Appendix F – Ecological Report

Boffa Miskell

Rangiora Eastern Road Connections

Ecological Report
Prepared for Waimakariri District Council

3 May 2021

Document Quality Assurance

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Prepared by:	Tanya Blakely Ecologist | Senior Principal Boffa Miskell Limited	
Reviewed by:	Vaughan Keesing Ecologist | Partner Boffa Miskell Limited	
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Cover photograph: Aerial view of proposed Rangiora Eastern Link looking south from Northbrook Road, © Boffa Miskell, 2021

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1.0 Introduction

The Waimakariri District Council (WDC) is preparing a Notice of Requirement (NOR) for a new road designation on the eastern side of Rangiora, which passes through agricultural and commercial land uses.

The designation connects Lineside Road and Northbrook Road. The area to which the NOR applies is referred to as Rangiora East Road Connection (RERC) and is shown in Figure 1 below. The proposed designation will form part of a roading link that will ultimately connect Lineside Road through to Coldstream Road (referred to as the 'Rangiora Eastern Link (REL)').

Those parts of the REL Link that do <u>not</u> form part of the proposed designation are:

- MacPhail Avenue, which is an existing road that connects Northbrook Road and Kippenberger Ave; and
- The connection from Kippernberger Avenue through to Coldstream Road.

1.1 Scope

This report assesses, at a high level, the ecological values within and adjacent to the proposed RERC alignment and to outline the potential effects of the construction and operation of this road on these ecological values.

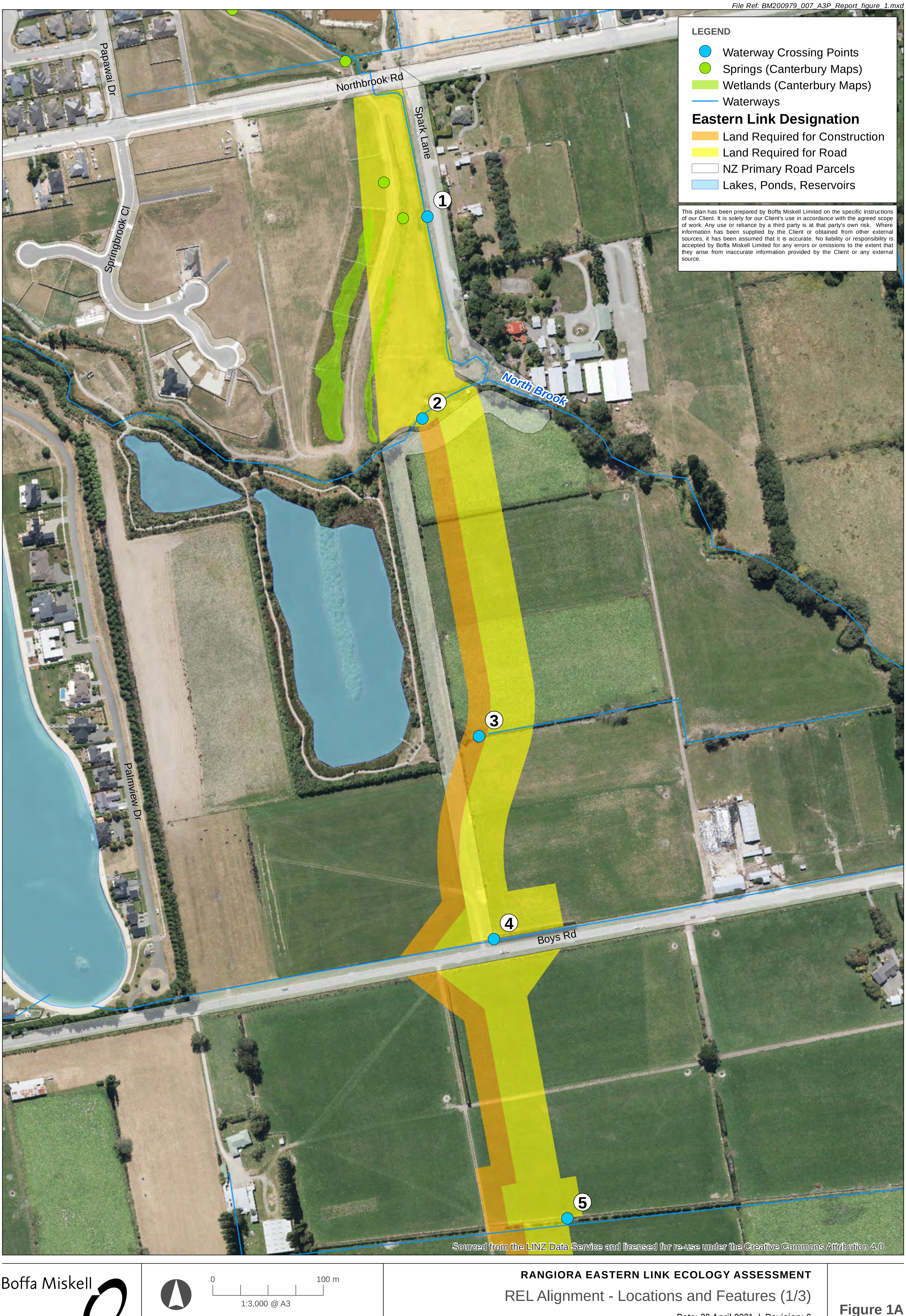
The RERC alignment and proposed designation provided to Boffa Miskell is shown in Figure 1.

This ecological assessment only considers the RERC section from Lineside Road through to Northbrook Road. The remainder of the REL is either already built (Northbrook Road to Kippenberger Ave) or is intended to be identified within, and developed as part of, a Development Area (Kippenberger Ave to Coldstream Road).

This high-level report is intended to inform the NOR and highlight if there are any fatal flaws or major constraints (e.g. ecological areas or values that warrant avoidance) and is not intended to be a full Ecological Impact Assessment (EcIA). An EcIA will be required at a later date, to inform resource consent applications to the regional council.

The objectives of this ecological assessment are to:

- Describe the existing ecological environment, features and ecological values of the area;
- Identify the potential effects on the ecological values of the area that may be impacted by the construction and operation of the proposed road;
- Identify potential opportunities to avoid, minimise or remedy potential adverse effects of the proposed RERC on the ecology of the area; and
- Provide recommendations for any additional assessments or specialist surveys required to complete a detailed Ecological Impact Assessment.



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Data Sources:
WSP; Canterbury Maps; LINZ Topo50 Data

Projection: NZGD 2000 New Zealand Transverse Mercator

RANGIORA EASTERN LINK ECOLOGY ASSESSMENT

REL Alignment - Locations and Features (1/3)

Date: 29 April 2021 | Revision: 0

Plan prepared for WSP by Boffa Miskell Limited

Project Manager: tanya.blakely@boffamiskell.co.nz | Drawn: JMo | Checked: TBl

Figure 1A

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0 100 m

1:3,000 @ A3

Data Sources: WSP; Canterbury Maps; LINZ Topo50 Data

Projection: NZGD 2000 New Zealand Transverse Mercator

RANGIORA EASTERN LINK ECOLOGY ASSESSMENT

REL Alignment - Locations and Features (2/3)

Date: 29 April 2021 | Revision: 0

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Project Manager: tanya.blakely@boffamiskell.co.nz | Drawn: JMo | Checked: TBl

Figure 1B

File Ref: BM200979_009_A3P_Report_figure_3.mxd

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0 100 m

1:2,500 @ A3

Data Sources: WSP; Canterbury Maps; LINZ Topo50 Data

Projection: NZGD 2000 New Zealand Transverse Mercator

RANGIORA EASTERN LINK ECOLOGY ASSESSMENT

REL Alignment - Locations and Features (3/3)

Date: 29 April 2021 | Revision: 0

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Figure 1C

2.0 Methodology

2.1 Desktop Review

A desktop review was undertaken, and included:

- Review of route option, including area of land required for construction activities and land required for road (revised designation received 19 April 2021);
- Draft stormwater and flood risk technical report prepared by WSP (Version 6, received 26 January 2021);
- Draft landscape and visual technical report prepared by WSP (dated 18 January 2021);
- A desktop investigation to obtain existing information on ecological values in the vicinity of the proposed RERC (between Lineside Road and Northbrook Road);
- Existing information on avifauna / bird species within or nearby the proposed RERC was investigated by Karin Sievwright (Ecologist, Boffa Miskell), including:
  - Data from the Ornithological Society of New Zealand's (OSNZ) atlas (Robertson et al. 2017) was collated from the 10 x 10 km grid square (247, 576), which encompasses the proposed RERC.
  - The primary and secondary habitats[1] for each of the bird species recorded within the grid square was obtained from Heather and Robertson (2015), along with each species' threat status according to the current New Zealand Threat Classification for avifauna (Robertson et al. 2017). The species list obtained from the OSNZ atlas data served as a base list of avifauna species recorded in the wider area and, therefore, potentially present at or near the proposed RERC.
  - Further literature and website searches were undertaken to obtain additional information regarding bird species known to occur within the surrounding habitats. This included the eBird citizen science database; species lists were derived from hotspot survey locations near the RERC.
- Discussion with WDC Ecologists to understand any additional information on ecological values held by the Council; and
- GIS (spatial) databases and aerials, including:
  - Location of springs and wetlands mapped in Environment Canterbury's Canterbury Maps;
  - Waterways (river centre lines) shown on New Zealand Topographical Maps;
  - The NIWA-administered New Zealand Freshwater Fish database (NZFFD): this database holds records of freshwater fish distributions and occurrences based on previous surveys. The conservation status of fish species found in the NZFFD records was assessed based on the most recent conservation threat status for New Zealand's freshwater fishes (Dunn et al. 2018).

