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APPENDIX F

Preliminary Freshwater Ecology Assessment

DRAFT

PRELIMINARY ECOLOGICAL SURVEYS OF THE PROPOSED MIMIHAU WIND FARM SITE, SOUTHLAND

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PRELIMINARY ECOLOGICAL SURVEYS OF THE PROPOSED MIMIHAU WIND FARM SITE, SOUTHLAND

Contract Report No. 6656

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Project Team:
Rose Stuart – report author - fresh water ecology
Stella McQueen – peer review

Prepared for:
Contact Energy Ltd
PO Box 10472
Wellington 6143

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Reviewed and approved for release by:

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Kelvin Lloyd
Principal Ecologist
Wildland Consultants Ltd

1. INTRODUCTION

Roaring 40s Wind Power Ltd, on behalf of Contact Energy Ltd (the client), are assessing a wind farm project which will be known as the Mimihau Wind Farm project. The project site spans both Jedburgh Station and Matatriki Forest on the Slopedown Range in Southland,

A recent desktop assessment by Wildland Consultants Ltd[1] has identified ecological features and values potentially present at the site, and constraints that these would pose on wind farm development. The desktop assessment identified several components that required field surveys to develop a more thorough understanding of the ecological values present, and their distributions within the site and potential influences on the development and layout of the windfarm.

This report details the findings of the field surveys recommended by the previous report, covering vegetation, fresh water, lizards, avifauna, and terrestrial invertebrates.

2. METHODS

2.1 Fresh water

A two-day site visit was conducted over 13-14 December 2022 to assess the values present within the waterways of the potential wind farm site. A habitat assessment was conducted along with sampling fish and invertebrate populations.

2.1.1 Sampling sites

Seven sites were selected for preliminary freshwater surveys (Figure 1). These were selected based on previous desktop assessment (Wildland Consultants 2022), and aimed to cover as many potentially impacted catchments as possible. Six sites were selected from tributaries of the Mimihau Stream, and one in the Kaiwera Stream near where the transmission line is proposed. All sites were placed downstream of proposed wind turbine locations

1 Wildland Consultants 2022: Assessment of ecological values at the proposed Mimihau wind farm site, Southland. *Wildland Consultants Ltd Contract Report No. 6531*. Prepared for Contact Energy Ltd.

