Kaimai Wind Farm: Supplementary Culvert Assessment Report

Report Number: 1708069-03

Prepared for: Ventus Energy (NZ) Limited

ECOLOGY NEW ZEALAND

CONTENTS

1.0 INTRODUCTION

This report[1], prepared by Ecology New Zealand Limited (ENZL) for Ventus Energy (NZ) Limited ('the client'), presents the results of supplementary culvert assessment investigations undertaken as part of the proposed Kaimai Wind Farm Project in response to the request for further information under section 92 of the Resource Management Act 1991. It is intended that this report be read in conjunction with the main Ecological Effects Assessment (Kessels EEA) report prepared for the Project by Kessels Ecology (Kessels)[2] and all additional reports prepared by ENZL. A full introduction and context to this Project is detailed within Section 1 of the Kessels report.

1.1 Overview of Ecological Investigations

The EEA prepared by Kessels provides a robust assessment of actual and potential ecological effects associated with the construction and operation of the proposed Kaimai Wind Farm. The ecological investigations undertaken by Kessels were conducted from 2009 to 2017 and provide robust multi-year ecological datasets that informed the ecological effects assessment. Key ecological matters covered in the Kessels report include vegetation communities, bats, avifauna, herpetofauna, invertebrates and freshwater ecology. The findings of those investigations are described in detail in Section 6 of the Kessels report with recommendations for management provided in Section 7.

This supplementary Culvert Assessment Report is aimed at broadening the conclusions summarised within these overarching ecological works and providing further details to address specific questions raised by Waikato Regional Council. Specifically, this report is aimed at providing an ecological assessment of proposed culvert upgrades.

1.2 Proposed Works

The creation of the Kaimai Wind Farm Project will result in the upgrade of the current roading infrastructure located within the site (488 Rawhiti Rd). This infrastructure upgrade will include the upgrade of eight culverts to avoid/minimise the potential adverse effects of overflow during heavy rainfall events and the extension of the culverts to facilitate the necessary increase in road width. The following table details the culverts assessed and a brief description of the work required at each culvert.

[1] This report is subject to the Report Limitations provided in Attachment A.

[2] Kessels Ecology, March 2018. Kaimai Wind Farm, Ecological Effects Assessment March 2018

Table 1 Details of the location of the culvert (distance from Rawhiti Rd), current culvert and planned works detailed within the engineering report.

Culvert Number	Culvert Locations (m)	Size / Type	Max Capacity (m^3/sec)	Q2 Discharge (m^3/sec)	Required Works	Required metre
C1	100	2x2 Box	10	12.8	Replace with 2x2x3 box	6
C2	250	450 Conc	0.3	0.8	Place with 900 Ø	5
C3	780	1050 Steel	2.2	10.8	Replace with 2x2 box	2
C4	1300	1800 & 1050	11	9.8	Leave (& fit upgrade road)	0
C5	1740	450 Conc	0.3	0.3	Extend & Construct Spillway	5
C6	2060	1650 Conc	4	5.1	Construct Concrete spillway	0
C7	2260	375 Conc	0.25	0.2	Extend Culvert (fit road)	2.5
C8	2420	900 Conc	2.0	3.0	Extend Culvert (raise road)	5

2.0 METHODOLOGIES

2.1 Desktop Survey

A desktop assessment was carried out to establish the various stream catchments that flow through and out of the site and determine which stream system would be directly affected by the culvert installation and any associated. It was found that while four identified streams flow out of the site Romaru Stream, Waitoki Stream, Kauoiti Stream and the headwaters of the Owhakatina Stream, only the Romaru Stream would be directly impacted by the proposed culvert upgrades and such was the focus of the assessment. The New Zealand Freshwater Fish database was accessed on the 15/08/18 to determine the fish species present within the impacted catchments and align them against Kessels AEE. Due to the low level of records the search was widened out of the impact stream reach to include two additional reaches, Owhakatina Stream, (within the nearby tributaries of the wider Waihou River catchment) and Waitoki Stream. In addition, a search under the wider Waihou River catchment was included to try extrapolate the additional potential fish data.

2.2 Stream Assessment

Two ecologists assessed the impacted reach between 30/08/18 to 31/08/18. All stream reaches to be impacted by the proposed culvert upgrades were photographed and classified as either permanent, intermittent or ephemeral. An assessment of 50m up and downstream of the proposed culvert works were undertaken. The assessments examined the four key ecological function groups.

- Hydraulic functions (processes associated with water storage, conveyance, flood flow retention and sediment transport);
- Biogeochemical functions (processes associated with the processing of minerals, particulates and water chemistry);

- Habitat provision functions (the type, amount and quality of habitat for flora and fauna); and
- Native biodiversity functions (the occurrence of diverse populations of indigenous native plants and animals).

