Te Ahu a Turanga; Manawatū Tararua Highway
Notices of Requirement for Designations
Volume Three: Technical assessments

NZ TRANSPORT AGENCY
WAKA KOTAHI

New Zealand Government

6. TERRESTRIAL ECOLOGY

IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	Notices of requirement for designations under section 168 of the Act, in relation to Te Ahu a Turanga; Manawatū Tararua Highway Project
BY	**NZ TRANSPORT AGENCY** Requiring Authority

TE AHU A TURANGA: TECHNICAL ASSESSMENT #6
TERRESTRIAL ECOLOGY

TABLE OF CONTENTS

INTRODUCTION 3
EXECUTIVE SUMMARY 5
PROJECT DESCRIPTION 7
EXISTING ENVIRONMENT 10
METHODOLOGY 15
PROJECT SHAPING 19
ASSESSMENT OF EFFECTS 21
MEASURES TO AVOID, REMEDY OR MITIGATE ACTUAL OR POTENTIAL ADVERSE (TERRESTRIAL ECOLOGY) EFFECTS 31
CONCLUSION AND RECOMMENDATIONS 38
APPENDIX 6.1: Terrestrial Vegetation and Habitats assessment report 42
APPENDIX 6.2: terrestrial fauna assessment report 43

TABLE OF FIGURES

Figure 6.1. Distribution of indigenous ecosystem types within the proposed designation area including Chainage (CH) references. 9

Figure 6.2. Predicted potential pre-human vegetation compositions (Leathwick, 2005) for the proposed designation area (outline shown) and surrounding landscape. 11

TABLE OF TABLES

Table 6.1. Ten ecosystem types located within the proposed designation boundaries. 12
Table 6.2. Criteria for describing magnitude of effect (EIANZ, 2018). 17
Table 6.3. Criteria for describing level of effect based on matrix of ecological value and magnitude of effect (EIANZ, 2018). 17
Table 6.4. Estimates of activities, their locations, and the resulting temporal scale, magnitude and level of adverse effects 28
Table 6.5. Mitigation and offset quantities. 35

INTRODUCTION

1. My name is **Dr Adam Forbes**. I am the founder and Principal Ecologist of Forbes Ecology, and I am the author of this report.

2. I have been advising the NZ Transport Agency since September 2017 on ecological matters in respect of its proposed Te Ahu a Turanga; Manawatū Tararua Highway project (the "**Project**").

3. My technical contributions have included:

   (a) informing the NZ Transport Agency's consideration of alternative routes for the Project;

   (b) inputting to 'Project shaping' in respect of the selected route option;

   (c) preparing an assessment of the Project's effects on indigenous vegetation and habitats (the "Terrestrial Vegetation and Habitats Assessment report", attached to this assessment as **Appendix 6.A**);

   (d) scoping, overseeing and reviewing aspects of the Terrestrial Fauna Ecology Assessment (attached to this assessment as **Appendix 6.B**)[1] and the Freshwater Ecology Assessment;[2] and

   (e) advising on how to manage the Project's adverse effects on ecological values.

Qualifications and experience

4. I have the following qualifications and experience relevant to this assessment:

   (a) I hold a PhD in Forestry from the University of Canterbury School of Forestry, and I am an Invited Research Associate with the School.

   (b) I have fourteen years' experience working as an ecological consultant. The last six years have been as independent self-employed consultant.

   (c) During my time as an ecological consultant I have undertaken a number of ecological assessments for Resource Management Act 1991 ("**RMA**") applications. These projects have included surveys and descriptions of ecological values, assessments of statutory ecological

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[1] The Terrestrial Fauna Ecology assessment was co-researched and co-authored by Andrew Blayney and Karin Sievwright who are terrestrial fauna ecologists employed by Boffa Miskell. I rely on information provided in their report.

[2] The Freshwater Ecology Assessment report is referred to here as (Miller, 2018) and this report is appended to the Landscape, Natural Character and Visual Effects Assessment report.

significance (including in terms of section 6(c) of the RMA) for both applicants and territorial authorities, assessments of effects and development of effects management and monitoring strategies.

(d) Since 2013 I have worked extensively on the Roads of National Significance projects in the Wellington and Manawatū-Whanganui ("**Horizons**") regions. This includes ongoing roles as Ecology Reviewer to Wellington Councils for Transmission Gully, Greater Wellington Regional Council Reviewer for both Mackays to Peka Peka and Peka Peka to Ōtaki, and I have assisted the NZ Transport Agency with the ecological aspects of the corridor options stages of the Ōtaki to north of Levin project. Through these projects I have developed a thorough understanding of the ecological effects and effects management aspects of large-scale roading developments.

Code of Conduct

5. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Purpose and scope of assessment

6. The purpose of this report is to provide an overview of the assessments carried out of the Project's effects on terrestrial ecology, which form part of the wider Assessment of Environmental Effects ("**AEE**") supporting the Notices of Requirement ("**NoR**") to be lodged for the Project. In this report I specifically cover:

(a) the existing environment in terms of terrestrial ecology features within the designation area;

(b) ecologically relevant aspects of the 'Project shaping' process;

(c) the Project's actual and potential effects on terrestrial ecology;

(d) the proposed ways in which the ecological effects of the Project will be managed; and

(e) recommended matters to be included as proposed NoR conditions.

Assumptions and exclusions in this assessment

7. Detailed design of the Project has not yet been undertaken, and the NZ Transport Agency is not yet seeking regional resource consents, or a waiver of the outline plan of works process, for the Project. At this stage, therefore, the Project to be assessed includes a designation corridor within which the road is proposed to be constructed. My assessment has taken into account that flexibility and the potential for effects on terrestrial ecology anywhere within the designation (subject to recommended constraints on detailed design to avoid or minimise particular effects, as I explain below).

EXECUTIVE SUMMARY

8. The NZ Transport Agency is seeking to designate land for the purposes of an alternative State Highway route across the Ruahine Range.

9. Of the proposed designation area, 38.5 ha (c. 10%) comprises terrestrial vegetation and habitats which are classified (based on composition, structure, and condition) into the following ten distinct ecosystem types and areas, ranging in ecological value from Very High to Low. Seven ecosystem types were assessed as significant, by reference to Horizons' One Plan Policy 13-5.

Ecosystem type	Area (ha)	Value level	RMA s6(c)
Old-Growth (OG) Forests (Alluvial)^	4.23	Very High	Yes
OG Forests (Hill Country)	1.78	Very High	Yes
Secondary Broadleaved Forests with OG Signatures	3.07	High	Yes
OG Treelands	0.41	High	Yes
Advanced Secondary Broadleaved Forests	2.93	High	No
Raupō Dominated Seepage Wetlands (High Value)	0.55	High	Yes
Secondary Broadleaved Forests and Scrublands	16.32	Moderate	No
Kānuka Forests	4.52	Moderate	Yes
Indigenous-Dominated Seepage Wetlands (Mod. Value)	0.56	Moderate	Yes
Mānuka, Kānuka and Divaricating Shrublands	4.12	Low	No

^This area calculation includes 0.05 ha of Very High value Threatened-Nationally Critical swamp maire forest. Areas are slope corrected using the project LiDAR dataset.

10. The proposed designation area contains potential populations of non-threatened and At-Risk lizard species, terrestrial invertebrate values ranging from Negligible to High, and Threatened and At-Risk bird species using shingle riverbed, wetland, forest and grassland habitats. Monitoring to date has not detected long-tailed bats, however further monitoring is scheduled for the summer of 2018-19 to determine the status of bat populations at the most likely habitats with the aim of clarifying the effects management pathway for bats.

11. Key actual or potential adverse effects of the Project include:

For terrestrial vegetation and habitats:

(a) clearance or modification of indigenous vegetation and habitats;

(b) habitat fragmentation and isolation; and

(c) edge effects on retained vegetation and habitats;

For terrestrial fauna:

(d) injury or mortality during vegetation clearance and earthworks;

(e) disturbance during critical nesting periods (birds);

(f) permanent loss of habitats; and

(g) modification of habitats in the form of:

    (i) increased fragmentation and isolation due to reduced habitat connectivity;

    (ii) creation of edge effects and consequential effects to composition, structure and food sources in retained habitats; and

    (iii) invasions and corresponding impacts of non-native plant and animal species.[3]

12. A stepped approach is proposed for vegetation clearance. The proposed approach allows flexibility within the designation area for works to proceed without being constrained by lower value ecosystems that can be replaced in relatively short timeframes through replacement planting; and to manage

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[3] Another potential effect of the Project relates to sedimentation, arising from construction of the Manawatū River crossing, of foraging areas along the riverbed, which in turn could impact dotterel foraging. This potential effect will be considered in the context of the regional resource consents required for the Project, in light of the precise bridge configuration and construction methodology proposed.

effects to higher value ecosystem types through avoidance and minimisation of effects, as defined by specific effects envelopes. Effects envelopes were developed to limit levels of effect on High and Very High value features to levels acceptable on ecological grounds,[4] given appropriate mitigation and offsetting measures. Measures are proposed to address adverse effects associated with increased fragmentation/isolation and edge effects.

13. Adverse effects on fauna from vegetation and habitat loss are directly addressed through the avoidance, replacement planting and offset measures discussed above. Disturbance of fauna (particularly lizards and birds), including during critical bird breeding seasons, will be addressed through provisions detailed in the Ecological Management Plan regarding effects management (e.g., preconstruction surveys and salvage) and scheduling of works outside of critical periods or, if not possible, through preconstruction surveys and constraints on works during specific time periods of high sensitivity.

14. Regarding terrestrial fauna, following full implementation of mitigation and offset measures, the level of adverse effect would be Very Low-Low, with net benefits to terrestrial fauna likely to be realised over time.

15. In broader terms, too, the proposed mitigation and offset package is likely to address adverse effects and offset residual adverse effects to a biodiversity net-gain position (and indeed, I understand that a condition will be proposed to ensure that outcome). Put another way, on the basis of the offset package proposed, in my view the Project will have net benefits in respect of terrestrial ecology values.

PROJECT DESCRIPTION

16. A Project description is provided in section C of the Assessment of Effects and Supporting Documents (volume 3). Details describing the Project are not repeated here, other than specific elements expanded on below.

17. **Figure 6.1** presents the configuration of indigenous ecosystems relative to the designation area and the indicative design. I refer to chainages (CH) throughout this report and these are shown on **Figure 6.1**.

18. In terms of the Project's effects (and the later detailed design process), several sites in particular have been key focal points for my assessment.

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[4] Effects envelopes represent maximum allowable limits on species and ecosystems of very high conservation concern (i.e., swamp maire, old growth forests, high value seepage wetlands) and limit the magnitude of effect in specific locations (not designation wide) for other ecosystem types.

Works associated with the newly proposed bridge across the Manawatū River may affect, on the right (northern) bank of the River, an area containing a collection of High and Very High ecological values and levels of conservation concern (CH4000-4400). The Project also intersects with two areas subject to Queen Elizabeth II Trust ("**QEII**") covenants, including one at CH5600-5800. These areas, and other crossings of streams along the alignment, are important considerations for the detailed design phase of the Project, in that they present opportunities to minimise the extent of adverse effects to both terrestrial and freshwater ecosystems.

19. The Project description considered for this assessment does not provide particular design detail in relation to these areas. In my opinion, however, some design constraints are required in order to guide the detailed design process and ensure that the adverse effects of the Project on terrestrial ecology are acceptable, taking into account proposed mitigation and offsetting measures. These recommended constraints are discussed further below.

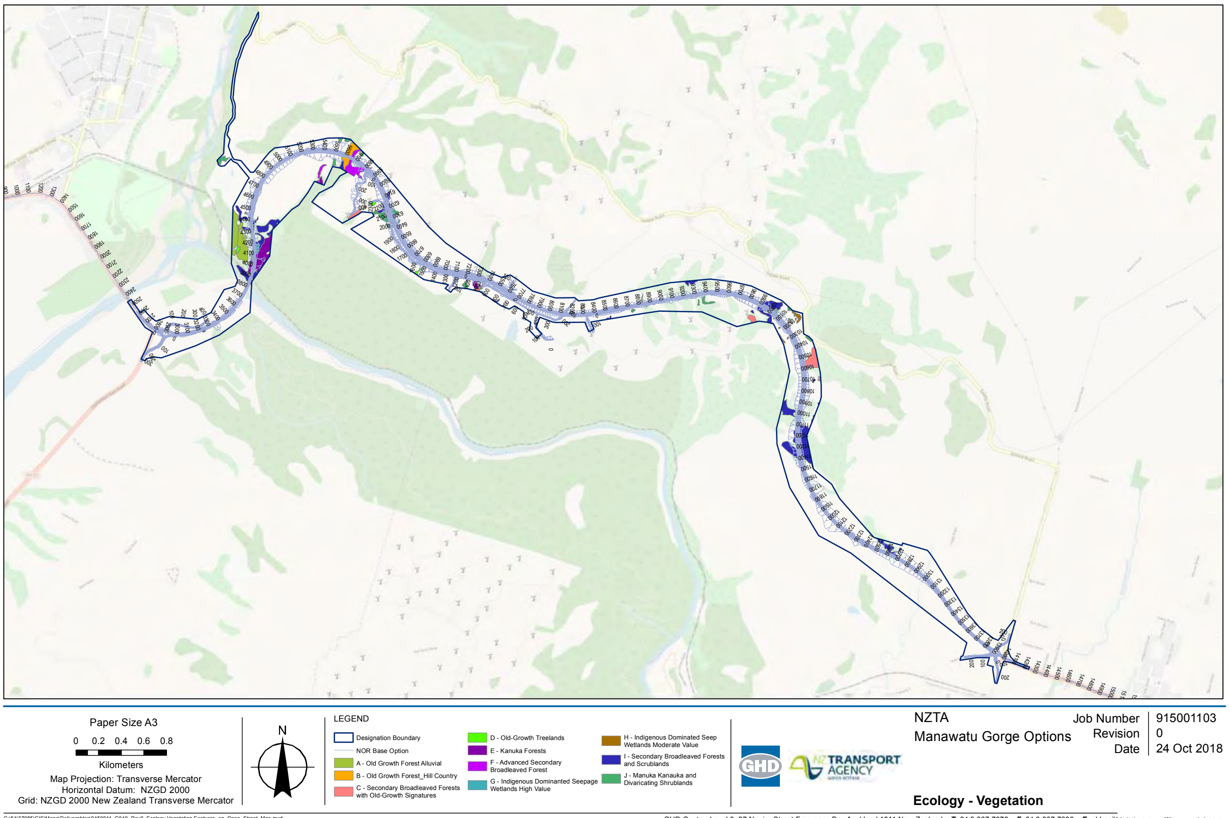

Figure 6.1. Distribution of indigenous ecosystem types within the proposed designation area including Chainage (CH) references.[5]

Note, ecosystems within the designation area but not mapped are within areas assumed to be clear of works (e.g., in mitigation areas) and thus are not included in the scope of effects/mitigation/offset. The plan does not show all access routes and the Project plans should be referred to for the location of site access alignments.