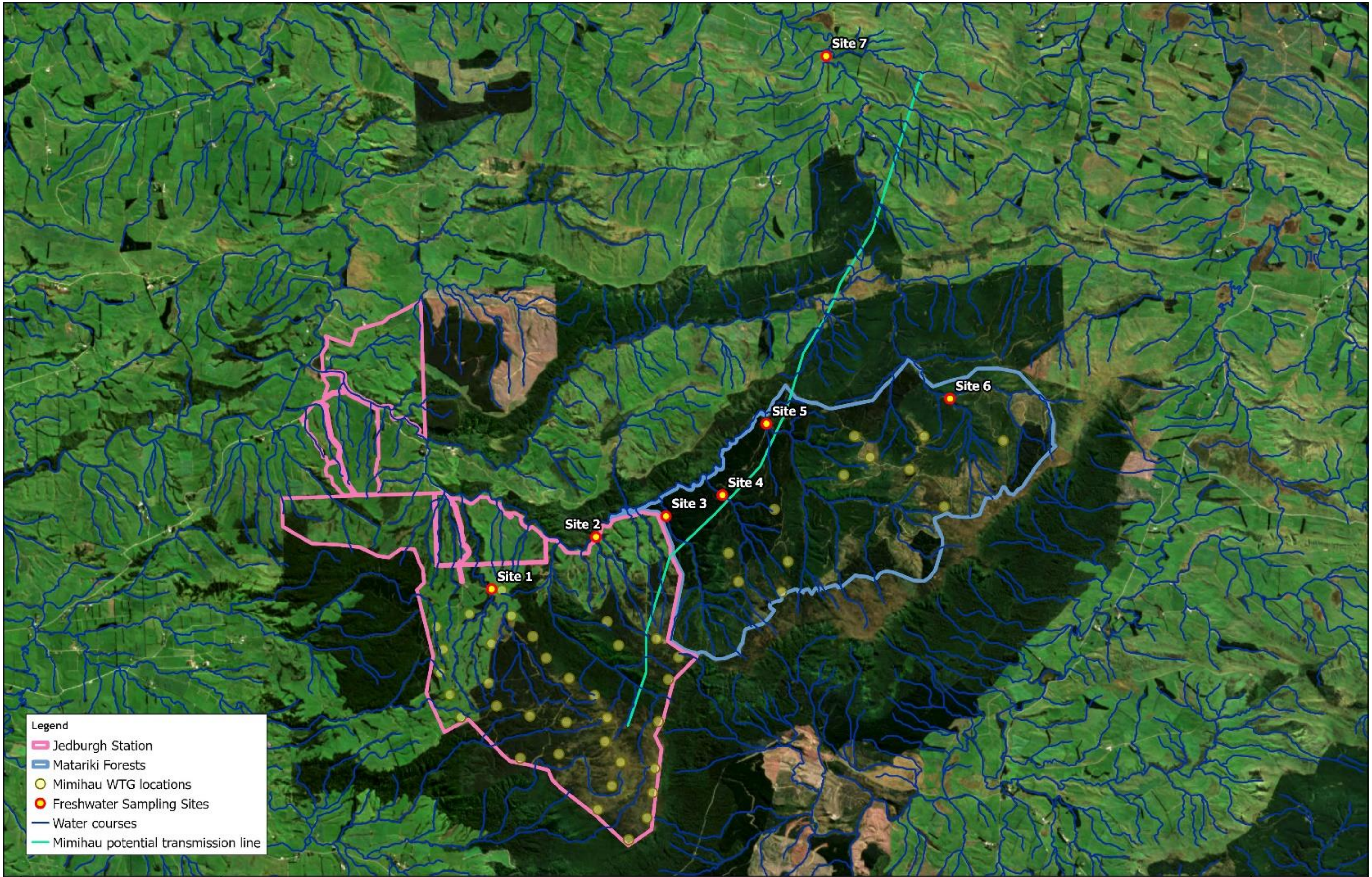

Figure 1: Location of freshwater sampling sites within the proposed Mimihau Wind Farm area

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2.1.2 Stream habitat assessment

Rapid habitat assessments (Clapcott 2015) were conducted for each of the seven sites. For this assessment, ten habitat parameters at each site are scored individually, then scores are added to give an overall habitat quality score. The parameters assessed are:

- Deposited sediment
- Invertebrate habitat diversity
- Invertebrate habitat abundance
- Fish cover diversity
- Fish cover abundance
- Hydraulic heterogeneity
- Bank erosion
- Bank vegetation
- Riparian width
- Riparian shade

Photographs were taken at all sites, with particular focus on recording any notable hydrological features.

Where there was concern regarding fish passage through an instream structure, a fish passage assessment was conducted using the NIWA Fish Passage Assessment Tool.

2.1.3 Fish

To survey freshwater fish, an unbaited fyke net and gee-minnow trap were set overnight at each site. Fyke nets were positioned to best intercept fish moving within the waterways, typically with the wing perpendicular to the flow as allowed by stream width (for example Plate A2.2). Gee-minnow traps were situated alongside a bank where smaller fish were likely to seek refuge, for example under overhanging vegetation (Plate A2.9). All fish caught were identified to species and a representative sample were measured before being released close to where they were captured.

2.1.4 Macroinvertebrates

Aquatic macroinvertebrates were sampled at each site following protocol 'C1 hard-bottomed semi-quantitative' (Stark *et al*. 2001) utilising a kick net (square shape, 0.5 mm mesh size). Samples were preserved in methylated spirits, and processed using protocol 'P2 fixed count with scan for rare taxa' (Stark *et al*. 2001). The macroinvertebrate community was assessed using the following metrics:

- Taxonomic richness: the number of taxa present (a taxonomic group of any rank, such as a species, genera or family, macroinvertebrates are identified to different levels for MCI), reflecting the quality of the site.