2.3 Aquatic Fauna Assessment

To assess the fish community, four locations throughout the Romaru Stream were selected. These sites were selected to represent areas either with or without riparian cover and selected to represent fish communities throughout the reach to ascertain potential fish passage barriers (natural and/or artificial). Survey methodologies included the following:

- Electrofishing: 50m reaches were fished throughout the selected site downstream of the culvert. Electric fishing was carried out using an EFM300 backpack electric fishing machine. The electric fishing machine temporarily stuns the fish, allowing them to be captured. All fish captured were identified and their size estimated before they were returned to their habitats.[3].
- Trapping: Gee minnow traps were deployed to attempt to survey fish species not effectively targeted by electrofishing surveys. Eight Gee minnows were placed over the four selected sites with a trap placed a maximum of 50 m up and downstream of the culvert. Traps were placed fully submerged due to the temperature and high level of oxygenation within the stream channel. Gee minnows were baited with marmite to lure fish into the traps.
- Spotlighting: Four hours of nocturnal spotlighting was undertaken to detect any nocturnal species that the Gee minnow trap may not capture.

An Index of Biotic Integrity (IBI) was calculated for the site based on fish species present, altitude and distance from the coast.[3]

Macroinvertebrates were sampled from instream habitats to obtain semi-quantitative data in accordance with the Ministry for the Environment's current "Protocols for Sampling Macroinvertebrates in Wadeable Streams"[4]. Sampling was undertaken at the four sites selected using C1 protocols for hard bottom streams. The samples were preserved in isopropyl alcohol and sent to the laboratory and sorted using presence and absence to the lowest practical macroinvertebrate taxonomical level. From the results three biotic indices were calculated. The number of taxa, the number of *Ephemeroptera* (mayflies); *Plecoptera* (stoneflies) and *Trichoptera* (caddisflies) or EPT taxa and Macroinvertebrate Community Index (MCI).

EPT are three orders of insects that are generally sensitive to organic or nutrient enrichment but exclude *Oxyethira* and *Paroxyethira* as these taxa are not sensitive and can proliferate in degraded habitats. The MCI is based on the average sensitivity score for individual taxa recorded within a sample. MCI scores of >120 are indicative of excellent habitat quality, 100 - 119 are indicative of good habitat quality, 80 – 99 are indicative of fair habitat quality and < 80 are indicative of poor habitat quality[5].

[3] Application of the Index of Biotic Integrity Methodology to New Zealand Freshwater Fish Communities. Joy, M.K. & Death, R.G. (2004) Environmental Management, 34 , 415-428.

[4] Protocols for sampling macroinvertebrates in wadeable streams. Stark, J.D.. Boothroyd, I.K.G.. Harding, J.S.. Maxted, J.R.. Scarsbrook, M.R.. (2001)

[5] Stark JD, Maxted JR 2007. A user guide for the Macroinvertebrate Community Index. Prepared for the Ministry for the Environment. Cawthron Report No.1166. 58 p.

Legend

- Culvert locations
- Gee Minnow Trap
- Macroinverterbrate Sample
- Electrofishing Survey
- Stream Reach

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100 0 100 200 300 400 m

1:8,500 @ A3

Projection: WGS 84 / Pseudo Mercator
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Kaimai Wind Farm

Romaru Stream Culvert Assessment

Date: 27 september 2018 | Revision : 1

Plan prepared for Ventus Energy (NZ) Limited by Ecology New Zealand Limited
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3.0 FISH

A search of the NZFFD identified a diverse species richness throughout the wider Waihou River catchment with over 20 fish species present, of which 10 are noted as native. In contrast the impact reach only had the presence of four species all of which where noted as native. The adjacent Waitoki stream presented an additional species identified as torrentfish (*Cheimarrichthys fosteri*). These records confirm the records presented within Kessels Ecological Assessment Report.

Table 2 Species noted within the wider Waihou River catchment, with a breakdown of specific tributaries, taken from the NZFFD.

Common Name	Scientific Name	Native/ Exotic	Romaru Stream	Waitoki Stream	Owhakatina Stream
Shortfin	*Anguilla australis*	Native	Present	Present	
Longfin	*Anguilla dieffenbachii*	Native	Present	Present	
Torrentfish	*Cheimarrichthys fosteri*	Native		Present	
Dwarf Galaxias	*Galaxias Divergens*	Native			
Banded kokopu	*Galaxias fasciatus*	Native			
Inanga	*Galaxias maculatus*	Native			
Crans bully	*Gobiomorphus basalis*	Native			
Common bully	*Gobiomorphus cotidianus*	Native	Present	Present	
Freshwater mussel	*Hyridella menziesii*	Native			
Mullet	*Mugil cephalus*	Native			
Koura	*Paranephrops sp*	Native			
Freshwater shrimp	*Paratya curvirostris*	Native	Present		
Common smelt	*Retropinna retropinna*	Native	Present	Present	
Eel sp		Native			
Bully sp		Native			
Catfish	*Ameiurus nebulosus*	Exotic			
Goldfish	*Carassius auratus*	Exotic			
Gambusia	*Gambusia affinis*	Exotic			Present
Rainbow trout	*Oncorhynchus mykiss*	Exotic			
Perch	*Perca Fluviatilis*	Exotic			
Brown trout	*Salmo trutta*	Exotic			
Rudd	*Scardinius erythrophthalmus*	Exotic			
Tench	*Tinca tinca*	Exotic			
Salmonid sp		Exotic			

Given the limited fishery records with the NZFFD an extensive fish survey was undertaken to ascertain the population and distribution throughout the catchment. Three of the four species found within the NZFFD were confirmed to be present throughout the catchment with no common smelt being captured during the survey efforts.

