ecoLogical Solutions

Environmental Consultants

July 2024

Darfield Agrivoltaic Facility
Assessment of Ecological Effects

Submitted to:

NZ Clean Energy Ltd

water fauna flora land

Quality Assurance

This report has been prepared and reviewed by the following:

Prepared by: Owen Woodward
Ecologist

Reviewed by: Richard Montgomerie
Ecologist

Status: Draftv2 **Issued:** 29 July 2024

ecoLogical solutions

tauranga office
115 the strand, tauranga 3141.
po box 13507
p: 07 577 1700

auckland office
building 4/195 main highway,
ellerslie, auckland, 1051
[redacted]

northland office
30 leigh street, kāeo
po box 180, kāeo 0448
[redacted]

www.ecoLogicalsolutions.co.nz

Table of Contents

Index to Tables

Index to Figures

1.0 Introduction

1.1 Background

Darfield Solar & Energy Storage Limited (DSES) are seeking resource consents to construct an agrivoltaics facility, also known as a solar farm, over an area of approximately 148-ha on predominantly pastoral land located at 1352 Homebush Road, Darfield ('the site'). The proposed development would supply renewable electricity to the New Zealand market and help achieve the country's 100% renewable electricity target by the target date of 2030.

Ecological Solutions Limited was engaged by DSES to undertake terrestrial and aquatic surveys to inform an Assessment of Environmental Effects (AEE) to form part of the resource consent application.

1.2 Site Description

The site is located approximately 2 km north-north-west of Darfield and c. 3 km south of the Waimakariri River (Figure 1). It is approximately 148 ha and lies within the jurisdiction of the Selwyn District Council (SDC) and Environment Canterbury (ECan). The Site is bound by West Coast Road (SH73) to the southwest, Homebush Road to the south, Loes Road to the east and Auchenflower Road to the north (Figure 1). The Darfield Fonterra Factory and Kimberley Substation is adjacent to the site to the west.

Vegetation at the time of survey, within and immediately surrounding the site, was dominated by exotic species typical of the Canterbury Plains farmscape (Figure 2). Adjacent to the site to the south is McHughs Forest Park, a 43 ha public recreation reserve containing exotic trees, primarily Douglas fir (*Pseudotsuga menziesii*).

One watercourse bisects the site north-south which forms part of the Selwyn water race network. There are no areas of wetland present on the site.

1.3 Proposed Agrivoltaic Development

The preparation of this AEE has been undertaken based upon plans provided by DSES (Figure 3). DSES seeks to establish a renewable energy project within the site, consisting of 117 megawatts (MW) of solar photovoltaic energy plus 106 MW / 200-400 MWh of battery energy storage (BESS). The proposal includes the installation of approximately 180,000 solar PV modules (also referred to as solar panels) to be fixed onto a single axis tracking mounting system tracking east/west. The PV modules are proposed to be mounted on single-axis tracking tables. When parallel to the ground panels will be approximately 1.4 m to 2.1 m above the ground and 2.45 m to 3.1 m high at maximum tilt. There will be a 3.22 gap between each row of solar tables. It is proposed that the PV tracking tables will operate during all daylight hours of every day of the year.

Battery energy storage system (BESS) units are proposed to be located within the site adjacent to site substation, switching station building and site office. The solar farm will be connected to the Kimberley Substation, located within the land occupied by the Fonterra Kimberley Factory, via an overhead line or underground cable.

The construction phase for the project is expected to approximately 12-18 months. The proposed development will be operational for 40 years. It is proposed to continue grazing the site with sheep for the duration of the project. Minimal vegetation clearance is required during construction and this is limited to exotic trees.

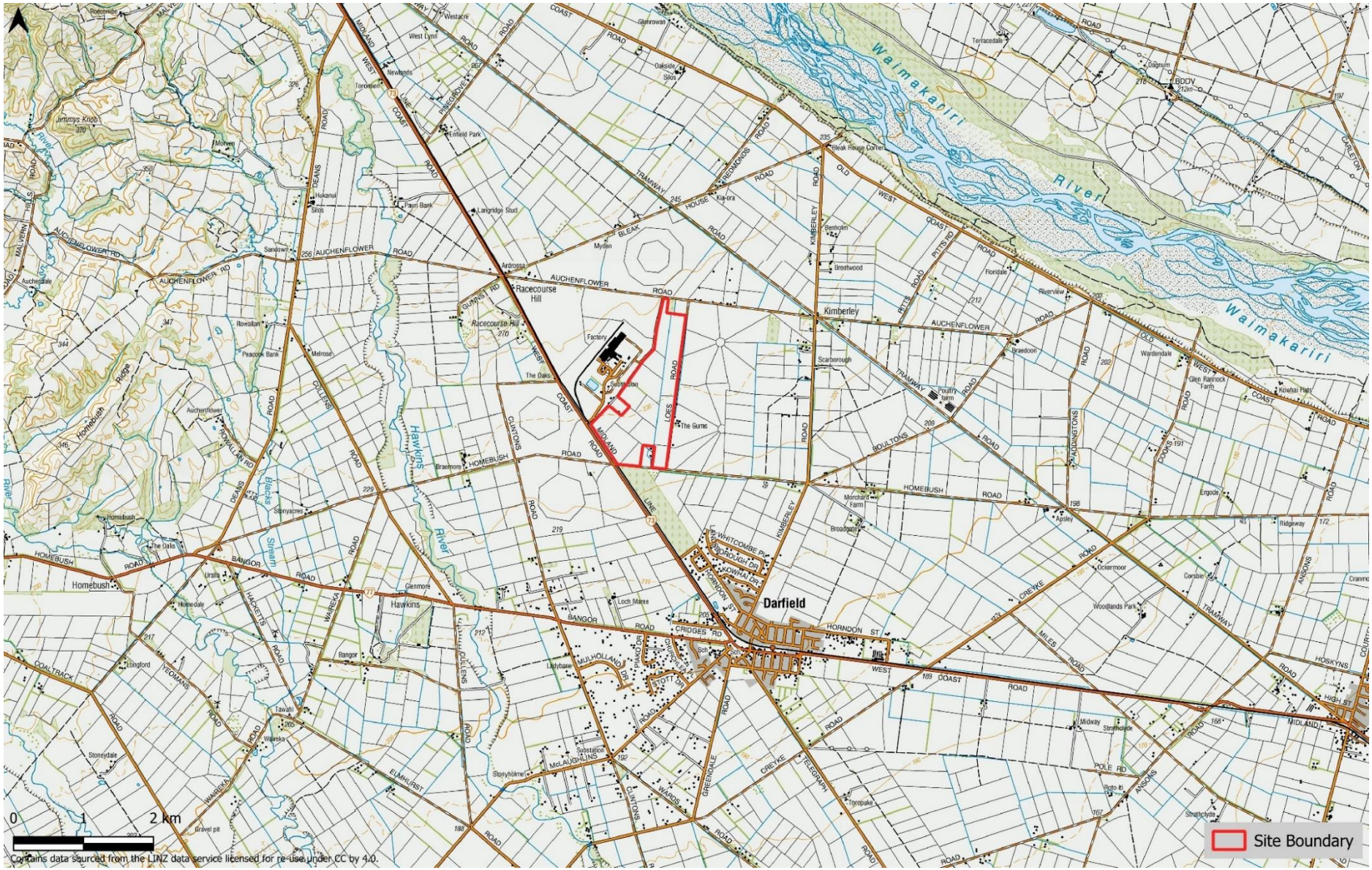

Figure 1: Location of the proposed Agrivoltaic Facility at 1352 Homebush Road, Darfield.