- Ephemeroptera, Plecoptera, and Trichoptera (EPT): these orders of macroinvertebrates are generally sensitive to pollution and have high tolerance scores. EPT taxonomic richness is the number of taxa belonging to Ephemeroptera (mayflies), Plecoptera (stoneflies) or Trichoptera (caddisflies) in the sample. The percentage of EPT taxa within the sample provides information on the richness and diversity of these sensitive groups in the sampled stream, and an indirect indicator of water pollution.

- Macroinvertebrate Community Index (MCI, Stark 1985): an index of pollution and nutrient enrichment. MCI is derived from the presence/absence of species and each species' tolerance to poor water quality (species tolerance score range 1 to 10). MCI values can then be used to assign water quality classes (<80 = 'Poor', 80-99: 'Fair', 100-119: 'Good', >119: 'Excellent').

High taxonomic richness, percentage of EPT taxa, or MCI score generally indicates clean water and an undisturbed, structurally complex invertebrate habitat.

3. FRESH WATER

A summary of stream features for each of the sites is provided in Table 1.

3.1 Rapid habitat assessments

A rapid habitat assessment was completed at each of the seven sites. There was significant variability in the habitat assessment scores between the sites, with a minimum score of 54 (Site 2) and maximum of 89 (Site 3). Site 2 contained a small stream with poor riparian vegetation and limited diversity of habitats compared to Site 3 which had good riparian vegetation and an excellent diversity of habitats. On average across all sites, invertebrate habitat diversity scored the highest and naturalness of bank vegetation scored the lowest (Table 2).

Table 1: Summary of stream parameters at each of the seven sites sampled.

Site	Easting (NZTM)	Northing (NZTM)	Stream Order	Mean Flow (Minimum Flow) L/s	Distance to the Sea (km)	Upstream Catchment (km^2)	Minor Catchment	Major Catchment
1	1294798.58	4862691.38	3	150 (37)	72.7	5.78	Mimihau Stream South Branch	Mataura River
2	1296911.96	4863747.09	1	28 (6)	73.7	1.11	Mimihau Stream South Branch	Mataura River
3	1298329.45	4864166.73	3	139 (30)	75.7	4.88	Mimihau Stream South Branch	Mataura River
4	1299473.34	4864593.80	2	82 (17)	77.2	2.65	Mimihau Stream South Branch	Mataura River
5	1300363.11	4866039.66	3	380 (97)	78.9	12.31	Mimihau Stream South Branch	Mataura River
6	1304083.23	4866549.15	2	92 (22)	85.0	3.33	Mimihau Stream North Branch	Mataura River
7	1301575.22	4873490.41	4	486 (104)	129.3	21.68	Kaiwera Stream	Clutha River

Table 2: Rapid stream habitat assessments for the seven sites sampled. Each category has a maximum score of 10, giving a maximum total of 100.

Site	Deposited sediment	Invertebrate habitat diversity	Invertebrate habitat abundance	Fish cover diversity	Fish cover abundance	Hydraulic heterogeneity	Bank erosion	Bank vegetation	Riparian width	Riparian shade	Overall score
1	9	9	9	9	7	9	9	8	9	8	**86**
2	8	6	6	6	5	5	7	4	4	3	**54**
3	9	10	10	10	8	5	10	8	9	10	**89**
4	4	6	3	8	5	7	7	8	9	8	**65**
5	10	9	10	9	7	5	9	5	4	6	**74**
6	8	9	6	9	8	10	10	6	10	5	**81**
7	8	8	10	4	5	6	2	4	4	7	**58**
Average parameter score	8.00	8.14	7.71	7.86	6.43	6.71	7.71	6.14	7.00	6.71	72.43

3.2 Fish passage

All sites were located near a culvert or bridge structure, two pose a barrier for fish passage.