Common bully (*Gobiomorphus cotidianus*) were present in high numbers throughout the lower to mid-reach of the impact stream (C1 – C5) yet were not recorded in any sites higher than C6 - this is likely due to the presence of a natural barrier, in the form of a waterfall between C5 and C6, preventing the poorer climbing species passing through (Plate 1). A significant number of common bullies caught appeared to be gravid.

Longfin eel (*Anguilla dieffenbachii*) were noted throughout the catchment in lower numbers compared to shortfin eel (*Anguilla australis*). Individuals caught throughout the reach presented several age classes with a large individual (1.5m) being caught at C7 within a large deep pool system. Shortfin eels were present through the entire catchment with individuals caught throughout the reach presenting a range of age classes with the large individuals recorded around 1 m in length. The presence of both longfin and shortfin eels above the waterfall indicate that this presents no barrier to anguilliformes.

The presence of freshwater shrimp (*Paratya curvirostris)* throughout the lower reaches (C1 – C4) of the impact site indicate that connectivity to the site from the coast environment is suitable for all but the poorest climbers. Likely indicating that there are other factors resulting in the low fish diversity within the impact reach. This will be discussed in more detail in Section 6.0.

Table 3 Species caught within the Romaru Stream catchment.

Culvert Number	**Methodology**	Shortfin Eel	Longfin Eel	Common Bully	Koura
C1	Spotlighting	1		4	
	Gee Minnow			16	
	Electrofishing	5	1	13	6
C4	Gee Minnow			8	
	Electrofishing	2		6	
C5	Gee Minnow				
	Electrofishing	8	1	11	
C6	Gee Minnow				
C7	Electrofishing	5	1		High Density

Plate 1 View of small waterfall identified as a potential barrier to poor climbers

4.0 MACROINVERTEBRATES

Samples were taken from four of the culverts throughout the impact reach (C2, C4, C5, C8). At each site, areas of approximately 1m^2 were sampled with ten sweeps to give a total of 4m^2 as per C1 protocol recommendations. Site descriptions are laid out within section 5.0.

Table 4 Macroinvertebrate species found within the Romaru Stream catchment.

Taxa			MCI Score	C2	C4	C5	C8
Ephemeroptera	Coloburiscidae	Coloburiscus	9	1			
	Leptophlebiidae	Austroclima	9	1	1		1
		Deleatidium	8	1			
		Zephlebia	7	1	1		1
	Nesameletidae	Nesameletus	9				1
Plecoptera	Gripopterygidae	Acroperla	5	1	1		1
Trichoptera	Conoesucidae	Pycnocentrodes	5	1	1		
	Hydrobiosidae	Hydrobiosis	5	1	1	1	1
		Psilochorema	8	1			
	Hydropsychidae	Aoteapsyche	4	1	1		1
	Hydroptilidae	Oxyethira	2	1	1	1	1
	Leptoceridae	Triplectides	5	1	1		
Coleoptera	Elmidae		6	1	1		1
Coleoptera		other	5	1	1		
Odonata: Zygoptera		Xanthocnemis	5	1	1		
Diptera	Chironomidae	Chironomus	1	1	1	1	
		Corynoneura	2	1			
		Maoridiamesa	3	1			
		Orthocladiinae (excl. Corynoneura)	2	1	1	1	1
		Polypedilum	3	1		1	
		Tanytarsini	3		1		
	Dolichopodidae		3				1
	Simuliidae	Austrosimulium	3	1	1	1	1
			1	1	1		
	Tipulidae	Aphrophila	5	1	1		1
		Hexatomini (excl. Paralimnophila)	1			1	
		Paralimnophila	1			1	
Megaloptera		Archichauliodes	7	1	1		1
Collembola			6		1		
Crustacea	Amphipoda	Paracalliope	5	1	1		1
Crustacea	Decapoda	Paratya	5	1			
Crustacea	Isopoda	Isopoda (excl. Paranthura)	5	1			
Acarina			5			1	
Arachnida		Dolomedes	5		1		
Mollusca	Gastropoda	Latia	3	1	1		
		Potamopyrgus	4	1	1	1	1
Oligochaeta			1	1	1		1
Nemertea	Coloburiscidae	Coloburiscus	3			1	1
# of taxa				**29**	**24**	**11**	**17**
Sum of scores				**133**	**104**	**39**	**80**
MCI				**91.72**	**86.67**	**70.91**	**94.12**
EPT Richness				**11**	**8**	**2**	**7**

The species diversity found within the main reaches is markedly stable across C2, C4 and C8 ranging between MCI score of 94.12 to 86.67. This is likely due to similar physical characteristics of the stream

through the main impact reach. These MCI scores result in the main channel being classed as fair habitat under national standards. C5 stands out as an outliner being poor with a lower MCI score of 70.91. This lower scored is not unexpected as the condition of the survey site was a degraded tributary of the main channel which follows through C5 before confluence with the main channel. This tributary exhibit standard degraded characteristic of a small farm stream that cattle have access to.

5.0 STREAM ASSESSMENT

The Romaru catchment (impact reach) is a permanent, hard bottomed, degraded stream flowing through intensively farmed agricultural land in the Paeroa area of the Waikato region. The Romaru Stream commences within the site and flows in a south-westerly direction for approximately 3.3km before leaving the site. Given the multiple culvert works being undertaken the following assessment for each reach around the culvert are set out below.