[1] For the purpose of this report, primary habitat refers to the habitat that the species spends most of its time. Secondary habitats are other habitat types that the species may also use.

- Project description and preliminary designation options provided to us by WDC.

2.2 Site investigation

Tanya Blakely (Senior Ecologist | Senior Principal) and Jaz Morris (Ecologist) walked the proposed RERC alignment on 22 January 2021.

Observations of the existing ecological values were made, including:

- General, riparian and in-stream habitat conditions, and fish passage of the (natural and human-made) waterways to be crossed by the RERC;
- Vegetation communities and habitats for fauna within the RERC footprint;
- Incidental recordings of fauna, such as birds and lizards; and
- Identifying if any wetland habitats are within the designation, particularly to understand the implications of the National Policy Statement for Freshwater Management (NPS-FM) and the National Environmental Standards for Freshwater (NES-F)[2] in relation to these habitats.

This information has been used to assess (at a high level) the terrestrial, wetland, riparian and in-stream ecological conditions. Specialised surveys (e.g. in-stream / aquatic or lizard communities or vegetation / botanical surveys) have not been completed as part of this work.

3.0 Existing environment

The RERC designation lies to the east of Rangiora township in the Cam River / Ruataniwha catchment. The catchment is around 84 km^2, with three main tributaries (North, Middle and South Brooks, known as the Three Brooks) draining much of central and southern Rangiora, discharging into the Cam River / Ruataniwha. The catchment is a lowland spring-fed system, with the North and Middle Brooks originating in urban areas and passing through rural land downstream, and South Brook passing through predominantly rural land. Groundwater moving down from the Ashley River is also thought to have an influence on the surface flows in this area.

The RERC lies within the Canterbury Plains Ecological Region and the Low Plains Ecological District (ED) (McEwan 1987). Historically, the area was a raupō and harakeke swamp, drained in the mid to late 1800s to make way for agricultural and, more recently, residential land.

The waterways (and the catchment) have been managed from a drainage and flood conveyance perspective, and dredging, clearing of macrophytes (aquatic plants) and maintenance of riparian vegetation are all common practice. Several wetlands have been constructed in the area, including for stormwater treatment facilities. These wetlands have indigenous plantings around their margins providing habitat for terrestrial fauna (birds and terrestrial invertebrates) and waterfowl, and the waterbodies likely support aquatic fauna including indigenous fish species.

[2] The NPS-FM and NES-F 2020 sets out the “effects management hierarchy” required to be followed for managing activities in wetlands and rivers.

The following sections summarise the known (and likely) ecological values within the area generally, including waterways that are in the vicinity of the RERC designation footprint.

3.1 Terrestrial Habitats and Fauna

The proposed RERC is primarily in agricultural or urban land use, with little remnant indigenous vegetation remaining. Vegetation is dominated by improved pasture and pasture weeds, and shelter belts consisting of various exotic plant species. Some indigenous plantings are present in riparian margins along waterways and stormwater treatment basins.

3.1.1 Avifauna (Birds)

The vegetation communities present provide habitat for common and widespread, indigenous and exotic birds (e.g. spur-winged plover, paradise duck, exotic songbirds).

The desktop review provided a base list of 50 bird species from the OSNZ square and eBird records that encompasses the RERC and that may be present based on the habitat types within the site[3].

This list of 50 species is provided in Table 1 and includes three Threatened species (white heron, black stilt and black-billed gull) and six At-Risk species (black shag, pied shag, South Island pied oystercatcher, red-billed gull, New Zealand pipit and Australian coot).

Most of the Threatened and At-Risk species have only been observed in very low numbers (e.g. one observation of a South Island oystercatcher in 2009, one observation of a white heron in 2020 and four in 2009) (Table 2). However, high numbers of Australian coot (e.g. 44 observed in 2015), black-billed gulls (e.g. 55 observed in 2009) and a few red-billed gulls (e.g. six observed in 2013) have been recorded at the adjacent Northbrook wetlands and ponds. These species likely use these habitats for foraging and / or roosting. New Zealand pipit is likely to be present in areas of open country / farmland habitat; they may potentially nest in areas that are not heavily grazed by stock (Karin Sievwright, pers. comm. 3 March 2021).

[3] Species were excluded if their primary habitats were not within the project area and / or if they were likely very rare visitors to the site.

Table 1. Avifauna species present, or likely to be present, within the proposed RERC. Data from the OSNZ square that encompasses the site, and eBird hotspot records.

SPECIES - Robertson et al. 2012		**CONSERVATION STATUS - Robertson et al. 2017**			Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Oceanic	Urban/Residential	OSNZ Square Record	eBird Record Northbrook wetlands	eBird Record Northbrook ponds
Black shag	*Phalacrocorax carbo novaehollandiae*	Native	At Risk	Naturally Uncommon[SO Sp]									✓		✓
Pied shag	*Phalacrocorax varius varius*	Endemic	At Risk	Recovering									✓		
Little shag	*Phalacrocorax melanoleucos brevirostris*	Native	Not Threatened	Not Threatened[Inc]									✓		✓
White-faced heron	*Egretta novaehollandiae*	Native	Not Threatened	Not Threatened[SO]									✓		✓
White heron	*Ardea modesta*	Native	Threatened	Nationally Critical[OL SO St]									✓		✓
Black swan	*Cygnus atratus*	Native	Not Threatened	Not Threatened[SO]									✓	✓	✓
Canada goose	*Branta canadensis*	Introduced	Introduced	Introduced & Naturalised[SO]									✓		✓
Feral goose	*Anser anser*	Introduced	Introduced	Introduced & Naturalised[SO]									✓		
Paradise shelduck	*Tadorna variegata*	Endemic	Not Threatened	Not Threatened									✓	✓	✓
Mallard	*Anas platyrhynchos*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Grey teal	*Anas gracilis*	Native	Not Threatened	Not Threatened[Inc SO]									✓		✓
New Zealand shoveler	*Anas rhynchotis*	Native	Not Threatened	Not Threatened									✓	✓	✓
NZ scaup	*Aythya novaeseelandiae*	Endemic	Not Threatened	Not Threatened[Inc]									✓	✓	✓
Swamp harrier	*Circus approximans*	Native	Not Threatened	Not Threatened[SO]									✓		✓
California quail	*Callipepla californica*	Introduced	Introduced	Introduced & Naturalised[SO]									✓		✓
Pheasant	*Phasianus colchicus*	Introduced	Introduced	Introduced & Naturalised[SO]									✓		
Pukeko	*Porphyrio m. melanotus*	Native	Not Threatened	Not Threatened[Inc SO]									✓	✓	✓
South Island pied oystercatcher	*Haematopus finschi*	Endemic	At Risk	Declining									✓		✓
Pied stilt	*Himantopus h. leucocephalus*	Native	Not Threatened	Not Threatened									✓		✓
Black stilt	*Himantopus novaezelandiae*	Endemic	Threatened	Nationally Critical[CD RR]									✓		
Spur-winged plover	*Vanellus miles novaehollandiae*	Native	Not Threatened	Not Threatened[SO]									✓	✓	✓
Black-backed gull	*Larus d. dominicanus*	Native	Not Threatened	Not Threatened[SO]									✓	✓	✓
Red-billed gull	*Larus novaehollandiae scopulinus*	Native	At Risk	Declining									✓	✓	✓
Black-billed gull	*Larus bulleri*	Endemic	Threatened	Nationally Critical[RF]									✓	✓	✓
Kereru	*Hemiphaga novaeseelandiae*	Endemic	Not Threatened	Not Threatened[CD Inc]									✓		
Rock pigeon	*Columba livia*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Shining cuckoo	*Chrysococcyx l. lucidus*	Native	Not Threatened	Not Threatened[DP]									✓		
Little owl	*Athene noctua*	Introduced	Introduced	Introduced & Naturalised[SO]									✓		
Kingfisher	*Todiramphus sanctus vagans*	Native	Not Threatened	Not Threatened									✓		✓
Skylark	*Alauda arvensis*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Welcome swallow	*Hirundo n. neoxena*	Native	Not Threatened	Not Threatened[Inc SO]									✓	✓	✓
NZ pipit	*Anthus n. novaeseelandiae*	Native	At Risk	Declining									✓		
Dunnock	*Prunella modularis*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Blackbird	*Turdus merula*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Song thrush	*Turdus philomelos*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Grey warbler	*Gerygone igata*	Endemic	Not Threatened	Not Threatened									✓	✓	✓
South Island fantail	*Rhipidura fuliginosa fuliginosa*	Endemic	Not Threatened	Not ThreatenedEF									✓	✓	✓
Silvereye	*Zosterops lateralis lateralis*	Native	Not Threatened	Not Threatened[SO]									✓	✓	✓
Bellbird	*Anthornis m. melanura*	Endemic	Not Threatened	Not Threatened									✓		✓
Yellowhammer	*Emberiza citrinella*	Introduced	Introduced	Introduced & Naturalised[SO]									✓		✓
Chaffinch	*Fringilla coelebs*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Greenfinch	*Carduelis chloris*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Goldfinch	*Carduelis carduelis*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Redpoll	*Carduelis flammea*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
House sparrow	*Passer domesticus*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Starling	*Sturnus vulgaris*	Introduced	Introduced	Introduced & Naturalised[SO]									✓	✓	✓
Magpie	*Gymnorhina tibicen*	Introduced	Introduced	Introduced & Naturalised[SO]									✓		✓
Australian coot	*Fulica atra australis*	Native	At Risk	Naturally Uncommon[Inc SO]										✓	✓
Mute swan	*Cygnus olor*	Introduced	Introduced	Introduced & NaturalisedSO											✓
Cape barren goose	*Cereopsis novaehollandiae*	Introduced	Introduced	Introduced & NaturalisedSO											✓

Table 2. Highest abundances of species observed at the eBird hotspot sites.