Site 2 had a significantly perched culvert (Plate 1); this culvert has a drop of approximately 0.35 metres and is undercut by approximately 0.15 metres. Indigenous fish cannot jump over obstacles as trout can; they can climb past obstacles, but not upside-down. The concrete culvert is narrower than the stream, increasing the velocity within the culvert, this creates a velocity barrier.

Site 4 has a slight barrier through a buildup of debris against the upstream end of the triple-barreled culvert partially blocking of two of the barrels and a small fall (approximately 0.15 metres) has formed around debris near the third barrel.

Plate 1: Downstream end of the perched culvert identified at Site 2.

In addition to these two barriers, the following other fish passage observations were made:

- At site 1, there is a ford present (Plate A2.1). It is comprised of large gravel and cobbles and posed no fish passage concerns for smaller species at the time of site visit. There is the potential for issues for larger fish species, or for all fish species during periods of low flow.
- Site 3 is an excellent example of a fish-friendly structure; it is a large, single-barreled culvert with corrugations (Plate A2.4). There were some large rocks within the culvert itself, but these posed no issues for fish passage and may have a positive effect by providing fish cover within the culvert.
- Site 6 has many points along the stream bed where angled bedrock is exposed creating steep flows which may provide barriers to fish with poor swimming or climbing abilities.
- Sites 5 and 7 are both crossed by bridges which pose no fish passage concerns.

3.3 Fish captures (fyke nets and gee-minnow traps)

The fish community found at the Kaiwera Stream site were dissimilar to those found in the Mimihau Stream tributaries (Tables 3, 4). This is unsurprising given the differences in topography, stream type, and river catchment. Species captured at the Kaiwera Stream site were longfin eel (*Anguilla dieffenbachii*), brown trout (*Salmo trutta*), juvenile bullies (*Gobiomorphus* sp., too small to be identified to species level, but based on NZFFD records they are most likely upland bullies (*Gobiomorphus breviceps*)) and kōura (*Paranephrops australis*). Whereas at the Mimihau Stream tributaries there were kōura and non-migratory galaxiids (tentatively identified as Gollum galaxiids, *Galaxias gollumoides*).

Table 3: Species and catch numbers for each of the seven sampling sites. Counts include both fyke nets and gee-minnow traps.

Waterway	Site	Common Name	Species Name	Count
Mimihau South Branch	1	Gollum galaxias	*Galaxias gollumoides*	4
Mimihau South Branch	1	Kōura / crayfish	*Paranephrops australis*	1
Mimihau South Branch	2	-	-	0
Mimihau South Branch	3	Kōura / crayfish	*Paranephrops australis*	1
Mimihau South Branch	4	Gollum galaxias	*Galaxias gollumoides*	2
Mimihau South Branch	4	Kōura	*Paranephrops australis*	6
Mimihau South Branch	5	Gollum galaxias	*Galaxias gollumoides*	11
Mimihau South Branch	6	Kōura / crayfish	*Paranephrops australis*	4
Mimihau South Branch	6	Gollum galaxias	*Galaxias gollumoides*	39
Kaiwera Stream	7	Longfin eel	*Anguilla dieffenbachii*	1
Kaiwera Stream	7	Brown trout	*Salmo trutta*	1
Kaiwera Stream	7	Bullies (juvenile)	*Gobiomorphus sp.*	5
Kaiwera Stream	7	Kōura / crayfish	*Paranephrops australis*	1

Table 4: Summary of species captured. Threat status from Dunn et al. 2018.

Common Name	Species Name	Total Count	Threat Status
Gollum galaxiid	*Galaxias gollumoides*	56	Threatened - Nationally Vulnerable
Kōura / crayfish	*Paranephrops australis*	13	Not Threatened
Juvenile bully	*Gobiomorphus* sp.	5	Not Threatened
Longfin eel	*Anguilla dieffenbachii*	1	At Risk - Declining

Brown trout	*Salmo trutta*	1	Introduced and Naturalised

Of the 56 galaxiids caught, 53 were between 45 and 80 millimetres, and the remaining three were significantly larger at 10.5, 10.5 and 13.5 centimetres (Figure 2). Additionally, groups of small galaxiids were observed at sites 1 and 4, these fish were likely post-larvae juveniles and were small enough to evade capture in either trap or net (Plate 2). The presence of these juvenile fish is a positive indicator of population health and successful recruitment.

