browsing. See Section 13.7 Ecological Enhancement Plan, below, for further details.

Any area that is enhanced or protected should be legally protected to ensure that biodiversity loss does not occur over the lifetime of the project. Legal protection options include QEII covenants.

12.2 Vegetation and flora

Avoidance of Indigenous Vegetation and Notable Plant Species

The current panel area mostly comprises exotic grasslands and planted exotic vegetation. Therefore, it will be possible for design of the solar farm to avoid areas with indigenous and ecologically-significant vegetation and known locations of Threatened and At Risk plants.

Solar panel locations should be selected so that the locations of ground supports for the panels avoid At Risk or Threatened species. Solar panels should also be constructed in areas where At Risk indigenous species density is low, to minimise the effects of shading. Access to and around the site by machinery should be planned carefully to avoid destruction to At Risk species or patches of predominantly indigenous vegetation.

More detailed vegetations surveys will be required to ensure that At Risk species are avoided wherever possible.

Biosecurity Management Plan

Risk of introduction of pest plants can be mitigated by utilising the existing access road as much as possible and avoiding indigenous habitats. Any soil or fill bought into the site could be sourced locally. Ideally, no fill will be bought in from outside of the site and if it is necessary to bring it in then it should be from a 'clean' source in close proximity. Surveys and control of pest plants and ecological weeds should be undertaken to ensure that new species don't establish and expand.

Indigenous Planting

The applicant intends to plant indigenous species between and surrounding the solar panels to promote native species regeneration. Indigenous planting advice should be provided by a qualified vegetation ecologist and plants should be sourced locally. In addition, ongoing invasive weed control will be implemented through sheep grazing and manual removal of invasive species.

If these actions are taken, it is considered that the effects of the project on indigenous vegetation and At Risk flora will be **less than minor to minor**.

12.3 Avifauna

Loss of Habitat and Impacts on Breeding Birds

The proposed solar farm footprint is mostly grassland of various types. Although access to similar habitat is readily available in the surrounding area, the habitat loss will affect breeding and foraging birds if construction work occurs during the breeding season. Construction activities during the breeding season (July – March) are likely to injure or kill breeding birds, eggs, and chicks. Ideally, as much construction work as possible should occur outside the bird breeding season. However, given the size of the project, it is inevitable that some construction will occur during the breeding season, and a bird management plan will therefore be needed, including surveying for breeding birds no more than eight days prior to the start of works. A suitably qualified and experienced avifauna ecologist should produce the Avifauna Management Plan and undertake the pre-works surveys.

Disturbance During Construction

Proposed works must avoid disturbing birds in the rivers and wetland areas adjacent to the site. To avoid this disturbance, a buffer area of 100 metres should be maintained between the near edge of rivers/wetlands and any area where machinery and power tools are used. These buffer zones must be total exclusion areas, and cannot be used for vehicle access to the construction site. In particular, the river delta near the southern corner of the site and the area of wetland and the braided riverbeds must be avoided.

Habitat Enhancement

The site is in close proximity to the Department of Conservation release site for kakī/black stilt, which is classified as an Important Bird Area, and measures to protect river and wetland habitats should be implemented. Primarily, this would involve pest control around the Ōhau C site, especially near the rivers. Stonefield drylands within the site should be maintained and buffer zones or setback areas will be required to protect avifauna habitat.

Ongoing Disturbance

Vehicle access should be limited to be at least 100 metres away from all waterbodies and river areas. Vehicles must drive slowly within the solar farm as birds will breed within gravel areas and could potentially utilise the vehicle tracks as breeding sites.

Prevention of future disturbance, death, or injury due to solar farm activities will partly be dependent on the final solar farm design. Providing clear areas between solar panel arrays will allow birds to navigate the access corridors and avoid bird strikes when landing or departing from the site. Monitoring of the solar farm should be undertaken after the construction phase and during the lifetime of the solar farm, to assess whether mortality due to bird strike actually occurs.

12.4 Lizards

Further Surveys Required

A targeted lizard survey, following the relevant Department of Conservation Inventory and Monitoring Toolbox for Herpetofauna (Lettink and Monks, 2012), is required to more accurately assess the lizard species, abundances, and areas of lizard habitat on site to inform a Lizard Management Plan (see below).

Lizard Management Plan (LMP)

Unless all areas of lizard habitat identified following a targeted lizard survey can be absolutely avoided from all adverse impacts of development, then a LMP and associated Wildlife Act Authority will be required for the project. The actual details of lizard management (including any offsetting or compensation measures) will be addressed in the LMP. The LMP should contain:

- Ways to adequately avoid lizards and their habitats where possible.
- A thorough assessment of alternatives to lizard salvage, including
  - Compensation or other suitable means to enhance lizard populations offsite.
- Habitat restoration and enhancement, including:
  - Appropriate indigenous vegetation planting and pest animal and plant control.
  - Salvage and relocation of lizards to an alternative location outside of the development footprint, if sufficient avoidance or onsite mitigation is not feasible.

Avoid High Quality Lizard Habitats

Where high quality lizard habitats are present, these should be avoided. These areas include the stonefield drylands and sweet briar matagouri shrubland. Avoidance of high quality habitats should be the most important measure considered for the mitigation of potential effects on lizards, such as habitat loss, mortality, and disturbance.

Project Design that Includes Corridors

Corridors could also be created whereby areas of land are avoided, and preserved within the site to provide connectivity for species across the wider site, and to link habitats, both of high and low quality. This may help to preserve genetic diversity within more Threatened species, if these are found to be present within the site.

Site development with the implementation of these measures and a LMP may result in a **minor adverse** effect on lizards.