5.1 Culvert 1 (C1)

A 100m reach of the Romaru stream was assessed consisting of 50m upstream and 50m downstream of C1, which is located 100m along the current road. The stream within this section is subject to moderate-high shading in part due to the surrounding vegetation (primarily exotic pine) and the significant bank incision (greater than a metre). Physical instream habitat is generated by pool-riffle-run sequences and the presence of several bank undercuts. Due to the higher energetic nature of the stream system there was a diverse benthic substrate ranging from gravel up to the occasional boulder. In a few areas of shelter shallow flow sand banks have been deposited. Given the fast response nature of the catchment, localised sediment run-off appears to occur just after rain events, as noted on 30/08, however this is quickly flushed through as noted on the 31/08 Channel width averaged around 4m with the deepest pool at 0.5m. The culvert is located at the start of the site and is noted as an arched culvert over the current stream system. This allows for no disturbance of the stream bed and as such has no significant impact on flow. There was no presence of macrophytes within the main channel however some periphyton was noted on several cobbles and stones that were lifted from the stream reach. The stream reach presented a well oxygenated system with no signs of anoxic conditions. There were no signs of direct stock impact to the stream reach. In general, this section of stream was deemed to have moderate to high ecological values based on the observable physical abiotic and biotic factors.

Plate 2 View of downstream of C1

Plate 3 View of downstream looking up to C1

Plate 4 View of upstream looking down to C1

Plate 5 View of upstream of C1

5.2 Culvert 2 (C2)

A 50m reach of the main channel of the Romaru stream downstream of the culvert and 50m upstream of the culvert within a tributary were assessed around C2 which is located 250m along the current road. The upstream environment is characterised as a potential wetland system, with *Juncus* spp noted throughout the area. Given stock access to this area and the wider lowland area it is highly possible the wetland has been formed due to long term cattle poaching of the stream. Further upstream the tributary can be seen returning to a defined stream channel, likely due to the gradient increase. In general, the tributary feeding into the main channel is significantly degraded with no shading through the entire reach and cattle access throughout. The main channel in contrast to the tributary exhibited similar characteristics to those outlined in C1, with the stream reach presenting a defined channel comprised of a mixture of sediment particles ranging from coarse sand (especially at the confluence) to boulders. Flow within this reach is noted to be slightly higher due to the marginal increase in gradient. This also is likely linked to the narrower channel profile ranging between 1.5 – 2.5 m wide. Shading along this section of stream is moderate – low with occasional totara (*Podocarpus totara*) and manuka (*Leptospermum scoparium*) providing some shading on the true left bank (TLB). Fish passage through the connective culvert is not impeded because of the absence of any perching. In general, the main channel presents moderate ecological values with the tributary presenting a poor system based on the observable physical abiotic and biotic factors.

Plate 6 View of upstream wetland stream at C2

Plate 7 View of downstream of C2 looking at the confluence

Plate 8 View of C2 discharging into the tributary

5.3 Culvert 3 (C3)

A 100m reach of the Romaru stream (50m upstream and 50m downstream) was assessed around C3, located 780m along the current road. The stream within this section is subject to moderate shading in part due to the surrounding vegetation - primarily exotic pine on the TLB in the downstream section and exotic/ native mix on the true right bank (TRB) - with significant bank incision in the upstream section. Physical instream habitat is generated by pool-riffle-run sequences, with a significant pool present at the culvert discharge, and the presence of several bank undercuts. Due to the higher energetic nature of the stream system there was a diverse benthic substrate ranging from gravel up to the occasional boulder. In a few areas of shelter shallow flow sand banks have been deposited which has allowed for the establishment of *Ranunculus* spp and water cress (*Nasturtium officinale*). Channel width ranged around 2m wide, with the scoured pool at the culvert discharge being around 4.5m wide, observable depth did not exceed 1m. The culvert was as an old cast iron culvert that has significant signs of corrosion along it. The gradient of the culvert likely limits any fish passage to those species with moderate-good climbing ability, in low flow periods. There is evidence that in periods of high rainfall the culvert is over-topped. The stream reach presented a well oxygenated system with no signs of anoxic conditions. There were no signs of direct stock impact to the stream reach. In general, this section of stream was deemed to have moderate ecological values based on the observable physical abiotic and biotic factors.

Plate 9 View of downstream of C3 including large pool

Plate 10 View of upstream looking down on C3

Plate 11 View of upstream of C3

5.4 Culvert 4 (C4)

A 100m reach of the Romaru stream (50m upstream and 50m downstream) was assessed around C4, located 1300m along the current road. The stream within this section is subject to low shading in part due to the lack of surrounding vegetation with only a few isolated totara and manuka. Physical instream habitat is generated by pool-riffle-run sequences, with a significant pool present at the culvert discharge. There are a few minor areas of bank undercutting however no significant undercuts were noted. Due to the higher energetic nature of the stream system there was a diverse benthic substrate ranging from gravel up to the occasional boulder. In a few areas of shelter shallow flow sand banks have been deposited. The macrophyte growth throughout the reach is patchy and is generally located within areas of slow flow. Channel width ranged around 2m, with the scoured pool at the culvert discharge being around 4.5m wide. Observable depth exceeded 1.4m. The main culvert within this reach presented a minor perch setup, however given the presence of various life stages of common bully located upstream it is likely this perch barrier is overcome in high flow rates. The stream reach presented a well oxygenated system with no signs of anoxic conditions. Stock have direct access to the stream reach with a dead sheep noted in the end of the downstream reach. In general, this section of stream was deemed to have moderate – low ecological values based on the observable physical abiotic and biotic factors.