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[5] Note that this figure and others in this assessment depict a previous iteration of the proposed designation area; three relatively small areas relating to unformed access tracks, in areas of pasture, have since been added.

EXISTING ENVIRONMENT

Landscape context

20. The designation area spans three ecological districts ("**ED**"), Manawatū Plains, Manawatū Gorge North, and Woodville ED. Rainfall and temperature are conducive to rapid regeneration of lowland native forest species. The Manawatū Gorge Scenic Reserve ("**MGSR**") is an important ecological feature, particularly so for this Project given its close proximity to the designation area. The MGSR comprises several large protected lowland forest remnants summing to approximately 1000 ha in total. A number of smaller native vegetation remnants exist in the surrounding landscape. Many of these are associated with gully systems and a number benefit from formal legal protection in the form of conservation covenants.

21. The predicted pre-human forest compositions (Leathwick, 2005) are shown in **Figure 6.2** below. These mainly comprised alluvial forest associations on the flats near both Ashhurst and Woodville and the intervening hill country featured rimu/tawa-kamahi forests (as represented by the MGSR today).

22. During times of human occupation indigenous vegetation has been extensively cleared and converted to agricultural and urban land uses. Clearance of indigenous cover has resulted in the contemporary land cover being of a predominantly exotic composition. The 'Land Environments', in terms of (Leathwick et al., 2003), traversed by the proposed designation area are classified as 'Chronically' or 'Acutely Threatened Environments', meaning that the combinations of landform and climate that are present in this landscape, at a national scale, contain less than 20% or 10% (respectively) of indigenous cover remaining (Walker et al., 2015).

23. While exotic vegetation communities within the alignment do present habitat opportunities for some fauna species, the ecosystem types of most value are the indigenous communities, particularly those that represent pre-human compositions, are threatened, or were rare prior to human occupation.

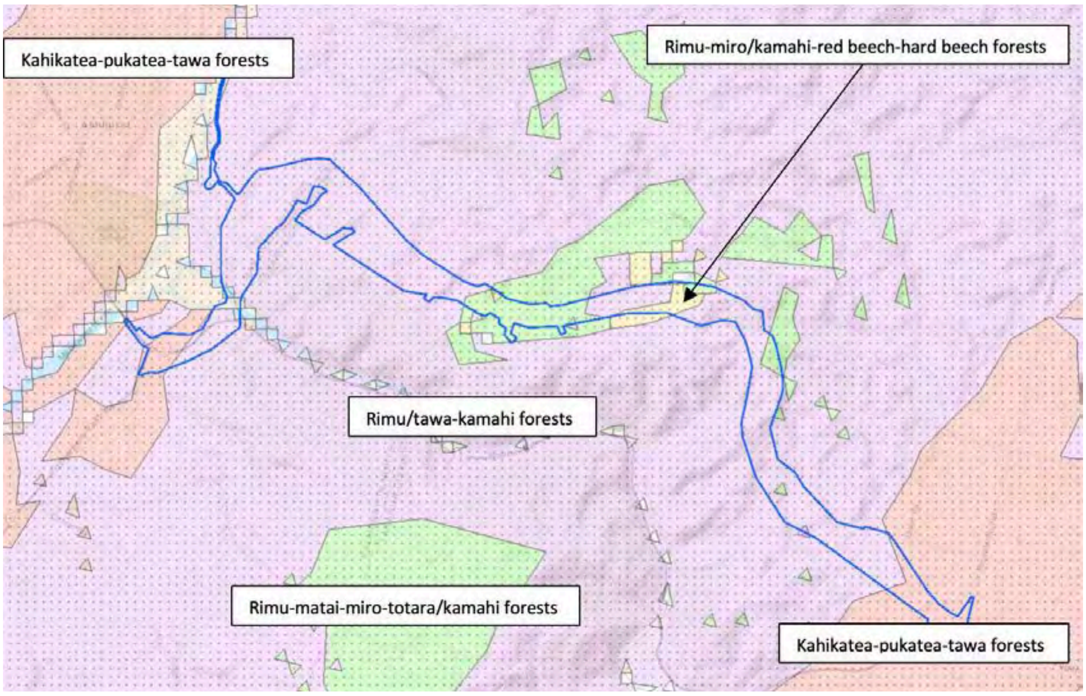

Figure 6.2. Predicted potential pre-human vegetation compositions (Leathwick, 2005) for the proposed designation area (outline shown) and surrounding landscape.

Terrestrial vegetation and habitats

24. Landcover within the designation area is predominantly exotic and these exotic communities are typically pastoral in origin. Exotic grasslands predominate. Exotic conifers occur as small plantations and as individual trees. Various exotic angiosperm species (e.g., Gorse, Willow) also occur.

25. Indigenous communities have been classified into 10 distinct terrestrial ecosystem types and these can be regarded as fauna habitats for policy purposes. The ten indigenous ecosystem types and their respective areas are listed in **Table 6.1** below.

26. The designation area covers 375.7 ha of land,[6] of which 38.5 ha (c.10%) comprises indigenous terrestrial ecosystems[7]. The land cover of the 337.2ha balance area within designation is predominantly exotic pasture with small areas of exotic plantation forest.

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[6] The designation area calculation is to be updated as it omits three relatively small areas, in pasture, added recently.

[7] Note, this calculation and the vegetation cover figures in this paragraph excludes areas of indigenous ecosystems located within the designation area that are not mapped (due to those areas being within potential mitigation areas and thus not needing to be cleared, and thus not mapped).

Table 6.1. Ten ecosystem types located within the proposed designation boundaries.

Ref.	Ecosystem classification	Finalised area (ha)
1	Old-Growth Forests (Alluvial)^	4.23
2	Old-Growth Forests (Hill Country)	1.78
3	Secondary Broadleaved Forests with Old-Growth Signatures	3.07
4	Old-Growth Treelands	0.41
5	Advanced Secondary Broadleaved Forests	2.93
6	Raupō Dominated Seepage Wetlands (High Value)	0.55
7	Secondary Broadleaved Forests and Scrublands	16.32
8	Kānuka Forests	4.52
9	Indigenous-Dominated Seepage Wetlands (Moderate Value)	0.56
10	Mānuka, Kānuka and Divaricating Shrublands	4.12
	Total	38.49

^This area calculation includes 0.05 ha of Threatened-Nationally Critical (de Lange et al., 2018) swamp maire forest. Areas are slope-corrected using the Project LiDAR dataset.

27. The ecological values of the 10 ecosystem types are described in Tables 6.A.5-6.A.10 of the Terrestrial Vegetation and Habitats Assessment report. The levels of ecological value and corresponding One Plan Schedule F threat/rarity status can be summarised as follows:

Very High value:

1. Old-Growth Forests (Alluvial)[8]
2. Old-Growth Forests (Hill Country)[9]

High value:

3. Secondary Broadleaved Forests with Old-Growth Signatures[10]
4. Old-Growth Treelands[11]
5. Advanced Secondary Broadleaved Forests
6. Raupō-Dominated Seepage Wetlands[12]

Moderate value:

7. Secondary Broadleaved Forests and Scrublands

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[8] Threatened (One Plan).

[9] Threatened (One Plan).

[10] Threatened (One Plan).

[11] Threatened (One Plan).

[12] Rare (One Plan).

8. Kānuka Forests[13]
9. Indigenous-Dominated Seepage Wetlands[14]

<u>Low value:</u>

10. Mānuka, Kānuka and Divaricating Shrublands

28. Horizons' One Plan Policy 13-5 provides criteria for assessing significance of vegetation and habitats. Section 4 of the Terrestrial Vegetation and Habitats Assessment report assesses statutory ecological significance, using the Policy 13-5 criteria, for the purposes of section 6(c) of the RMA. In summary, the following ecosystems have been determined as ecologically significant (numbered according to the list of ecosystems above):

(a) Old-growth forests and treelands (1, 2, and 4);

(b) Secondary forests with old-growth signatures (3);

(c) Seepage wetlands (6, 9); and

(d) Kānuka forests (8).

29. Items 5, 7, and 10 from the list above - i.e. the secondary broadleaved forests (both advanced and recent) and scrublands, and the native shrublands - are not considered significant when assessed against Policy 13-5 criteria. Those ecosystem types account for almost two-thirds of the potentially affected indigenous vegetation within the proposed designation - 23.37ha of 38.49ha. However, while these ecosystems do not qualify as significant in a statutory sense, the ecosystems do provide habitats for native fauna and represent an essential phase of forest regeneration. The effect on these ecosystems has been assessed and mitigation is recommended for their loss as a result of the Project.

Terrestrial fauna

30. Seven lizard species are potentially present within the designation area. New Zealand lizards are difficult to detect and, despite their non-detection within the daytime and nocturnal surveys carried out, it is very likely that At-Risk lizard species occur within the proposed designation area, particularly amongst either native or exotic vegetation where stock grazing does not occur; that is, between CH2500-12800. The presence of lizards (and High lizard values) is more likely in habitats connected to remnant

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[13] Threatened (One Plan).

[14] Rare (One Plan).

habitats such as the gully systems and habitats with existing connections to the MGSR.

31. Based on inferences from habitat quality and configuration, the established trees, scrublands and seepage wetlands between CH4000 and 5800 (Western Rise) are expected to hold Moderate-Low terrestrial invertebrate values. The old-growth forest of the Western QEII area has direct connection with the MGSR and is likely to hold High invertebrate values. The relatively expansive areas of regenerating secondary broadleaved forests and scrublands between CH9900 and 12700 are likely to hold Moderate ecological value. Other areas of the alignment would be of Low to Negligible value for their terrestrial invertebrate assemblages.

32. The most important bird habitats and values occur on and near the Western Rise parts of the Project. These include the shingle riverbed habitat of the Manawatū River which supports a diversity of wetland and riverbed birds such as banded (Nat. Vul.)[15] and black-fronted dotterel, black- (Nat. Cri.) and red-billed (Dec.) gull, and Caspian tern (Nat. Vul.). The old-growth forests support a diversity of common forest bird species and potentially also Threatened and At-Risk species such as whitehead (Dec.), North Island rifleman (Dec.), and North Island kākā (Rec.). The seepage wetland at CH4100-4200 potentially supports swamp specialists such as marsh crake (Dec.) and Australasian bittern (Nat. Crit.). On the Eastern Rise, bush falcon (Rec.) was observed and can be assumed to range across the entire proposed designation area. Pipit (Dec.) is potentially present in exotic grasslands throughout the designation area.

33. Bioacoustics monitoring failed to detect long-tailed bats, and the experts who carried out the monitoring concluded that there is a low possibility of long-tailed bats being present in the Project area. However, there are trees within the designation area that have the attributes which provide roost cavities and also riparian and forest edge habitats in gullies with nearby mature forest providing potential roosting sites. Further work is scheduled in 2018-2019 to resolve current uncertainties regarding the presence/absence of long-tailed bat.

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[15] These and all other threat classifications in this paragraph follow Robertson et al., (2017). Abbreviations used are: Nat. Crit. = Threatened-Nationally Critical; Nat. Vul. = Threatened-Nationally Vulnerable; Declining = At Risk-Dec.; Rec. = At Risk-Recovering.

METHODOLOGY

34. Detailed methodologies for both the Terrestrial Vegetation and Habitats and Terrestrial Fauna Assessments are contained in the respective reports, appended. Ecological values of terrestrial species and ecosystem types were assessed using current best practice methods (Environment Institute of Australia and New Zealand ("**EIANZ**"), 2018) for evaluating ecological values in the impact assessment framework. The assessment was based on the information available regarding species presence and the types of ecosystems present. Structured criteria to guide ecological values assessments are provided by EIANZ (2018; Table 4, p. 64) and these criteria formed the basis of the values assessment. They are:

    1. **Representativeness**:
        - Extent to which area is typical or characteristic; and
        - Size.
    2. **Rarity/distinctiveness**:
        - Amount of habitat or vegetation remaining;
        - Supporting nationally or locally Threatened, At Risk, or uncommon species;
        - Regional or national distribution limits;
        - Endemism;
        - Distinctive ecological features; and
        - Natural rarity.
    3. **Diversity and pattern**:
        - Level of natural diversity; and
        - Biodiversity reflecting underlying diversity.
    4. **Ecological context**:
        - Contribution to network, buffer, linkage, pathway;
        - Role in ecosystem functioning;
        - Important fauna habitat; and
        - Contribution to ecosystem service.

35. For the indigenous vegetation and habitats within the designation area, each of the four criteria was evaluated and given a categorical ranking of either High, Moderate, Low or Negligible. Overall value was then assessed using the following summation from the above criteria assessment:

- **Very High** value = Area[16] rates High for 3 or all of the four assessment matters. Likely to be nationally important and recognised as such.
- **High** value = Area rates High for 2 of the assessment criteria, Moderate and Low for the remainder, or Area rates High for 1 of the assessment matters, Moderate for the remainder. Likely to be regionally important and recognised as such.
- **Moderate** value = Area rates High for one matter, Moderate and Low for the remainder, or Area rates Moderate for 2 of more assessment matters Low or Very Low for the remainder. Likely to be important at the level of the Ecological District.
- **Low** value = Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
- **Negligible** value = Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder.

36. The assessment of ecological effects addressed the degree to which the proposed activity would diminish the attributes that made a given feature ecologically significant. The level of effect was determined through analysis of the level of ecological value and the magnitude of adverse effect (EIANZ, 2018). Both positive and adverse effects were considered. The assessment of magnitude and level of effect followed the EIANZ (2018) assessment criteria shown in **Table 6.2** and **Table 6.3** respectively.

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[16] Of each ecosystem type/specific feature.

Table 6.2. Criteria for describing magnitude of effect (EIANZ, 2018).

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

Table 6.3. Criteria for describing level of effect based on matrix of ecological value and magnitude of effect (EIANZ, 2018).

Ecological value → Magnitude ↓	Very high	High	Moderate	Low	Negligible
Very High	Very high	Very high	High	Moderate	Low
High	Very high	Very high	Moderate	Low	Very low
Moderate	High	High	Moderate	Low	Very low
Low	Moderate	Low	Low	Very low	Very low
Negligible	Low	Very low	Very low	Very low	Very low
Positive	Net gain	Net gain	Net gain	Net gain	Net gain

37. Levels of effect were then considered further, in terms of national guidance regarding appropriate levels of ecological management response. National guidance on ecological management of effects was sourced from EIANZ (2018) and the Department of Conservation ("**DOC**") (2014; and references therein).