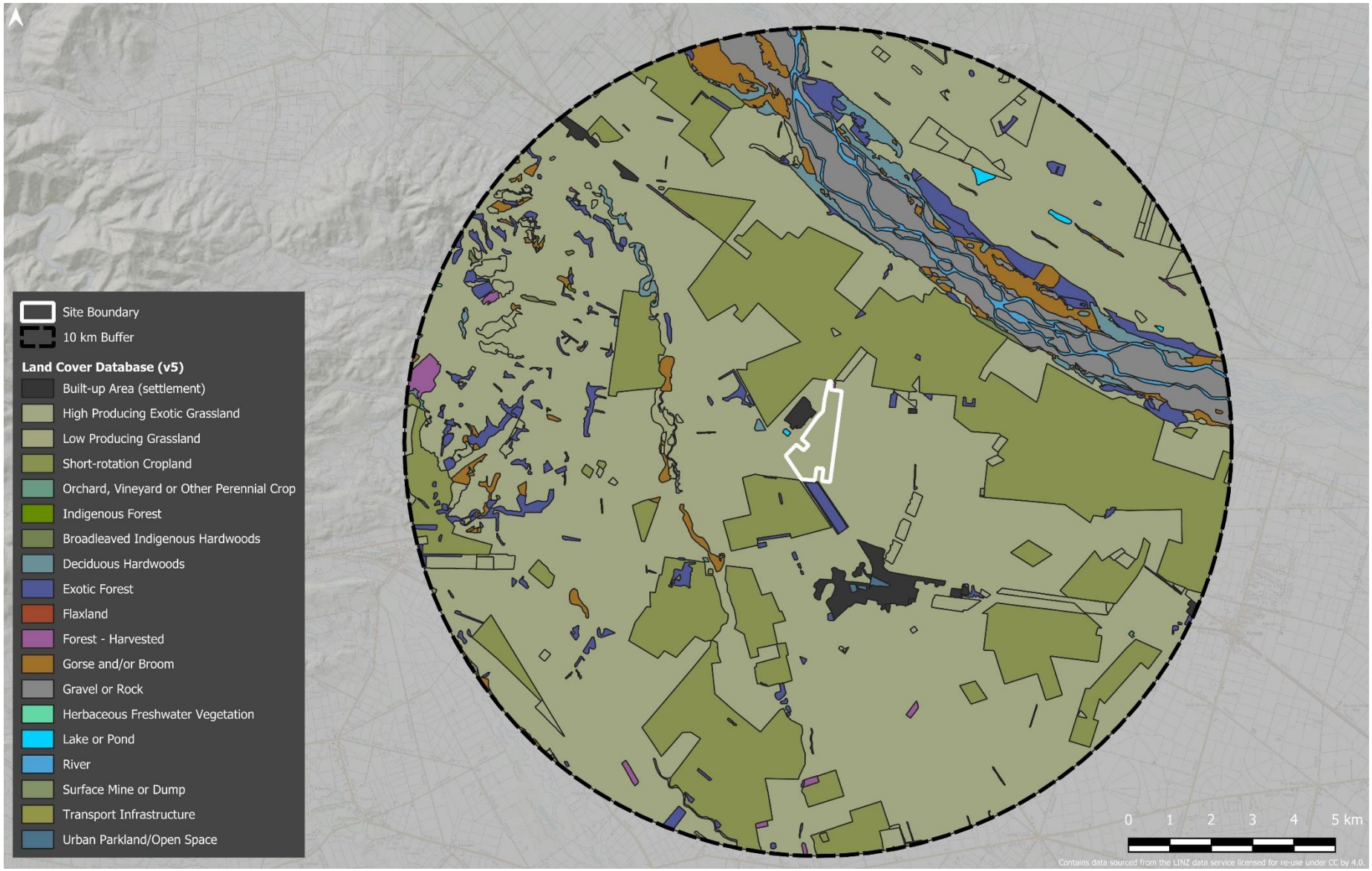

Figure 2: Vegetation cover (LCDB v5.0).