Species	Jan 2021	March 2020	June 2019	March 2019	May 2015	June 2013	Aug 2009
Australian coot	19				44		
Black-billed gull	1						55
Red-billed gull	2					6	
Black shag		1					
White heron			1				4
South Island pied oystercatcher							1

3.1.2 Herpetofauna (Lizards)

Potential lizard habitat is present in the long grass area adjacent to Northbrook wetland stormwater ponds. This is likely to support Canterbury grass skink (*Oligosoma aff. polychroma* Clade 4, At Risk, Declining) (Samantha King, pers. comm. 3 March 2021).

3.2 Aquatic Habitats and Fauna

The proposed RERC designation crosses over numerous spring-fed waterways, including three major tributaries of the Cam River: North, Middle and South Brook (also referred to as the "Three Brooks").

The following is a general summary of the information available on the catchment. More specific information relevant to each potential crossing is provided below.

3.2.1 Water quality

The Canterbury Regional Council (ECan) regularly monitors the surface water quality of the Cam River / Ruataniwha catchment. WDC also undertakes limited water quality sampling of the Three Brooks (S. Allen, WDC, pers. comm).

Results from the ECan monitoring at the 'South Brook at Marsh Road' site indicates that faecal coliforms (measured as *Escherichia coli*) are high. Nutrient levels are also high, with parameters for nitrates also commonly exceeded[4]. Evidence collated by Hudson (2017) also found that water quality guidelines were exceeded for these parameters.

Water quality data collated by Hudson (2017) indicates that dissolved oxygen levels and temperature in the Three Brooks is within a suitable range to support aquatic fauna.

3.2.2 Riparian vegetation and habitats

Riparian vegetation along the Three Brooks is predominantly pasture grasses - reflective of the urban and agricultural land the waterways pass through. Occasional exotic trees and shrubs, including willow species, hawthorn and gorse are also present (McMurtrie 2008).

Some areas of planted indigenous vegetation have improved habitat quality along some reaches of the Three Brooks alongside stormwater treatment basins.

[4] https://www.lawa.org.nz/explore-data/canterbury-region/river-quality/waimakariri-river-catchment/south-brook-at-marsh-road/

3.2.3 Aquatic habitats for fauna

The in-stream habitat available in the catchment is variable. In general, the waterways have some reaches of coarser substrate, which provides good habitat for fish and macroinvertebrates. However, sediment discharges have been identified as a significant problem in the catchment (Hudson 2010, Hudson 2017), which is reflected in some reaches of the Three Brooks having high sediment cover. Middle Brook was identified by Hudson (2010) as having a high cover of sediment.

3.2.4 Aquatic fauna

The fish and macroinvertebrate communities of the waterways within the RERC designation were not assessed during the site investigation.

3.2.4.1 Macroinvertebrates

However, previous assessments of the Three Brooks have indicated that the aquatic community is dominated by molluscs (e.g. snails), oligochaete worms, chironomid midge larvae and crustaceans, with relatively few 'clean-water' taxa present (EOS Ecology 2005). Nevertheless, the Three Brooks do support several caddisfly and mayfly taxa (Trichoptera and Ephemeroptera, respectively; two of the "clean-water" insect groups) (EOS Ecology 2005).

The recorded macroinvertebrate community index (MCI) indicates North and Middle Brooks to be of "fair" stream health indicating "probable moderate enrichment"[5], and South Brook to be of "good" stream health (EOS Ecology 2005). Significant changes to catchment management, such as changes to stormwater management and stock access, have occurred since these assessments were undertaken, which may have affected the instream habitat and water quality, and therefore the aquatic fauna.

Kēkēwai (freshwater crayfish) are present in North and South Brooks. North Brook, in particular, provides habitat for significant densities of kēkēwai (McMurtrie 2008). Kōura Creek (also known as Crayfish Creek, a tributary of North Brook) is a known 'hotspot' for kōura. Potential fish barriers between North Brook and the upper reach of Kōura Creek upstream of Northbrook Road has meant that kēkēwai have proliferated there, where the steep-sided clay banks are suitable for burrowing into.

Kēkēwai is an At Risk – Declining species (Grainger et al. 2014).

3.2.4.2 Fish

Longfin eel (*Anguilla dieffenbachii*), shortfin eel (*A. australis*), upland bully (*Gobiomorphus breviceps*), common bully (*G. cotidanus*), kanakana / lamprey (*Geotria australis*), and the introduced brown trout (*Salmo trutta*) are known to occur within the Three Brooks (EOS Ecology 2005, Hudson 2017, NZFFD accessed 2020). Inanga (*Galaxias maculatus*) and giant bully (*G. gobioides*) may also be present.

Kanakana / lamprey is listed as Threatened, Nationally Vulnerable; longfin eel, inanga and giant bully are listed as At Risk, Declining. Common bully, upland bully and shortfin eel are all classified as Not Threatened, and brown trout is Introduced and Naturalised (Dunn et al. 2018).

Many of these species are considered taonga and important mahinga kai species.

Importantly, many of the freshwater fishes that inhabit the Three Brooks and tributaries are migratory, requiring access to the sea to complete their lifecycles. Lamprey have been found in

[5] Based on the macroinvertebrate community present in these waterways, and interpretation of the Macroinvertebrate Community Index (MCI) of Stark and Maxted (2007).

their juvenile state (known as ammocoetes) in the North and South Brooks, and the lower reaches of Kōura Creek – sometimes in significant numbers (EOS Ecology 2005). It is possible that the Cam River / Ruataniwha is a lamprey spawning ground (Taylor & Marshall 2017) with juveniles moving upstream into the brooks to feed for several years, before migrating to the sea to begin their marine life phase. A historic fish barrier (a small culvert) to the upper reaches of Kōura Creek may have prevented lamprey and other fish species such as eels and trout, from colonising this reach (McMurtrie 2008).

Aquatic habitats that the RERC crosses are discussed from north to south, numbered 1-10 (as shown in Figure 1).

3.3 Location specific information

3.3.1 Crossing 1 – Kōura Creek at Spark Lane

The proposed RERC alignment includes crossing or potential reclamation and relocation of Kōura Creek at Spark Lane (Figure 1).

Initially, the RERC was proposed to minimise the length of crossing or potential for reclaiming and relocating Kōura Creek, by crossing the waterway immediately upstream of its confluence with North Brook. However, the land required for the road now extends across Kōura Creek and into a stormwater treatment area, immediately to the west of Kōura Creek and Spark Lane (Figure 1). It was thought that this stormwater treatment area would only be used for walking and cycling facilities as there is not enough room with the existing Spark Lane road reserve for both the RERC carriageway and pedestrian and cycle facilities. WDC may in the future investigate relocating Kōura Creek to provide opportunities to create the RERC outside of the existing Spark Lane road reserve.

Kōura Creek is a perennial, spring-fed headwater stream, which originates approximately 200 m upstream on Northbrook Road, and flows into North Brook a further 300-350 m downstream of the springhead (Figure 2). In 2009, WDC developed a stormwater treatment area, immediately to the west of Kōura Creek and Sparks Lane. This stormwater treatment area involved planting indigenous species within the riparian margins of the section of creek adjacent to Sparks Lane. Two new channels were also constructed to the west of Kōura Creek as part of this stormwater treatment area.

Existing information available on Kōura Creek is over 10 years old, but still gives a good indication of the likely ecological values of the waterway. Prior to the riparian planting in 2009, the banks of Kōura Creek along Spark Lane were dominated by grasses, which presumably were periodically maintained / trimmed. Current vegetation is a mix of densely planted flaxes / harakeke, *Carex* sedges / pūrei and indigenous tree species, such as cabbage trees / tī kouka (Figure 3). Because of these plantings, the creek is well shaded in many places, but abundant macrophytes (consisting largely of common indigenous and exotic species such as creeping bent, sweetgrass, watercress and monkey musk) cover the bed in un-shaded areas.

Kōura Creek supports a range of indigenous freshwater species including kēkēwai / freshwater crayfish (or kōura, *Paranephrops zealandicus*), tuna / longfin and shortfin eels (*Anguilla dieffenbachii* and *A. australis*) and kanakana / lamprey (*Geotria australis*) (McMurtrie 2008).

There are also numerous springs nearby Site 1, which are of ecological and cultural value (Figure 1).

Figure 2. Kōura Creek flowing under Northbrook Road (top) and alongside Spark Lane (right). Photo taken looking upstream (north).

Figure 3. Kōura Creek with riparian plantings, such as harakeke, pūrei, tī kouka.

3.3.2 Crossing 2 – North Brook

The proposed RERC alignment crosses North Brook just upstream of its confluence with Kōura Creek and approximately where Spark Lane terminates (Figure 1).

North Brook is also a perennial, spring-fed waterway, within predominantly urban land use. Previous investigations on the ecological values of the waterway show it has a generally stony bottom, with limited silt in places (EOS Ecology 2005). It is important to note, however, that this information may be outdated, and siltation of the bed may be greater in places today due to stormwater discharges and runoff from urban and rural land uses.