12.5 Terrestrial invertebrates

Habitat Avoidance

Destruction of indigenous brooms and other indigenous flowering plants should be avoided where possible, to ensure continued breeding and feeding plant access for New Zealand blue butterfly. Loss of areas of bare ground and rock should be avoided where

possible, to minimise the loss of basking areas for New Zealand blue butterfly. Therefore, dry, open habitats should be avoided. If these habitats cannot be avoided, which is likely as much of the site is open, then habitat enhancement in other sections of the site should be implemented.

Further Studies

Notable orthopterans may all be present on-site. Surveys for all these species are necessary. The surveys should be carried out in the open habitat areas, particularly towards the east of the site.

Invertebrate Management Plan

A Grasshopper Management Plan will be required if robust grasshopper are found in further surveys due to their protection under the Wildlife Act (1953). An Invertebrate Management Plan will be required if minute grasshopper or short-horned grasshopper, and/or Tekapo ground wētā, are found to be present.

Habitat Restoration

Ōhau C contains several patches of dry, open habitat that could be enhanced or restored for indigenous invertebrates such as short-horned grasshopper and minute grasshopper. Predator control throughout the site, through implementation of a predator control plan designed by a suitably-qualified ecologist, would benefit terrestrial invertebrates.

12.6 Freshwater fauna

A sediment management plan is necessary to ensure that there are no accidental discharges of disturbed sediment into the adjacent waterways. This should include consideration of the timing of works to avoid disruption of sediment when high rainfall events are predicted.

A setback from the surrounding waterways would also reduce the risk of sediment or incidental chemical pollution occurring.

12.7 Wildlife management

A Wildlife Act 1953 authority (permit) is required to carry out modification or land development that have adverse impacts on indigenous New Zealand fauna, including some invertebrates, all lizards and most avifauna (Department of Conservation 2019).

As protected species are likely to be present within the proposed solar farm footprint and adverse effects may be unavoidable, fauna management plans are likely to be required: Lizard Management Plan, Avian Management Plan, Robust Grasshopper Management Plan. An Invertebrate Management Plan will also likely be recommended for the protection of At Risk and Threatened invertebrate populations within the site if others are found during targeted surveys. Management plans are often required as a resource consent condition, as are continuing to meet all other legal obligations (such as obtaining required permits) when carrying out consented activities.

If vegetation clearance or works are to be undertaken during the avifauna breeding season, especially within 100 metres of any river or wetland area, an Avifauna Management Plan will be required to avoid and mitigate adverse effects.

If required, and depending on levels and types of disturbance, fauna management plans should contain measures that clearly avoid, mitigate, offset, or compensate for the disturbance to species, populations, and their habitats. Wildlife management actions for lizards, avifauna, and invertebrates could include avoidance of habitat and/or relocation of lizards or invertebrates and site management (e.g., habitat enhancement, pest management, monitoring) at specific sites. The Department of Conservation will need to be reasonably confident that, on balance, lizard, avifauna, and invertebrate populations to be affected will not be worse off than prior to development of the site. *In situ* mitigation management of lizards, avifauna, and invertebrates, or offsetting or compensatory tools, may be needed.

12.8 Ecological Enhancement Plan (EEP)

12.8.1 Overview

The Mackenzie Basin has undergone extensive landscape modification and degradation due to human activities, particularly the introduction of agriculture and associated exotic plant species. Development of the Mackenzie Basin is likely to continue.

FNSF intends to ecologically enhance 89 hectares of unused land on the site. This is the first project of its kind in the Basin and represents a substantial opportunity to preserve the unique ecology of the Mackenzie country. In order to restore ecological functions and improve biodiversity, an Ecological Enhancement Plan (EEP) will be developed that emphasises the restoration of indigenous vegetation, and results in habitat creation for indigenous fauna.

The EEP will prioritise the restoration of regionally typical indigenous vegetation and habitats as well as the management of problematic exotic species. Site enhancement could therefore contribute significantly to the recovery of the vegetation and habitats in the Mackenzie Basin, and promote long-term ecological resilience across the wider landscape.

Relatively little is known about the management and restoration of dryland ecosystems in Aotearoa New Zealand and restoration will likely be challenging and will require adaptive management that is informed by long-term monitoring. Ongoing monitoring will assess the success of the EEP and ensure that management adapts to achieve the desired outcomes.

The EEP is intended to generate a net gain for ecology at the site, and is complemented by a range of actions that avoid or minimise the potential for adverse effects of this project. Prioritising these actions will ensure that, across the project, potential adverse effects are mitigated in the most effective manner.

12.8.2 Indigenous revegetation

The total area of the proposed enhancement zone to be revegetated, where required, is 89 hectares. This will be undertaken differently in two zones: an enhancement zone and a visual screening zone, as described below.

Enhancement Zone

The EEP will be focussed on the enhancement zone, which will be restored to be representative of the original outwash plain vegetation that typifies the Pukaki Ecological District. The area will be managed to attain the dominance of indigenous shrubs, tussocks, and herbs, with exposed stony gravel.