Plate 12 View of downstream of C4

Plate 13 View of downstream looking up to C4

Plate 14 View of small perch on C4

Plate 15 View of upstream of C4

5.5 Culvert 5 (C5)

A 50m reach of the main channel of the Romaru stream downstream of the culvert and 50m upstream of the culvert within a tributary were assessed around C5, located 1740m along the current road. The upstream environment presents a small upland permanent stream reach that has been highly modified with the presence of several PVC culvert pipes throughout the 50m upstream reach. The stream is directly accessed by stock with signs of significant pugging. Connectivity to the upstream environment is significantly limited with the presence of the perching (exceeding 0.5m) on both PVC pipe. Shading through this tributary is very poor where the stream is not piped. Connectivity to the main channel is through C5, however, during the assessment it was noted that the stream had appeared to scour around the culvert with normal flow now flowing around the culvert instead. The downstream main channel presents a similar system to the previous C4 assessment with poor shading, diverse instream habitat and diverse benthic substrate. The stream reach presented a well oxygenated system with no signs of anoxic conditions. Stock have direct access to the stream. In general, the main channel exhibits moderate – low ecological values and the tributary reach has low ecological values based on the observable physical abiotic and biotic factors.

Plate 16 View of upstream of C5

Plate 17 View of upstream looking at C5

Plate 18 View of downstream looking at discharge of C5

Plate 19 View of downstream of C5 including Gee Minnow location

5.6 Culvert 6 (C6)

A 50m reach of the main channel of the Romaru stream downstream of the culvert and 50m upstream of the culvert within a tributary were assessed around C6 located 2060m along the current road. In contrast to C2 and C5 the tributary that confluences just after C6 is a significant major tributary and is only approximately 300m shorter than the main channel. Given the similar status of the main channel and tributary they will be described as the same. The stream within this section is subject to moderate-high shading in part due to the surrounding vegetation, primarily exotic pine in the downstream reach and mixed native/exotic vegetation in the upper stream environment. Shading was also provided by the significant bank incision (greater than one metre). Physical instream habitat was generated by pool-riffle-run sequences with another deep scoured pool system downstream of the culvert discharge. The reach had several bank undercuts providing additional habitat. Due to the higher energetic nature of the stream system there was a diverse benthic substrate ranging from gravel up to the occasional boulder - any coarse sand deposition was either very infrequent or absent from this section of stream. Channel width ranged around 3m with the main pools deeper than 1.5m. There were no macrophytes within the reach however some periphyton was noted on several cobbles and stones that were lifted from the stream reach. The stream reach presented a well oxygenated system with no signs of anoxic conditions. The current culvert is a perched concrete structure. This culvert likely acts as a significant barrier to all but the best climbers, however, given the absence of common bully at this point in the catchment this is unlikely to affect the remaining native fish populations. In general, the reach exhibits moderate ecological values based on the observable physical abiotic and biotic factors.

Plate 20 View of downstream pool of C6

Plate 21 View of upstream looking at C6

Plate 22 View of upstream tributary

5.7 Culvert 7 (C7) & Culvert C8

Given the close proximity and lack of distinctive variation between C7 and C8 the streams will be described together. For C7 a 50m reach of the main channel of the Romaru stream downstream of the culvert and 50m upstream of the culvert within a tributary were assessed. For C8 A 100m reach of the Romaru stream (50m upstream and 50m downstream) were assessed around the culvert. Given the distance up the catchment and the change in gradient, the channel become more constrained averaging around 1 – 2m in width at any point. The pool-riffle-run sequences are also interspersed with cascades throughout both reaches. The presence of a narrow channel and cascades results in deeper pools averaging 0.7m. Due to the higher energetic nature of the stream system there was a diverse benthic substrate ranging from small cobbles up to boulder. Small areas of gravel beds were noted however these features became more infrequent the further upstream the assessment progressed. There were no coarse sand beds present. The reach contained no macrophyte growth however there was a reasonable level of vegetation overhanging from the rank grass growth and sedge present within the reaches. Both reaches were exposed to very low shading with relatively no riparian vegetation aside from the grass and sedge growth. There was stock access throughout both reaches. The stream reaches presented a well oxygenated system with no signs of anoxic conditions. Both culverts were marginally perched and would likely be exceeded in high flow events. Given only eels were recorded within these higher reaches it is unlikely these perches would affect fish passage. In general, the reach exhibits moderate – low ecological values based on the observable physical abiotic and biotic factors.

Plate 23 View of upstream of C7 looking towards C7

Plate 24 View of downstream of C7

Plate 25 View of downstream looking at discharge of C8

Plate 26 View of downstream of C8 viewing the small perch

6.0 ASSESSMENT OF EFFECTS

As part of the proposed Kaimai Wind Farm Project, the Project Civil Engineer (M. J. Preston of Civil Engineering Services and Tektus) has recommended the upgrade of eight culverts on site to avoid/minimise the potential adverse effects of overflow during heavy rainfall events and to safely accommodate larger vehicles as part of the windfarm construction. As detailed within Table 1 6 culverts are currently proposed to be extended. With the various extension length consider it is expected that a total of 25.5m of stream will be lost across the project.