In 2005, the riparian vegetation was predominantly grass and herb mix, with some exotic trees along the banks. Indigenous vegetation was uncommon. Today, the area where the RERC is proposed to cross has pūrei planted immediately alongside the waterway, providing some shade and stable undercut banks in the waterway (Figure 4 and Figure 5).

There is abundant cover of macrophytes (as shown in Figure 5), and the stream health is noted to be fair to poor (based on the Macroinvertebrate Community Index (MCI) measures from EOS Ecology 2005).

Nevertheless, a study by Aquatic Ecology Limited (AEL) in 2017, found a substantial number of brown trout redds (egg nests) in North Brook, as well as abundant kēkēwai and kanakana (AEL 2017). The NZFFD indicates other species are present in North Brook, including longfin eels and freshwater shrimp; and EOS Ecology (2005) also found upland bully (a non-migratory species) and common bully present in the brook.

Figure 4. North Brook near the confluence with Kōura Creek where the proposed RERC alignment crosses. Photo taken looking downstream (northeast).

Figure 5. North Brook with deep, clear spring-fed water and abundant macrophytes (creeping bent, monkey musk, water speedwell, and cape pondweed).

3.3.3 Crossing 3 – Farm drainage waterway

The proposed RERC alignment crosses a small, presumably spring-fed farm drainage waterway (Figure 1).

This waterway is shown as a waterway line on NZ Topo spatial data, so presumably is a natural waterway that has been modified for farm drainage. It is a tributary of North Brook.

The waterway appears to commence immediately upstream of where the RERC is proposed to cross and flows in an approximately eastern direction before joining North Brook. At and downstream of the proposed RERC crossing, the waterway appears to be perennial. However, the waterway at the location of the proposed crossing did not have surface water present when we conducted our site walkover, and it appears that the upper section / "headwater" may be ephemeral (it did not have a defined channel and appears that it will only contain surface water during and shortly after heavy rainfall events).

The channel is approx. 1.5 m and had c.10 cm of surface water present on the day of our site walkover.

The channel is straight and incised, with soft sediments dominating the bed; the waterway appears to be regularly maintained for drainage purposes (Figure 6). The vegetation is predominantly rank pasture grasses with some exotic shrubs, which together provide a reasonable amount of shade to the waterway. Given there is surface water present and due to its proximity to and connection with North Brook, it’s possible that this waterway provides habitat for more tolerant fish and macroinvertebrate species, including shortfin eels.

Figure 6. Farm drain (photo taken c.80 m downstream of the proposed RERC alignment where surface water was present).

3.3.4 Crossing 4 – Boys Road Waterway

The proposed RERC alignment crosses a waterway the flows alongside Boys Road (Figure 1).

This waterway is shown as a waterway line on NZ Topo spatial data, so is likely to be a natural waterway that has been modified for roadside drainage. It is a tributary of North Brook and may receive surface water input from Northbrook wetland stormwater ponds to the west.

The waterway is perennial and has reasonable flow in places. The channel is straight and incised, and at the proposed RERC crossing, the waterway is approximately 2 m wide, with c.20 cm water depth with a mixture of cobble-gravel and soft sediments on the bed (Figure 7).

The farm access has a culvert crossing, which is perched and is likely to disrupt fish accessing upper reaches of the waterway (Figure 8).

The vegetation is predominantly rank pasture grasses with a shelter belt on the northern bank at the RERC crossing location, which provides high shading to the stream.

Given the perennial and reasonable flows, presence of cobbles and gravels, and the proximity to and connection with North Brook, this waterway is likely to support a reasonably representative assemblage of macroinvertebrate and fish species, including eels and bullies.

Figure 7. Roadside waterway tributary of North Brook, on the north side of Boys Road.

Figure 8. Perched culvert in the roadside waterway and tributary of North Brook.

3.3.5 Crossings 5 & 6 – Farm drainage waterways

The proposed RERC alignment crosses two small, presumably spring-fed farm drainage waterways (Figure 1).

Both waterways are also shown as waterway lines on NZ Topo spatial data, so presumably they are natural waterways that have been modified for farm drainage. Both waterways appear to be a tributary of North Brook, but have been straightened and channelised, running alongside fence lines primarily to drain the farmland.

The waterway at Crossing 5 (Figure 9) is approx. 1.5 m and had c.20 cm of surface water present on the day of our site walkover.

The waterway at Crossing 6 (Figure 10) is approx. 2 m wide and also had c. 20 cm of surface water present on the day of our site walkover.

The channels of both waterways are straight and incised, with soft sediments dominating the bed; the waterways appear to be regularly maintained for drainage purposes. The vegetation is predominantly rank pasture grasses with some exotic shrubs, but these provide little shade to the waterways. However, as with the other farm waterways, given the presence of surface water and the proximity and connectedness to North Brook, these waterways may provide habitat for more tolerant fish and macroinvertebrate species, including shortfin eels.

Figure 9. Waterway at Crossing 5: a tributary of North Brook (left: looking upstream; right: looking downstream). Abundant duckweed and dense, emergent creeping bent, watercress and monkey musk indicate high nutrient loads and slow flow.

Figure 10. Waterway at Crossing 6: a tributary of North Brook (left: looking upstream; right: looking downstream). A similar waterway to that at Crossing 5.

3.3.6 Crossing 7 – Middle Brook

The proposed RERC alignment crosses Middle Brook near Dunlops Road and north of Marsh Road (Figure 1).

Middle Brook is a spring-fed waterway, sometimes known as South Brook Tributary. Previous studies have found that the waterway generally has a cobble-dominated bed (EOS Ecology 2005). The riparian vegetation, immediately adjacent to the waterway, is a mixture of planted pūrei, scattered willow trees, and rank exotic grasses. The vegetated riparian buffer is narrow, with only c.1 m width of plantings.

The channel immediately at the RERC crossing (and extending above and below) is straightened and channelised, but plantings overhang the creek and provide some shading and habitat for in-stream fauna (Figure 11).

The waterway is approximately 2 m wide and has perennial flow, with variable water depths including fast runs and deep pools providing habitat for a variety of aquatic species.

AEL (2017) highlighted that Middle Brook provides spawning habitat for brown trout, with lots of redds throughout the creek, and juvenile kanakana were present indicating this species may also spawn in the waterway.

Other species previously found in Middle Brook include longfin and shortfin eels, and upland and common bullies (NZFFD records, EOS Ecology 2005).

There is an irrigation intake and pumphouse located generally within the proposed crossing location (Figure 12). The irrigation intake consists of a concrete weir that impounds the flow to allow sufficient depth for a pump to take water. This is likely to impede passage of most, if not all, freshwater fish species that migrate and move along Middle Brook.

Figure 11. Middle Brook (looking upstream). A deeper, slow-flowing pool is impounded by a vehicle crossing point and water intake structure.

Figure 12. Middle Brook (looking downstream). An irrigation intake is located immediately upstream of a c.40 cm weir that likely prevents upstream and downstream fish passage.

3.3.7 Crossing 8 – Marsh Road waterway

The proposed RERC alignment crosses another waterway that is crossed by Marsh Road (Figure 1).

We did not sight this waterway while on our site walkover, but it is shown as a waterway line on NZ Topo spatial data, and there is a mapped spring located approx. 70-100 m upstream of the crossing midpoint.

Sophie Allen, WDC, noted that the waterway can have strong flow, but there is no information held on the ecology (S Allen WDC pers. comm. 2021).

3.3.8 Crossing 9 – South Brook

The proposed RERC alignment crosses South Brook, where it flows through the WDC dog pound and wastewater treatment plant (Figure 1).

South Brook is the third of the three spring-fed brooks flowing through this area. It converges with North Brook and then flows into the Cam River. The waterway is approx. 4 m wide and still follows a relatively sinuous path through rural land and also the southern commercial zone of Rangiora.

The riparian margins are planted with pūrei (predominantly on the south or true right side) with kōhūhū trees (*Pittosporum tenuifolium*) on the north or true left side (Figure 13). The kōhūhū are particularly important for providing substantial shade and leaf litter inputs to the stream; essential components of the freshwater ecosystem for good stream health.

The stream health is noted to be good to poor (based on the Macroinvertebrate Community Index (MCI) measures from EOS Ecology 2005). As with North and Middle Brooks, South Brook has been found to have trout redds throughout, owing to the cobble-bottom bed. The waterway also supports kēkēwai, and longfin and shortfin eels, upland and common bullies, and brown trout. The WDC Wastewater Treatment Plant (WWTP) staff noted they often feed large longfin eels under the bridge within the site. A large (>1 m long) longfin eel was visible during the day, presumably habituated to vibrations from humans and being fed. The bridge and stable undercut banks likely provide good habitat for these large eel/s.

Figure 13. South Brook (left: looking upstream; right looking downstream) at the proposed RERC crossing point, within the Rangiora Wastewater Treatment Plant.

3.3.9 Crossing 10 –Constructed wetland

The proposed RERC alignment may cross part of a constructed wetland (Figure 1).

This waterbody is a constructed wetland with mature plantings of pūrei, Juncus spp. rushes, and tī kōuka. The native floating red fern (*Azolla*) is also abundant, which can be seen in the aerial image (Figure 14 and Figure 15). This constructed wetland provides important habitat for waterfowl and while it is not connected to adjacent waterways via surface water, there is an apparent input via a swale to the north. The wetland habitat appears to be suitable for freshwater fish species such as shortfin eels, although as this is a migratory species the presence of this fish would require connection to other waterways at some point.

Figure 14. Constructed wetland at south end of proposed RERC alignment.