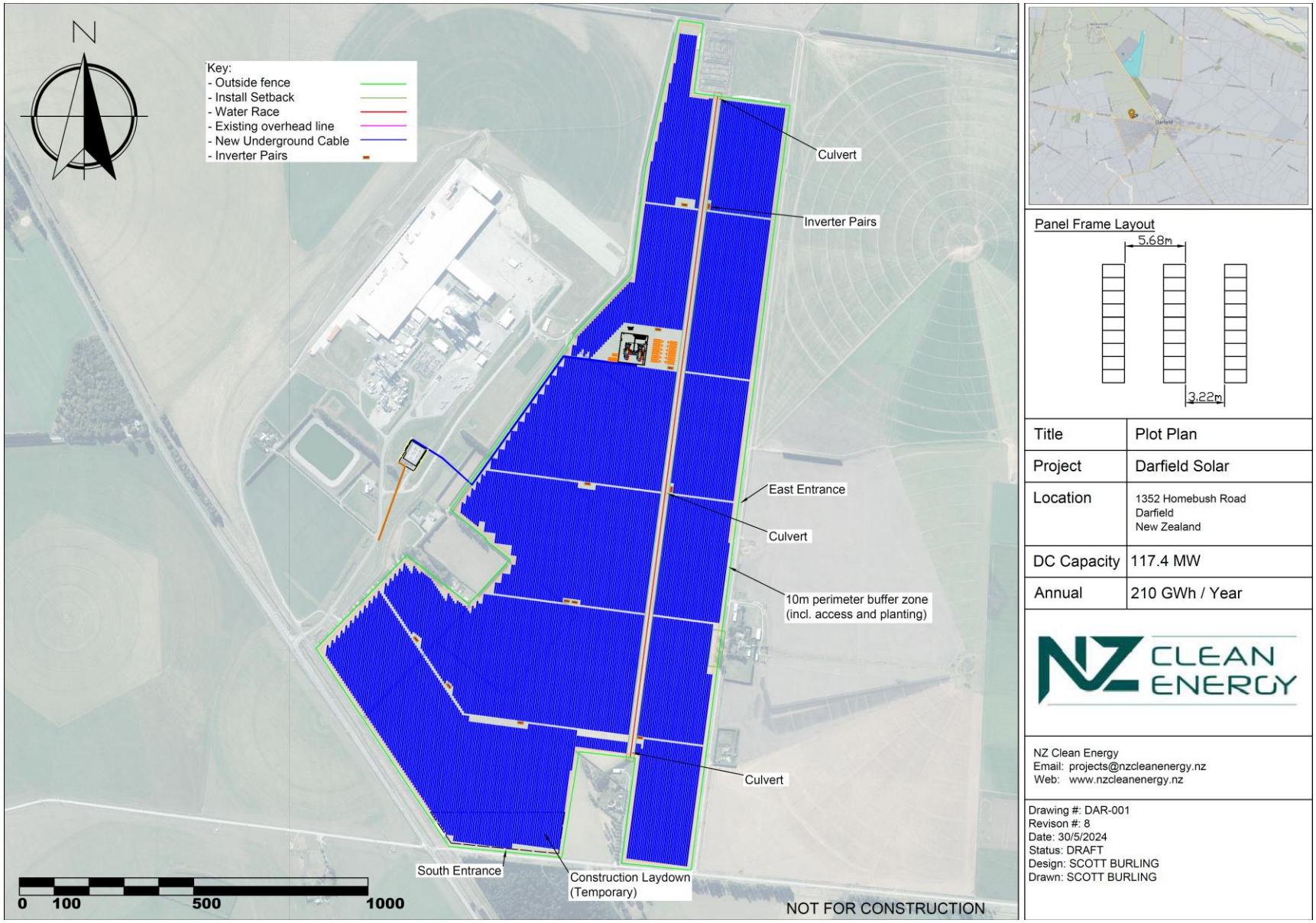

Figure 3: Proposed Agrivoltaic Facility site design (NZ Clean Energy, Drawing # DAR-001; Rev # 8 dated 30 May 2024).

1.4 Scope of Report

Ecological Solutions Limited (ESL) was engaged by DSES to undertake baseline terrestrial and aquatic surveys and prepare an Assessment of Environmental Effects (AEE) to form part of the resource consent application. Based on the results of ecological surveys undertaken, the AEE also provides recommendations to avoid, remedy and/or mitigate any adverse ecological effects of the proposed Agrivoltaic Facility. This AEE has been prepared using the information available at the time of preparation. As such it does not necessarily include assessment of any actual or potential adverse environmental effects identified in other expert reports (e.g., stormwater).

2.0 Ecological Context

The site is situated within the High Plains Ecological District (ED) within the Canterbury Plains Ecological Region. The High Plain ED is bound by the Okuku River to the north, Rangitata River to the south, fringing the eastern foothills of the Southern Alps along its length while the Low Plains ED is to the east. The district ranges between 150 and 600m a.s.l. and receives 800 mm–1000 mm of rainfall annually (McEwen 1987).

The district was originally primarily forested though this was replaced by largely short tussockland prior to European arrival. Today scarce pockets of native vegetation remain as the area has been further modified for sheep and cattle grazing (McEwen 1987). The former indigenous terrestrial ecosystem expected to have occurred naturally in the ED is predominantly mataī, kahikatea, tōtara, broadleaved forest (MF3) (Singers & Rodgers 2014).

The Waimakariri River which lies c. 3km to the north of the site is a large braided river, originating on the eastern slopes of the Southern Alps, it has a catchment area of 2,500 km^2. It supports several notable freshwater fish species and it's braidplain provides important breeding and nesting habitat for various Threatened and At Risk indigenous braided river birds. It is listed on the eCAN's map service[1] as an area of outstanding natural features and is classified as part of "Biodiversity Type 1 Water body of Significant National Value for Biodiversity", meaning the whole river system is nationally important for biodiversity (Ministry for the Environment 2014).

3.0 Methodology

3.1 Terrestrial Ecology

3.1.1 Vegetation

An initial desktop assessment was carried out using aerial imagery (Google Earth, Retrolens, topographic maps and GIS datasets) and ecological documentation (e.g., Leathwick et al. 2004; Maseyk, 2007; Singers and Rogers, 2014) to assist in determining historic landcover and vegetation types, current landcover and vegetation types, and hydrological patterns that might correspond with potential wetlands. A survey was carried out at the site on 28 May 2024. Plant species encountered were recorded and terrestrial habitats described and photographed.

[1] https://opendata.canterburymaps.govt.nz/datasets/ecan::land-of-outstanding-regional-significance/about

3.1.2 Avifauna

Existing avifauna records within 10 km of the site were obtained from the New Zealand eBird database. These records were then used to prioritise which species would likely be present at the site given the habitat(s) available there. All birds seen or heard during the site visit were recorded and potential avian habitats were identified during the walk-through survey undertaken on 28 May 2024.

3.1.3 Herpetofauna

Existing lizard records within 5 km of the site were obtained from the Department of Conservation's (DOC) database. These records were then used to prioritise which species would likely be present at the site given the habitat(s) available there. Potential lizard habitat within the site was identified by a walk-through survey undertaken on 28 May 2024.

3.1.4 Bats

Bat survey records within 25 km of the site were obtained from the Department of Conservation (DOC) database to assess the likelihood of bats using the site. This information informed a desktop identification of habitat features within or near the site that may be important to long-tailed bats for navigation (e.g., roads, hedgerows, rivers), feeding (e.g., edges of tall vegetation, wetlands, rivers) and roosting (e.g., trees >15 cm diameter at breast height (DBH) likely to exhibit typical colonial roost features such as crevices).

A survey of potential roost trees on the site was carried out on 28 May 2024. As this type of survey is not dependent on bat activity, it can be undertaken at any time of the year. The survey involved assessing trees for features that could potentially provide suitable roost sites for long-tailed bats. Trees ≥15 cm DBH within the survey area were systematically assessed to identify trees that contain one or more of the following features:

- Hollows.
- Cavities.
- Knot holes.
- Cracks.
- Flaking, peeling, and decorticating bark.
- Epiphytes.
- Broken or dead branches or trunk.
- Cavities/hollows/shelter formed by double leaders.

3.2 Freshwater Ecology

3.2.1 Wetlands

An initial desktop review was carried out using aerial photography (Google Earth and Retrolens) to assist in identifying potential locations of wetlands within the site. A ground survey at the site was undertaken on 28 May 2024 to identify any potential wetlands on or within 100 m of the site that required delineation in accordance with the protocols set out in the relevant guidelines which applied at the time of the assessment (Clarkson 2014, Fraser et al. 2018, Clarkson et al. 2021, MfE 2021, 2022, 2022b).

3.2.2 Watercourses

Watercourses identified within the site were classified in accordance with Environment Canterbury definitions. General stream habitat characteristics (e.g., channel width, water

depth, substrate type and size, freshwater habitat type, and the amount of riparian shading) were recorded and described in order to assist with the assessment of ecological values.

3.2.3 Fish Fauna

A search of the New Zealand Freshwater Fish Database (NZFFD) and Wilderlab's database of publicly available environmental DNA (eDNA) data was carried out to check for fish records within the site and wider catchment.

One composite eDNA sample was taken from the watercourse within the site that held sufficient surface water to provide an indication as to the fish species present and assist with the assessment of ecological values. The sample was collected and preserved according to Wilderlab's protocols and sent to the Wilderlab laboratory for multi-species analysis.