The total number of indigenous plants to be planted in the enhancement zone will be between 500,000-750,000, and will be a mixture of the following eco-sourced species (among others):

- Matagouri
- *Olearia lineata*
- *Corokia cotoneaster*
- *Coprosma propinqua*
- *Phyllocladus alpinus*
- *Sophora microphylla*
- Desert broom (*Carmichaelia petriei*)
- *Hebe* species
- Golden spaniard (*Aciphylla aurea*)
- *Carex* species
- *Celmisia semicordata*
- *Festuca novae-zelandiae*
- *Gaultheria antipoda*
- *Poa* species

Visual Screening Zone

Selected parts of the EEP will be dedicated to visual screening, and this zone will comprise the areas closest to the development footprint. A 40 metre wide strip surrounding the entire development footprint will be revegetated with shrubs and trees that will reach a mature height of at least three metres. This area will be planted with taller-growing eco-sourced species such as:

- Mānatu/ribbonwood (*Plagianthus regius* subsp. *regius*)
- Kānuka (*Kunzea robusta*)
- Matagouri
- *Olearia lineata*
- *Corokia cotoneaster*
- *Coprosma propinqua*

Some of these species are not typical of the outwash vegetation that would have originally occurred at the site, but is typical of the Ecological District, and is therefore

considered to be ecologically-appropriate. This part of the EEP is nevertheless expected to generate benefits for local fauna (this is expanded upon below). Planting of taller stature species may require adaptation of the existing soil conditions to ensure that species reach the required height. If this is required, biosecurity measures and ecological-appropriateness will need to be taken into account.

12.8.3 Ongoing maintenance

Pest Animal Control

Pest mammals have significant detrimental effects on indigenous ecology and particularly notable impacts in the Mackenzie Basin are due to the effects of lagomorphs, mustelids, rodents, and domestic stock.

Stock exclusion is appropriate at the site and would provide benefits for many biodiversity types. The most appropriate control strategy for mammalian pests is yet to be determined, with different strategies likely to have various benefits and risks. A cost-benefit analysis for pest control options will be required as all options have trade-offs. Appropriate management must consider the existing biodiversity values of the site and should be implemented by suitably qualified and experienced pest control operators.

Predator-proof fencing and eradication of introduced mammals may be an appropriate way to enhance the habitat for a wide variety of indigenous fauna and this option is being considered by FNSF. Sufficiently regular pest monitoring and fencing maintenance would be required long-term, to ensure that mammals are excluded from the enhancement site.

Landscape-scale pest control is associated with significantly higher risk than predator-proof fences, because mice are a predator of many indigenous fauna, and these are unlikely to be controllable without the ongoing use of aerially broadcast toxins or very intensive ground-based control. If other introduced mammals are controlled, but not mice, mouse numbers can be expected to increase substantially. This may erode any positive effect of pest control if mice prove to be significant predators. Pest control in the area would have to be undertaken in perpetuity to remain effective. In contrast, predator-proof fences, as suggested above, can be kept mouse-free (Hutcheon *et al*. 2011; Reardon *et al.* 2012).

Landscape-scale control could possibly be considered for a smaller area (10-100 hectares), and predator-proof fencing around the whole site, plus implementation of a predator-control plan within the site, would benefit all invertebrates.

Exotic Vegetation Management

The area subject to the EEP is likely to require ongoing maintenance to control weeds, particularly as planted species become established. Notably, vegetation dynamics are likely to change with mammal exclusion. For example, lagomorph control may exacerbate the dominance of some weedy species.

While the optimal techniques require further consideration and are beyond the scope of this assessment of ecological effects, it is likely that implementation of the EEP will

involve the use of various combinations of mechanical methods for the control of invasive species, soil cultivation, and weed control. Light grazing by sheep may be required to keep weeds down and should not result in substantial adverse effects of indigenous fauna if limited to low numbers, although the land should not be used for farming.

The use of herbicides, pesticides and fertilisers are likely to be generally inappropriate in the reserve, as many indigenous fauna are sensitive to sprays. Sprays should also be avoided on land around the reserve.

Site Access

Access to the parts of the site to be restored should be undertaken on foot to avoid disturbance to fauna. If absolutely necessary, vehicle access to the reserve should be limited to essential visits inside the fence (e.g. for plant care or monitoring), and speed should be kept to below 20 kph.

To avoid damage to nest sites or disturbance of breeding birds, site maintenance and replanting should be undertaken during the non-breeding period, particularly if vehicles are to be used. If this is impractical, site maintenance could be undertaken during the breeding season but after a survey for breeding activity by a suitably qualified and experienced avifauna ecologist, no more than seven days before works start.

Legal Protection

The land needs to be formally protected as a dedicated reserve to ensure that there is long-term protection and associated benefits. This may include protection using a QEII covenant. As noted above, while light grazing (e.g. with sheep) may be necessary to control weeds, the site should not be used for farming.

Monitoring

Monitoring will be necessary to determine the success of the EEP and ongoing management, including the uptake of enhanced habitat by relevant fauna species. To ensure success of the EEP implementation programme, monitoring is likely to be required for at least 10 years for some species, such as larger-bodied skinks.

12.8.4 Habitat creation for fauna species

Indigenous revegetation and the control of weeds and pest animals will enhance existing habitat and increase its suitability and availability for Threatened and At Risk indigenous fauna. The benefits and options for additional habitat creation are described below.

Avifauna

Permanent habitat creation through restoration of the outwash plain and stonefield grassland will provide breeding habitat for Threatened and At Risk species, including South Island pied oystercatcher, banded dotterel, and New Zealand pipit, and potentially black-fronted tern. If implementation of the EEP successfully creates habitat

that avifauna use, this will have critical implications for the management of this area to avoid disturbance to nesting birds.

Tree species to be planted within the visual screening zone surrounding the entire development footprint and adjacent to the rivers and wetlands may provide roosting sites for shag species, including black shag and little shag. Shags prefer trees which are close to or overhanging water.

Lizards

Permanent habitat creation will be undertaken for lizard species present within the area. Permanent habitat creation should include the use of rock piles, targeted planting, pest control, and the exclusion of stock from high value sites.

The addition of habitat refuges for lizards should include rock piles deposited along dry river channels. Installation of these rock piles would be undertaken in a way that facilitates connectivity between high value lizard sites and is likely to support lizard population recovery and gene flow between otherwise isolated populations. These sites may also be utilised for lizard releases following any lizard salvage (as a requirement in the LMP), if required within areas of disturbance. Following successful implementation of the EEP, it may be possible to release threatened larger-bodied skinks into the site, to increase the population viability of these species long-term within the Mackenzie Basin.