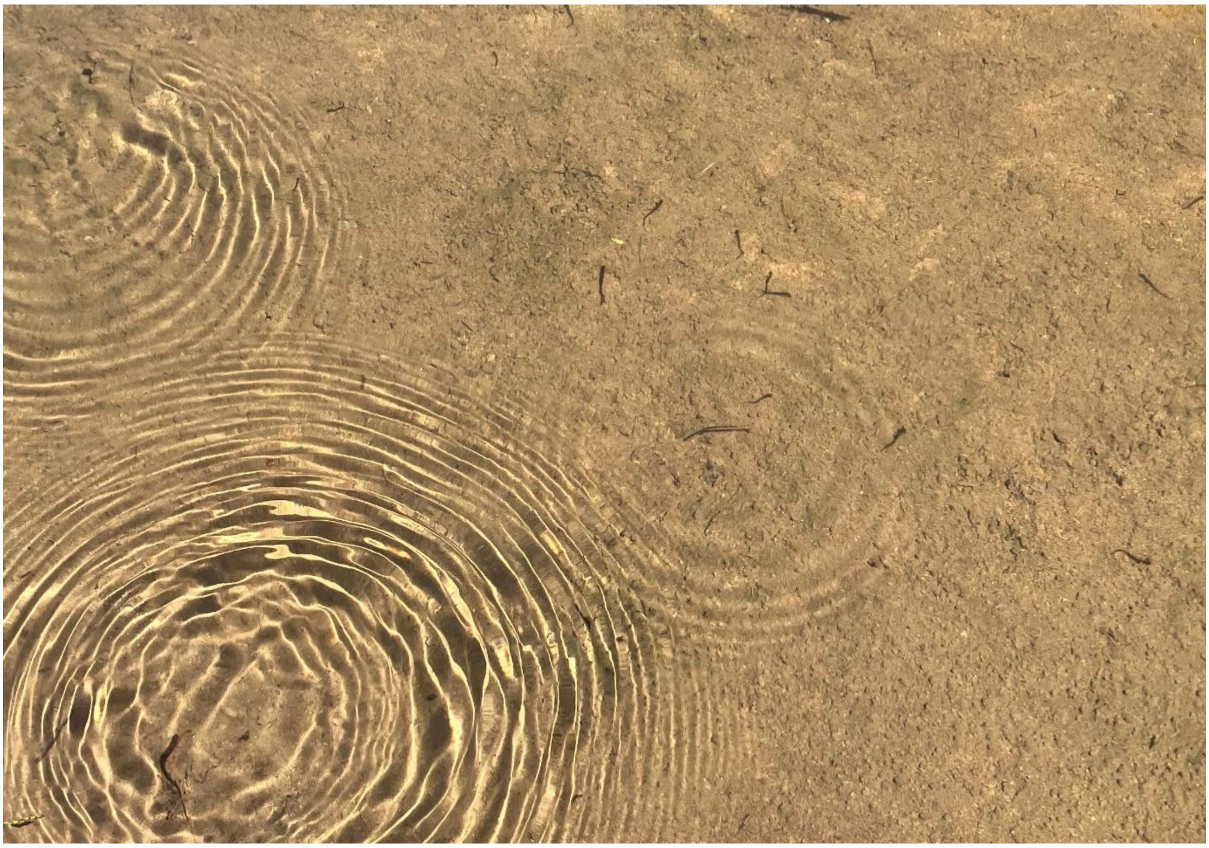


Plate 2: Juvenile galaxiids observed at Site 1, shadows of the fish are more visible than the fish themselves

Figure 2: Size distribution of Gollum galaxiids captured from streams within the potential Mimihau windfarm site