3.3 Assessment of Ecological Values

Terrestrial and freshwater ecological values within the site were determined following the approach outlined in the Ecological Impact Assessments Guidelines (EcIAG) (Roper-Lindsay et al. 2018) published by the Environment Institute of Australia and New Zealand (EIANZ). The approach for assigning ecological value to terrestrial and freshwater environments involves the assessment of four matters that include 'representativeness, rarity/ distinctiveness, diversity and pattern and ecological context' and with consideration of the attributes listed in the EcIAG. Overall value is assigned to a given feature based on the four matters listed above and the scoring system outlined in the EcIAG.

3.4 Canterbury Regional Policy Statement

Chapter 9 – Ecosystems and Indigenous Biodiversity

9.3.1 Protecting significant natural areas

3. Areas identified as significant will be protected to ensure no net loss of indigenous biodiversity or indigenous biodiversity values as a result of land use activities. Areas identified as significant will be protected to ensure no net loss of indigenous biodiversity or indigenous biodiversity values as a result of land use activities.

Habitats and indigenous biodiversity within the Site were assessed against the significance criteria for representativeness, rarity/distinctiveness, diversity and pattern or ecological context as outlined in Canterbury Regional Policy Statement 2013 (CRPS).

3.5 Assessment of Environmental Effects

3.5.1 Approach

The effects assessment approach used in this report followed the method outlined in the EcIAG (Roper-Lindsay et al. 2018). The EcIAG assist with assessing values and effects in a consistent and transparent way and requires professional judgement when applying the framework and matrix approach. The method involves assigning values to ecological features and assessing the magnitude of effect of the proposed activity to determine an overall level of effect using the matrix provided in the EcIAG.

3.5.2 Magnitude of effect

The magnitude of effect on each ecological value was considered in relation to the scale of the effect, extent of habitat loss or modification in relation to remaining habitat, duration of the effect, extent of the effect on species at the population level, impact on the sustainability

of the ecosystem and intensity of the unmitigated effect. The magnitude of effect associated with each activity was evaluated based on the criteria outlined in Table 8 of the EcIAG reproduced as Table 1 below. The magnitude of effects ranges between negligible and very high.

Table 1: Criteria for describing magnitude of effect (Roper-Lindsay et al. 2018).

Magnitude	Description
Very high	Total loss or very major alteration to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the Site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature.
High	Major loss or major alteration to key elements/ features of the baseline (pre-development) conditions such that post development character/ composition/ attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature.
Moderate	Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed; AND/OR loss of a moderate proportion of the known population or range of the element/feature.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns; AND/OR having a minor effect on the known population or range of the element/feature.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the “no change” situation; AND/OR having negligible effect on the known population or range of the element/feature.

3.5.3 Overall level of effect

The overall ‘level of effect’ on ecological features for each activity was determined using the matrix approach outlined in the EcIAG. The matrix approach matches ecological values with the magnitude of effect associated with each proposed activity to derive an overall ‘level of effect’. The level of effect for each proposed activity was determined both with mitigation and without mitigation. This assessment framework allows for effects to be ranked on a gradient from ‘very low’ to ‘very high’ and provides justification for avoidance, mitigation and offsetting requirements (Table 2).

Level of effect should be used to guide the ecological management response required. In general, significant changes will be required for projects with effects in the ‘very high adverse’ category if they are to be accepted. ‘High’ and ‘moderate’ levels of effects will require avoidance, extensive offset or compensation actions. ‘Low’ and ‘very low’ levels of effects should be minimised through design and operational measures.

Table 2: Criteria for describing level of effect (Roper-Lindsay et al. 2018).

Magnitude ▼	Ecological value ▶				
	Very high	***High***	***Moderate***	***Low***	***Negligible***
Very high	Very high	Very high	High	Moderate	Low
High	Very high	Very high	Moderate	Low	Very low
Moderate	High	High	Moderate	Low	Very low
Low	Moderate	Low	Low	Very low	Very low
Negligible	Low	Very low	Very low	Very low	Very low
Positive	Net gain	Net gain	Net gain	Net gain	Net gain

4.0 Terrestrial Ecology

4.1 Vegetation

Vegetation across most of the site was dominated by exotic species such as grasses and herbaceous pasture forage species, conifer and broadleaved shelterbelts. A typical example of this vegetation is shown in Figure 4.

The main pasture species were cocksfoot (*Dactylis glomerata*), lucerne (*Medicago sativa*) and white clover (*Trifolium repens*) with occasional plantain (*Plantago lanceolata*), hawkbit (*Leontodon taraxacoides)* and catsear (*Hypochaeris radicata*). Some paddocks had been in crops of Brassica and had recently been resown.

Shelter belts composed of Leyland cypress (*Cupressus* × *leylandii*), macrocarpa (*Cupressus macrocarpa*), pine (*Pinus radiata*) and birch (*Betula pendula*) which form the majority of the tree cover on the site. There is also a stand of shining gum (*Eucalyptus nitens*) on the property though this is outside of the solar farm footprint (Figure 6).

Figure 4: Mixed broadleaf and conifer shelterbelt at the site.

Figure 5: Silver birch and pampas hedgerow at the site.

Figure 6: Ecological features at the site.

4.2 Avifauna

Birds seen at the site during the May 2024 survey were fantail (*Rhipidura fuliginosa fuliginosa)*, spur-winged plover (*Vanellus miles*), goldfinch (*Carduelis carduelis*), magpie (*Gymnorhina tibicen)*, blackbird (*Turdus merula)* and sparrow (*Passer domesticus*).

A total of 53 species were listed in the eBird database within 10 km of the site. Thirteen of those species are of conservation interest (Table 3). Many of these are associated with the nearby Waimakariri River which provides important feeding and nesting habitat.

As the site comprises homogenous and heavily modified grazed pasture and rotational crops it does not provide suitable habitat.

Table 3: Birds of conservation interest recorded within 10 km of the site.

Common name	Scientific name	Conservation status (Robertson et al. 2021)
Banded Dotterel	*Charadrius b. bicinctus*	At Risk – Declining
Black Shag	*Phalacrocorax carbo*	At Risk – Relict
Black-billed Gull	*Chroicocephalus bulleri*	At Risk – Declining
Black-fronted Tern	*Chlidonias albostriatus*	Threatened – Nationally Endangered
Grey Duck	*Anas gracilis*	Threatened – Nationally Vulnerable
Little Shag	*Microcarbo melanoleucos*	At Risk – Relict
New Zealand Falcon	*Falco novaeseelandiae*[1]	Threatened – Nationally Vulnerable
New Zealand Pipit	*Anthus n. novaeseelandiae*	At Risk – Declining
Pied Shag	*Phalacrocorax varius*	At Risk – Relict
South Island Pied Oystercatcher	*Haematopus finschi*	At Risk – Declining
Variable Oystercatcher	*Haematopus unicolor*	At Risk – Recovering
White Heron	*Ardea alba*	Threatened – Nationally Critical
Wrybill	*Anarhynchus frontalis*	Threatened – Nationally Increasing

Note: [1]Assumed to be eastern falcon (*Falco novaeseelandiae novaeseelandiae*).