38. Regarding levels of effect, EIANZ (2018) recommends:

> **Very High adverse**: *Project effects in the 'Very High adverse' category are unlikely to be acceptable on ecological grounds alone (even with compensation proposals). Activities having very high adverse effects should be avoided. It is not the ecologist's role to make determinations with regard to project viability. The ecologist should present an objective and scientifically robust assessment of the effects of the project to assist the applicant in coming to an informed decision about project viability. Where very high adverse effects cannot be avoided, a net biodiversity gain would be appropriate.*
>
> **High and Moderate adverse**: *Options in the 'High and Moderate adverse' category represent a level of effect that requires careful assessment and analysis of the individual case. Such an effect could be managed through avoidance, design, or extensive offset or compensation actions. Wherever adverse effects cannot be avoided, no net loss of biodiversity values would be appropriate.*
>
> **Low and Very Low adverse**: *Should not normally be of concern, although normal design, construction and operational care should be exercised to minimise adverse effects. If effects are assessed taking impact management developed during project shaping into consideration, then it is essential that prescribed impact management is carried out to ensure Low or Very Low level effects.*

39. Offsetting principles contained in the DOC (2014) Guidance on Good Practice Biodiversity Offsetting in New Zealand were applied. In particular, ecological features of elevated conservation concern were assessed as to their status regarding the limits of offsetting.[17]

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[17] See sections 6.2 and 6.3 of the Vegetation and Habitats Assessment report.

Statutory considerations, including national standards, regional and district plans and other relevant policies

40. The status of ecosystem types regarding statutory ecological significance was assessed using One Plan Policy 13-5 which sets out criteria regarding representativeness, rarity and distinctiveness, and ecological context. The criteria are provided in full in Table 6.A.11 of the Vegetation and Habitats Assessment report.

PROJECT SHAPING

Role in MCA process

41. I was involved as ecology advisor to the NZ Transport Agency on the previous project stage, the Manawatū Gorge Alternative - Detailed Business Case ("**DBC**"). Through the DBC phase, I assessed the ecological aspects and levels of ecological constraint of the 18 corridor options for the purposes of the multi-criteria analysis ("**MCA**") which helped inform the preferred corridor selection.

42. The ecological assessments of the 18 corridors (long-list options) was a valuable exercise (in terms of avoidance) in that a number of corridor options were able to be either ruled out, or scored unfavorably, due to the nature of some of the ecological risks associated with the lands they traversed. I considered a number of the options to be fatally flawed due to the ecological values potentially affected and the inability to avoid adverse effects to those values.

43. Even after careful amendments to the corridor boundaries to avoid important ecological sites, the resulting four short-listed options all presented substantial adverse ecological risks. At the conclusion of the shortlist stage, in ecological terms, there was no clearly preferable corridor alignment (although Option 3, which was developed as the basis for the Project, fared better than the other short-listed options in terms of freshwater ecology, with a 'moderate adverse' rather than 'significant adverse' rating). At the same time, it was clear there would be a requirement to carefully manage ecological constraints within discrete locations in any of the four corridor options.

44. As part of the DBC, I also assessed the ecological implications of six sub-options (i.e., A-F) for connections between the western end of Option 3 (at differing start points) and the existing SH3 southwest of Ashhurst.

Sub-options A and, to a lesser extent, B crossed similar terrain/terrestrial ecosystems to that of the Project and presented moderate adverse risks. Sub-options C to E traversed to the northwest and presented only minor adverse risks. Sub-option F commenced immediately to the north of the Manawatū River crossing and presented only minor adverse ecology risks.

Designation shaping

45. Vegetation and habitats were surveyed and mapped early in the Project timeline and this information was provided to the design team for use as a digital layer when considering design changes.

46. I attended the Project briefing and site visit and contributed to a number of design workshops and conference calls with other technical specialists. I presented information regarding ecological values, effects, and effects management at two mitigation workshops.

47. Regarding the designation extent, I highlighted opportunities to extend the designation to take in potential mitigation sites in a number of locations and these are described in the Design Philosophy Statement provided as an Appendix to the Assessment of Environmental Effects (volume 2). At around CH10400, I recommended that an earlier designation boundary that lay to the south, which took in a large area of regenerating forest, be contracted to the north to exclude the forested area from the designation.

Future shaping - constraints on detailed design

48. As noted above, the area of the Western Rise, immediately north of the Manawatū River (CH4000-4400) has the greatest ecological sensitivity and has high levels of constraint in terms of options to route a road in a manner that avoids features of High and Very High ecological value. Options for routing to the west are diminished by the culturally significant Parahaki Island, and options to the east by the MGSR. These fundamental constraints have made avoidance and minimisation of adverse ecological effects at CH4000-4400 very challenging. Other areas of particular ecological value at CH5600-5800 and CH6100-6400 also present constraints on future detailed design options. While these elements have not yet 'shaped' the Project that has been assessed by other specialists, a significant part of my work has involved assessing potential designs to identify recommended constraints on the future detailed design of the Project in these areas. This process and its outcomes are described further below.

ASSESSMENT OF EFFECTS

Adverse effects on terrestrial vegetation and habitats

General

49. The majority of the designation area is in exotic pasture and areas are of low sensitivity and are not discussed further here.

CH4000-4400 Northern Bridge Landing

50. In the highly constrained reach of the designation area between CH4000-4400, many of the ecological features potentially affected are of Very High ecological value.[18] These ecological features are described in detail in Vegetation and Habitats Assessment report, and can be summarised as:

    (a) Threatened alluvial old-growth forests, of which <2.5% of the vegetation type remains regionally.

    (b) A small remnant stand dominated by 14 mature swamp maire trees, which is a species classified as Threatened-Nationally Critical (de Lange et al., 2018).

    (c) A rare seepage wetland ecosystem.

    (d) A High value unnamed stream ecosystem.

51. As discussed in Sections 6.2 and 6.3 of the Vegetation and Habitats Assessment, the first three of the above ecosystems are both highly vulnerable (they contain highly threatened species or ecosystems) and highly irreplaceable (there are few options for replacing or conserving the potentially affected biodiversity components elsewhere).[19]

52. Analysis of an indicative embankment design through this area indicated that adverse effects on those species or ecosystems would be of Very High adverse level and would be incapable of appropriate mitigation or offsetting, and so that design would not have been supportable on ecological grounds. This led to a broader process, involving analysis of other potential designs, from which I have derived an 'effects envelope' of parameters within which I consider the Project must be designed and constructed, in order to be

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[18] Following the EIANZ (2018) evaluation methodology.

[19] Norton (2008; Principle 3 therein) gave an example of <10% remaining as a threshold for habitats and nationally threatened as a threshold for species, below which clearance was inappropriate under any circumstances and specified the local context would set the level of limits to offsetting.

appropriate in terrestrial ecology terms (considering a recommended package of offset and other mitigation measures).

53. Four potential 3D road alignment designs (representing a range of alignments, to the east and west, between the constraints of Parahaki Island and the MGSR) were assessed. For each potential alignment, the likely impacts of an embankment (i.e., a shorter Manawatū River crossing bridge transitioning to an embankment immediately on the north river bank) and a longer viaduct, with a pier or piers constructed beneath, were assessed. Aspects of these analyses are presented in Section 5.2 of the Vegetation and Habitats Assessment report.

54. My analyses determined that each of the embankment options assessed would have Very High adverse effects on the ecosystems at CH4000-4400 (with permanent effects of a Very High magnitude). Following DOC (2014) and international (Pilgrim et al., 2013) good practice biodiversity offsetting guidance, the combined Very High levels of conservation concern (see Figure 6.A.7 of the Vegetation and Habitats Assessment report) plus permanent and severe residual impact magnitude (Appendix G of the Vegetation and Habitats assessment) indicates levels of effect that are inappropriate for biodiversity offsetting in that there is a lack of certainty that offsetting measures will be effective in appropriately addressing effects on biodiversity (i.e. these effects would be beyond the limits of offsetting).

55. After extensive assessment of design options, involving collaboration with various engineering disciplines within the Project team, I reached the conclusion that due to site constraints and the configuration of these critical ecosystems, there are unlikely to be any available options to construct an embankment within the proposed designation in a manner that could limit the level of effect to less than Very High adverse. This means that a principle of good practice offsetting (BBOP 2012), DOC (2014) and also One Plan Policy 13-4(c)(iv) is unlikely to be achieved with the level of effects that would result from an embankment.

56. A design that would be acceptable based on national ecological impact assessment and offsetting guidance would need to reduce the magnitude and duration of effect to achieve a level of effect less than Very High adverse. This is likely to involve the combination of an alignment that responds to the ecological values and elevates the structure in the form of a viaduct rather than an embankment, to minimise the impact magnitude and to

allow ecosystems to persist and be restored (i.e. not a permanent effect on their overall character).

57. That said, I have identified a recommended effects envelope based on my assessment of the various options - and guided in particular by the level of effects associated with two potential viaduct scenarios that I consider to be acceptable, as assessed in Section 5.2.1 of the Vegetation and Habitats Assessment report (annexed as Appendix 6.A). The parameters of this effects envelope allow for construction of the Project (likely a viaduct, unless another design and construction methodology can be devised to enable construction effects to remain within the envelope) in a manner that would reduce the magnitude and duration of adverse ecological effects on ecological features of Very High and High ecological value to an acceptable level, in my view (taking into account offsetting and mitigation measures).

58. Activities within the effects envelope will:

    (a) cause no more than Moderate **magnitude** of adverse effect, on ecosystems with High or Very High **ecological value**, to ensure that the Very High adverse **effect** level is avoided; if so, effects are likely to be supportable on ecological grounds (with appropriate mitigation/offsetting); and

    (b) cause effects on ecosystems of High or Very High ecological value that are not permanent,[20] in terms of the ecosystem's overall character. Effect duration should be long-term (c. 25 years) or less.

59. In practical terms, by way of illustration, the following effects on ecosystems of particular value (in the relevant part of the proposed designation) would come within the acceptable effects envelope, with appropriate offsetting and mitigation:

    (a) **Threatened old-growth alluvial forests**: no more than 0.1 ha of Moderate magnitude/High level of effect, AND of no more than long-term (c. 25 years) duration, in terms of effects on the overall character of the ecosystem. In practice, this would cover the limited loss of canopy or emergent tiers, or loss of forest vegetation. Crucially, the effect would not be permanent in terms of overall character (notwithstanding that there may be some permanent effects, such as beneath the footprint of a viaduct pier); rather, the effects duration

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[20] This and all other descriptions of effects duration follow EIANZ (2018) Table 8.

would be long-term or less in overall character and would be addressed through remediation plus restoration offsets.

(b) **Threatened-Nationally Critical swamp maire stand**: retention of all trees. Effects of canopy pruning to result in Low or Negligible magnitude of effect, and Moderate or Low level of effect. No permanent adverse effects on overall character of the stand (or indeed on any tree in it, apart from by way of canopy pruning).

(c) **Rare seepage wetland**: no more than 0.13 ha of Moderate magnitude/High level of effect, AND of no more than temporary (c. 15 years) duration. In practice this would allow for construction activities to directly modify no more than 0.13 ha of the seepage. The effects would be temporary in overall character and would be addressed through remediation plus restoration offsets.

(d) **Kānuka forest**: as an ecosystem of Moderate ecological value, even effects of a Very High magnitude could in theory be appropriately offset using the prescribed environmental compensation ratios ("**ECRs**"). That said, I understand that disturbance of the kānuka forest could likely be limited to an area of no more than 1 ha, which I would support as the retained kānuka forest would assist with the mitigation and offset treatments I discuss below (e.g., retirement, protection, and gap planting).

CH5600-5800 and CH6100-6400 - QEII areas

60. Two other areas of particular ecological sensitivity are the QEII protected sites located at CH5600-5800 ("**Western QEII**") and CH6100-6400 ("**Eastern QEII**").

61. The Western QEII, where it is crossed by the proposed designation at CH5600, contains Very High value old-growth forest,[21] and High value broadleaved forest in advanced stages of regeneration, as well as High value freshwater tributaries.

62. In respect of this area I went through a similar process to that described above. After extensive assessment of design options, involving collaboration with various engineering disciplines within the Project team, I reached the conclusion that due to site constraints and the configuration of the protected

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[21] Representative of pre-human rimu/tawa-kamahi forests, 19.5% of this ecosystem type remains in the Horizons region.

forest, there were no available options to avoid Very High adverse effects. However, the old-growth forest at this location is of lesser vulnerability than the alluvial old-growth forest at CH4000-4400 and there are options immediately adjoining the affected forest for restorative replacement planting and pest control. In my opinion, the effect to the old-growth forest is able to be addressed by offsetting, but it is critical that detailed design is rigorous in application of measures to limit the effect duration (i.e., minimise permanent effects) and magnitude/severity (i.e. minimise the extent of clearance).

63. Likewise, the effect on the High value advanced secondary broadleaved forest would be Very High, as would the effect on the High value tributaries. Detailed design must take steps to limit the duration and magnitude of effect to these High value ecosystems.

64. Again, as with the CH4000-4400 section discussed above, in my view the detailed design process must be constrained by an envelope of effects in these areas.

65. As part of the process of identifying such an envelope, four differing alignments for crossing the gully containing the Western QEII were examined. Three of these were near the crossing point shown as the current indicative design on the NoR drawings (the indicative design is one of these options) and one option that crossed the gully close to the northwest corner of MGSR, where the vegetation and habitats crossed are of less value, was assessed.

66. Aspects that limited the potential to minimise impacts to vegetation and habitats were design limits on the grade, curve geometry and elevation of the alignments as they ascended the Western Rise. This combination of design parameters meant that the southernmost crossing near the MGSR could not be progressed as an option. Due to the grade restrictions on road design, where the alignment crosses the ridgeline (at CH5600), the alignment is low relative to the ridge. Further, the ridgeline ascends to the north meaning the further the alignment is to the north the greater the cut and consequential impact on the old-growth forest. I recommended the southern-most alignment for this reason and on the basis of the ecological value and conservation concern of the old-growth forest. Recommendations were made to bridge and use retaining walls at the crossing of the stream tributary at this site (CH5800) to minimise both forest and stream impacts.

67. Nonetheless, to reflect my view that other potential design options might have similarly acceptable effects, I have prescribed an effects envelope as specified in Table 6.A.15 of the Vegetation and Habitats Assessment report. Effects to the ecosystems beyond this envelope should not be permitted, in accordance with my recommendations. The effects envelope can be summarised as no more than 1 ha of old-growth (hill country) and 0.5 ha advanced secondary broadleaved forest (with retained forests in these ecosystem types to be protected).