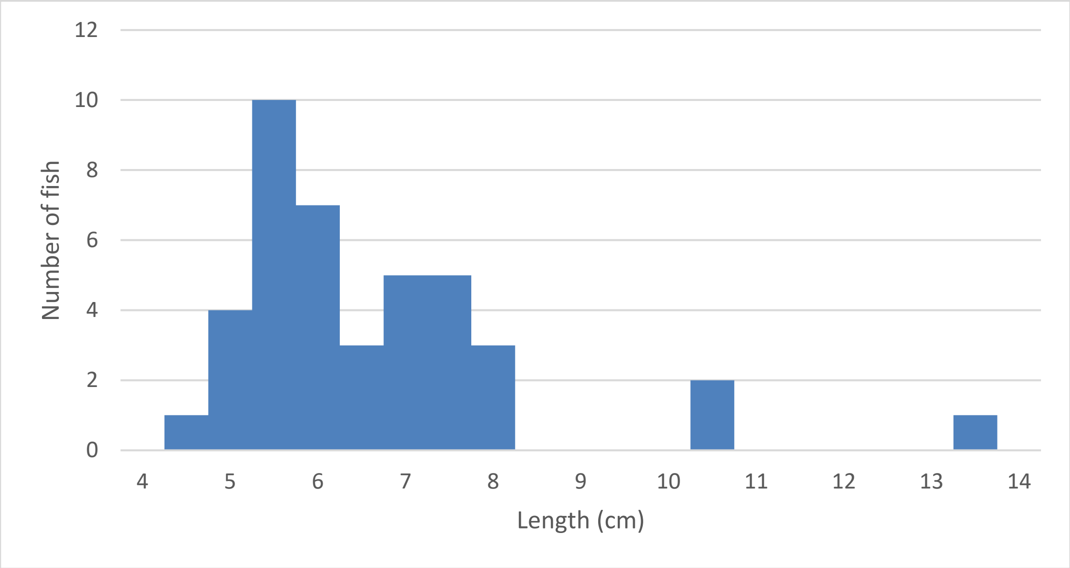
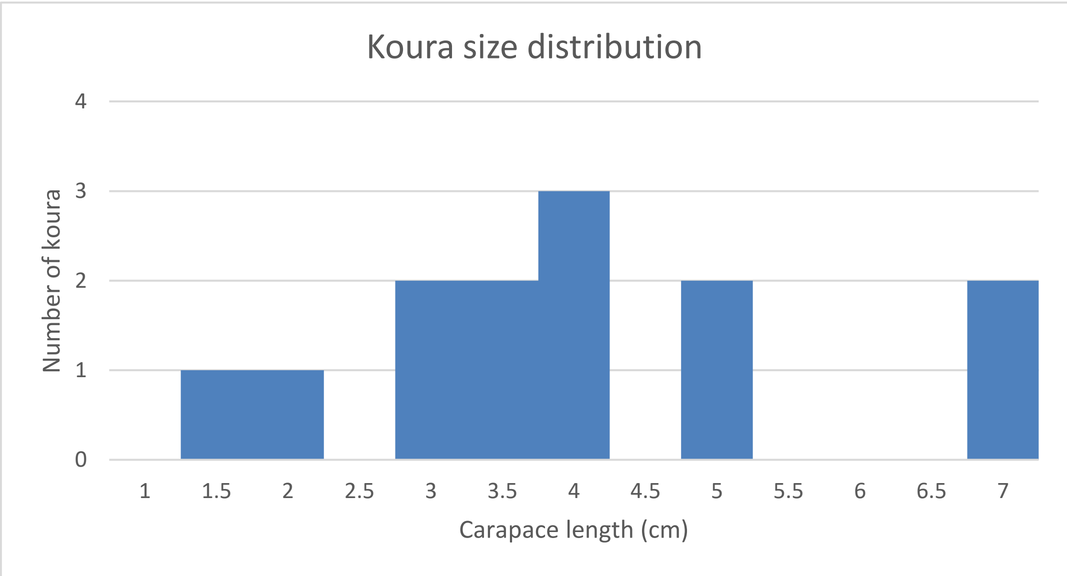


Figure 3: Size distribution (carapace length) of koura captured from streams within the potential Mimihau windfarm site.