Figure 15. Constructed wetland at south end of proposed RERC alignment.

4.0 Ecological Value

Assessments of ecological value follow the terminology and methodology of Roper-Lindsay et al. (2018).

4.1 Terrestrial Habitats and Fauna

The vegetation present at the RERC site is almost entirely improved pasture (exotic grasses and a range of exotic pasture weeds), with shelterbelts of exotic species and a very small number of possibly self-established climbing pohuehue. This vegetation is not at all representative of natural vegetation communities that occur, or that formerly would have occurred, in the Low Plains ED. It does not support any nationally or locally Threatened, At Risk or locally uncommon species, has extremely low indigenous plant diversity and is unimportant as habitat for fauna. It is of **Negligible** ecological value.

4.1.1 Avifauna

Bird species observed or likely to occur within the RERC included Threatened, At Risk and Not Threatened indigenous or exotic species (Table 1 and Section 3.1.1).

Most of the Threatened and At-Risk species have only been observed in very low numbers, with the exception of Australian coot (high numbers), black-billed gulls (high numbers) and red-billed gulls (a few). New Zealand pipit is likely to be present in areas of open country / farmland habitat and may nest in areas not heavily grazed by stock. Threatened species are considered of **Very High** ecological value, At Risk species are **High** or **Moderate** ecological value and Not Threatened and Introduced species are considered to have **Low** and **Negligible** ecological value, respectively.

4.1.2 Lizards

Rank grass adjacent to the proposed RERC alignment, between the designation and the Northbrook stormwater wetland, may provide habitat for Canterbury grass skink. But this area is outside of the designation so has not been discussed further.

4.2 Freshwater Habitats

The proposed RERC alignment crosses numerous spring-fed waterways, including natural waterways and human-modified or human-made drainage systems. The habitat conditions of these waterways are variable, ranging for **High** to **Low** ecological value.

4.3 Freshwater Fauna

Many of the waterways are known, or likely, to support freshwater species of conservation interest. One Threatened – Nationally Vulnerable species (kanakana, lamprey), the At Risk – Declining longfin eel, kēkēwai and numerous Not Threatened by indigenous species, as well as the Introduced and Naturalised brown trout are present. Inanga and giant bully (both At Risk – Declining) may also be present in North, Middle and South Brook. The freshwater fauna values range from **Very High** to **Low**.

4.4 Summary of Ecological Values

Table 3 summarises our assessment of ecological value based on the EIANZ (Roper-Lindsay et al. 2018) methodology.

Table 3. Summary of ecological values assigned to vegetation, avifauna, and freshwater habitats at the RERC site.

Ecosystem Component	Representativeness	Rarity / Distinctiveness	Diversity and Pattern	Ecological Context	Overall Ecological Value
Terrestrial Vegetation and Habitats					
All vegetation between Northbrook Road and Lineside Road	*Very Low*	*Very Low*	*Very Low*	*Very Low*	*Negligible*
Avifauna (All Species Present, Except for Scarce Visitors)					
Threatened species	*3 species (see Table 1)*				*Very High*
At Risk – Declining species	*3 species (see Table 1)*				*High*
Other At Risk species	*3 species (see Table 1)*				*Moderate*
Not Threatened species	*Numerous species (see Table 1)*				*Low*
Introduced species	*Numerous species (see Table 1)*				*Negligible*
Freshwater Habitats					
North, Middle and South Brooks	*High*	*Very High*	*High*	*Moderate*	*High*

Ecosystem Component	Representativeness	Rarity / Distinctiveness	Diversity and Pattern	Ecological Context	Overall Ecological Value
Other waterways and constructed wetland	*Moderate*	*Moderate*	*Low*	*Low*	*Moderate*
Freshwater Fauna					
Threatened	*1 species*				*Very High*
At Risk	*At least 2 species*				*High*
Not Threatened	*At least 3 species*				*Low*
Introduced	*1 species*				*Negligible*

5.0 Potential Ecological Effects

This section assesses the potential effects on the terrestrial, riparian and in-stream ecology of the proposed RERC alignment and numerous waterway crossings, during construction and operation. We have not attempted to discuss all potential impacts in detail, instead focussing on the most likely potential effects that are typical of roading programmes, and recommendations to avoid, remedy or mitigate these based on our current understanding of the proposed activity.

An Ecological Impact Assessment would be required to support resource consent applications to the regional council at a later stage.

The proposed RERC has the potential to affect both the riparian and in-stream environment of the waterways described above. These include both construction and operational effects.

5.1 Riparian vegetation and terrestrial habitats

The riparian margin at this site includes indigenous plantings, which provide some shading to the stream, important food resources to aquatic life, and support terrestrial species such as birds, insects and lizards.

The construction of the road crossings will result in the permanent loss of this habitat for aquatic and terrestrial species. The extent and exact locations of riparian vegetation to be lost (temporarily or permanently), and the subsequent effects on the existing ecological values is currently unknown but unlikely to be spatially extensive (i.e. low magnitude) relative to the remaining areas.

- Replanting with ecologically suitable, indigenous species that provide shading to the river and habitat for terrestrial fauna is likely to be required as mitigation.

5.2 Habitat loss, mortality and disturbance of terrestrial fauna

Construction activities associated with the RERC may result in the permanent loss of habitat for Canterbury grass skink and New Zealand pipit (both At Risk) and Not Threatened and Introduced bird species. The vegetation and habitats within the proposed alignment do not appear to be suitable for these species, but areas adjacent to the alignment and potentially within the designation may provide habitat of interest.

5.2.1 Avifauna

Construction: The mobile nature of most avifauna species means that potential for direct mortalities associated with the construction of the RERC will likely be confined to birds breeding within the project footprint, if construction activities occur during the breeding season. The only species identified that may nest within the project footprint is New Zealand pipit. Pipit may nest in areas of open country / farmland that are not heavily grazed by stock. However, much of the proposed alignment is heavily grazed by stock (in particular, cattle). As such we consider the magnitude of effect of construction mortality on potentially nesting pipit to be negligible. If construction occurs during the pipit nesting season (start of August until the end of March), it is recommended that the grass is kept grazed or mown until the commencement of earthworks to reduce the potential availability of pipit nesting habitat.

Operation: Avifauna crossing the pathway of traffic may be at risk of mortalities. Based on the avifauna assemblage present, both within the proposed RERC designation and the waterbodies adjacent to this, species that will most likely to suffer traffic mortalities will be common native and introduced birds such as pukeko and waterfowl. Given that there are many roads in the wider landscape, we assume that birds in the area will be habituated to traffic and mortality risk will be low. As such the magnitude of the effect of operation mortalities on these species' populations is considered to be Negligible.

5.3 Loss of headwaters and flow permanence

Loss of waterway headwaters is a matter that needs to be carefully considered as part of the detailed design of the RERC. For example, the land required for the road extends across Kōura Creek and into the stormwater treatment area immediately to the west of Kōura Creek and Spark Lane. WDC may in the future investigate relocating Kōura Creek to provide opportunities to create the RERC outside of the existing Spark Lane road reserve. There are numerous other spring-fed waterways and spring heads that sit within, or are nearby, the RERC designation.

Waterway headwaters and spring heads, such as those located within the RERC designation, are of ecological value supporting indigenous macroinvertebrate and fish species, including Threatened, At Risk and taonga species.

Assuming that new subsoil drainage will be required to redirect shallow groundwater away from the road footprint, these headwaters and spring heads may be susceptible to reduced flow after the road has been constructed due to shallow groundwater also being directed away from the adjacent waterways. It will be important that these shallow groundwaters, and the importance of maintaining flow permanence of these spring-fed waterways, are understood and carefully considered during the design of the road. This will be particularly important for Kōura Creek, and North, Middle and South Brooks.

- Avoiding stream loss (e.g. through loss of flow permanence, reclamation, piping / infilling) is an explicit requirement of the National Policy Statement for Freshwater Management 2020 (Policy 7). Where this is not practicable, a clear approach, using the effects management hierarchy, to managing the adverse effects on the ecology will be necessary.
- Advice from a suitably qualified and experienced freshwater ecologist should be included in the design and build stages for the road.

5.4 Fish passage

The construction and operation of the RERC involves crossing of numerous waterways, including at least three that have high ecological values and support migratory fish populations.

Many of New Zealand's freshwater fish are migratory and, therefore, require unimpeded passage between the sea and freshwater habitats to complete their lifecycles. Even for non-migratory species, it's important that their movement within a waterway is not restricted or impeded.

In-stream structures, such as culverts, can disrupt or impede the free movement of fish along waterways.

The Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (NES-F) sets out the design standards and monitoring requirements for installation of culverts. To meet the permitted activity rules, the culvert must provide for the same passage of fish upstream and downstream as would exist without the culvert, <u>for the lifetime of the structure</u>. In essence, the culvert needs to be designed (including size) and installed to meet ecological needs and the success of this must be monitored. This is likely to require a larger culvert than may be sized for conveyance of flood events.

- Advice from a suitably qualified and experienced freshwater ecologist should be included in the design and build stages for the road.

5.5 Culvert length

Culvert length is another important consideration as this could have significant effects on the freshwater ecology values within the designation.

There is a myriad of evidence to show that (amongst other factors) high velocities within culverts create barriers to the passage of fish species to and from the sea. A great deal of research has been conducted to determine either maximum tolerated velocities for New Zealand's freshwater fishes, or to develop specific structures to remedy barrel velocities in already constructed culverts. As discussed in Section 5.3 on Fish Passage, the NES-F regulations stipulate design criteria the culverts must meet for permitted activity standards (also see https://www.doc.govt.nz/nature/habitats/freshwater/fish-passage-management/nz-fish-passage-guidelines/).