Invertebrates

This plan is designed to provide benefits for all indigenous invertebrates, but particularly robust grasshopper, Tekapo ground wētā, short-horned grasshopper, minute grasshopper, New Zealand blue butterfly, carabid beetles, and moths.

Grasshoppers will benefit from enhancement of open gravel riverbed habitat. Weeds will be removed mechanically as herbicides are not tolerated by grasshoppers. Indigenous gravel riverbed species will be included in the planting plan. Further from the river, areas of rocks, lichen, mosses, and bare earth with little or no vegetative cover will be created. The bare habitat should ideally be interspersed with pohuehue among larger rocks, and indigenous grasses, which will provide habitat for indigenous moths which feed on grasses, lichens, and mosses. Carabid beetles will benefit from rock stacks and other indigenous vegetation planted. New Zealand blue butterfly will benefit from indigenous legumes (e.g. broom) planted, as well as being able to utilise bare open areas and shelter under foliar cover.

12.8.5 Anticipated outcomes of the EEP

This work will require a restoration plan, and will need to be implemented by suitably qualified and experienced ecologists and restoration specialists. If the EEP is implemented appropriately, it is likely to result in the following suite of **positive** effects:

- Vegetation and flora:
  - Permanent habitat creation for Threatened and At Risk plants.
  - Increase in the extent of indigenous vegetation.
  - Protection of palatable plant species from grazing.

- Protection from conversion to other land uses, such as farming.

- Avifauna:
  - Permanent habitat creation.
  - Creation of roosting habitats.
  - Increased breeding success.

- Lizards:
  - Permanent habitat creation.
  - Creation of breeding habitats.
  - Reduction in landscape-level habitat fragmentation.
  - Creation of a suitable release site for lizards affected by other developments, including species that have been extirpated at Ōhau C.
  - Release of populations from predator pressure.

- Terrestrial invertebrates:
  - Permanent habitat creation.
  - Creation of breeding habitats.
  - Release of populations from predator pressure.

Very little is known about the management and restoration of dryland ecosystems in Aotearoa New Zealand. While challenging, this project will generate nationally important information regarding the management of dryland ecosystems. The project would help to address a critical dryland ecosystem knowledge gap and thus enhance the management of these ecosystems more widely throughout Canterbury and Aotearoa New Zealand.

12.9 Assessment of potential effects following mitigation

Levels of ecological effects on indigenous biodiversity following the implementation of appropriate mitigation actions are presented in Table 7. Accurate prediction of the levels of effect with mitigation in place is not straightforward, but the table gives a broad picture of how effects can be reduced significantly with mitigation measures in place.

There are numerous ways by which indigenous biodiversity could be adversely affected and the ecological effects of this development could be substantial if the project is not designed appropriately to address the ecological features and values known to be present at this site.

Notably, most of these potentially adverse effects can be avoided or greatly reduced if the project is implemented thoughtfully. Mitigation actions that involve designing the project to avoid areas that are important to biodiversity are likely to be disproportionately important to the maintenance of biodiversity at this site. Further surveys, as well as management plans designed by suitably qualified ecologists, will be required to ensure that adequate mitigation is implemented for the project.

Table 7: Potential significance of ecological effects if appropriate and effective mitigation is implemented.

Effect	Level of Effect Without Mitigation	Level of Effect With Mitigation (without EEP)	Estimated Level of Effect with Successful[1] EEP
Clearance of At Risk flora	Minor	Less than minor	**Positive**
Vegetation clearance	Negligible	Negligible	**Positive**
Microclimatic changes beneath solar panels, resulting in changes to vegetation	Less than minor	Negligible	Negligible
Microclimatic effects on At Risk flora	Minor	Less than minor	**Positive**
Risk of introduction of pest plants	Minor to more than minor	Minor	Minor
Injury/death/displacement of lizards	More than minor	TBC[2]	TBC[2]
Loss of lizard habitat	More than minor	Minor	**Positive**
Lizard habitat/population fragmentation	More than minor	TBC[2]	TBC[2]
Disturbance to lizards due to earthworks	More than minor	TBC[2]	TBC[2]
Lizard breeding failure and/or avoidance	More than minor	TBC[2]	TBC[2]
Reduction of high quality lizard habitats due to shading	More than minor	TBC[2]	**Positive**
Ongoing disturbance to lizards	Minor	TBC[2]	TBC[2]
Death or injury of avifauna	More than minor	Minor	Minor
Ongoing disturbance of avifauna	More than minor	Minor	Minor
Loss or modification of avifauna habitat	Minor	Less than minor	**Positive**
Displacement of breeding avifauna	More than minor	Minor	Less than minor
Risk of bird strike	More than minor	Minor	Minor
Creation of concrete and cobbled areas	Positive	Positive	**Positive**
Reduction in invertebrate habitat	More than minor	Less than minor	**Positive**
Mortality to invertebrates	More than minor	Minor	Minor
Disturbance to invertebrates during works	More than minor	Less than minor	Less than minor
Reduction in invertebrate habitat quality due to shading	More than minor	Minor	**Positive**
Ongoing invertebrate disturbance	More than minor	Less than minor	Less than minor

13. CONCLUSIONS

This report describes the potential ecological effects of a proposed solar energy development in the Mackenzie Basin. Various desktop and field surveys have provided information to support the findings presented in this report. The Ōhau C site consists predominantly of grazed and cultivated land, with indigenous vegetation on the site margins.