3.4 Macroinvertebrates

As was observed in the fish surveys, there was a notable difference in the macroinvertebrate communities between the Kaiwera Stream site and the Mimihau Stream tributary sites (Table 5). The Kaiwera Stream macroinvertebrate community had a significantly higher abundance of individuals, with over 50% more than the most abundant sample from the Mimihau Stream. The diversity at the Kaiwera Stream was similar as the average diversity in Mimihau Stream, although the key groups within the samples differ. The Mimihau tributary sites all contain representatives from Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies) groups, with a diversity of both stoneflies and caddisflies present. The Kaiwera Stream sample lacked any caddisflies, and also had the lowest overall proportion of EPT taxa (41.7%). Overall, the Kaiwera Steam site had the lowest MCI value (104 – classified as 'good'), in contrast all Mimihau tributary sites except Site 3 obtained an MCI score of 'excellent', Site 3 had a slightly lower rating of 'good' (116)

Overall, *Deleatidium* larvae (mayflies; MCI score 8) were the most abundant taxon observed, followed by Elmidae larvae (riffle beetles; MCI score 6). These species are both common in hard bottomed streams (stones or gravel), and feed on organic material on and within the substrate. *Deleatidium* feed by scaping diatoms and other film forming species off of surfaces, and Elmidae larvae gather detritus and other organic material from interstitial spaces. *Deleatidium* have a preference for swift flowing waters that are well oxygenated with shading to regulate water temperature.

Table 5: MCI scores and macroinvertebrate community composition for the seven stream sites sampled within the proposed Mimihau windfarm area.

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Number of Taxa	10	14	16	11	11	15	12
Number of Rare Taxa	2	1	0	1	1	1	4
Total individuals	274	684	888	134	201	639	2016
MCI Value - including rare taxa	128	125	116	120	123	135	104
SQMCI Value	7.0	6.5	6.5	7.3	6.3	6.3	6.8
Number of EPT taxa	5	8	9	5	7	9	5
Number of EPT invertebrates	226	384	588	88	99	438	1264
% EPT of the taxon total	50.0%	57.1%	52.9%	45.5%	63.6%	60.0%	41.7%
% EPT of the total number of invertebrates	82.5%	56.1%	66.2%	65.7%	49.3%	68.5%	62.7%

4. FRESH WATER VALUES

The ecological values of the waterways surveyed varies between individual sites. Site 2 has a relatively poor value in its present state, but it has great potential for remediation and an increase in value through improvement of instream habitat, connectivity, and riparian buffer.

The other five Mimihau Stream sites are all high-moderate value waterways. They contain threatened galaxiid species that are abundant at some sites, showing that important habitat is present, and they have good to excellent MCI scores. The riparian margins vary in condition, but most provide good buffering and some shading of the waterways, and the streams themselves provide a variety of habitats for freshwater fauna.

The site on the Kaiwera Stream is of a moderate ecological value. The waterway is in a poorer overall condition when compared to the Mimihau stream sites, damage to the banks caused by vehicle access and stock has degraded the site, however it contains a greater diversity of fauna species, and a significantly higher invertebrate abundance. It also has the potential to support the threatened Clutha flathead galaxiids, although their presence was not able to be confirmed by this survey.

5. CONSTRAINTS TO WINDFARM DEVELOPMENT

5.1 Fresh water

The freshwater values, habitats, and species observed pose no immediate or specific constraints on the wind farm development. However, it is important that protection of the freshwater habitats is considered when planning the final layout of the farm, such as by ensuring that there are riparian buffers retained around waterways to minimise potential sediment inputs or pollutant runoff, that these potential inputs are minimised to reduce the initial risk of water pollution, and by ensuring that fish passage is maintained.