4.3 Herpetofauna

A search of the herpetofauna database revealed no records within 5 km of the site. The closest herpetofauna records to the site were c. 8 km away at Dagnum Reserve on the northern outer margins of the Waimakariri River braidplain and consisted of four Canterbury grass skink (*Oligosoma aff polychroma Clade 4*) and two unidentified skinks.

The majority of the site comprised grazed pasture, which does not provide suitable habitat for lizards. The pampas (*Cortaderia selloana*) hedgerow may provide habitat for skink, although this is unlikely given the surrounding habitat is extremely modified and does not provide adequate refugia for skink to colonise from. A temporary pile of woody debris was present within a small grove of *Eucalyptus* trees, which was just outside the site boundary, and may provide refugia for skinks (see Figure 6 and Figure 7).

Figure 7: Woody debris within a grove of *Eucalyptus* trees just outside the site boundary.

4.4 Bats

A search of DOC bat survey database revealed that there had been multiple bat surveys completed in this area, including of the surrounds of the Fonterra plant adjacent to the site, however there no bats have been recorded. Trees within the site do not have suitable roosting features and it is considered that bats are highly unlikely to use the Site.

5.0 Freshwater Habitats

5.1 Artificial Watercourses

There were no natural watercourses or natural inland wetlands at the Site. There is one artificial watercourse present that bisects the Site (Figure 8) constructed as part of a 1,700km network of water races used for irrigation and stock water, managed by Selwyn District Council.

The artificial watercourse is approximately 2.3 km long within the site. Although not a natural watercourse, stock water races can provide habitat for fish and aquatic invertebrate communities (Sinton 2008).

The stock water race flow appears to be permanent and is regulated upstream to provide a constant volume of flow. The wetted width ranged between 0.5-1.5 m and visually estimated depths ranged between 0.2–0.5 m. Substrate was predominantly fine silt/clay although there were several (albeit small) areas where larger gravels and cobble were observed. Nearly the entire length of the watercourse comprised run habitat of fairly uniform velocity. The water race within the site is smaller and provides poorer habitat compared to other larger water races within the network that have more diverse and larger statue bankside plantings.

Aquatic vegetation present in the artificial watercourse included glaucous sweetgrass (*Glyceria declinata*), red azolla (*Azolla rubra*), curly pondweed (*Potamogeton crispus*) and

starwort (*Callitriche stagnalis*).

One channel was present at the site which was dry at the time of the survey (Figure 9). The channel follows a fence line and connects to the water race via a culvert (refer to Figure 6 for the drain location).

Figure 8: The water race that bisects the site showing shallow surface water, homogenous run habitat and no channel shade.

Figure 9: Dry channel.

5.2 Fish Fauna

There are no NZFFD records within the site. The NZFFD and Wilderlab public database does however hold relevant records for 14 species within the 'catchment' (Selwyn water race network) as shown in Table 4. Of these species, six have a conservation status of 'At Risk – Declining' (i.e., bluegill bully, Canterbury Galaxias, īnanga, longfin eel, torrentfish and freshwater mussel) and the Canterbury mudfish has a 'Threatened – Nationally Critical' status (Dunn et al. 2018). All native fish recorded in the catchment except Canterbury galaxiid, Canterbury mudfish and upland bully are diadromous and migrate between the marine and freshwater environments to compete their life-cycles.

The water race within the site provides poor quality aquatic habitat due to the shallow, homogenous run habitat and lack of riparian shading and therefore is unlikely to support species of conservation interest.

Results of the eDNA sampling at the Site's downstream boundary indicated the presence of just two fish species within/upstream of the Site: upland bully (*Gobiomorphus breviceps*), and shortfin eel (*Anguilla australis*) and three unidentified bullies (Appendix A). These results are consistent with NZFFD records and reflect the poor habitat quality of the race within the site.

Table 4: NZFFD records upstream and downstream of the site.

Common Name	Scientific Name	Conservation Status	Upstream	Downstream
Bluegill bully	*Gobiomorphus hubbsi*	At Risk – Declining	•	•
Brown trout	*Salmo trutta*	–	•	•
Canterbury Galaxias	*Galaxias vulgaris*	At Risk – Declining	•	•
Canterbury mudfish	*Neochanna burrowsius*	Threatened – Nationally Critical	•	
Chinook salmon	*Oncorhynchus tshawytscha*	–	•	•
Freshwater mussel	*Echyridella menziesi*	At Risk – Declining	•	
Goldfish	*Carassius auratus*	–	•	
īnanga	*Galaxias maculatus*	At Risk – Declining	•	
Koura	*Paranephrops*	–	•	
Longfin eel	*Anguilla dieffenbachii*	At Risk – Declining	•	•
Rainbow trout	*Oncorhynchus mykiss*	–	•	
Shortfin eel	*Anguilla australis*	–	•	•
Torrentfish	*Cheimarrichthys fosteri*	At Risk – Declining	•	•
Upland bully	*Gobiomorphus breviceps*	–	•	•
Unidentified bully	*Gobiomorphus*	–	•	
Unidentified eel	*Anguilla*	–	•	•
Unidentified salmonid	*Salmo*	–	•	

6.0 Assessment of Ecological Values

6.1 Terrestrial Ecological Values

6.1.1 Vegetation

The ecological values of both exotic and indigenous vegetation on the site are summarised in Table 5. Vegetation within the site is dominated by exotic vegetation, characterised by high producing exotic grassland (grazed pasture), conifer and broadleaved shelterbelts, rotational seasonal cropping (brassicas and lucerne). Exotic vegetation on the site has 'low' or 'very low' ecological value across the four attributes assessed, with the overall ecological value of vegetation on the site assessed as 'low' or 'negligible'.

6.1.2 Avifauna

The site contains very little suitable habitat for native birds. Bird species recorded at the site were mostly common native and exotic species. While a number of birds with a conservation status have been recorded within 10 km of the site, these records are predominantly associated with the Waimakariri River and its braidplain or riparian vegetation. The absence of indigenous vegetation at the site further limits potential bird habitat within the site. Overall, the site is of 'low' ecological value for avifauna (Table 5).

6.1.3 Herpetofauna

The site is and historically has been actively managed for sheep grazing which involves seasonal pasture maintenance and rotational cropping creating disturbance that makes it unsuitable for skinks. Habitat within the site scores 'very low' for representativeness, diversity and pattern and 'low' for Ecological context in relation to lizards. The site is of overall 'negligible' value for lizards (table 5).

6.1.4 Bats

No bats have been detected near the site and no roost or breeding habitat was identified within the site. As a result, the bat habitat values have been assessed as 'negligible' (table 5).