68. At the Eastern QEII, three alignment options were assessed where the road crossed the forested (secondary broadleaved) gully. In all of these options the alignment crossed this area at a low elevation meaning there would be insufficient height to bridge the waterway and forest. Of the options, I recommended the northernmost on the basis that it minimised effects on the best quality forest, reduced the fragmentation effect (no longer would any forest be retained to the north of the road) and minimised the number of tributary streams that were crossed.

69. Nonetheless, for the crossing of the Eastern QEII site (CH6100-6400), I have prescribed an effects envelope (Section 5.3.3 of the Vegetation and Habitats Assessment) comprising limits on disturbance beyond the extent of cut and fill. Tracking and ancillary works should be minimised in indigenous vegetation (irrespective of composition) and stream ecosystems at this location.

Other valued areas within the proposed designation

70. Otherwise, there are a number of ecosystems within the designation where effects the Project's effects will need to be managed carefully. For example, the alignment makes perpendicular crossings of a number of waterways between CH6400-8600, and I recommend that retaining walls be used where possible to reduce the extent of fill in gullies as this would reduce the extent of impact on freshwater ecosystems.

71. Further, on the Eastern Rise, three options were investigated to reduce the length of interaction between the road and the stream around CH12100-12700. I recommend that the southernmost option be favoured, if possible, as this would avoid direct interactions with the stream.

72. That said, across the balance of the designation (i.e., other than in CH4000-4400 and the QEII areas), in my view it is acceptable, in ecological terms, for

construction activities to proceed with minimal constraint, provided recommended mitigation and offsetting measures are implemented. The sites discussed with regard to effects envelopes above contain High and Very High levels of ecological value, meaning that constraints are necessary to minimise the level of adverse effect. However, the lower value terrestrial ecosystems can be more readily replaced through restorative planting and adverse effects to fauna inhabiting these ecosystems can be mitigated by pre-clearance intensive surveys. On this basis, permission is sought to potentially clear all native shrublands (4.12 ha) and secondary broadleaved forests and scrublands (16.32 ha) that have been mapped (Figure 6.1) within the designation. The conditions and Ecological Management Plan will specify steps to be taken to minimise the disturbance and loss of native shrublands and secondary forests and scrubland. However, even the effects of complete clearance could effectively be offset through replacement restorative planting required through the proposed designation conditions.[22]

73. Effects of severance and fragmentation on existing forest habitats are difficult to remediate because the effect is permanent. These effects can be mitigated through delivering the configuration of restorative plantings (those required for both landscape and ecological mitigation purposes) in a manner that buffers existing sites and connects sites that are currently isolated.

74. Where partial clearance of forest stands is necessary, edge effects on a remaining forest stand are inevitable and could extend up to 50 m into the stand (Young & Mitchell, 1994). Restorative buffer planting would be required to seal, and where space allows, buffer, the newly created forest edge and thereby reduce the influence that the surrounding environment had on the microclimate and assemblages within the forest edge zone.

75. An overall summary of levels of adverse effect (including the recommended effects envelopes) on terrestrial vegetation and habitats is reproduced below in **Table 6.4** (from Table 6.A.16 of the Vegetation and Habitats Assessment report). This table represents a 'worst case' of effects in terrestrial ecology terms, in that it assumes clearance of all vegetation within the proposed designation, subject to the 'effects envelopes' and other constraints I have identified.

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[22] Again, as noted above, those ecosystem types are not considered significant when assessed against Policy 13-5 criteria.

Table 6.4. Estimates of activities, their locations, and the resulting temporal scale, magnitude and level of adverse effects

Activities	Description	Location(s)	Temporal scale	Magnitude of effect	Level of effect
Vegetation clearance and modification of lower value (Moderate-Low value) ecosystem types	Potential designation-wide clearance of secondary broadleaved forest and scrublands and native shrublands	Designation wide	Temporary (medium term - *c*. 15 years)	Potentially Very High, as all of these ecosystem types could be cleared within the designation area. Likely to be Moderate with avoidance measures applied	High-Moderate
Vegetation clearance and modification of higher value (Moderate-Very High value) ecosystem types	Restricted clearance and modification of old-growth forests and treelands, secondary forests containing old-growth signatures, advanced broadleaved forest, kānuka and seepage wetlands	▪ 0.10 ha[23] of alluvial old-growth forest CH4000-4400	Long term (*c*. 25 years)	Moderate	High
		▪ 1 ha of hill country old-growth forest CH5650	Permanent (replacement not possible)	Very High (assuming the remaining area is avoided at CH5600)	Very High
		▪ 2.2 ha secondary forest containing old-growth signatures CH7300, 10500-10700	Long term (*c*. 25 yrs.)	High (assuming 0.41 ha avoided at CH6100)	Very High
		▪ 0.5 ha of advanced secondary broadleaved forest CH5700-5800	Long term (*c*. 25 yrs.)	High (assuming the remaining area is avoided at CH5750-5850)	Very High
		▪ 1 ha of kānuka forest (likely) at CH4200, minimise kānuka clearance elsewhere	Medium term (c. 15 years)	Moderate	Moderate
		▪ 0.13 ha of raupō seepage wetland CH4200[24]	Long term, (remediation possible)	Moderate, assuming direct effects avoided to remaining 0.42 ha	High
		▪ A remnant stand of 14 swamp maire CH4150	Long term (*c*. 25 yrs.)	Low or Negligible, assuming all swamp maire are retained, with some canopy pruning	Moderate or Low

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[23] In addition, 0.05 ha has been allowed for minor old-growth forest clearance associated with the access track from Saddle Road across S. Bolton's land to the vicinity of CH4000.

[24] In addition, permanent loss of 0.39 ha of moderate value seepage wetland is assumed in the effects and offset calculation.

Activities	Description	Location(s)	Temporal scale	Magnitude of effect	Level of effect
Habitat fragmentation isolation	Severance of existing habitats resulting in one or more isolated habitat fragments	Dependent on final design	Permanent where replacement planting cannot remedy the severance or reconnect the fragment with an adjacent habitat	High, fragmentation and isolation would result in major loss and alteration of baseline conditions, attributes would be fundamentally changed	Very High-Low
Edge effects	Opening and exposing a forest edge to an open adjacent landscape	Dependent on final design	Temporary (medium term - 5-15 years)	Moderate, post-development character will be partially changed but minimised through buffer planting	Very High-Low

Adverse effects on terrestrial faunas

76. Effects on lizards, terrestrial invertebrates, avifauna and bats are discussed in Section 6 of the Terrestrial Fauna Assessment report (in **Appendix 6.B**). The drivers of the Project's adverse effects among the above fauna groups would be similar and can be summarised as:

    (a) injury or mortality during vegetation clearance and earthworks;

    (b) disturbance during critical nesting periods (birds);

    (c) permanent loss of habitats;

    (d) modification of habitats in the form of:

        (i) increased fragmentation and isolation due to reduced habitat connectivity;

        (ii) creation of edge effects and consequential effects to composition, structure and food sources in retained habitats; and

        (iii) invasions and corresponding impacts of non-native plant and animal species.

77. Further intensive survey work is required to confirm the status of long-tailed bat populations in the designation area and provide the ability to assess the effect on bats. Section 7.4 of the Terrestrial Fauna Assessment report provides an approach to address this current uncertainty.

78. The Terrestrial Fauna Report records the uncertainty in respect of which herpetofauna and invertebrate communities are present in the Project corridor. Taking a conservative approach, the Report records that non-grazed areas have a High value for herpetofauna and that parts of the corridor have value for invertebrates ranging from Moderate-Low to High, with the remainder of the corridor being of Negligible-Low value for invertebrates.

79. It has been determined that the alignment corridor is potentially utilised by 19 notable indigenous avifauna species for various activities (such as nesting, foraging and/or roosting), including four Threatened species and 15 At-Risk species. These species are considered to have Very High (Threatened species) or High ecological value (At-Risk species).

80. Summary ratings of adverse effects to fauna are given in the Terrestrial Fauna Assessment report for lizards, terrestrial invertebrates, and birds and are not repeated here.

MEASURES TO AVOID, REMEDY OR MITIGATE ACTUAL OR POTENTIAL ADVERSE (TERRESTRIAL ECOLOGY) EFFECTS

Terrestrial vegetation, habitats and fauna

81. Adverse effects to terrestrial vegetation and habitats will be addressed through avoidance and minimisation of effects to High and Very High value ecosystems through the effects envelopes approach discussed above. Of particular importance, this achieves avoidance of Very High magnitude adverse permanent effects to those features of Very High levels of conservation concern, for which clearance is inappropriate and offsetting not feasible.

82. For ecosystem types that can be replaced through restorative planting, replacement planting is proposed at the ECRs shown in **Table 6.5**. These ECRs are essentially multipliers by which the total affected area is multiplied to derive a replacement planting quantum. The ECRs are based on my expert judgement and their range of values considers the spatial area and quality (including considerations of scarcity) of the ecosystem types affected, and makes provision for time lag for delivery, risk of failure and uncertainty of outcome. In recommending these ECRs, I have also benchmarked the values to the extent I deem appropriate with the ECRs required for similar roading projects.[25] The mitigation/restoration ECRs for these ecosystem types range from 1:1 (native shrublands) to 5:1 (kānuka forests, old-growth treelands, and secondary broadleaved forests with old-growth signatures).

83. For the most threatened/rare/vulnerable and irreplaceable/complex ecosystems/features (old-growth forests, the seepage wetland and the nationally critical swamp maire), an approach of addressing adverse effects by replacement planting would not replace the full spectrum of biodiversity attributes lost. Instead, a package[26] of complementary, permanent, positive

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[25] Table 11-50 of Transmission Gully Technical Report 11; Tables 6 and 8 of MacKays to Peka Peka EMP Attachments 1 and 5 respectively; Peka Peka to Otaki Draft Ecological Management Plan (Section 6); Table 4.1 of Mount Messenger Technical Report 7h.

[26] It should be noted that although I considered using the DOC's Microsoft Excel-based biodiversity offset calculator (Maseyk et al., 2015) to develop the offset package, my concerns over the ability of the model to adequately capture the complexity of biodiversity attributes present in this case meant that I instead have developed a bespoke package based on ecological science and principles, expert judgement and peer review, applied to the present context.

effects/restoration measures is needed to replace the lost biodiversity features to a level that a net biodiversity gain is achieved.

84. The net biodiversity gain outcome is important, both in terms of biodiversity offsetting (DOC, 2014) and ecological impact assessment (EIANZ, 2018) good practice guidance and the One Plan policy requirements. In particular, Policy 13-4 of the One Plan prescribes a net gain biodiversity outcome in response to a proposal's more than minor adverse effects in rare or threatened habitats.[27]

85. I understand that the NZ Transport Agency is to put forward a designation condition that requires offsetting to achieve a net indigenous biological diversity gain, with reference to the direction given by Policy 13-4.

86. It is my professional opinion that the restoration treatments in items (a) and (c) below would achieve and maintain a net biodiversity gain position. To achieve a net gain position, the lost habitat area must be replaced (i.e., habitat creation) in a like-for-like manner and with an additional area to address the time lag and uncertainties associated with establishing a native forest successional trajectory. Item (c) is relevant given the ongoing adverse effects that pests have on the forest and wetland biodiversity components that are subject to offset measures. Thus, the adverse effects of pests on like ecosystems must be addressed to achieve and maintain a net gain biodiversity position. Item (b) can also make an important contribution to biodiversity net gain as retiring, protecting and gap planting the existing forest ecosystems constitutes an enhancement of existing habitat immediately adjacent to a main area of impact (CH4000-4400) and restoration of these forests also makes a significant contribution in a landscape ecology sense, securing and strengthening an ecological corridor between MGSR and Ashhurst Domain. The precise scale of the biodiversity offset package would depend on the design and how that is constructed, and thus the end scale of effects.

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[27] In this case, these are the old-growth forests and treelands, secondary forests with old-growth signatures, seepage wetlands, and kānuka forests. Policy 13-4 also envisages a net gain outcome in respect of more than minor adverse effects in at-risk habitats assessed to be significant in terms of Policy 13-5, and significant (residual) adverse effects in at-risk habitats not assessed to be significant - neither of these categories apply in this case.

87. In my assessment, based on the potential adverse effects of works within the designation corridor, a biodiversity offset package that achieves a biodiversity net gain would include the following components:

(a) Replacement planting using like-for-like composition and physiography to ensure there is a significant overall increase in the affected extent of affected ecosystems. Replacement planting is required following ECRs ranging from 4:1 to 12:1 listed in **Table 6.5** below and were developed taking into account the same considerations as for the mitigation ECRs described above. Particularly important are the like-for-like replacement planting sites for addressing impacts to old-growth forest ecosystem types. Initial discussions with Palmerston North City Council and Manawatū District Council officers have indicated approximately 14 ha of alluvial floodplain that is currently grazed could (in principle) be available at Ashhurst Domain for ecological planting to replace lost alluvial old-growth forests (the availability of this site is subject to Council confirmation). Potential sites for hill country old-growth forest replacement planting are numerous as indicated as areas 2, 3, 4 and 5 in Figure 6.A.9 of the Terrestrial Vegetation and Habitats Assessment report.

(b) Legal and physical protection (in perpetuity), including retirement from grazing, of existing forests located in close proximity to the location of effects. This action would require the NZ Transport Agency to secure a significant area of existing and degraded forests. One option for protection, retirement and gap planting is shown on Figure 6.A.9 of the Terrestrial Vegetation and Habitats Assessment report. Restorative planting is an important component of this treatment - through planting canopy gaps and clearings with suitable forest species the process of forest restoration is accelerated. The protection, retirement, and gap planting treatment would have the added benefit of securing landscape connectivity, effectively extending the boundary of the existing forest that is managed as MGSR and providing a habitat connection towards the Ashhurst Domain.

(c) Long-term (in perpetuity) integrated pest control is offered across all mitigation planting and offset replacement planting areas and also the existing forests that would be legally and physically protected, retired from stock grazing, and existing gaps/clearings planted with native tree species. Suitable pest control could cover possums and rats to achieve and maintain either a 5% residual trap catch/tracking index score or, if this monitoring method or target proves inappropriate for the configuration of control areas, an alternative outcome-related target (e.g., foliar browse) will be specified in the Ecological Management Plan. Further work is required to determine the optimal configuration for animal pest control, this might include for example a collaboration with DOC on a nearby project targeting animal pests specific to that project. Plant pest control will target pest species that threaten the regeneration and/or long-term maintenance of forest plants (e.g., shade tolerant species (e.g., barberry) or light demanding vines (e.g., old man's beard); not gorse or broom). This will enhance the terrestrial vegetation and habitats and associated biodiversity values of the mitigation and offset areas. Pest control will ensure that the permanent losses in biodiversity are permanently addressed, and that the net-gain position in biodiversity is maintained in the long term.