The site is drained by several identified catchments (Waikato Regional Council GIS, River Layer and Topomaps) Romaru Stream, Waitoki Stream, Kauoiti Stream and the headwaters of the Owhakatina Stream. All of these streams form part of the wider Waihou River catchment. However, the only stream to be impacted by the proposed culvert upgrades is the Romaru Stream and is the focus of this assessment.

Four key areas for potential impact are considered for the proposed culvert upgrades:

- Fish passage maintenance or improvement;
- Sediment and erosion control;
- Consideration of potential injury or death of resident fish; and
- Overall stream ecological values

6.1 Fish Passage

The design and placement of a culvert can significantly affect or even eliminate the possibility of fish passage upstream. Species with good climbing ability (shortfin and longfin eels) were found all the way up to C8 within the Romaru Stream. Common bullies were found at every site from C1 to C5 but not above this. Given that this species is considered to have limited climbing ability it would seem that the culverts up to this point are not causing a significant barrier to fish passage. Therefore, it is more likely that a natural barrier (such as the waterfall described in Section 3.0) is preventing those species with poorer climbing ability from accessing the higher reaches. These species may still make their way past partial barriers (the current culverts) in many cases, however the weaker climbing species will be essentially locked out of potential habitat (and in some instances important breeding sites) if a barrier is present thus reducing the carrying capacity of the catchment.

The presence of common bullies and freshwater shrimps shows that barriers are not the limiting factor preventing other species from populating the Romaru Stream from the wider Waihou catchment. It is considered more likely to be due to factors such as poor thermoregulation (due to lack of shading) or poor water quality (due to the stream's location within an agricultural setting). The MCI scores for this stream ranged from poor to fair indicating generally poor water quality and not all fish species would be able to tolerate these conditions.

To remediate the potential effects of the culvert upgrades, a design that is sensitive to fish passage should be used. For replacement of culverts, it is recommended that culverts be placed well below the level of the current stream bed and material placed in the culvert to replicate the natural stream bed present on site and allow for natural substrate movement. Culverts should be placed at the same gradient and alignment as the stream and the diameter should be equal to or greater than the average stream width (stream width should be determined as the defined stream channel that majority of the flows are contained within) – narrower culverts cause a sudden increase in flow rate which can reduce the ability of fish to move through the culvert. Placement should be such that "perching" of the culvert is avoided – if a culvert is above the water level on the downstream side, then there is a gap between two effective stream beds which prevents fish from migrating past this point. If this situation is unavoidable (for example with those culverts that will remain in place but be extended) the installation of a fish ladder or similar

should be undertaken to maintain connectivity. The previous recommendations for culvert installation have been drawn from the NIWA Fish Passage Guidelines[6]

If these suggestions are implemented then there should be a net ecological benefit in terms of fish passage over the site.

6.2 Sediment & Erosion Control

Given that some degree of earthworks/excavations are likely to be required to replace the current culverts, there is a risk of significant sediment entering the stream system. Increases in sediment can adversely affect both aquatic fauna and flora by reducing light penetration through the water column, smothering plants and invertebrates, altering flow regime, altering the temperature in the stream and in extreme cases, clogging of the gills of fish. Appropriate sediment and erosion control practices should be put in place before and during earthworks to prevent erosion of the stream banks and of disturbing soil in the riparian zone to prevent any sediment from entering the stream during the culvert upgrades.

6.3 Fish Salvage

Where culvert upgrades are likely to lead to the disturbance of the in-stream bed, a fish salvage should be implemented to avoid impacts on native fish such as injuries or mortalities. Fish salvage would involve the temporary damming and diversion of the stream upstream and downstream of the culvert, followed by a combination of electric-fishing and/or netting/trapping, in addition to the supervision of the dewatering process. Any fish salvaged would be relocated downstream so they are not harmed during the culvert upgrade works. A detailed site-specific fish management plan should be prepared before the work is undertaken to ensure that the correct methodologies are selected.

6.4 Stream Ecological Values

The replacement and/or extension of eight of the existing culverts on site is unlikely to have any long-term impacts on the overall ecological value of the eight reaches assessed. However, based on engineer details it is assumed that loss of 25.5m of permanent stream will be required. This does not assume for any installation of riprap or scour protection. However, this installation of scour protection should not be required if the culverts are placed well below the level of the current stream bed and material placed in the culvert to replicate the natural stream bed.

The applicant proposes to undertake extensive fencing and riparian planting of the headwaters of the Waitoki Stream which are within the site by way of mitigation for the stream loss. Given that even with a "standard" compensation ratio of around 3:1, the required restoration length would only be around 76.5m, assuming highest level of impact. It is considered that this expansive restoration of the headwaters far outweighs any negative impacts of extending the sites culverts. The current envisaged riparian planting and fencing will see over one km of headwater stream reaches of Waitoki Stream restored and protected. Fencing and planting of the upper reaches of the Waitoki Stream will improve multiple parameters including shading, habitat provision, temperature moderation, connectivity to the riparian zone, filtration of sediment and contaminants and regulation of flood flows. This will have flow-on positive effects for the ecological values of the remainder of the main channel downstream and thereby improve the habitat quality for aquatic fauna and flora. It is recommended a full detailed riparian restoration plan is produced that details the length of stream reaches, planting plan and fencing plan to ensure optimum ecological benefits are achieved.