6.2 Freshwater Ecological Values

The single waterbody on the site is an artificial watercourse that is part of the Selwyn District stock water race network. The 2.3 km reach located within the site scored 'low' on measures of representativeness and diversity/pattern due to its artificial nature, lack of habitat diversity, including structure and composition (both riparian and instream). Due to the presence of diadromous fish of conservation interest upstream of the site, the water race may provide a migratory pathway and scored 'moderate' on measures of ecological context. Overall, the ecological value of the water race on site is assessed as 'low' (Table 6).

6.3 Canterbury Regional Policy Statement

Freshwater and terrestrial habitats and vegetation on site or adjacent to the site do not meet the criteria for significance in CRPS 2013. The Waimakariri River c. 3km from the site to the north is identified as a 'Biodiversity Type 1 Water body of Significant National Value for Biodiversity'.

Table 5: Summary of terrestrial ecological values following the approach in EcIA guidelines.

Feature		Representativeness	Rarity and Distinctiveness	Diversity and pattern	Ecological Context	Overall value	Comments
Exotic Vegetation	Grassland/pasture	Very low	Very low	Very low	Very low	Negligible	Vegetation does not represent any native ecosystem type. It is exclusively exotic and is neither rare, threatened nor distinctive.
	Cropping	Very low	Very low	Very low	Very low	Negligible	
	Shelterbelts	Very low	Very low	Low	Low	Low	
	Hedgerows	Very low	Very low	Low	Low	Low	
Avifauna		Low	Low	Low	Low	Low	Habitat value for avifauna was considered low. Heavy grazing pressure and rotational cropping reduces the likelihood of successful ground nesting by pipit or other species
Herpetofauna		Very low	Very low	Very low	Low	Negligible	The sites heavy modification makes it unlikely lizards have persisted within the site.
Bats		Very low	Very low	Very low	Low	Negligible	Habitat value for bats was considered very low. It is considered unlikely that bats are present at the site.

Table:6 Summary of freshwater ecological values following the approach in EcIA guidelines.

Feature	Representativeness	Rarity and Distinctiveness	Diversity and Pattern	Ecological Context	Overall value	Comments
Water race - aquatic habitat	Low	Low	Low	Low	Low	Artificial watercourse of low ecological value.
Dry channel – aquatic habitat	Very low	Very low	Very low	Very low	Negligible	Dry channel that provides temporary, poor-quality habitat.
Fish fauna	Low	Low	Low	Moderate	Low	Habitat value of the artificial watercourse on site is considered low.

7.0 Assessment of Effects

7.1 Introduction

The potential ecological effects identified and assessed in the following section include:

Terrestrial Environment

- Vegetation clearance.
- Effects on avifauna habitat.
- Effects on lizard habitat.
- Effects on bat habitat.

Freshwater Environment

- Sedimentation effects on artificial watercourse habitat.
- Effects on fish passage.

7.2 Effects on Terrestrial Environments

7.2.1 Vegetation Clearance

It is anticipated that much of the 'low' ecological value exotic vegetation on the site (e.g., conifer and broadleaved shelterbelts) will be removed. Most of the exotic grassland will be retained on the site. The magnitude of effect on exotic vegetation is either 'very low' or 'negligible' (no effect), owing to the ubiquitousness of these features in the rural landscape. The resulting overall level of effect without mitigation (none is proposed) is 'very low' (Table 6).

7.2.2 Effects on Avifauna and Habitat

The project will result in the removal of shelterbelt exotic trees that have the potential to provide nesting habitat for common native and exotic birds species typically found in the rural environment. While the majority of birds within the site are expected to be common species of no conservation interest, vegetation clearance or trimming (particularly of mature trees) can adversely affect native species when completed over the breeding season (September-February inclusive). If vegetation clearance occurs during the breeding season, other mitigation techniques such as avoiding trees containing nests until chicks have fledged should be employed to minimise effects. With the appropriate level of mitigation, effects on avifauna is assessed as 'low' (Table 6).

7.2.3 Bird Strike

Avian collisions with solar farms are recognised internationally as a potential cause of avian mortality (McCrary et al. 1986; Kagan et al. 2014, Kosciuch et al. 2020) however, there is substantial uncertainty about the severity of the issue, particularly at the population level. There is a strong geographical limitation in the available evidence, the majority of which originates in the southwestern United States. The relevance of this evidence to the ecological context of New Zealand is not known and it is problematic to assume evidence from south western United Sates is directly transferable to New Zealand given the differences in species and habitats.

Estimates of anthropogenic mortality by all causes suggests that solar farms are low risk compared with other built structures such as building windows, roads, fossil fuel power plants, power lines and others (Walston et al 2016). Solar PV facilities represent a lower risk of causing bird strike compared to other types of solar farms which use reflective panels to concentrate sunlight on central receivers, which introduces an additional risk to birds of singeing of feathers (Kagan et al 2014).

An overrepresentation of birds associated with water was found in some studies (Kagan et al 2014) leading to the development of the 'lake effect hypothesis', whereby birds collide with solar panels having mistakenly identified them as bodies of water. Quantitative evidence for this theory is scarce and appears dependent on a number of factors which remain poorly understood (Kosciuch et. al. 2021). The 'lake effect' appears to not be the dominant driver of bird strike as the most commonly affected species are those which do not associate with water (Kosciuch et al 2020). The lake effect has the greatest potential to effect water obligate or water associate birds flying over the site at high altitude as screening plantings will obscure the panels from birds flying at low altitude, except at short distances.

An alternative causal explanation of collision mortality has not been examined, though the default alternative is that these collisions are incidental. Incidental collisions with clear and reflective panels collectively cause a significant portion of total anthropogenic avian mortality (Klem 2009). Solar PV panels are not transparent and reflectivity is intentionally reduced for power generation efficiency, two factors which reduce the risk of bird strike (Brown 2020). Only birds using the site as habitat either permanently or temporally are potentially exposed to a risk of incidental collision.

It is difficult to assess the likelihood or magnitude of this potential effect in New Zealand in general, however it is likely to be lower than bird strike mortality from other sources. As habitat on site or in the immediate surroundings is unsuitable for birds of conservation value and the site is not considered to be beneath a significant flyway for water associate birds, we consider it to be the effect to be very low in this instance.

7.2.4 Effects on Herpetofauna and Habitat

Clearance of vegetation and earthworks during construction could potentially impact lizards, however it is considered unlikely that lizards could be present at the site. The effects on lizards without mitigation is assessed as 'very low'.

7.2.5 Effects on Bat Habitat and Direct Injury/Mortality

It is considered unlikely that bats could be present at the site, therefore the overall level of effect without mitigation (none is proposed) is 'very low' (Table 6).

7.3 Effects on Freshwater Environments

7.3.1 Construction works

Physical works associated with installing Agrivoltaic Facility infrastructure, access tracks, and the culverts the site have the potential to result in fine sediment mobilisation and runoff into the water race on site and the downstream receiving water race network.

The potential risk for and adverse effects of a sedimentation event (e.g., stormwater runoff) would be temporary, being restricted to the construction phase. The addition of fine sediment to freshwater environments has the potential to alter water chemistry, increase turbidity and decrease light penetration that affects primary production and feeding for some fish species. The deposition of sediment can also smother surfaces, decrease interstitial spaces and decrease the amount of suitable habitat available for benthic invertebrates

(impacting upon secondary production).