6. MONITORING, MANAGEMENT AND MITIGATION RECOMMENDATIONS

6.1 Fish passage

The two structures causing fish passage issues require remediation, which will increase the potential habitat available to fish within the surrounding waterways. Remediation at Site 4 will be simple, as it only requires clearance of debris from the upstream side of the triple-barreled culvert, although this will need care as the debris may be providing refuge for a number of species. Remediation at Site 2 will be more involved. The significant fall height and undercutting means a simple remediation such as installation of spat rope will be insufficient. A fish ramp or similar structure is be recommended for the downstream end, with works to improve the upstream alignment. However, if this road is to be upgraded for windfarm access purposes, a complete replacement of the structure would give the best outcomes for restoring fish passage.

6.2 Further freshwater monitoring

It is recommended that eDNA surveys are conducted at sites throughout the proposed windfarm area. This will provide two benefits to the understanding of the system and the management of this site. Firstly, eDNA will enable definitive confirmation of the presumed Gollum galaxiids in the waterways. Secondly, eDNA allows a snapshot to be generated of all species present in the area, and can provide information on cryptic, very uncommon, or hard-to-capture indigenous species, as well as information on pest species that may be present. This is particularly important in the Kaiwera Stream, where fish database records indicate the presence of Clutha flathead galaxiids, but where no galaxiids were captured during surveys.

Further monitoring of these waterways using similar methods is recommended. This preliminary survey has generated a good snapshot of the species present and the quality of the available habitats. Annual or biannual monitoring would generate a more in-depth baseline of the freshwater values present, as seasonal and within-season variation is typical in freshwater systems. Having a solid baseline dataset taken over several seasons/years will likely be required as part of the consent, and be used as a reference to compare monitoring data taken during and after construction.

The greatest potential effect that the windfarm development will have on the freshwater ecosystem is an increase in fine sediment inputs. It is recommended that a fine sediment monitoring component is added to future freshwater surveys. The SAM-4 protocol as described by Clapcott *et al*. 2011 is deemed most appropriate given the habitat types present. This can then create a good understanding of pre-development conditions, to enable clear comparisons once development begins.

ACKNOWLEDGMENTS

Thanks to Steve Harding for assistance during the site visit.

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APPENDIX 1

APPENDIX 2: SITE PHOTOGRAPHS

Plate A2.1: Ford crossing at Site 1, large gravel size and sufficient water depth ensures that fish passage is unlikely to be an issue during normal flows.

Plate A2.2: Fyke net set upstream of the ford at Site 1.

Plate A2.3: Site 2 perched culvert.

Plate A2.4: The culvert at Site 3 is an example of a fish-friendly structure. Views looking upstream (left) and downstream (right) from within the culvert. Width of the culvert is approximately that of the stream, and is in line with the stream both in and out. The water is a similar depth and velocity within the culvert as it is in the stream, and a small amount of bed material has collected within the culvert.

Plate A2.5: Debris build-up at the upstream end of the triple barrelled culvert at Site 4, this will restrict fish passage and has caused a small fall to develop, directing majority of the stream flow down the right most barrel. Dashed outline indicates the approximate location of the central culvert barrel.

Plate A2.6: Site 5, this site had a well-defined riffle-run hydrological structure.

Plate A2.7: Stream bed formation at Site 6, where elevated bedrock forms sloped runs with deeper areas of pools between.

Plate A2.8 Natural fall upstream of the bridge crossing at Site 7

Plate A2.9 Gee minnow and fyke nets set at Site 7.

Plate A2.10: Large kōura caught at Site 3, note the soft, commensal flatworms living on the front claws. These do not negatively affect the kōura, but eat tiny crumbs of food it creates.

Plate A2.11: Several galaxiids captured at Site 5.

Plate A2.12: Side view of a galaxiid captured at Site 6, showing the large eye, small mouth and rounded head shape typical of a Gollum galaxiid.

Plate A2.13: Longfin eel captured at Site 7, weighing 3.2 kg and with a length of 92 cm. A longfin eel this size is most likely a female.

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