[6] New Zealand Fish Passage Guidelines For Structures up to 4 meters, 2018, Franklin, Gee, Baker, Bowie, National Institute of Water & Atmospheric Research, 2018019HN.

7.0 RECOMMENDATIONS AND MITIGATION

As the proposed culverts upgrades will result in the loss of stream bed within the Romaru Stream catchment and the potential injury/death of native fauna, the following ecological management actions are proposed to ensure that a net ecological benefit for the site's aquatic ecological values are achieved:

- An Ecological Management Plan (EMP) should be prepared and implemented on-site. This EMP should initially be reviewed and approved by Waikato Regional Council. The EMP should address the following:
    - A Fish Management Plan (FMP) should be produced, by an appropriately qualified and experienced ecologist. The FMP should detail fish salvage and exclusion methodology. The FMP should be implemented before any work on the culverts is undertaken.
    - A Mitigation Planting Plan shall be prepared and implemented to mitigate the loss of aquatic ecological values. The plan should outline a detailed plan of the areas identified for restoration. The plan should include weed and pest control to ensure successful establishment of the riparian planting. Mitigation planting shall be undertaken immediately after the successful implementation of weed control across the restoration reaches. Plants shall be eco-sourced where possible and planted by experienced operators.

- Fish passage design should be incorporated into all culvert upgrade designs. Fish passage designs should follow NIWA fish passage guidelines and should be reviewed by a suitable qualified ecologist to ensure they are suitable for all current fish species and potential future species.

- Appropriate erosion, sediment and containment controls should be installed prior to the commencement of the culvert upgrades to reduce the risk of any sediment and/or containments entering the wider Waihou River catchment.

8.0 CONCLUSIONS

Supplementary freshwater ecological investigations were carried out by ENZL as an extension to the investigations described in detail within the Kessels EEA. Investigations included visual watercourse assessments, macroinvertebrate sampling and assessment of fish species present both on site and within the wider catchment. Notable findings were the degree of connectivity between the Romaru Stream and the wider Waihou River catchment despite the presence of multiple historic culverts on site and the presence of common bullies a significant way up the Romaru Stream despite the presence of perched culverts. It is considered that through culvert design that is sensitive to fish passage and retrofitting of existing culverts with fish passage devices, in combination with the extensive restoration proposed in the headwaters, the overall ecological impact will be resoundingly positive.

ATTACHMENT A

Report Limitations

This Report/Document has been provided by Ecology New Zealand Limited (ENZL) subject to the following limitations:

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iii) Conditions may exist which were undetectable given the limited nature of the enquiry ENZL was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Report/Document. Accordingly, if information in addition to that contained in this report is sought, additional studies and actions may be required.

iv) The passage of time affects the information and assessment provided in this Report/Document. ENZL's opinions are based upon information that existed at the time of the production of the Report/Document. The Services provided allowed ENZL to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

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ATTACHMENT B

Culvert Designs

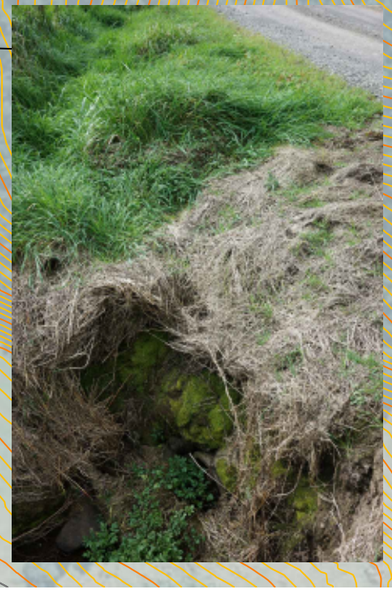
CULVERT 780
EXISTING 7m WIDE 1050Ø STEEL
REPLACE WITH 2mx2m 9m LONG BOX

PROPOSED ROAD 1

CLEANFILL ACTIVITY ALONG PAPER ROAD CORRIDOR INSIDE MPDC DISTRICT PROJECTED TO BE LESS THAN 1000m^3 SUBJECT TO TOPOGRAPHICAL SURVEY AND DETAILED DESIGN IN FUTURE

CULVERT 250
EXISTING 5m WIDE 450Ø CONCRETE
REPLACE WITH 10m WIDE 900Ø

CULVERT 100
EXISTING 2mx2m 3m LONG BRIDGE
REPLACE WITH 2mx2m 9m LONG BOX



Notes:

1. FOR INFORMATION PURPOSES ONLY.

2. BOUNDARIES, CONTOURS AND OTHER BASE INFORMATION SHOWN IS INDICATIVE ONLY AND PRIMARILY INFORMED BY AERIAL LIDAR SURVEY BY SYNERGY POSITIONING SYSTEMS LTD IN APRIL 2016.

3. COORDINATES SHOWN ARE IN TERMS OF MT EDEN 2000 CIRCUIT AND LEVELS ARE RELATIVE TO THE AUCKLAND 1946 VERTICAL DATUM.

4. THE PROPOSED ROAD ALIGNMENT, TURBINE PLATFORMS, AND OVERALL EARTHWORKS ARE BASED ON AN INDICATIVE ROAD ALIGNMENT AND REMAIN SUBJECT TO DETAILED DESIGN.