[1] The level of effect provided here assumes thoughtful design and appropriate implementation, as well as ongoing monitoring that drives adaptive management of the EEP.

[2] The level of effect with mitigation will be determined by the outcome of a lizard management plan, which is yet to be developed for this project.

The most ecologically valuable vegetation and habitats within this site are sweet briar-matagouri shrubland, brome-hawkweed-sheep sorrel grassland/herbfield and stonefield drylands. Five Threatened or At Risk plant species are likely to occur on-site. A broad assemblage of avifauna uses, or is likely to use the site, including various Threatened and At Risk species. Two lizard species have been recorded on-site, one of which is classified as At Risk. An additional two At Risk and two Threatened lizard species may occur on-site but further surveys are required to confirm whether they are present. One invertebrate species that is in decline has been recorded on-site, and an additional four notable species may be present.

Significant ecological values also occur adjacent to the site and some could potentially be affected by the development, including ecologically-significant wetlands and braided river systems. Furthermore, the Ōhau C site is adjacent to an Important Bird Area, where captive bred kakī/black stilt are released annually.

A variety of potential ecological effects are outlined in this report. However, details of the project design have not been finalised, which provides a substantial opportunity to avoid adverse effects. Subject to project design, some potential ecological effects may not apply. Many of the residual potential effects can be mitigated effectively through thoughtful project design.

For some biodiversity types, it is difficult to accurately assess the level of ecological effects of the project, and the degree to which these can be mitigated. Further ecological information will need to be collected to fully understand the types and levels of ecological effects on some features.

Development and land use change within high value vegetation and habitats, such as indigenous lizard and invertebrate habitat at the margins should be avoided. The cocksfoot grassland and brassica cropland habitats, which comprise most of the site, are likely to be more suitable for development, subject to the findings of a targeted lizard survey.

The site would benefit from ecological enhancement, as most of it is currently highly disturbed and cultivated. Without development, it is likely to remain in a degraded state. However, development of a solar farm provides an opportunity to enhance the ecosystem and habitats and to restore parts of it to be more representative of an indigenous-dominant outwash plain. The creation of additional shelter and basking areas for invertebrates is likely to result from the proposed development, which will provide limited benefits for some invertebrate species.

The applicant's intent is to design the project to avoid adverse ecological effects, and to achieve a net gain for local indigenous biodiversity. Sensitive design of the solar farm, combined with appropriate ecological management and enhancement, can achieve positive benefits for indigenous biodiversity at this site.

ACKNOWLEDGMENTS

Richard Homewood is thanked for providing access to the site as well as client liaison.

REFERENCES

Atkinson I.A.E. 1985: Derivation of vegetation mapping units for an ecological survey of Tongariro National Park, central North Island, New Zealand. *New Zealand Journal of Botany 23*: 361-378.

Cieraad E., Walker S., Price R., and Barringer J. 2015: An updated assessment of indigenous cover remaining and legal protection in New Zealand''s land environments. *New Zealand Journal of Ecology* 39(2).

Clarkson B.R., Hicks A., Robertson H.A., Rance B.D., and Ledgard G. 2013: A monitoring approach for Southland's wetlands. *Landcare Research Contract Report LC1536*. Prepare for Environment Southland. 40 pp.

Coughlan A. 2022: Risk assessment and mitigations of the potential impacts of trout predation on New Zealand's indigenous fish species. *Unpublished Master of Science Thesis*. Massey University.

Davis N.G., Hodson R,. and Matthaei C.D. 2022: Long-term variability in deposited fine sediment and macroinvertebrate communities across different land-use intensities in a regional set of New Zealand rivers. *New Zealand Journal of Marine and Freshwater Research 56*(2): 191-212.

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., Breitwieser I., Schonberger I., Hindmarsh-Walls R., Heenan P.B., and Ladley K. 2018: Conservation status of New Zealand indigenous vascular plants, 2017. *New Zealand Threat Classification Series 22*. Department of Conservation, Wellington. 82 pp. https://www.doc.govt.nz/Documents/science-and-technical/nztcs22entire.pdf

Department of Conservation 2020: PRR Interim Strategic Plan 2020 – 2023. https://www.doc.govt.nz/globalassets/documents/conservation/land-and-freshwater/freshwater/prr/draft-interim-strategic-plan-2020.pdf

Environment Canterbury 2013: Canterbury Regional Policy Statement 2013. Environment Canterbury.

Hitchmough R.A., Barr B., Knox C., Lettink M., Monks J.M., Patterson G.B., Reardon J.T., van Winkel D., Rolfe J., and Michel P. 2021: Conservation status of New Zealand reptiles, 2021. *New Zealand Threat Classification Series 35*. Department of Conservation, Wellington. 15 pp.

Hoare R.J.B., Dugdale J.S., Edwards E.D., Gibbs G.W., Patrick B.H., Hitchmough R.A., and Rolfe J.R. 2017: Conservation status of New Zealand butterflies and moths (Lepidoptera). *New Zealand Threat Classification Series 20*. Department of Conservation, Wellington. 13 pp.

Jowett I.G. and Boustead N.C. 2001: Effects of substrate and sedimentation on the abundance of upland bullies (*Gobiomorphus breviceps*). *New Zealand Journal of Marine and Freshwater Research 35*(3): 605-613.

Lettink M., and Monks J. 2012: Herpetofauna: Inventory and monitoring toolbox, Department of Conservation, Wellington. Available online: https://www.doc.govt.nz/globalassets/documents/science-and-technical/inventory-monitoring/im-toolbox-herpetofaunda-introduction-to-monitoring.pdf

Mathers K.L., Doretto A., Fenoglio S., Hill M.J., and Wood P.J. 2022: Temporal effects of fine sediment deposition on benthic macroinvertebrate community structure, function and biodiversity likely reflects landscape setting. *Science of the Total Environment 829:* p.154612.