88. Potential sites and configuration of mitigation and offset treatments are discussed and mapped in Figure 6.A.9 of the Terrestrial Vegetation and Habitats Assessment report and are not discussed further here. Other potential sites on privately-owned hill country in the eastern study area and hill country and alluvial sites to the west of the study area are also being investigated at the time of writing.

89. Edge effects will be addressed through restorative buffer planting.

Table 6.5. Mitigation and offset quantities.

Mitigation quantities			
Ecosystem type	**Area actually/potentially affected (ha)**	**ECR**	**Replacement planting requirement (ha)**
Secondary Broadleaved Forests with Old-Growth Signatures	3.07	5	15.35
Old-Growth Treelands	0.41	5	2.05
Kānuka Forests	1.59	5	7.95
Advanced Secondary Broadleaved Forests	2.93	4	11.72
Secondary Broadleaved Forests and Scrublands	16.32	3	48.96
Manuka, Kānuka and Divaricating Shrublands	4.12	1	4.12
Mitigation replacement planting total area			90.15
Swamp maire mitigation planting are to be at the rates of 1:100 for damage (but retention); and 1:200 for unforeseen permanent loss			
Offset quantities			
Old-Growth Forests (Alluvial)^	0.15	12	1.8
Old-Growth Forests (Hill Country)^	1	10	10
Raupō Dominated Seepage Wetlands (High Value)	0.13	4	0.52
Indigenous-Dominated Seepage Wetlands (Moderate Value)	0.56	2	1.12
Offset replacement planting total area			13.44
Other treatments in the offset package			**Area required (ha)**
Retirement, protection and canopy gap planting			c. 32
Integrated pest control[28] in perpetuity over the entire replacement planting and retirement, protection and gap planting treatment areas, or a similar suitable alternative pest control project			135.59

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[28] Animal pest control will address brushtail possums and rats and will maintain the density of those species below a 5% residual trap catch/tracking index. If this monitoring method or target proves inappropriate for the configuration of control areas, an alternative outcome-related target (e.g., foliar browse) will be specified in the Ecological Management Plan. Plant pest control will target pest species that threaten the regeneration and/or long-term maintenance of forest plants (e.g., shade tolerant species (e.g., barberry) or light demanding vines (e.g., old man's beard); not gorse or broom).

90. The Project's adverse effects on fauna from vegetation and habitat loss are directly addressed through the replacement planting and offset measures discussed above. It is also important that loss and disturbance of valuable fauna habitats will be avoided or otherwise minimised as far as practicable; the ECRs provide an incentive for constructors to achieve this.

91. Disturbance of fauna during critical breeding seasons will be addressed through provisions detailed in the Ecological Management Plan regarding the scheduling of works outside of critical periods or, if not possible, through preconstruction surveys and constraints on works during specific time periods of high sensitivity. Effects to birds will be addressed through:

    (a) a preclearance survey for cryptic bird species potentially inhabiting the raupō seepage, and for Whitehead in forests of the Western Rise, if works are required during their nesting season,

    (b) measures to address risks to Pipit in grassland habitats during their breeding season, and

    (c) seasonal management protocols to address potential effects to riverbirds associated with the Manawatū River crossing.

92. Effects to lizards will be addressed through intensive searches of impacted habitats for the purposes of salvage and relocation of resident lizards to suitable and secure habitats prior to disturbance.

93. Effects and mitigation required to address effects on long-tailed bats is to be addressed through further intensive bioacoustics bat surveys (which are programmed) and specific management plan provisions that respond to the survey results.

94. Regarding terrestrial fauna, I support the conclusion in Section 8 of the Terrestrial Fauna Assessment report that following full implementation of mitigation measures, the level of adverse effect would be Very Low-Low, with a net benefit being realised over time.

95. Indeed, with adherence to the effects envelopes recommended for areas of High and Very High ecological value/conservation concern, and with the mitigation and offset treatments described herein, it is my opinion that the effects management and positive effects proposed will result in a better configuration and level of ecological function of terrestrial vegetation and habitat than currently exists. Key aspects underpinning this position is that

all replacement plantings will be like-for-like, including restoration of highly threatened forest ecosystems (alluvial forest) and species (nationally critical swamp maire). Replacement plantings will be of an improved configuration in that the replacement plantings will be large and contiguous, joining existing fragmented sites where possible, and enhancing landscape scale connectivity, and significantly expanding the size of the (already large and high quality) MGSR.

96. Following full implementation of mitigation and offset proposals, it is my opinion that a net-gain position for terrestrial biodiversity would result from the Project (as will be required by the proposed designation condition, by reference to Policy 13-4).

97. Conditions are required to address the following aspects of terrestrial ecology:

    (a) Preparation of an Ecological Management Plan, covering:

        (i) Identification of ecological values (which would be based on the information present in this assessment and supporting documentation updated and expanded as necessary);

        (ii) Objectives and methods to demonstrate how effects on terrestrial biodiversity will be monitored, managed, and mitigated, including but not limited to:

            (1) Indigenous ecosystems/valued vegetation;

            (2) Lizards;

            (3) Bats;

            (4) Terrestrial invertebrates; and

            (5) Breeding bush, wetland, and riverbed birds;

        (iii) Application of effects envelopes;

        (iv) Staff training on ecological requirements;

        (v) Use of ecosourced plant material, particularly regarding swamp maire, to ensure local genetic diversity is retained;

        (vi) Measures to prevent plant pest introductions;

(vii) Salvage and transfer materials (soils, woody debris) for use in ecological mitigation areas;

(viii) Animal pest management; and

(ix) A plan for the delivery of mitigation and offset requirements including:

(1) Mitigation/offset principles;

(2) A programme for delivery;

(3) Species lists;

(4) Site locations and boundaries;

(5) Confirmation of restoration treatment components;

(6) Nature and duration of legal and physical protection;

(7) Proposed management and monitoring;

(8) Measures and thresholds of mitigation and offset success; and

(9) Procedures should mitigation and offset measures not be successful;

(b) Preparation of a Lizard Management Plan; and

(c) Preparation of an Avifauna and Bat Management Plan.

CONCLUSION AND RECOMMENDATIONS

98. The designation area within which the Project is proposed to be constructed contains 10 indigenous ecosystem types covering a combined area of 38.5 ha. The 10 terrestrial ecosystems can be regarded as habitats for policy purposes. Ecosystem/habitat values range from Very High (old-growth forests) to Low (native shrublands).

99. The proposed designation area contains fauna species representative of shingle riverbeds, native forest, and mixed pastoral landscapes. Highest avifauna values are associated with the Manawatū Riverbed, forest, wetland and scrubland ecosystems/habitats between CH4000 and 5800. Seven lizard species are potentially present and terrestrial invertebrate values are expected to be highest within intact old-growth forests connected to protected

areas. Further survey work is required to determine bat presence, following which effects and any necessary management response can be prescribed.

100. Measures are required to minimise effects to terrestrial ecosystems. Effects envelopes have been prescribed for specific areas of particular ecological value and conservation concern. These measures would include limiting clearance to agreed extents, buffer planting to address edge effects in retained vegetation, restoring damaged ecosystems to reduce the magnitude and duration of effect. In the area CH4000-4400, the use of a viaduct rather than an embankment is likely to be a design decision critical to achieving an acceptable level of adverse ecological effects.

101. Intensive pre-construction/clearance surveys for fauna species of conservation concern are required. This would include salvage and relocation of lizards, survey and avoidance/minimisation of works impacts on birds during critical nesting seasons, minimising impacts on indigenous ecosystems to minimise the impact on terrestrial invertebrates.

102. To ensure that adverse effects on ecology are appropriately managed, it is recommended that the approaches to effects management set out herein and, in the Vegetation, and Habitats Assessment and Terrestrial Fauna Assessment reports are implemented in full.

103. It is recommended that the mitigation and offset proposal specified in the Vegetation and Habitats Assessment report is implemented in full so as to demonstrate the attainment of a net-gain position in biodiversity in terms of Policy 13-4.

104. With adherence to the effects envelopes recommended for areas of High and Very High ecological value/conservation concern, with other effects management measures adopted, and with full implementation of mitigation and offset proposals, it is my opinion that a net-gain position for terrestrial biodiversity would result from the Project.

Dr Adam Forbes

BIBLIOGRAPHY

BBOP. (2012). Standard on biodiversity offsets. Washington, D.C. BBOP. Retrieved from https://www.forest-trends.org/wp-content/uploads/imported/BBOP_Standard_on_Biodiversity_Offsets_1_Feb_2013.pdf

de Lange, P.J., Rolfe, J.R., Barkla, J.W., Courtney, S.P., Champion, P.D., Perrie, L.R., Beadel, S.M., Ford, K.A., Breitwieser, I., Schonberger, I., Hindmarsh-Walls, R., Heenan, P.B., Ladley, K. 2018: Conservation status of New Zealand indigenous vascular plants, 2017. New Zealand Threat Classification Series 22. Wellington: Department of Conservation. Retrieved from: https://www.researchgate.net/publication/325556614_Conservation_status_of_New_Zealand_indigenous_vascular_plants_2017

DOC. (2014). Guidance on Good Practice Biodiversity Offsetting in New Zealand. Retrieved from https://www.doc.govt.nz/Documents/our-work/biodiversity-offsets/the-guidance.pdf

EIANZ. (2018). Ecological Impact Assessment (EcIA). EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems [2nd edition]. Retrieved from https://www.eianz.org/document/item/4447

Leathwick, J., Morgan, F., Wilson, G., Rutledge, D., Mcleod, M., Johnston, K. (2003). Land environments of New Zealand: A technical guide. Retrieved from https://www.landcareresearch.co.nz/resources/maps-satellites/lenz/products/land-environments-of-new-zealand-technical-guide

Leathwick J.R., McGlone M., Walker S., & Briggs C.M. (2005). Predicted potential natural vegetation of New Zealand. Lincoln, Manaaki Whenua Press. [Poster]

Millar, K. (2018). Te Ahu a Turanga. Freshwater - Ecological Impact Assessment. Prepared for New Zealand Transport Agency. Tauranga: Boffa Miskell.

Norton, D. A. (2009). Biodiversity offsets: two New Zealand case studies and an assessment framework. *Environmental Management*, *43*(4), 698-706.

Pilgrim, J. D., Brownlie, S., Ekstrom, J. M., Gardner, T. A., von Hase, A., Kate, K. T., ... & Ussher, G. T. (2013). A process for assessing the offsetability of biodiversity impacts. *Conservation Letters, 6*(5), 376-384.

Robertson, H. A., Baird, K., Dowding, J. E., Elliott, G., Hitchmough, R., Miskelly, C., McArthur, N., O'Donnell, C. F. J., … & Taylor, G. (2017). Conservation status of New Zealand birds, 2016. Wellington: Department of Conservation.

Walker, S., Cieraad, E., & Barringer, J. (2015). The Threatened Environments Classification for New Zealand 2012: A guide for users. Lincoln: Landcare Research.

Young, A., & Mitchell, N. (1994). Microclimate and vegetation edge effects in a fragmented podocarp-broadleaf forest in New Zealand. *Biological Conservation, 67*(1), 63-72.

APPENDIX 6.1: TERRESTRIAL VEGETATION AND HABITATS ASSESSMENT REPORT

APPENDIX 6.2: TERRESTRIAL FAUNA ASSESSMENT REPORT

6.A

ASSESSMENT OF TERRESTRIAL VEGETATION & HABITATS

Forbes Ecology

Te Ahu a Turanga – Manawatū Tararua Highway Project

Assessment of Terrestrial Vegetation and Habitats

Report prepared for the New Zealand Transport Agency

Table of Contents

EXECUTIVE SUMMARY 6

1.0 INTRODUCTION 9
  1.1 BACKGROUND 9
  1.2 REPORT OBJECTIVES 10

2.0 METHODS 11
  2.1 VEGETATION AND HABITAT DESCRIPTIONS AND MAPPING 11
  2.2 ECOLOGICAL VALUES ASSESSMENT 12
  2.3 ECOLOGICAL SIGNIFICANCE ASSESSMENT 13
  2.4 ECOLOGICAL EFFECTS ASSESSMENT 14
    2.4.1 Ecological management response 17

3.0 INDIGENOUS VEGETATION AND HABITATS 18
  3.1 ECOLOGICAL VALUES 18
  3.2 LEVELS OF ECOLOGICAL VALUE 18

4.0 ECOLOGICAL SIGNIFICANCE ASSESSMENT 33
  4.1 ASSESSMENT OF ONE PLAN CRITERIA 33

5.0 VEGETATATION CLEARANCE/MODIFICATION ACTIVITIES AND EFFECTS 37
  5.1 CLEARANCE OR MODIFICATION OF INDIGENOUS VEGETATION AND HABITATS 37
    5.1.1 Habitat fragmentation and isolation 38
    5.1.2 Edge effects 38
  5.2 MAGNITUDES AND LEVELS OF ADVERSE EFFECTS 38
    5.2.1 Immediately north of the Manawatū River crossing (CH4000–4400) 39
  5.3 EFFECTS ENVELOPES 47
    5.3.1 North of Manawatu River Crossing (CH4000–4400) 47
    5.3.2 Western QEII covenant (CH5600–5800) 48
    5.3.3 Eastern QEII covenant (CH6100–6400) 49
  5.4 DESIGNATION WIDE (EXCLUDING MITIGATION AND PROTECTED VEGETATION AREAS) 49

6.0 EFFECTS MANAGEMENT 53
  6.1 MITIGATION AND OFFSETTING PRINCIPLES AND FRAMEWORKS 53
    6.1.1 The mitigation hierarchy 53
    6.1.2 BBOP (2012) biodiversity offsetting principles 54
    6.1.3 One Plan biodiversity offset policy direction 55
  6.2 ASSESSMENT OF OFFSETABILITY OF AFFECTED ECOSYSTEM TYPES 56
  6.3 LIMITS TO OFFSETTING FOR ECOSYSTEMS WITHIN THE DESIGNATION AREA 58
  6.4 AVOIDANCE, MINIMISATION, REHABILITATION/RESTORATION, OFFSETTING PROPOSED 63
  6.5 PROPOSED MITIGATION AND OFFSET AREAS 66

6.0 RECOMMENDATIONS 69

REFERENCES 70

Appendices

Appendix A: Photographs of Examples of Ecosystem Types within the Proposed Designation Area
Appendix B: Forest Dominance (Point-Centred Quarter) Survey Data
Appendix C: Recce Survey Data
Appendix D: Forest Condition (FORMAK) Assessment Data
Appendix E: Assumptions Regarding Construction Access Requirements
Appendix F: Assessment of Offsetability (following Pilgrim et al., (2013) Table 2)
Appendix G: Assessment of Threatened Flora (Singers & Bayler, 2018)