However, the length of a culvert is not something that is often assessed, and the length of a culvert may be a significant factor determining whether a structure is, or is not, a barrier to fish and fauna passage. Some research suggests that culvert length may, in part, be due to low light levels inside the culverts, and that light conditions may affect the movement behaviour of at least some freshwater fish species. However, there remains a marked gap in scientific knowledge on whether the movement behaviour of freshwater fishes is influenced by light (i.e. light intensity).

The effect of darkness on migration of New Zealand's freshwater fish remains an area of debate.

However, the passage from light to dark, and vice versa, conditions encountered when entering and leaving culverts and piped networks may inhibit migration. Alternatively, if fish do continue to migrate through a dark piped network, they may need to pause to acclimate to the new conditions, which in turn may increase the amount of time a fish remains within the culvert, increasing fatigue and reducing passage (Boubée et al. 1999).

Regardless of the potential “darkness effect”, installation of culverts in waterways results in a total change of the habitat and can render that section of the stream uninhabitable for some species.

- It is essential that a suitably qualified and experienced freshwater ecologist provides advice into the design and build stages for the road.
- Avoiding the installation of culverts is recommended as a first principle. Bridges will certainly have a better ecological outcome; and may be more cost-effective in the long term given the requirements to monitor and maintain fish passage for the life of a culvert.
- Where avoidance is not possible, mitigation for stream loss is likely to be required, which may include enhancement of adjacent sections of waterway.

5.6 Increased impervious surfaces

The construction of the RERC will result in additional impervious surfaces within the catchment. The RERC itself will result in a significant increase in impervious surface, as there is currently none or very little within the designation.

Increases in the area of impervious surfaces can reduce natural flow paths (via infiltration) to waterways during rainfall events, resulting in ‘flashy’ flows. Contaminants and pollutants (e.g. sediments, heavy metals) from the surrounding urban environment also accumulate on these hard surfaces (e.g. roads, footpaths) and enter waterways during rainfall events. Both of these can have adverse effects on the ecology and health of waterways.

Road contaminants, including petrochemicals (oil, fuels) copper (from brake pads), zinc (from tyres) lead and fine sediments, build up during rainfall events and are transported by stormwater flows in waterways and other receiving environments.

- Additional impervious surfaces adjacent to waterways needs to be carefully considered and we recommend that a suitably qualified and experienced freshwater ecologist provides advice during the detailed design stage and when developing the construction methodology, to avoid or minimise effects on the ecology.
- The design should include appropriate stormwater treatment systems to receive and treat the runoff from the RERC, to avoid adverse ecological effects on the receiving environment.
- This will need to include a detailed EcIA using information regarding specific design and construction methods for the road. An ecologist should also be engaged to provide advice for the landscaping plan and replanting following works to maximise potential ecological benefits.

5.7 Lighting effects

Ecological light pollution is the alteration of natural cycles of light and dark by artificial light sources, which has adverse effects on animals and ecosystems. Artificial lights can attract or repel organisms and can have far reaching effects for biota and ecosystems (Longcore and Rich 2004). Artificial lights can increase predation, adversely affect migration behaviours, alter competition for food and habitat resources, reduce foraging time, and disrupt predator-prey relationships. Whilst understanding the ecological effects of light pollution on New Zealand’s freshwater ecosystems and fauna is still in its infancy, it’s likely that freshwater fishes and macroinvertebrates (including adult stages of aquatic insects) may be adversely affected by artificial lights.

For example, many of New Zealand's indigenous freshwater fishes and aquatic insects are nocturnal and artificial lights spilling into waterways may adversely affect behaviours, movement or migrations patterns, and foraging.

Aquatic insects have a winged adult stage, and it's this life stage that is most likely to be attracted to any lighting that may be included in the proposed road design. It is uncertain how lighting may impact fish migration and behaviour, particularly for nocturnal species. Terrestrial fauna, including birds and terrestrial invertebrates may also be impacted. Given the currently rural land use, there is currently very little lighting immediately adjacent to the waterways.

In New Zealand, aquatic insects emerge as adults for reproduction and to disperse throughout the year, however, there is a peak emergence period in the warmer months. There may be periods of the year when aquatic insects are more susceptible to lighting and this should be considered during the design phase, including in the context of existing night lighting in the surrounding urban environment.

While all new lighting could have an adverse effect on the ecology, LED lighting, which emits a "white" light, is of particular concern. Research into the differences between sodium vapour lamps and light-emitting diodes (LED) lighting is still in its infancy, LED lighting has been shown to have significant adverse effects on insect behaviour (Pawson & Bader 2014).

- Advice from a suitably qualified and experienced freshwater ecologist should be included in the detailed design to determine the effects of lighting and any impact management measures required to manage any adverse effects.
- Advice may include recommendations such as: avoiding lighting adjacent to the waterways; and where new lighting is needed, it should designed to avoid light spill onto and over the waterways and riparian vegetation (i.e. using angled mounting and rear shielding). It is also recommended that the use of blue LEDs is avoided where possible, however, noting that further research information is pending on this matter.

5.8 Earthworks

The construction of the RERC will involve extensive earthworks along its length, using a variety of different machinery and equipment. These earthworks may involve clearance of riparian habitat from the banks of the river. All such earthworks have the potential to expose sediment, which can then be mobilised by rain and wind and enter adjacent waterways, resulting in increased suspended sediments and sedimentation of downstream habitats.

5.9 Suspended sediment

Suspended sediment can alter water chemistry (including lowering dissolved oxygen concentrations), increase turbidity and reduce light penetration and visual clarity downstream. Elevated turbidity can have adverse ecological effects, particularly if it is sustained for a long period of time. Increased turbidity levels can result in reduced photosynthesis and, therefore, affect growth of aquatic plants and algae (the food source of many macroinvertebrates). Feeding activity and foraging success can be reduced by elevated turbidity (Cavanagh et al. 2014), by both limiting abilities to detect prey and reducing availability of food. It can limit the ability of visually foraging fish to feed (e.g. trout) and result in avoidance behaviour of indigenous species such as banded kokopu (Richardson et al. 2001). High loads of suspended sediments can also damage fish gills and make them more susceptible to disease, or even result in mortality (Rowe et al. 2009); macroinvertebrate communities can shift towards "sediment-tolerant" / burrowing taxa such as chironomids and aquatic worms, which is less suitable food for fish communities (Cavanagh et al. 2014).

5.10 Sedimentation of habitats

Most of New Zealand's aquatic species (that have been included in laboratory tests) are likely able to withstand and survive exposure of high suspended sediment loads for short durations. However, if sediment is discharged to the river, it is most likely to settle out on the riverbed downstream, which can clog the interstitial spaces between substrates, settle on macroinvertebrates (clogging gills) and smother food (algae and macroinvertebrate) resources. This deposited sediment is likely to stay in place until the next high flow event through the system. Because the waterways are spring fed, there is limited potential for flushing of these fine sediments out of the system.

5.11 Inputs of other contaminants

In addition to inputs of sediments, there is potential for concrete slurry and other construction contaminants to be discharged into the river, particularly where concrete structures are poured *in situ*.

Accidental discharge of fresh concrete to freshwater can have significant adverse effects on the freshwater environment. Fresh concrete and cement particles entering a waterbody can alter pH concentrations, resulting in highly alkaline water. This can be extremely toxic to some aquatic plants and animals. In addition to pH effects, discharge of concrete and cement particles could also embed substrates, smother habitat, and destroy spawning / feeding grounds. Concrete contamination of waterbodies can cause burning of gills, suffocation of fishes and other fauna.

Other contaminants, such as fuels and lubricants from machinery, can enter waterways when machinery is used in / nearby riverbeds (Scales 2014). These contaminants can also have toxic and lethal, or sublethal, impacts and may adversely affect aquatic communities and stream health. The impacts are likely to be infrequent and short in duration, with effects relatively localised and temporary in nature. However, longer duration works, or large spills, may have further reaching (in time and space) effects on ecological values.

- It will be essential to establish robust erosion and sediment control measures for the duration of the works. Environment Canterbury's Erosion and Sediment Control Guidelines (ECan 2007), or national best practice guidelines, should be consulted and followed. Measures to avoid sediment and other contaminants inputs into the river include staging works to minimise the total area of exposed soil; stabilising exposed soils as soon as possible (e.g. replanting, grassing, hessian matting[6]); using temporary support / falsework, sediment fences, silt booms and sheet piling to prevent sediment and fresh concrete from entering the water. Sediment tanks, or other suitable measures, should be used to ensure only clean water is discharged back to the river during dewatering activities.
- Refilling / refuelling of machinery should be kept outside of the riverbed and away from banks, to avoid discharge of fuels and other contaminants to the river.

5.12 River Diversions

The road construction is likely to include temporarily diverting waterways to install culverts at the proposed road crossing locations. The construction activities may also require bunding and over

[6] We recommend that fully biodegradable options, such as hessian matting, are used to avoid plastic remnants remaining in the environment.

pumping of surface flows, to allow construction activities to be done in dry conditions (i.e. outside of flowing water).

River diversions are often undertaken to temporarily move / shift the flow of a watercourse and allow activities to be carried out in dry conditions. There are numerous advantages of working “in the dry”, including reducing the ecological effects of sediment discharges and downstream sedimentation. However, diverting watercourses also causes local-scale disturbance and mortality of aquatic life, such as stranding and desiccation of fish and other life.