McEwen M.W. (Comp) 1987: Ecological Regions and Districts of New Zealand. *New Zealand Biological Resources Centre Publication No. 5.* Department of Conservation, Wellington.

Ministry for the Environment. 2021: Defining 'natural wetlands' and 'natural inland wetlands'. Wellington: Ministry for the Environment. Robertson H.A., Baird K.A., Elliott G.P., Hitchmough R.A., McArthur N.J., Makan T.D., Miskelly C.M., O'Donnell C.F.J., Sagar P.M., Scofield R.P., Taylor G.A., and Michel P. 2021: Conservation status of birds in Aotearoa New Zealand, 2021 . *New Zealand Threat Classification Series 36*. Department of Conservation, Wellington. 43 pp.

Patrick B. and Patrick H. 2012: Butterflies of the South Pacific. Otago University Press and Otago Museum.

Ryan P.A. 1991: Environmental effects of sediment on New Zealand streams: a review. *New Zealand Journal of Marine and Freshwater Research 25*(2): 207-221.

Sowersby W., Thompson R.M., and Wong B.B.M. (2015): Invasive predator influences habitat preferences in a freshwater fish. *Environmental Biology of Fishes, 99*(2-3): 187-193.

Trewick S., Hegg D., Morgan-Richards M., Murray T., Watts C., Johns P., and Michel P. 2022: Conservation status of Orthoptera (wētā, crickets and grasshoppers) in Aotearoa New Zealand, 2022. *New Zealand Threat Classification Series 39*. Department of Conservation, Wellington.

Vink, C. J. (Cornelis Jacob). 2002: Lycosidae (Arachnida: Araneae). Manaaki Whenua Press, Lincoln, Canterbury, New Zealand. *Fauna of New Zealand No. 44.*

Weston M.A., McLeaod E.M., Blumstein D.T., and Guay P.-J. 2016: A review of flight-initiation distance and their application to managing disturbance to Australian birds. *Emu Austral Ornithology 112*(4). 269-286 p.

Williams P.A., Wiser S., Clarkson B., and Stanley M. 2007: New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. *New Zealand Journal of Ecology 31*(2): 199-128.

VASCULAR PLANT SPECIES RECORDED DURING THE FIELD SURVEY

Threat status of indigenous species is from de Lange *et al.* 2018.

Pest plant species recorded are classified as either 'pests' or 'Organisms of Interest' (OOI) according to their status under the Environment Canterbury Regional Pest Management Plan (CRPMP; 2018-2038).

Species	Common Name	Plant Type	Native or Exotic	Conservation Status	Pest Status
Achillea millefolium	Yarrow	Dicot herb	Exotic		
Agrostis capillaris	Brown top	Grass	Exotic		
Aira caryophyllea	Silvery hair grass	Grass	Exotic		
Anthoxanthum odoratum	Sweet vernal	Grass	Exotic		
Anthosachne solandri	Native wheatgrass, blue wheatgrass	Grass	Native	Not Threatened	
Bromus catharticus	Prairie grass	Grass	Exotic		
Bromus tectorum	Downy brome	Grass	Exotic		
Bromus hordeaceus	Soft brome	Grass	Exotic		
Carmichaelia australis	Native broom, common broom	Shrub	Native	Not Threatened	
Carex breviculmis	Grassland sedge	Sedge	Native	Not Threatened	
Capsella bursa-pastoris	Shepherds purse	Dicot herb	Exotic		
Carmichaelia monroi	Stout dwarf broom	Shrub	Native	At Risk - Declining	
Chenopodium album	Fathen	Dicot herb	Exotic		
Cichorium intybus	Chicory	Dicot herb	Exotic		
Cirsium arvense	Californian thistle	Dicot herb	Exotic		
Coprosma propinqua	Mingimingi, mikimiki	Shrub	Native	Not Threatened	
Cytisus scoparius	Scotch broom	Shrub	Exotic		PEST
Dactylis glomerata	Cocksfoot	Grass	Exotic		
Discaria toumatou	Matagouri, tūmatakuru	Tree	Native	At Risk - Declining	
Echium vulgare	Vipers bugloss	Dicot herb	Exotic		OOI
Festuca novae-zelandiae	Fescue tussock, hard tussock	Grass	Native	Not Threatened	
Festuca rubra	Red fescue	Grass	Exotic		
Geranium molle	dovesfoot cranesbill	dicot herb	Exotic		
Hypericum perforatum	St Johns wort	dicot herb	Exotic		OOI
Juncus articulatus	Jointed rush	rush	Exotic		
Juncus conglomeratus	Soft rush	rush	Exotic		
Lepidium solandri	Maniototo peppercress	Dicot herb	Native	Threatened - Nationally Critical	
Lolium perenne	ryegrass	grass	Exotic		
Lotus pedunculatus	lotus	dicot herb	Exotic		
Medicago sativa	lucerne	dicot herb	Exotic		
Melicytus alpinus	porcupine shrub	shrub	Native	Not Threatened	
Microtis unifolia	onion orchid, maikaika	orchid	Native	Not Threatened	
Muehlenbeckia axillaris	creeping pōhuehue	vine	Native	Not Threatened	
Pilosella officinarum	mouse-ear hawkweed	dicot herb	Exotic		OOI