Table of Figures

Figure 6.A.1. Overview of the proposed designation area. The proposed designation area and Notice of Requirement indicative design are shown in blue. 9
Figure 6.A.2. Distribution of indigenous ecosystem types within the proposed designation area. Note, ecosystems within the designation but not mapped are within areas assumed to be clear of works (e.g., in mitigation areas) and thus are not included in the scope of effects/mitigation/offset. 20
Figure 6.A.3. Key features of High and Very High ecological value located within the CH4000–4400 reach. Note, kānuka is the common name for a number of species in the genus Kunzea. 45
Figure 6.A.4. Embankment design options from preliminary indicative design (blue/easternmost) and detailed business case (DBC; red/westernmost) used for effects envelope predictions. The relevant vegetation polygons shown are green = old-growth forest (inc. swamp maire stand), blue = seepage, purple/red shades = kānuka. 45
Figure 6.A.5. Process of assessing offsetability (Figure 1 from Pilgrim et al. (2013), reproduced). 57
Figure 6.A.6. Reproduction of Figure 2 of DOC (2014), illustrating the format of ranking biodiversity conservation concern in terms of irreplaceability and vulnerability. 57
Figure 6.A.7. Levels of conservation concern for ecosystems within the proposed designation area as defined by the combination of vulnerability and irreplaceability (format follows Figure 6.A.6). 61
Figure 6.A.8. Offsetability as indicated by the relationship between conservation concern and likelihood of offset success. Taken from Figure 2 of Pilgrim *et al.* (2013). 62
Figure 6.A.9. Potential mitigation/offset replacement planting and retirement areas. Treatments are numbered in order of preference applying ecological principles. More area is identified than would be needed. 68

Table of Tables

Table 6.A.1. Criteria for describing magnitude of effect (EIANZ, 2018). 16
Table 6.A.2. Criteria for describing level of effect (EIANZ, 2018). 16
Table 6.A.3. Timescales for duration of effects (EIANZ, 2018). 16
Table 6.A.4. Ten ecosystem types located within the proposed designation boundaries......18

Table 6.A.5. Ecological values assessment of old-growth forests and treelands within the proposed designation area. 21
Table 6.A.6. Ecological values assessment of secondary broadleaved forests with old-growth signatures within the proposed designation area. 23
Table 6.A.7. Ecological values assessment of advanced secondary broadleaved forests and secondary broadleaved forests and scrublands within the proposed designation area.25
Table 6.A.8. Ecological values assessment of mature kānuka forest within the proposed designation area. 27
Table 6.A.9. Ecological values assessment of native shrublands within the proposed designation area. 29
Table 6.A.10. Ecological values assessment of indigenous–dominated wetlands within the proposed designation area. 31
Table 6.A.11. Ecological significance assessment (applying One Plan criteria) of indigenous ecosystem types located within the designation area. 34
Table 6.A.12. Ecosystem types for which full clearance is sought versus clearance constrained. 37
Table 6.A.13. Summary of effects scenarios for embankment and viaduct options over CH4000–4400. 46
Table 6.A.14. Level of effect description (EIANZ, 2018) for Western QEII crossing. 48
Table 6.A.15. Effects envelopes for Western QEII crossing CH5600–5800. 48
Table 6.A.16. Estimates of activities, their locations, and the resulting temporal scale, magnitude and level of adverse effects 50
Table 6.A.17. Relative levels of conservation concern (as defined by the combined rating of irreplaceability and vulnerability) of ecosystems within the proposed designation. 60
Table 6.A.18. Summary comparison of likelihood of offsetting biodiversity loss from embankment versus viaduct options on the threatened-nationally critical swamp maire stand and the rare seepage ecosystem. 62
Table 6.A.19. Mitigation and offset quantities. 65

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Cover photograph:
Aerial view of the Manawatū Gorge showing the forests of the Manawatū Gorge Scenic Reserve, the Manawatū River, and the existing road (July 2018).

EXECUTIVE SUMMARY

The New Zealand Transport Agency (NZTA) is seeking planning approvals under the Resource Management Act (1991) to designate land for the purposes of an alternative State Highway route across the Ruahine Range. Forbes Ecology was engaged to provide an assessment of Terrestrial Vegetation and Habitats within the proposed designation, the associated actual and potential effects, and how those effects should be managed.

The composition, structure and condition of terrestrial vegetation and habitats were surveyed using both quantitative and qualitative survey techniques during August 2018. Ecological values and effects were assessed using current best practice methods (Environment Institute of Australia and New Zealand [EIANZ], 2018) for evaluating ecological values in the impact assessment framework. The ecological (statutory) significance of terrestrial vegetation and habitats was assessed using the criteria set out in Policy 13-5 of the Horizons One Plan. Effects management was structured around the mitigation hierarchy and good practice biodiversity offsetting guidelines (Business and Biodiversity Offsets Programme [BBOP], 2012; Department of Conservation [DOC], 2014). Terrestrial vegetation and habitats were assessed as to their status regarding the limits of offsetting (Pilgrim et al., 2013).

Of the proposed designation area, 38.5 ha (c. 10%) comprises terrestrial vegetation and habitats which are classified (based on composition, structure, and condition) into the following ten distinct ecosystem types and areas, ranging in ecological value from Very High to Low. Seven ecosystem types are assessed as significant regarding One Plan Policy 13-5.

Ecosystem type	Value level	RMA s6(c)	Area (ha)
Old-Growth (OG) Forests (Alluvial)^	Very High	Yes	4.23
OG Forests (Hill Country)	Very High	Yes	1.78
Secondary Broadleaved Forests with OG Signatures	High	Yes	3.07
OG Treelands	High	Yes	0.41
Advanced Secondary Broadleaved Forests	High	No	2.93
Raupō Dominated Seepage Wetlands (High Value)	High	Yes	0.55
Secondary Broadleaved Forests and Scrublands	Moderate	No	16.32
Kānuka Forests	Moderate	Yes	4.52
Indigenous-Dominated Seepage Wetlands (Mod. Value)	Moderate	Yes	0.56
Mānuka, Kānuka and Divaricating Shrublands	Low	No	4.12
			Sum = 38.49

^This area calculation includes 0.05 ha of Very High Value Threatened-Nationally Critical swamp maire forest. Areas are slope corrected using the project LiDAR dataset.

The majority of the designation features exotic pasture cover and the most common indigenous vegetation cover is Moderate value secondary broadleaved forests and scrublands. Several locations within the proposed designation feature habitats and species of Very High value and Very High levels of Conservation Concern (i.e., Vulnerability + Irreplaceability; Pilgrim et al., 2013).

Actual and potential adverse effects are identified as being clearance or modification of indigenous vegetation and habitats, habitat fragmentation and isolation, and edge effects on retained vegetation and habitats.

A stepped approach is proposed for vegetation clearance. The proposed approach allows flexibility within the designation area for works to proceed without being constrained by lower value ecosystems that can be replaced in relatively short timeframes through replacement planting; and to manage effects to higher value ecosystem types through avoidance and minimisation of effects, as defined by specific effects envelopes. Effects envelopes were developed that reduced levels of effect on High and Very High value features to levels acceptable on ecological grounds given appropriate mitigation and offsetting measures. Measures are proposed to address adverse effects associated with increased fragmentation/isolation and edge effects.

A mitigation and offset package is proposed to address adverse effects and to offset residual adverse effects to a biodiversity net-gain position. Key elements of the recommended mitigation and offset package are as follows (noting that the package will be updated to respond to the adverse effects of the project once detailed design has been undertaken, taking into account how effective the mechanisms intended to incentivise further avoidance of effects have been, and noting that retirement areas are subject to the NZTA acquiring the necessary land rights):

1. Up to 90.15 ha of like-for-like replacement indigenous restoration plantings (to account for the loss of up to 28.44 ha of habitat /ecosystem);
2. Replacement planting of swamp maire at ratios of 1:100 for damage/canopy pruning and 1:200 for unforeseen permanent loss/mortality;
3. Up to 13.44 ha of like-for-like replacement planting comprising (to account for the loss of up to 1.84 ha of habitat /ecosystem):
    a. Alluvial (1.8 ha) and hill country (10 ha) old-growth forests,
    b. Seepage wetlands (1.64 ha);
4. Retirement, protection and canopy gap planting of c. 32 ha of existing indigenous forests; and

5. Integrated pest control[1] in perpetuity over the entire replacement planting and retirement, protection and gap planting treatment areas (i.e., c. 135.59 ha), or an alternative pest control project, in collaboration with Iwi, DOC and Horizons.

Mitigation and offset areas are recommended (in priority order based on ecological principles). In combination and in conjunction with existing terrestrial vegetation and habitats, the mitigation and offset package would provide a significant extension to the regionally significant Manawatu Gorge Scenic Reserve (MGSR), connect and buffer existing remnants, and aim to provide landscape-scale ecological corridor between the MGSR and Ashhurst Domain.

---

[1] Animal pest control will address brushtail possums and rats and will maintain the density of those species below a 5% residual trap catch/tracking index. If this monitoring method or target proves inappropriate for the configuration of control areas, an alternative outcome-related target (e.g., foliar browse) will be specified in the Ecological Management Plan. Plant pest control will target pest species that threaten the regeneration and/or long-term maintenance of forest plants (e.g., shade tolerant species (e.g., barberry) or light demanding vines (e.g., old man's beard); not gorse or broom).

1.0 INTRODUCTION

1.1 Background

The existing State Highway 3 through the Manawatū Gorge has been permanently closed due to geotechnical instability. In response, the New Zealand Transport Agency (NZTA) is seeking planning approvals under the Resource Management Act 1991 to designate land for the purposes of an alternative State Highway route across the Ruahine Range. The corridor was identified from an earlier MCA process where 18 potential routes were assessed.

Forbes Ecology has been engaged by NZTA to provide a description of the vegetation and habitats within the proposed designation area, to assess the associated actual and potential effects, and how those effects should be managed. An overview of the proposed designation area is presented below in Figure 6.A.1. A copy of the project description is contained in the AEE report. This report informs the ecology assessment report.

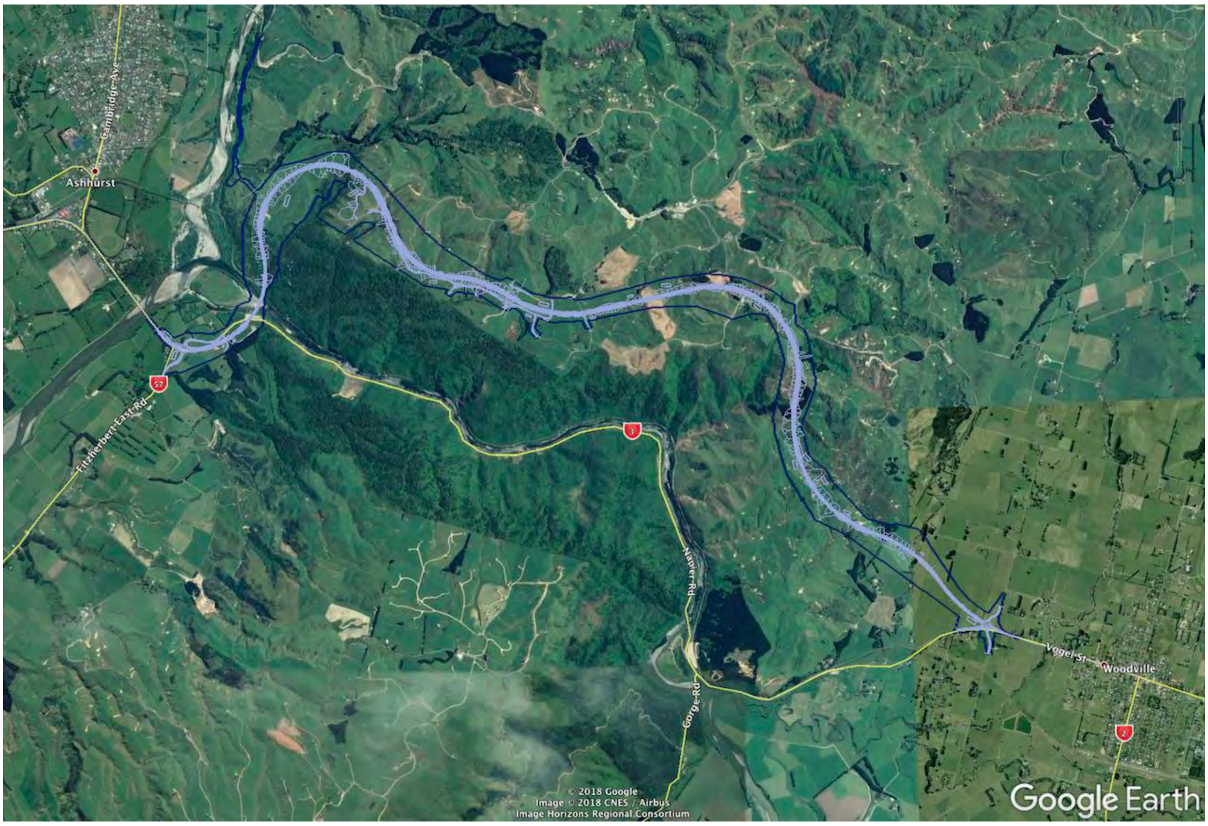

Figure 6.A.1. Overview of the proposed designation area. The proposed designation area and Notice of Requirement indicative design are shown in blue. Note that this figure and others in this assessment depict a previous iteration of the proposed designation area; three relatively small areas relating to unformed access tracks, in areas of pasture, have since been added.

1.2 Report Objectives

In relation to terrestrial indigenous vegetation and habitats within the proposed designation area, this report addresses the following objectives:

1. Classify and quantify the extent of indigenous vegetation and habitats.
2. Describe the nature and level of ecological values of vegetation and habitats.
3. Assess the ecological significance in terms of RMA S6(c) criteria.
4. Assess the levels of effect from the project to vegetation and habitats.
5. Based on levels of ecological value and the project requirements, prescribe approaches to effects management including recommendations for mitigation and biodiversity[2] offsetting.

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[2] Biodiversity has three components: species, genetic and ecosystem diversity (Swingland, 2001). This report addresses all three components but with an emphasis on ecosystem and habitat diversity.

2.0 METHODS

2.1 Vegetation and Habitat Descriptions and Mapping

All indigenous vegetation and terrestrial habitats located within the proposed designation area were classified according to vegetation structure and species composition, and their spatial extent within the corridor was mapped. This process was informed by data collected from the proposed designation area using the following methods.