The magnitude of unmitigated effects of a potential sedimentation event has been assessed as ‘low’ provided all construction works required for the Agrivoltaic Facility comply with erosion and sediment control plans that have been prepared in accordance with best practice guidelines. With the implementation of appropriate erosion and sediment control and treatment of stormwater the potential effects of a sedimentation event on the receiving environment during construction will be avoided/minimised.

7.3.2 Culverts

Stream works associated with the construction of culverts has the potential to result in the temporary loss of aquatic habitat and injury/mortality to fish and, if incorrectly installed, prevent fish passage. Potential effects on native fish should be managed by preparing and implementing a Native Freshwater Fish Relocation Plan prior to any stream works for the construction of culverts. The plan should be prepared by a suitably qualified and experienced freshwater ecologist.

To ensure appropriate avoidance of adverse effects the culverts should provide for fish passage. This can be achieved if they are designed to a standard similar to the NES-F standards provided in Regulation 70(2) (noting that the NES-F regulations themselves are not engaged in this instance). With mitigation to this standard, the overall level of effect is ‘very low.’

Table 6: Overall level of effects on ecological values for the proposed Agrivoltaic Facility before and after mitigation assessed at the Ecological District scale.

Environment	Ecological feature	Effect	Ecological value	Magnitude of effect	Level of effect (no mitigation)	Proposed mitigation measures	Level of effect (with mitigation)
Terrestrial	Exotic grassland/cropping	Short term damage	Negligible	Negligible	Very low	None	-
	Exotic hedgerows	Loss of vegetation extent and habitat values	Low	Low	Very low	None	-
	Exotic shelterbelts	Loss of vegetation extent and habitat values	Low	Low	Very Low	None	-
	Avifauna	Loss of potential nesting habitat (e.g., shelterbelt/hedgerow trees)	Low	Moderate	Low	Avoidance of felling within key breeding period(s).	Very low
	Avifauna	Bird strike mortality	Low	Low	Low	Shelterbelt planting, ant-reflective panel coatings.	Very low
	Herpetofauna	No effect	Low	Negligible	Very low	None	Very low
	Bats	No effect	Low	Negligible	Very low	None	-
Freshwater	Artificial watercourse	Sedimentation	Low	Low	Low	Best practise erosion and sediment controls.	-
	Artificial watercourse	Culvert installation causing fish injury/mortality or effects on upstream fish passage	Low	Low	Low	Design culverts in accordance with NES-F guidelines. Implement Native Fish Relocation Plan prior to and during works.	Very low

8.0 References

Brown, B. B., Santos, S., & Hunter, L. M. 2020. Bird-window Collision Study Manual Techniques and Practices for Bird-window Collision Studies.

Clarkson. B.R. 2014. A vegetation tool for wetland delineation in New Zealand. Landcare Research Contract Report LC1793.

Clarkson B.R., Fitzgerald, N. B., Champion, P.D., Forester, L., Rance, B. D. 2021. New Zealand wetland plant list 2021. Manaaki Whenua – Landcare Research Contract Report LC3975 for Hawke's Bay Regional Council.

Dunn, N.R., Allibone, R.M., Closs, G.P., Crow, S.K., David, B.O., Goodman, J.M., Griffiths, M., Jack, D.C., Ling, N., Waters, J.M., Rolfe, J.R. 2018. Conservation status of New Zealand freshwater fishes, 2017. New Zealand Threat Classification Series 24. Department of Conservation, Wellington. 11 p.

McEwen, W.M. 1987. Ecological Regions and Districts of New Zealand. Third revised edition in four (sheet 2) 1:500 000 Maps. New Zealand Biological Resources Centre, Department of Conservation, Wellington.

Fraser, S., Singleton, P., Clarkson, B. 2018. Hydric soils – field identification guide. Manaaki Whenua – Landcare Research Contract Report LC3233 for Tasman District Council.

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

Kagan, R. A., Viner, T. C., Trail, P. W., & Espinoza, E. O. (2014). Avian mortality at solar energy facilities in southern California: a preliminary analysis. *National Fish and Wildlife Forensics Laboratory*, *28*, 1-28.

Klem Jr, D. (2009). Preventing bird–window collisions. *The Wilson Journal of Ornithology*, *121*(2), 314-321.

Kosciuch, K., Riser-Espinoza, D., Gerringer, M., & Erickson, W. (2020). A summary of bird mortality at photovoltaic utility scale solar facilities in the Southwestern US. *PloS one*, *15*(4), e0232034.

Kosciuch, K., Riser-Espinoza, D., Moqtaderi, C., & Erickson, W. (2021). Aquatic habitat bird occurrences at photovoltaic solar energy development in Southern California, USA. *Diversity*, *13*(11), 524.

Leathwick, J.R., Morgon, F., Wilson. G., Rutledge. D., McLeod. M., Johnston. K. 2002. Land Environments of New Zealand: A Technical Guide. Ministry for the Environment., Manaaki Whenua-Landcare Research New Zealand Ltd.

Leathwick, J.R., McGlone, M.S., Walker, S. 2004. New Zealand's potential vegetation pattern. Manaaki Whenua Press, Lincoln, New Zealand.

Maseyk, F. 2007. Past and Current Indigenous Vegetation Cover and the Justification for the Protection of Terrestrial Biodiversity within the Manawatū-Wanganui Region: Technical Report to Support Policy Development. May 2007.

McCrary, M. D., McKernan, R. L., Schreiber, R. W., Wagner, W. D., & Sciarrotta, T. C. (1986). Avian mortality at a solar energy power plant. *Journal of Field Ornithology*, 135-141.

Ministry for the Environment (MfE). 2021. Wetland delineation hydrology tool for Aotearoa New Zealand. Wellington: Ministry for the Environment.

Ministry for the Environment (MfE). 2022. Wetland delineation protocols. Wellington: Ministry for the Environment.

Ministry for the Environment (MfE). 2022b. National list of exotic pasture species. Wellington: Ministry for the Environment.

NPS-FM 2023. National Policy Statement for Freshwater Management 2023.

O'Donnell, C.F.J., Borkin, K.M., Christie, J., Davidson-Watts, I., Dennis, G., Pryde, M., Michel, P. 2023. Conservation status of bats in Aotearoa New Zealand, 2022. New Zealand Threat Classification Series 41. Department of Conservation, Wellington.

Robertson, H. A., Baird, K.A., Elliott, G.P., Hitchmough. R.A., McArthur, N.A., Makan, T., Miskelly, C.M, O'Donnell, C.J., Sagar, P.M., Scofield, R.P, Taylor, G.A., Michel, P. 2021. Conservation status of birds in Aotearoa New Zealand. New Zealand Threat Classification Series 36. Department of Conservation, Wellington. 43 p.

Roper-Lindsay, J., Fuller S.A., Hooson, S., Sanders, M.D., Ussher, G.T. 2018. Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

Sinton, A. (2008). The ecology of freshwater communities of stock water races on the Canterbury Plains.