Species	Common Name	Plant Type	Native or Exotic	Conservation Status	Pest Status
Pinus contorta	lodgepole pine	tree	Exotic		PEST
Pinus species	Wilding pines	tree	Exotic		
Plantago lanceolata	narrow-leaved plantain	dicot herb	Exotic		
Polygonum aviculare	wireweed	dicot herb	Exotic		
Populus deltoides	eastern cottonwood, necklace poplar	tree	Exotic		
Raoulia australis	common mat daisy	dicot herb	Native	At Risk - Declining	
Raoulia hookeri	scabweed	dicot herb	Native	Not Threatened	
Rumex acetosella	sheeps sorrel	dicot herb	Exotic		
Salix ×fragilis	crack willow	tree	Exotic		
Sedum acre	stonecrop	dicot herb	Exotic		
Thelymitra longifolia	white sun orchid	orchid	Native	Not Threatened	
Trifolium arvense	haresfoot trefoil	dicot herb	Exotic		
Trifolium pratense	red clover	dicot herb	Exotic		
Trifolium repens	white clover	dicot herb	Exotic		
Trifolium subterraneum	subterranean clover	dicot herb	Exotic		
Veronica arvensis	field speedwell	dicot herb	Exotic		
Verbascum thapsus	woolly mullein	dicot herb	Exotic		
Vulpia bromoides	vulpia hair grass, brome fescue, squirrel-tailed fescue	grass	Exotic		
Vulpia myuros	vulpia hair grass, rats tail fescue	grass	Exotic		
Wahlenbergia albomarginata	NZ harebell	dicot herb	Native	Not Threatened	
Erodium cicutarium	storksbill	dicot herb	Exotic		
Leontodon taraxacoides	hawkbit	dicot herb	Exotic		
Poa trivialis	rough-stalked meadow grass	grass	Exotic		
Rosa rubiginosa	sweet briar, briar rose	shrub	Exotic		OOI
Populus alba	white poplar, silver poplar	tree	Exotic		

EVALUATION OF ECOLOGICAL SIGNIFICANCE OF ECOSYSTEMS, HABITATS, AND SPECIES AT THE ŌHAU C SITE AGAINST THE CANTERBURY RPS APPENDIX 3 CRITERIA SET

Ecological Significance Criteria	Shrubland	Cocksfoot Grassland	Herbfield	Dryland	Brassica cropland
Representativeness					
1. Indigenous vegetation or habitat of indigenous fauna that is representative, typical or characteristic of the natural diversity of the relevant ecological district. This can include degraded examples where they are some of the best remaining examples of their type, or represent all that remains of indigenous biodiversity in some areas.	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met
2. Indigenous vegetation or habitat of indigenous fauna that is a relatively large example of its type within the relevant ecological district.	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met
Rarity/Distinctiveness					
3. Indigenous vegetation or habitat of indigenous fauna that has been reduced to less than 20% of its former extent in the Region, or relevant land environment, ecological district, or freshwater environment.	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met
4. Indigenous vegetation or habitat of indigenous fauna that supports an indigenous species that is Threatened, At Risk or uncommon, nationally	**Threshold Met.** Shrubland supports potential habitat for At Risk lizard species.	**Threshold Met.** Foraging banded dotterels (*Charadrius bicinctus,* At Risk – Declining) observed, and potential	**Threshold Met.** New Zealand Blue Butterfly (*Zizina oxleyi* – Declining) observed. Foraging banded	**Threshold Met.** Southern Alps gecko observed (*Woodworthia* "Southern Alps" – At Risk – Declining). Stonefield	**Threshold Met.** Foraging banded dotterels (*Charadrius bicinctus* – At Risk – Declining) observed

Ecological Significance Criteria	Shrubland	Cocksfoot Grassland	Herbfield	Dryland	Brassica cropland
or within the relevant ecological district.	Matagouri (At Risk – Declining) present.	foraging and breeding habitat for tōrea/South Island pied oystercatcher (*Haematopus finschi,* At Risk – Declining) and pīhoihoi/New Zealand pipit (*Anthus novaeseelandiae novaeseelandiae*, At Risk – Declining). Supports potential habitat for At Risk lizard species.	dotterels (*Charadrius bicinctus* – At Risk – Declining) observed.	drylands provide habitat for minute grasshopper (*Sigaus minutus* – At Risk – Declining) foraging for banded dotterels (*Charadrius bicinctus* – At Risk – Declining) and potential foraging and breeding habitat for tōrea/South Island pied oystercatcher (*Haematopus finschi,* At Risk – Declining) and pīhoihoi/New Zealand pipit (*Anthus novaeseelandiae novaeseelandiae*, At Risk – Declining)	and potential foraging and breeding habitat for tōrea/South Island pied oystercatcher (*Haematopus finschi,* At Risk – Declining) and pīhoihoi/New Zealand pipit (*Anthus novaeseelandiae novaeseelandiae*, At Risk – Declining)
5. The site contains indigenous vegetation or an indigenous species at its distribution limit within Canterbury Region or nationally.	Threshold potentially met if Threatened lizard species are confirmed present.	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met
6. Indigenous vegetation or an association of indigenous species that is distinctive, of restricted occurrence, occurs within an originally rare ecosystem, or has developed as a result of an unusual environmental factor or combination of factors.	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met
Diversity and Pattern					
7. Indigenous vegetation or habitat of indigenous fauna that contains a high diversity of indigenous ecosystem or habitat types, indigenous taxa, or has changes in species composition reflecting the existence of diverse natural features or ecological gradients.	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met