Point-centred quarter (P-C Q) vegetation survey (Mueller-Dombois & Ellenberg, 2002) followed randomly defined transect start points in predetermined vegetation strata. The P-C Q survey provided quantitative data on tree species composition, density, basal area, and frequency, and these data provided a main basis for quantitative forest descriptions. The P-C Q was deployed in the two largest indigenous forest areas within the designation (CH4000 & CH5600)[3]. Survey points were located at 20 m intervals along transects and a minimum of 20 points were surveyed in each forest areas.

Recce survey (Hurst & Allen, 2007) using 10 × 10 m plots located on a stratified-random basis. Recce survey augmented P-C Q survey and provided quantitative data on the species composition and vertical structure of the forests surveyed. A Recce plot was randomly located in the old-growth alluvial forest at CH4000.

Ecological condition was assessed for each vegetation area covered by the P-C Q survey using the Forest Monitoring Assessment Kit (FORMAK) Site Assessment Form (Handford, 2004) in part. This provided a comprehensive assessment of ecosystem health for each vegetation area surveyed.

Walk-through surveys were conducted in an opportunistic manner within wetlands and other areas of vegetation within the proposed designation area, with notes kept on vegetation and habitats. Walk-though surveys were combined with observations against the wetland indicator species list (Clarkson, 2013) to delineate wetland boundaries.

High-resolution orthophotography and oblique photography was collected from a drone to assist with survey design, area measurements, and to support the quantitative data collected from the above methods on vegetation composition.

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[3] CH refers to Chainage, which is a standard measure in metres from one end of the corridor to the other. Refer to Figure 6.A.2 for CH references.

The above data was used, in combination, to provide detailed descriptions of the distribution, composition, and condition of vegetation and habitats within the designation area.

2.2 Ecological Values Assessment

Ecological values of terrestrial ecosystem types were assessed using current best practice methods (Environment Institute of Australia and New Zealand [EIANZ], 2018) for evaluating ecological values in the impact assessment framework. The assessment was based on the detailed information available for each ecosystem type as described by the previous section. Structured criteria to guide ecological values assessments are provided by EIANZ (2018; Table 4, p. 64) and these criteria formed the basis of the values assessment:

1. Representativeness:
    - Extent to which area is typical or characteristic,
    - Size.
2. Rarity/distinctiveness:
    - Amount of habitat or vegetation remaining,
    - Supporting nationally or locally Threatened, At Risk, or uncommon species,
    - Regional or national distribution limits,
    - Endemism,
    - Distinctive ecological features,
    - Natural rarity.
3. Diversity and pattern:
    - Level of natural diversity,
    - Biodiversity reflecting underlying diversity.
4. Ecological context:
    - Contribution to network, buffer, linkage, pathway,
    - Role in ecosystem functioning,
    - Important fauna habitat,
    - Contribution to ecosystem service.

For the indigenous vegetation and habitats within the designation area, each of the four criteria were evaluated and given a categorical ranking of either High, Moderate, Low, or Negligible. Overall value was then assessed using the following summation from the above criteria assessment:

- Very High value = Area rates High for 3 or all of the four assessment matters – likely to be nationally important and recognised as such.
- High value = Area rates High for 2 of the assessment criteria, Moderate and Low for the remainder, or Area rates High for 1 of the assessment matters, Moderate for the remainder – Likely to be regionally important and recognised as such.

- Moderate = Area rates High for one matter, Moderate and Low for the remainder, or Area rates Moderate for 2 of more assessment matters Low or Very Low for the remainder. Likely to be important at the level of the Ecological District.
- Low = Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
- Negligible = Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder.

The ecological values assessment was informed by data from the following sources:

- Project-related survey data (e.g., for flora, habitats/ecosystems, avifauna & herpetofauna).
- Regional and District Planning documents and supporting technical reports.
- National level databases such as Potential Predicted Vegetation (Leathwick et al. 2004), Threatened Environments Classification (Walker et al. 2012), Singers and Rogers (2014), Land Cover Database (Terralink 2004).
- Central Government's Protecting our Places (MfE, 2007), the four national priorities for biodiversity protection.

2.3 Ecological Significance Assessment

The Horizons Regional Council ("One Plan", Horizons Regional Council 2017) sets out policies and rules for the management of natural resources including indigenous habitats. Policy 13-5 sets out criteria for assessing the significance of, and the effects of activities on, an area of habitat. Accordingly, indigenous habitats within the designation area were assessed against the ecological significance assessment criteria regarding representativeness, rarity and distinctiveness, and ecological context, contained in One Plan Policy 13-5. While there are apparent overlaps between the assessment criteria for ecological values and ecological significance, the ecological values assessment is (compared to significance assessment) a more nuanced assessment, considering a wider range of sub-criteria that contribute to the overall score of each criterion. Effectively, the ecological values assessment provides a ranked non-statutory assessment. In contrast, the significance assessment process is binary (either significant or not) and needing only one positive response to trigger statutory significance under RMA s6(c).

The ecological significance assessment was guided by the following criteria:

1. Representativeness:

   Habitat that:

   a. Comprises indigenous habitat type that is under-represented (20% or less of known or likely former cover), or
   b. Is an area of indigenous vegetation that is typical of the habitat type in terms of species composition, structure and diversity, or large relative to other areas of the same habitat type in the Ecological District or Ecological Region or has functioning ecosystem processes.

2. Rarity and Distinctiveness:

   Habitat that supports an indigenous species or community that:

   a. Is classed as threatened (as determined by the New Zealand Threat Classification System and Lists), or
   b. Is distinctive to the region, or
   c. Is at a natural distributional limit, or
   d. Has a naturally disjunct distribution that defines a floristic gap, or
   e. Was originally (i.e. pre-human) uncommon within New Zealand and supports an indigenous species or community of indigenous species.

3. Ecological Context:

   Habitat that provides:

   a. Connectivity (physical or process connections) between two or more areas of indigenous habitat, or
   b. An ecological buffer (provides protection) to an adjacent area of indigenous habitat (terrestrial or aquatic) that is ecologically significant, or
   c. Part of an indigenous ecological sequence or connectivity between different habitat types across a gradient (e.g. altitudinal or hydrological), or
   d. Important breeding areas, seasonal food sources, or an important component of a migration path for indigenous species, or
   e. Habitat for indigenous species that are dependent on large and contiguous habitats.

2.4 Ecological Effects Assessment

Fundamentally, the assessment of ecological effects addressed the degree to which the proposed activity would diminish the attributes that made a given feature ecologically significant. The level of effect was determined through analysis of the level of ecological value and the magnitude of adverse effect (EIANZ, 2018). Both positive and adverse effects were considered.

The assessment of magnitude and level of effect followed the EIANZ (2018) assessment criteria shown in Table 6.A.1 and Table 6.A.2 respectively. When considering the magnitude of effect, the timescale of potential effects must be considered and EIANZ (2018, Table 9) provides recommended timescales for effect duration categories.

Table 6.A.1. Criteria for describing magnitude of effect (EIANZ, 2018).

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

Table 6.A.2. Criteria for describing level of effect (EIANZ, 2018).

Ecological value → Magnitude ↓	Very high	High	Moderate	Low	Negligible
Very High	Very high	Very high	High	Moderate	Low
High	Very high	Very high	Moderate	Low	Very low
Moderate	High	High	Moderate	Low	Very low
Low	Moderate	Low	Low	Very low	Very low
Negligible	Low	Very low	Very low	Very low	Very low
Positive	Net gain	Net gain	Net gain	Net gain	Net gain

Table 6.A.3. Timescales for duration of effects (EIANZ, 2018).

Permanent	Effects continuing for an undefined time beyond the span of one human generation (taken as approximately 25 years)
Long term	Where there is likely to be substantial improvement after a 25-year period (e.g., the replacement of mature trees by young trees that need >25 years to reach maturity, or restoration of ground after removal of a development) the effect can be termed ‘long term’
Temporary	Long term (15-25 years or longer – see above)
	Medium term (5-15 years)
	Short term (up to 5 years)
	Construction phase (days or months)

2.4.1 *Ecological management response*

Levels of effect were viewed in terms of national guidance regarding appropriate levels of ecological management response. National guidance on ecological management of effects was sourced from EIANZ (2018) and DoC (2014; and references therein[4]).

Regarding levels of effect, EIANZ (2018) recommends:

Very High adverse: *Project effects in the 'Very High adverse' category are unlikely to be acceptable on ecological grounds alone (even with compensation proposals). Activities having very high adverse effects should be avoided. It is not the ecologist's role to make determinations with regard to project viability. The ecologist should present an objective and scientifically robust assessment of the effects of the project to assist the applicant in coming to an informed decision about project viability. Where very high adverse effects cannot be avoided, a net biodiversity gain would be appropriate.*

High and Moderate adverse: *Options in the 'High and Moderate adverse' category represent a level of effect that requires careful assessment and analysis of the individual case. Such an effect could be managed through avoidance, design, or extensive offset or compensation actions. Wherever adverse effects cannot be avoided, no net loss of biodiversity values would be appropriate.*

Low and Very Low adverse: *Should not normally be of concern, although normal design, construction and operational care should be exercised to minimise adverse effects. If effects are assessed taking impact management developed during project shaping into consideration, then it is essential that prescribed impact management is carried out to ensure Low or Very Low level effects.*

Offsetting principles contained in the DoC (2014) Guidance on Good Practice Biodiversity Offsetting in New Zealand were applied. In particular, ecological features of elevated conservation concern were assessed as to their status regarding the limits of offsetting.

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[4] Includes BBOP (2012) good practice biodiversity offsetting principles.

3.0 INDIGENOUS VEGETATION AND HABITATS

3.1 Ecological Values

Indigenous terrestrial vegetation communities and terrestrial habitats were classified into ten distinct ecosystem types according to their composition, structure, and in the case of seepage wetlands, ecological condition/habitat potential. The designation area has a total area of 375.7 ha[5] and terrestrial indigenous ecosystems occupy 38.5 ha (i.e., c. 10% indigenous) of the designation area. The quantities and distribution of terrestrial ecosystems within the proposed designation area are summarised in Figure 6.A.2 and Table 6.A.4. below. Photographs of examples of each ecosystem type are provided in Appendix A.

Table 6.A.4. Ten ecosystem types located within the proposed designation boundaries.

Ref.	Ecosystem classification	Finalised area (ha)
1	Old-Growth Forests (Alluvial)^	4.23
2	Old-Growth Forests (Hill Country)	1.78
3	Secondary Broadleaved Forests with Old-Growth Signatures	3.07
4	Old-Growth Treelands	0.41
5	Advanced Secondary Broadleaved Forests	2.93
6	Raupō Dominated Seepage Wetlands (High Value)	0.55
7	Secondary Broadleaved Forests and Scrublands	16.32
8	Kānuka Forests	4.52
9	Indigenous-Dominated Seepage Wetlands (Moderate Value)	0.56
10	Mānuka, Kānuka and Divaricating Shrublands	4.12
	Total	38.49

^This area calculation includes 0.05 ha of Threatened-Nationally Critical swamp maire forest.
Areas are slope corrected using the project LiDAR dataset.

3.2 Levels of Ecological Value

The levels of ecological value of the ten identified ecosystem types are summarised below and described in detail in the tables that follow:

Very High value:

1. Old-Growth Forests (Alluvial)
2. Old-Growth Forests (Hill Country)

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[5] Slope corrected measurement. The designation area calculation is to be updated as it omits three relatively small areas, in pasture, added recently.

High value:

3. Secondary Broadleaved Forests with Old-Growth Signatures
4. Old-Growth Treelands
5. Advanced Secondary Broadleaved Forests
6. Raupō-Dominated Seepage Wetlands

Moderate value:

7. Secondary Broadleaved Forests and Scrublands
8. Kānuka Forests
9. Indigenous-Dominated Seepage Wetlands

Low value:

10. Mānuka, Kānuka and Divaricating Shrublands

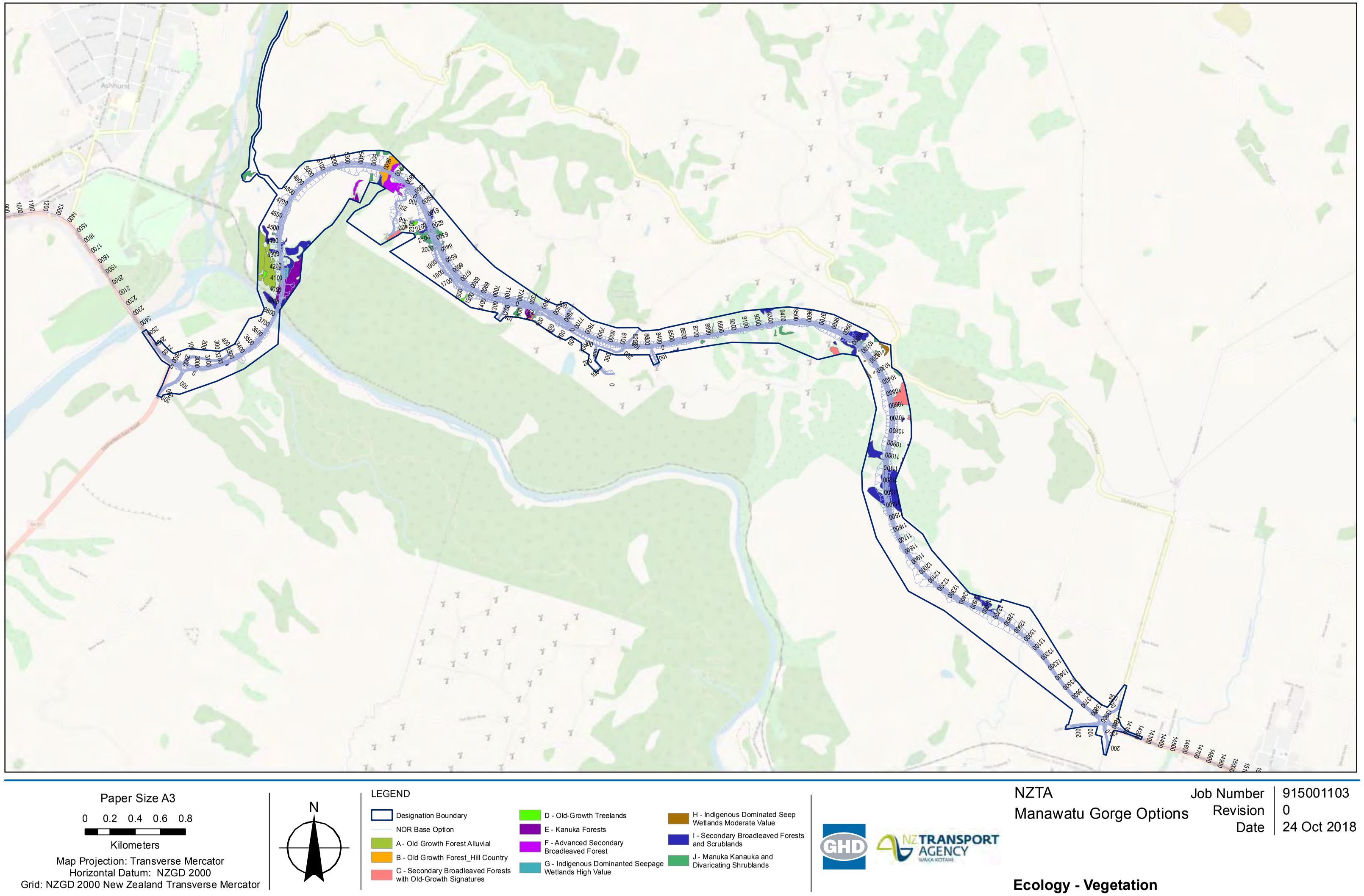

Figure 6.A.2. Distribution of indigenous ecosystem types within the proposed designation area. Note, ecosystems within the designation but not mapped are within areas assumed to be clear of works (e.g., in mitigation areas) and thus are not included in the scope of effects/mitigation/offset.