LEGEND

- EXISTING PROPERTY BOUNDARY
- JACKSON BOUNDARY
- ROTOKOHU FARMS BOUNDARY
- DENIZE BROTHERS BOUNDARY
- HDC/MPDC TERRITORIAL BOUNDARY
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- EXTENT OF EARTHWORK
- PROPOSED TURBINE LOCATION
- EXISTING TRANSPOWER NATIONAL GRID LINES
- PROPOSED STAGE 1 ROAD CENTER AND EDGE OF CARRIAGEWAY
- EXISTING FENCE
- POTENTIAL QUARRY SITE
- POTENTIAL CLEANFILL SITE
- EXISTING CULVERT
- PROPOSED UPGRADED CULVERT

A	ADDITIONAL PLAN FOR S92 RESPONSE	LT	04.10.18

REV:	DESCRIPTION:	BY:	DATE:

STATUS: RESOURCE CONSENT

TEKTUS Consultants Ltd
PO Box 80212 Green Bay
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m. 021 1434 874
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AUCKLAND 0632

SURVEYOR: SYNERGY POSITIONING SYSTEMS LTD
3/52 ARRENWAY DRIVE, ALBANY,
AUCKLAND 0632

SITE: KAIMAI WIND FARM
ROTOKOHU ROAD, PAEROA

TITLE: PRELIMINARY CIVIL ENGINEERING DRAWINGS

SUBTITLE: GENERAL ARRANGEMENT PLAN
DETAIL PLAN SHEET 8

SCALE AT A3:	DATE:	DRAWN:	CHECKED:
1:2500	04.10.18	LT	JT

PROJECT NO:	DRAWING NO:	REVISION:
T15022	200-8	A

CULVERT 1740
EXISTING 7.5m WIDE 450Ø CONCRETE
EXTEND TO 12.5m WIDE AND CONSTRUCT
CONCRETE SPILLWAY

CULVERT 2060
EXISTING 7.5m WIDE 1650Ø CONCRETE
RETAIN AND CONSTRUCT CONCRETE
SPILLWAY

CULVERT 2260
EXISTING 10m WIDE 375Ø CONCRETE
EXTEND TO 12.5m WIDE

CULVERT 2420
EXISTING 5m WIDE 900Ø CONCRETE
EXTEND TO 10m WIDE

PROPOSED ROAD 1

INDICATIVE ROAD ALIGNMENT WITH
6m PAVEMENT WIDTH

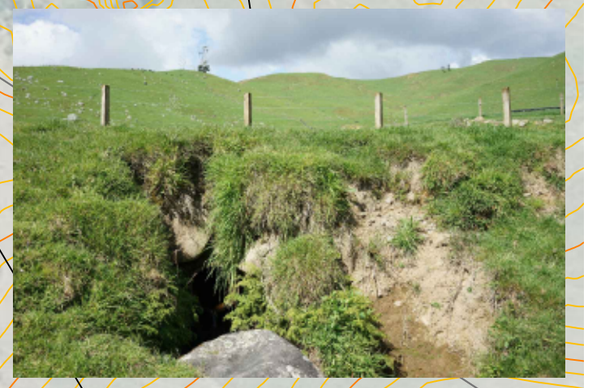
CULVERT 1300
EXISTING 7.5m WIDE 1800Ø
AND 1050Ø CONCRETE
TO BE RETAINED

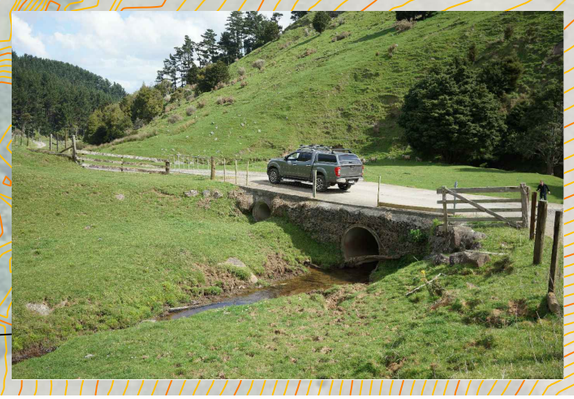
CH 1400

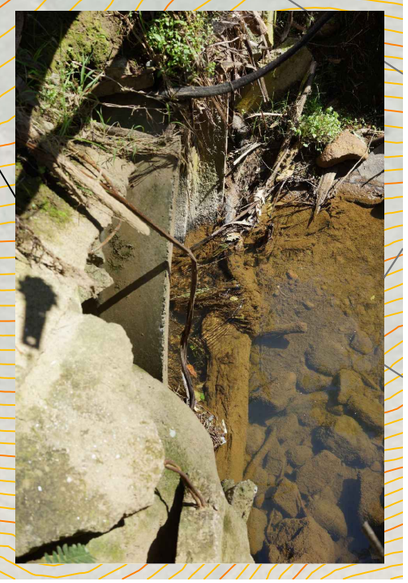
CH 1420

CH 2220

CH 2420







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DETAIL PLAN SHEET 9

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PROJECT NO:	DRAWING NO:		REVISION:
T15022	200-9		A