Of course, disturbance of habitat (resulting in injury / mortality of aquatic life and sediment discharge) also occurs during natural events, such as flood events. However, the difference is that flood events are preceded by environmental cues (rising water levels, increased velocities), which enables aquatic life to seek refuge (e.g. burrowing into substrates, moving to river margins, moving into smaller tributary waterways). Mechanical disturbance during in-river works (e.g. those associated with river diversions) are not preceded by these environmental cues. Therefore, these activities can result in higher mortality than disturbance from natural events and processes.

Sediment discharges may also increase as a result of vehicles travelling through flowing water and during temporary diversions (see Section 5.8 and 5.9 for potential effects on ecology).

Fish are likely to be stranded in the dry / drying channels or may be crushed by machinery as surface flows are diverted.

Mortality and disturbance of aquatic life (macroinvertebrates and fish) may be high during some activities, but also may have only minor local effects on populations in the wider context (e.g. catchment scale). This depends on the duration and frequency works are undertaken and the amount (area) of habitat affected, and how quickly recolonisation occurs after the disturbance ceases.

A key factor for speed of recovery appears to be the length of watercourse affected, how quickly a fresh comes through and the proximity of alternative suitable habitat, which acts as a nursery for recolonization by aquatic fauna.

Recolonisation of watercourses following mechanical disturbance (e.g. excavation) and channel drying (e.g. diversions) can be relatively quick (days to weeks), but this depends on an available source of colonists and habitat suitability. For example, macroinvertebrates may recolonise areas within 15-30 days after the disturbance has ceased, if conditions are right (Sagar 1983). Restoration of habitat conditions may require freshes or floods of sufficient size to move the substrate, which may take some time to eventuate, especially during the summer months.

If construction activities in waterways are of a short duration (1-4 days) and the scale of the work area (15 m of river bed) is small versus the wider context of the river and catchment, it is likely that effects on the ecology will also be short and unlikely to impact on fish at the population level. However, there remains the risk that fish are stranded in the dry / drying channels as surface flows of the waterways are temporarily diverted. This will result in the disturbance and mortality of aquatic fauna, including At-Risk fish species.

- Fish salvage, by a suitably qualified and experienced freshwater ecologist, prior to and during diversion activities will be required.

5.13 Dewatering

Dewatering may be required if any excavation works extend below groundwater level (such as the excavation required for installing the shallow footing foundations).

Earthworks should be clear of the water's edge, however, if earthworks do encroach on the interface between the banks and the water, works may affect in-stream habitat such as undercut banks, which provide habitat for freshwater fish (e.g. eels, giant bullies). If dewatering is required, the site should be isolated (e.g. by using sheet piling or another appropriate sediment control option) around the excavation area to contain works.

There is also the risk that fish could be unintentionally killed during sheet piling and during dewatering. Recent case studies of dewatering at the interface of rivers have found there can be localised and unexpected drawdown effects of the waterway and fish can be stranded and unintentionally killed.

- To ensure fish mortality is avoided or minimised, a suitably qualified and experienced freshwater ecologist should be engaged to advise on appropriate and best practice methods to be used during construction. Mitigation measures to be used may include fish screens of 2-3 mm around all pump intakes, or fish salvage prior to and / or during dewatering activities.

5.14 Works within the bed of the river

The waterways within the RERC designation support a variety of macroinvertebrates (which live on the riverbed) and fish, including several Threatened and At-Risk species. If design or construction methods require works within or adjacent to the waterway, there is risk of mortality and disturbance of fish and other in-stream fauna and this needs to be considered and advice provided by a suitably qualified and experienced freshwater ecologist.

As discussed in Section 5.5, sediment discharge in waterways can result in smothering of macroinvertebrate and algae communities, clog fish gills, disrupt fish feeding behaviours and impede fish migration. In addition, any in-stream works (either of banks or in the river) could result in fish mortality through crushing and mechanical removal or disturbance of fish and other in-stream fauna.

Any installation of river-edge (scour) protection along the banks may require excavation of the banks and possibly the bed of the river. If not well managed, this excavation work could result in discharge of sediments and other contaminants (e.g. soils from the banks discharged to the river) and resuspension of sediments from the bed. During works, minimising exposing soil, particularly where it may interface with aquatic habitats, should be prioritised to reduce the risk of erosion and sediment discharge, and damage to in-stream habitat.

Furthermore, any river-edge protection work, or work in close proximity to the waterway, may disturb and potentially remove stable bank habitat used by in-stream fauna. Giant bullies and eels (both longfin and shortfin eels) are often found inhabiting these bank areas.

- Robust erosion and sediment control measures, such as silt fencing, should be used to contain localised sediment discharges, and will be necessary to minimise impact to the waterways.
- Advice from a suitably qualified and experienced freshwater ecologist should be included in the design and build stages for the road.

5.15 Critical periods for fish migration and spawning

In-stream works, and in particular temporary diversions or piping, have the potential to interfere with migration and spawning of freshwater fishes. As discussed above, elevated turbidity levels have been found to result in avoidance behaviours in some fish species. Increased turbidity levels can also limit the ability of visually foraging fish to feed (e.g. trout), and high loads of suspended sediments can damage fish gills and make them more susceptible to disease, or even result in mortality (Rowe et al. 2009). Furthermore, construction noise and vibrations can affect both terrestrial and aquatic fauna behaviour, particularly if disturbance continues for an extended period of time (Popper & Hawkins 2019).

It is, therefore, essential to avoid in-stream activities wherever possible, and especially during critical periods for fish migration and spawning. The LWRP governs when activities can and cannot be conducted in rivers listed that are known to be important for inanga and trout spawning.

The spawning and migration calendars, developed for New Zealand fish species, further guide the timing to avoid activities within and near waterways during other species' critical periods (Table 4 and Table 5).

The waterways the RERC is proposed to cross are known as important brown trout spawning habitat, and possibly also for kanakana. Critical spawning periods of kēkēwai should also be considered.

- Timing works to avoid critical spawning periods for these three, and other, species is recommended.
- It is recommended that critical fish migration periods (e.g. migration of adults to spawning habitats) are also considered and works within the waterways, particularly Kōura Creek and North, Middle and South Brooks, are avoided or minimised during this time.

Table 4. Freshwater fish spawning calendar, taken from NIWA (2015).

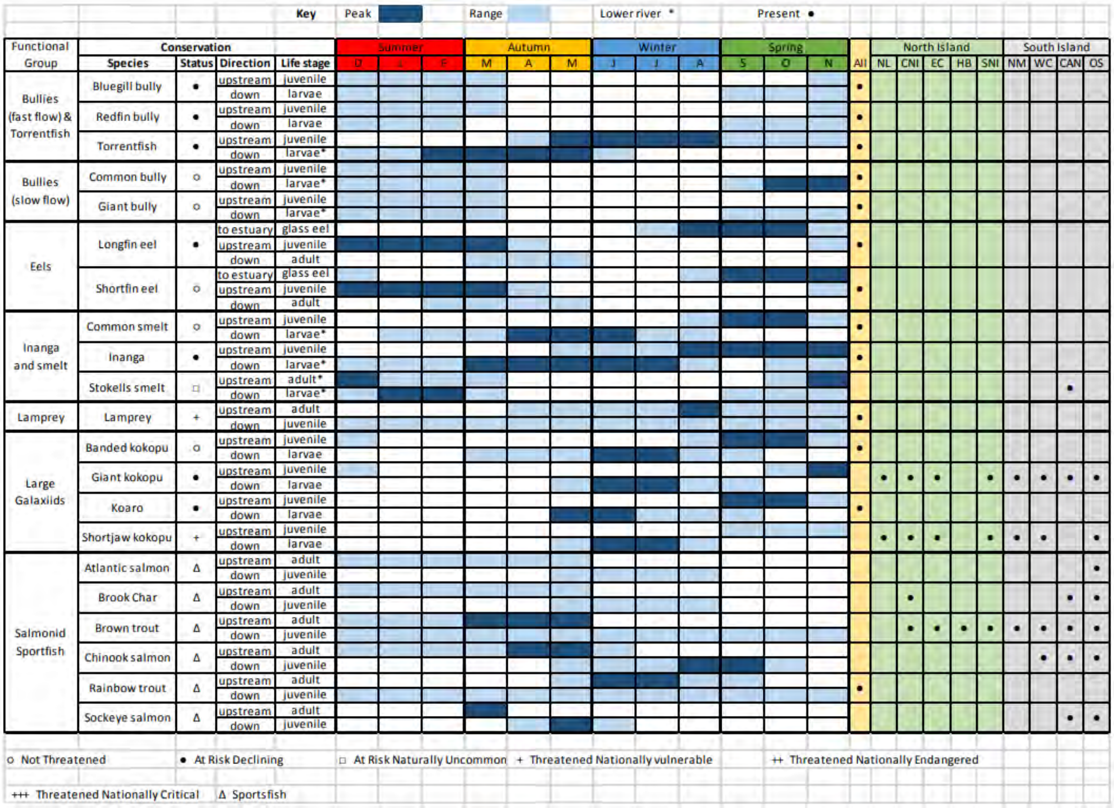
Key: Peak | Range | Larvae/Fry/Juveniles present | non migrant * | present •