Singers, N.J.D., Rogers, G.M. 2014. A classification of New Zealand's terrestrial ecosystems. Science for Conservation 325. Department of Conservation.

Walston Jr, L. J., Rollins, K. E., LaGory, K. E., Smith, K. P., & Meyers, S. A. 2016. A preliminary assessment of avian mortality at utility-scale solar energy facilities in the United States. *Renewable Energy*, *92*, 405-414.

APPENDIX A
Water race eDNA data

ScientificName	Rank	TaxID	CommonName	Group	53781
Ovis aries	species	9940	Sheep; pirikahu; hipi	Mammals	5500
Gobiomorphus breviceps	species	300741	Upland bully	Fish	2733
Aulodrilus pluriseta	species	76585	Aquatic oligochaete worm	Worms	2536
Gobiomorphus breviceps or mataraero	species	10000276	Upland or kaharore bully	Fish	1870
Limnodrilus hoffmeisteri	species	76587	Redworm	Worms	1167
Columba livia	species	8932	Pigeon	Birds	989
Lumbriculus variegatus	species	61662	Blackworm	Worms	688
Aporrectodea caliginosa	species	302032	Worm	Worms	468
Octolasion cyaneum	species	302033	Worm	Worms	379
Anguilla australis	species	7940	Shortfin eel; tuna; hao; aopori; hikumu	Fish	339
Hydroptilidae sp. 12KH6B	species	1877717	Purse-case caddisfly	Insects	64
Anas platyrhynchos	species	8839	Mallard duck; rakiraki	Birds	279
Lumbricus rubellus	species	35632	Red earthworm	Worms	225
Physella acuta	species	109671	Left handed sinistral snail	Molluscs	248
Cochliopodium kieliense	species	1512276	Amoeba	Amoebae	27
Potamopyrgus antipodarum	species	145637	Mud Snail	Molluscs	222
Bos taurus	species	9913	Cattle; kau	Mammals	191
Eiseniella tetraedra	species	1302610	Squaretail worm	Worms	184
Aporrectodea trapezoides	species	408844	Southern worm	Worms	172
Chaetogaster diaphanus	species	212246	Oligochaete worm	Worms	166
Nais christinae	species	1138466	Sludgeworm	Worms	0
Penthaleidae sp. Q091	species	1437083		Mites and tic	5
Dermatophagoides pteronyssinus	species	6956	House dust mite; Dust mite	Mites and tic	0
Nearctaphis bakeri	species	1074823	Aphid	Insects	0
Tuberolachnus salignus	species	96551	Giant willow aphid	Insects	0
Nais communis	species	188228	Sludgeworm	Worms	0
Naupactus leucoloma	species	299136	Broad-nosed weevil	Insects	0
Porphyrio melanotus	species	72013	Pukeko; pūkeko	Birds	41
Asplanchna sieboldii	species	84397	Rotifer	Rotifers	0
Lepus europaeus	species	9983	Brown hare; hea	Mammals	35
Rotaria rotatoria	species	231624	Rotifer	Rotifers	35
Bothrioneurum vejdovskyanum	species	188204	Worm	Worms	33
Aoteapsyche colonica	species	177870	NZ caddisfly	Insects	30
Prostoma graecense	species	324887	Freshwater nemertean	Ribbon worr	30
Sus scrofa	species	9823	Pig	Mammals	0
Dysaphis aucupariae	species	1425391	Aphid	Insects	23
Chaetogaster diastrophus	species	74727	Oligochaete worm	Worms	22
Corynoneura scutellata	species	611450	Non-biting midge	Insects	22
Hudsonema sp. NZCAD669	species	1969062	Cased caddisfly	Insects	20
Gyraulus corinna	species	10000037	NZ freshwater snail	Molluscs	18
Carduelis carduelis	species	37600	Goldfinch	Birds	0
Capitophorus elaeagni	species	527612	Artichoke aphid	Insects	15
Mus musculus	species	10090	House mouse	Mammals	14
Rhopalosiphum padi	species	40932	Bird cherry-oat aphid	Insects	0
Penthaleidae sp. Q080	species	1437082		Mites and tic	11
Deroceras reticulatum	species	145610	Grey field slug; Grey garden slug	Molluscs	9
Cochliopodium larifeili	species	1017091		Amoebae	0
Stylodrilus heringianus	species	77571	Worm	Worms	5
Gobiomorphus	genus	86236	Bullies	Fish	10691
Potamopyrgus	genus	145636	Mud snails	Molluscs	158
Physella	genus	175859	Freshwater Snail	Molluscs	99
Limnodrilus	genus	76586	Worm	Worms	143
Nais	genus	74730	Sludgeworm	Worms	62
Chaetonotus	genus	68038	Gastrotrich	Other	57
Cochliopodium	genus	313557	Amoeba	Amoebae	0
Pieris	genus	7115		Insects	28
Deleatidium	genus	551873	NZ mayfly	Insects	23
Vannella	genus	95228	Amoeba	Amoebae	0
Tubifex	genus	6385	Worm	Worms	8
Arion	genus	6542		Molluscs	8
Teladorsagia	genus	94964		Roundworm	8
Euchlanis	genus	231619		Rotifers	0
Pycnocentrodes	genus	177810	Stony cased caddisfly	Insects	5
Caprinae	subfamily	9963		Mammals	1479
Bovidae	family	9895	Even-toed ungulates	Mammals	248
Aphididae	family	27482	Aphids	Insects	18
Tubificinae	subfamily	1780203		Worms	91
Chironomidae	family	7149	Nonbiting midges	Insects	73
Columbidae	family	8930	Pigeons/doves	Birds	52
Lumbricidae	family	6392		Worms	28
Orthocladiinae	subfamily	43808		Insects	5
root	no rank	1	Unidentified	Other	16896
Metazoa	kingdom	33208	Metazoans	Other	1165
Arthropoda	phylum	6656	Arthropods	Other	19
Mammalia	class	40674	Mammals	Other	135
Insecta	class	50557	Insects	Other	82
Nemertea	phylum	6217	Bootlace worms	Other	94
Aves	class	8782	Birds	Other	69
unclassified Orthocladiinae	no rank	559852		Insects	0
unclassified Chaetogaster	no rank	2664999		Worms	32
Trichoptera	order	30263	Caddisflies	Insects	28
Rotifera	phylum	10190	Rotifers	Other	0
Oomycota	phylum	4762		Heterokont a	16
Arcellinida	order	318493		Amoebae	0
unclassified Paraphysomonas	no rank	2617784		Heterokont a	15
Artiodactyla	order	91561	Hoofed Animals	Mammals	14
Chromadorea	class	119089		Roundworm	14
Protostomia	clade	33317		Other	0
Sarcoptiformes	order	83137		Mites and tic	10
Dothideomycetes	class	147541		Fungi	0
Diptera	order	7147	Flies	Insects	8
unclassified Saccamoeba	no rank	2622403		Amoebae	0