Ecological Significance Criteria	Shrubland	Cocksfoot Grassland	Herbfield	Dryland	Brassica cropland
Ecological Context					
8. Vegetation or habitat of indigenous fauna that provides or contributes to an important ecological linkage or network, or provides an important buffering function.	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met
9. A wetland which plays an important hydrological, biological or ecological role in the natural functioning of a river or coastal system.	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met	Threshold Not Met
10. Indigenous vegetation or habitat of indigenous fauna that provides important habitat (including refuges from predation, or key habitat for feeding, breeding, or resting) for indigenous species, either seasonally or permanently.	**Threshold Met.** Shrubland provides habitat for At Risk lizard species.	**Threshold Met.** Provides habitat for At Risk lizard species. This habitat type provides important seasonal habitat for indigenous avifauna	**Threshold potentially met.** Provides potential habitat for minute and short horned grasshopper, and Tekapo ground wētā. This habitat type provides important seasonal habitat for indigenous avifauna	**Threshold Met.** Stonefield drylands provide habitat for the Southern Alps gecko (*Woodworthia* "Southern Alps"; At Risk-Declining). Robust grasshopper may use these rocks as a breeding site. This habitat type provides important seasonal habitat for indigenous avifauna	**Threshold potentially met.** This habitat type may provide seasonal habitat for indigenous avifauna, including tōrea/South Island pied oystercatcher (*Haematopus finschi,* At Risk – Declining) and pīhoihoi/New Zealand pipit (*Anthus novaeseelandiae novaeseelandiae*, At Risk – Declining)

MACKENZIE DISTRICT PLAN RULES AND DEFINITIONS

Vegetation Clearance

Rule 1 - Indigenous Vegetation Clearance excluding indigenous vegetation clearance associated with the Waitaki Power Scheme, the National Grid or the Opuha Scheme
Section 19 – Ecosystems and Indigenous Biodiversity

1.1 Permitted Activities – Indigenous Vegetation Clearance
1.1.1 Clearance of indigenous vegetation is a permitted activity provided one or more of the following conditions are met:

1. The clearance is within 2m of, and for the purpose of:
a) the maintenance or repair of, existing fence lines, vehicle tracks, roads, stock tracks, stock crossings, firebreaks, drains, ponds, dams, stockyards, farm buildings, water troughs and associated reticulation piping, or airstrips; or
b) the operation, maintenance, repair or upgrade of network utilities permitted by Rule 16.1.1.(j).

2. The clearance is of indigenous vegetation which has been planted and is managed specifically for the purpose of harvesting and subsequent replanting of plantation forest within 5 years of harvest and the clearance is not within a location specified in Rule 1.3.2; or

3. The clearance is of the indigenous understorey to plantation forest, and is incidental to permitted or otherwise authorised plantation forest clearance and the clearance is not within a location specified in Rule 1.3.2; or

4. The clearance is of indigenous vegetation which has been planted and/or is managed as part of a domestic garden or has been planted for amenity purposes or as a shelterbelt and the clearance is not within a location specified in Rule 1.3.2; or

5. The clearance is of indigenous vegetation carried out by or on behalf of a local authority for erosion and flood control works, including within 75m of a lake, 20m of the bank of a river, or 50m of any wetland;

6. The clearance is of indigenous vegetation within a defined Farm Base Area (see Appendix R); or

7. The clearance is of indigenous vegetation within an area of improved pasture and the clearance is not within a location specified in Rule 1.3.2.

8. The clearance is not within:
a) 100m of a lake
b) 20m of the bank of a river
c) 100m of an ecologically significant wetland
d) 50m of all other wetlands

1.2 Restricted Discretionary Activity – Indigenous Vegetation Clearance

1.2.1 Unless permitted under Rule 19.1 the clearance of indigenous vegetation clearance is a restricted discretionary activity provided the following conditions are met:
1. The farm enterprise has a Farm Biodiversity Plan (see Definitions).
2. The clearance is not within a Site of Natural Significance or on land above 900m in altitude.

3. The clearance is not within:
a) 100m of a lake
b) 20m of the bank of a river
c) 100m of an ecologically significant wetland
d) 50m of all other wetlands

Definitions[1]:

Improved Pasture: means an area of land where exotic pasture species have been deliberately sown or maintained for the purpose of pasture production, and species composition and growth has been modified and is being managed for livestock grazing.

Indigenous Vegetation: means a community of vascular plants, mosses and/or lichens that includes species native to the ecological district. The community may include exotic species, but does not include vegetation that has been planted as part of a domestic garden, for amenity purposes or as a shelterbelt, or exotic woody pest plants.

Significant indigenous vegetation and significant habitats of indigenous fauna:
means areas of indigenous vegetation or habitats of indigenous fauna which:
a) meet the criteria listed in the Canterbury Regional Policy Statement's Policy 9.3.1 and Appendix 3; or
b) are listed in Appendix I as a Site of Natural Significance; and
c) includes any areas that do not comprise improved pasture within the glacial derived or alluvial (depositional) outwash and moraine gravel ecosystems of the Mackenzie Basin as shown on Figure 1.

Vegetation Clearance: means the felling, clearing or modification of trees or any vegetation by cutting, crushing, cultivation, spraying, burning, irrigation, artificial drainage, and mob stocking. It includes oversowing, topdressing or overplanting on land that is not improved pasture. Clearance of vegetation shall have the same meaning.

Wetland: means a permanently or intermittently wet area, shallow water and land water margins that supports a natural ecosystem of plants and animals that are adapted to wet conditions.

[1] https://www.mackenzie.govt.nz/__data/assets/pdf_file/0003/513948/S03-Definitions-1-PC19-Amendment.pdf

Call Free 0508 WILDNZ
Ph: +64 7 343 9017
Fax: +64 7 3439018
ecology@wildlands.co.nz

99 Sala Street
PO Box 7137, Te Ngae
Rotorua 3042,
New Zealand

Regional Offices located in
Auckland, Hamilton, Tauranga,
Whakatane, Wellington,
Christchurch and Dunedin

ECOLOGY RESTORATION BIODIVERSITY SUSTAINABILITY

www.wildlands.co.nz