Functional Group	Species	Conservation Status	Summer D	Summer J	Summer F	Autumn M	Autumn A	Autumn M	Winter J	Winter J	Winter A	Spring S	Spring O	Spring N	All	North Island NL	North Island CNI	North Island EC	North Island HB	North Island SNI	South Island NM	South Island WC	South Island CAN	South Island OS
Bullies (fast flow) and Torrentfish	Bluegill bully	•													•									
	Redfin bully	•													•									
	Torrentfish	•													•									
Bullies (slow flow)	Common bully	o													•									
	Crans bully	o														•	•	•	•	•				
	Giant bully	o													•									
	Tarndale bully*	□																			•			
	Upland bully*	o													•									
Eels	Longfin eel	•													•									
	Shortfin eel	o													•									
Inanga and smelt	Common smelt	o													•									
	Inanga	•													•									
	Stokells smelt	□																					•	
Lamprey	Lamprey	+													•									
Large Galaxiids	Banded kokopu	o													•									
	Giant kokopu	•														•	•	•		•	•	•	•	•
	Koaro	•													•									
	Shortjaw kokopu	+														•	•	•		•	•	•		•
Mudfish*	Black mudfish	•														•	•							
	Brown mudfish	•															•					•		
	Canterbury mudfish	•																					•	
	Northland mudfish	+														•								
Non-Migratory Galaxiids*	Alpine galaxias	□																					•	•
	Bignose galaxias	+																					•	
	Canterbury galaxias	•																			•		•	•
	Dusky galaxias	++																						•
	Dwarf galaxias	•															•		•	•	•	•	•	
	Eldons galaxias	++																						•
	Taieri flathead galaxias	+																						•
	Gollum galaxias	+																						•
	Upland longjaw galaxias	+																					•	
	Lowland longjaw galaxias	+++																					•	•
	Roundhead galaxias	++																						•
	Dwarf inanga	•														•								
Salmonid Sportfish	Atlantic salmon	Δ																						•
	Brook Char	Δ															•						•	•
	Brown trout	Δ															•	•	•	•	•	•	•	•
	Chinook salmon	Δ																				•	•	•
	Mackinaw*	Δ																					•	
	Rainbow trout	Δ													•									
	Sockeye salmon	Δ																					•	•

o Not Threatened • At Risk Declining □ At Risk Naturally Uncommon + Threatened Nationally vulnerable ++ Threatened Nationally Endangered

+++ Threatened Nationally Critical Δ Sportsfish

Table 5. Freshwater fish migration calendar, taken from NIWA (2015).



5.16 Introduction or Spread of Freshwater Pests

Freshwater pests include (but are not limited to) aquatic plants, pest fish and the invasive alga didymo. These introduced species can cause enormous damage to our freshwater environments. The use of machines / vehicles in waterways can spread aquatic pests, such as didymo.

It will be essential to ensure all machinery, vehicles and equipment to be used in the waterways is free from aquatic pests, and particularly didymo.

The magnitude of effect of introduction of didymo (particularly to the major waterways) is considered high to very high, and on a very high ecological value this equates to a very high level of effect.

- It is essential that machinery and plant to be used in and near waterways are free of aquatic pests.

6.0 Summary

As described in Section 1.1, the objective of this high-level report is to inform the NOR and highlight if there are any fatal flaws or major constraints (e.g. ecological areas or values that warrant avoidance).

In summary, the existing ecological environment has been modified from areas of indigenous forest and raupō and harakeke swamp. This was drained in the mid to late 1800s and is now dominated by agricultural land surrounded by residential area.

Terrestrial ecology

- The terrestrial vegetation present at the RERC site is almost entirely improved pasture with shelterbelts of exotic species.
- Approximately 50 species of birds are known to occur within the area, including three Threatened and six At Risk species. However, most of these species have only been observed in low numbers. Australian coot, black-billed gulls and red-billed gulls have been regularly recorded at the adjacent Northbrook wetlands and ponds. New Zealand pipit (At Risk, Declining) is likely to be present in areas of open country / farmland habitat that is not heavily grazed by stock within the RERC.
- Rank grass adjacent to, but not within, the RERC likely provides habitat for an At-Risk lizard species (Canterbury grass skink).
- In general, there are no terrestrial ecology values that preclude the general alignment of the proposed RERC or suggest that the road should not be built in the designation proposed. However, certain design and construction elements will need to be carefully considered.

Freshwater ecology

- There are, however, numerous waterways within the RERC, which the proposed road will cross or reclaim.
- Riparian vegetation along these waterways, and adjacent stormwater treatment basins and wetland habitats, is dominated by indigenous plantings.
- The waterways that are proposed to be crossed support macroinvertebrate and fish species of conservation interest, including at least one Threatened and numerous At-Risk species. Many of these species are migratory and are considered taonga and important mahinga kai species.
- The presence of juvenile kanakana / lamprey and kēkēwai justifies careful consideration of avoiding stream loss (e.g. through reclamation, loss of flow permanence, culvert installation and piping) (NPS-FM Policy 7).
- Using bridges rather than culverts to establish road crossings is recommended, as the installation of culverts would result in the loss of or substantial changes to habitat essential for critical life stages of Threatened and At-Risk species.
- Fish passage regulations of the NES-F also require that culverts provide for the same passage of fish upstream and downstream as would exist without the culvert, to meet permitted activity standards. Generally, new culverts will need to be much larger than engineering / hydraulic requirements and meet minimum standards listed in the NES-F, including specific design elements. Detailed monitoring is now required before and after culvert installation to ensure fish passage is maintained for the life of the structure. It’s likely that this will result in increased “whole of life” costs for culverts, again highlighting that a bridge may be the more practicable and cost-effective (and ecologically better) option.

7.0 Recommendations

- Avoiding stream loss (e.g. reclamation, loss of flow permanence, culvert installation, piping) is an explicit requirement of the National Policy Statement for Freshwater Management 2020 (Policy 7). Where this is not practicable, a clear approach, using the effects management hierarchy, to managing the adverse effects on the ecology will be necessary.
- Avoiding the installation of culverts is recommended as a first principle. Bridges will certainly have a better ecological outcome; and may be more cost-effective in the long term given the requirements to monitor and maintain fish passage for the life of a culvert.
- Where avoidance of culverts or infilling of streams is not possible, mitigation for stream loss may be required, which may include permanent diversions or enhancement of adjacent sections of waterway.
- Specialist ecological surveys, including of the waterways and in-stream fauna, lizard and bird species, will be required to complete a detailed Ecological Impact Assessment for regional consents. These surveys will need to confirm ecological values present, identify the magnitude and level of effects of the proposed activity on these ecological values and provide recommendations on the effects management hierarchy including measures to avoid, remedy and mitigate adverse effects.
- If construction is to occur during the New Zealand pipit breeding season (start of August until the end of March), a pre-construction survey should be undertaken by a suitably qualified and experienced ornithologist.
    - If no breeding pipit are found, it is recommended that the grass is kept grazed or mown to reduce the potential availability of pipit nesting habitat until the commencement of earthworks.
    - If breeding pipit are found, advice from a suitably qualified and experienced ornithologist on management options will be required, which may include establishing exclusion zones around nest/s or delaying construction works until the end of the breeding season.
- Additional impervious surfaces adjacent to waterways needs to be carefully considered in terms of water quality discharged and flow dynamics and we recommend that a suitably qualified and experienced freshwater ecologist provides advice during the detailed design stage and when developing the construction methodology, to avoid or minimise effects on the ecology.
- Explore opportunities for ecological enhancement as part of the design process. For example, opportunities to improve fish passage in Middle Brook; weed control in riparian margins; realigned waterways to avoid culverting and improving sinuosity.
- The design should include appropriate stormwater treatment systems to receive and treat the runoff from the RERC, to avoid adverse ecological effects on the receiving environment.
- Lighting adjacent to the waterways should be avoided; and where new lighting is needed, it should be designed to avoid light spill onto and over the waterways and riparian vegetation (i.e. using angled mounting and rear shielding). It is also recommended that the use of blue LEDs is avoided where possible.

- It will be essential to establish robust erosion and sediment control measures for the duration of the works. Environment Canterbury's Erosion and Sediment Control Guidelines (ECan 2007), or national best practice guidelines, should be consulted and followed. Measures to avoid sediment and other contaminants inputs into the river include staging works to minimise the total area of exposed soil; stabilising exposed soils as soon as possible (e.g. replanting, grassing, hessian matting[7]); using temporary support / falsework, sediment fences, silt booms and sheet piling to prevent sediment and fresh concrete from entering the water. Sediment tanks, or other suitable measures, should be used to ensure only clean water is discharged back to the river during dewatering activities.
- Refilling / refuelling of machinery should be kept outside of the riverbed and away from banks, to avoid discharge of fuels and other contaminants to the river.
- To ensure fish mortality is avoided or minimised, a suitably qualified and experienced freshwater ecologist should be engaged to advise on appropriate and best practice methods to be used during construction. Mitigation measures to be used may include fish screens of 2-3 mm around all pump intakes, or fish salvage prior to and / or during dewatering activities.
- Timing works to avoid critical spawning periods for these three, and other, species is recommended.
- It is recommended that critical fish migration periods (e.g. migration of adults to spawning habitats) are also considered and works within the waterways, particularly Kōura Creek and North, Middle and South Brooks, are avoided or minimised during this time.
- It is essential that machinery and plant to be used in and near waterways are free of aquatic pests.
- Replanting riparian areas with ecologically suitable, indigenous species that provide shading to the river and habitat for terrestrial fauna is likely to be required as mitigation.
- Advice from a suitably qualified and experienced freshwater ecologist should be included in the design and build stages for the road.

[7] We recommend that fully biodegradable options, such as hessian matting, are used to avoid plastic remnants remaining in the environment.

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