Table 6.A.5. Ecological values assessment of old-growth forests and treelands within the proposed designation area.

Ecological feature	**Matters**	**Attributes to be considered**	**Assessment**	**Value level[6] (H, M, L, VL)**
Old-Growth Forests (Alluvial) Old-Growth Forests (Hill Country) Old-Growth Treelands[7] (Types 1, 2, & 4)	Representativeness	Vegetation habitats:		
		▪ Typical structure and composition	*The OG alluvial forests (CH4000–4100) are of a typical structure (noting stock understorey impacts[8]) and composition and are dominated by indigenous species. Expected species are present. The ground cover and subcanopy tiers are impacted by long-term stock access. There are charred wood remains within the existing forest, indicating previous burning of the forest.* *The OG hill country forest (Western Queen Elizabeth II National Trust Covenant (QEII); c. CH5600) has some representative canopy species missing, such as rimu – which would once have been emergent (as seen at the adjacent Manawatū Gorge Scenic Reserve). Indigenous species dominate, and most expected species are present.*	**High**
		▪ Indigenous species dominate		
		▪ Expected species and tiers are present		
		Species:		
		▪ Species assemblages that are typical of the habitat	*Species assemblages are typical of lowland forests in this area of the Ecological District.*	
		▪ Indigenous species that occur in most of the guilds expected for the habitat type		
	Rarity/distinctiveness	Criteria for rare/distinctive vegetation and habitats:		
		▪ Naturally uncommon, or induced scarcity	*The alluvial OG forests (CH4000–4400) represent communities that occur in productive lowland positions (e.g., floodplains and low elevation sites), thus across the region, most of these ecosystems have historically been cleared for agriculture and development. Hill country OG forests are also much reduced in extent, and as a result, these OG forests are amongst the most threatened forest compositions in the Horizons Region. The induced scarcity of both the alluvial and hill country OG forests means the*	**High**
		▪ Amount of habitat or vegetation remaining		
		▪ Distinctive ecological features		
		▪ National priority for protection		

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[6] Refer Table 6 of EIANZ (2018).

[7] Treelands in this category comprise mature forest canopy species but are grazed and sparse in canopy cover. Forest survey canopy dominance data from CH4000–4400 and CH5600 are contained in Appendix B.

[8] Refer forest condition assessment in Appendix D.

			forests are recognised as Threatened ecosystem types (i.e., <20% of former ecosystem extent remaining). *The OG forest remnants at CH4000–4400 are characteristic of alluvial landforms being located on stream terraces and terrace risers. These forests most closely represent podocarp/tawa–mahoe and kahikatea-pukatea-tawa forests and are the two most Threatened forest ecosystems in the Manawatū Region (only approx. 2.5% of each ecosystem type remains).* *The OG forest at CH5600 most closely represents rimu/tawa-kamahi forest (this is also the predicted pre-human forest composition for the area (Leathwick et al. 2005)). Rimu is missing from this forest and kamahi is scarce. Approximately 19.5% of this forest type remains in the Manawatū Region, making this forest a Threatened ecosystem.* *The land environments in which the OG forests remain are the least protected and most reduced (i.e., Acutely Threatened Environments; Walker et al., 2015), containing <10% nationally; meaning that their protection is Priority 1 of central Government's four national priorities for biodiversity protection (MfE, 2007).*	
		Criteria for rare/distinctive species or species assemblages:		
		▪ Habitat supporting Nationally-Threatened or At-Risk species, or locally uncommon species	*The old-growth forests are not confirmed as supporting Threatened, At Risk, or locally uncommon species, nor species at distribution limits, unusual species or assemblages or unusual levels of endemism. However, Threatened or At Risk fauna species may be present.*	
		▪ Regional or national distribution limits of species or communities		
		▪ Unusual species or assemblages		
		▪ Endemism		
	Diversity and pattern	▪ Level of natural diversity, abundance and distribution	*The alluvial OG forests have a natural diversity of canopy compositions which are expressions of the variation in underlying landform pattern. Pukatea and kahikatea dominate wet valley-floor positions whereas matai and titoki increase in dominance on dryer sites such as terrace risers. The abundance (e.g., basal area among canopy species) and distribution (microsite locations) of species is natural.* *The hill country OG forest is missing characteristic species of the emergent forest canopy tier. The forest is positioned in a sheltered location relative to the predominant westerly wind direction.* *All OG forests contribute seasonal resources in terms of fruit and nectar which have become scarce at the landscape scale due to widespread lowland forest clearance. The OG forests all have other areas of native forest within 1 km and form part of a landscape-scale habitat matrix amongst other forest remnants north of the Manawatū Gorge.*	**Forest = High; Treeland = Low**
		▪ Biodiversity reflecting underlying diversity		
		▪ Biogeographical considerations – pattern, complexity		
		▪ Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation		
	Ecological context	▪ Site history, and local environmental conditions which have influenced the	*The OG forests are structurally advanced and intact regarding forest stature and are of sufficient size and shape to support interior forest microclimate conditions. All OG*	**Medium**

		development of habitats and communities	*forests present occur in discrete patches and are thus influenced by edge effects from the surrounding pastoral landscape. Where stock access occurs (e.g., alluvial forests), forest regeneration is impaired, thus affecting integrity, form, functioning and ultimately the resilience of the forest site. If retired, the biotic and abiotic conditions prevailing would conceivably lead to a rapid recovery of forest regeneration and thus understorey integrity. In the absence of browsers, the forest ecosystems are viable in terms of regeneration processes.* *Perturbations resulting from fires and logging have, over time, shaped the contemporary forest structure and composition. The forest canopy species perform crucial functional roles in supporting communities of birds and insects.*	
		▪ The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA)		
		▪ Size, shape and buffering		
		▪ Condition and sensitivity to change		
		▪ Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material		
		▪ Species role in ecosystem functioning – high level, key species identification, habitat as proxy		
			Overall ecological value of OG forest[9]	**orest = Very High; Treeland = High**

Table 6.A.6. Ecological values assessment of secondary broadleaved forests with old-growth signatures within the proposed designation area.

Ecological feature	Matters	Attributes to be considered	Assessment	Value level[10] (H, M, L, VL)
Secondary Broadleaved Forests with Old-Growth Signatures (Type 3)	Representativeness	Vegetation habitats:		
		▪ Typical structure and composition	*The secondary forests have a forest structure and composition of dominant species representing mid-successional species, such as mahoe, five finger, hangehange, rangiora, ribbonwood, lancewood, and lemonwood. Manuka or kānuka may also be present. Mature forest canopy species are conspicuous, either as old trees remnant from past forest or in advanced stages of secondary succession following clearance. Although dominated by secondary broadleaved species, the signature of OG species means that these forests have either retained or attained a canopy composition comparable in representativeness to that of pre-human forest compositions.*	**Moderate**
		▪ Indigenous species dominate		
		▪ Expected species and tiers are present		

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[9] Refer Table 6 of EIANZ (2018).

[10] Refer Table 4 of EIANZ (2018).

		Species:		
		▪ Species assemblages that are typical of the habitat	*Species assemblages (e.g., forest birds) are typical of secondary lowland forests in this area of the Ecological District. The native OG components to some extent resemble the pre-human forest canopy composition, although the full range of mature forest canopy species are not represented.*	
		▪ Indigenous species that occur in most of the guilds expected for the habitat type		
	Rarity/distinctiveness	Criteria for rare/distinctive vegetation and habitats:		
		▪ Naturally uncommon, or induced scarcity	*Lowland forests that are representative of pre-human compositions have an induced scarcity and thus are recognised as Threatened ecosystem types (i.e., <20% of former ecosystem extent remaining).* *The land environments in which the secondary forests with OG signatures remain are poorly protected and are reduced in extent nationally (i.e., Acutely and Chronically Threatened Environments; Walker et al., 2015), meaning that their protection is Priority 1 of Central Government's four national priorities for biodiversity protection (MfE, 2007).*	**High**
		▪ Amount of habitat or vegetation remaining		
		▪ Distinctive ecological features		
		▪ National priority for protection		
		Criteria for rare/distinctive species or species assemblages:		
		▪ Habitat supporting Nationally-Threatened or At-Risk species, or locally uncommon species	*The secondary forests with OG signatures are not known to support Threatened, At-Risk, or locally uncommon species, nor species at distribution limits, unusual species or assemblages or unusual levels of endemism. However, Threatened or At Risk fauna species may be present.*	
		▪ Regional or national distribution limits of species or communities		
		▪ Unusual species or assemblages		
		▪ Endemism		
	Diversity and pattern	▪ Level of natural diversity, abundance and distribution	*The secondary forests with OG signatures have natural levels of floristic diversity, although at any site the full complement of potential mature forest canopy species (e.g., tawa, hinau or podocarps) and OG forest indicators (e.g., kiekie) are not present. The diversity of seral species is high in some cases. The biodiversity of these ecosystems responds to the underlying diversity of landform and abiotic variables. The forests have other areas of native forest within 1 km and form part of a fragmented landscape-scale habitat network amongst other forest remnants north of the Manawatū Gorge.*	**High**
		▪ Biodiversity reflecting underlying diversity		
		▪ Biogeographical considerations – pattern, complexity		
		▪ Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation		
	Ecological context	▪ Site history, and local environmental conditions which have influenced the development of habitats and communities	*The secondary forests with OG signatures are communities that have assembled following partial or complete forest clearance. These forests are often in gullies or on steep topography where stock browsing and other disturbance has been less, thus forest regeneration has advanced. The forests comprise mainly fast-growing,*	**Moderate**

		▪ The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA) ▪ Size, shape and buffering ▪ Condition and sensitivity to change ▪ Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material ▪ Species role in ecosystem functioning – high level, key species identification, habitat as proxy	*relatively light-demanding species. The forests are spatially configured in a range of sizes and shapes, and the ecological condition varies depending on stand age and the history of stock access.* *The OG signature forms an important functional component (e.g., a potential seed source, provision of resources to attract frugivorous seed dispersers) for further natural diversification of the secondary forest.*	
			Overall ecological value of secondary forest with OG signatures	**High**

Table 6.A.7. Ecological values assessment of advanced secondary broadleaved forests and secondary broadleaved forests and scrublands within the proposed designation area.

Ecological feature	Matters	Attributes to be considered	Assessment	Value level[11] (H, M, L, VL)
Advanced Secondary Broadleaved Forests; Secondary Broadleaved Forests and Scrublands (Types 5 & 7)	Representativeness	Vegetation habitats:		
		▪ Typical structure and composition ▪ Indigenous species dominate ▪ Expected species and tiers are present	*These secondary broadleaved forests are indigenous dominated but do not clearly represent pre-human compositions (i.e., absence of long-lived canopy species) or statures (e.g., no emergent tier). The advanced secondary forest (CH5600–5800) has a forest structure and composition representing a later phase of development. Mid-successional species, such as lancewood have attained greater representation in the canopy. Kānuka may also be present.*	**Advanced Secondary = Moderate; Secondary and Scrubland = Low**
		Species:		
		▪ Species assemblages that are typical of the habitat ▪ Indigenous species that occur in most of the guilds expected for the habitat type	*Species assemblages are typical of older secondary lowland forests in this area of the Ecological District.*	

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[11] Refer Table 6 of EIANZ (2018).

	Rarity/distinctiveness	Criteria for rare/distinctive vegetation and habitats:		
		▪ Naturally uncommon, or induced scarcity	*The land environments in which the advanced secondary broadleaved forest exist are poorly protected and are reduced in extent nationally (i.e., Acutely and Chronically Threatened Environments; Walker et al., 2015), meaning that their protection is Priority 1 of Central Government's four national priorities for biodiversity protection (MfE, 2007).*	**Moderate**
		▪ Amount of habitat or vegetation remaining		
		▪ Distinctive ecological features		
		▪ National priority for protection		
		Criteria for rare/distinctive species or species assemblages:		
		▪ Habitat supporting Nationally-Threatened or At-Risk species, or locally uncommon species	*The secondary broadleaved forests are not known to support Threatened, At-Risk, or locally uncommon species, nor species at distribution limits, unusual species or assemblages or unusual levels of endemism. However, Threatened or At Risk fauna species may be present.*	
		▪ Regional or national distribution limits of species or communities		
		▪ Unusual species or assemblages		
		▪ Endemism		
	Diversity and pattern	▪ Level of natural diversity, abundance and distribution	*The advanced secondary broadleaved forest has high levels of natural diversity. Secondary broadleaved forests and scrublands have natural levels of floristic diversity for seral forest. Both categories of secondary broadleaved forest are missing the mature forest canopy species (e.g., tawa, hinau or podocarps) and OG forest indicators (e.g., kiekie) in advanced stages of development (i.e., mature forest canopy species are not conspicuous). The diversity of seral species can be high. The biodiversity of these ecosystems responds to the underlying diversity of landform and abiotic variables. The forests have other areas of native forest within 1 km and form part of a fragmented landscape scale habitat network amongst other forest remnants north of the Manawatū Gorge.*	**Moderate**
		▪ Biodiversity reflecting underlying diversity		
		▪ Biogeographical considerations – pattern, complexity		
		▪ Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation		
	Ecological context	▪ Site history, and local environmental conditions which have influenced the development of habitats and communities	*The secondary forests are communities that have assembled following forest clearance. These forests are often in gullies or on steep topography where stock browsing and other disturbance has been less and thus forest regeneration has advanced. The forests comprise mainly fast-growing, relatively light-demanding species. The forests are spatially configured in a range of sizes and shapes, and the ecological condition varies depending on stand age and the history of stock access. The site of advanced broadleaved regeneration is legally protected and has a history of stock exclusion. The secondary broadleaved forests form an important functional component (e.g., a potential seed source, provision of resources to attract frugivorous seed dispersers) and provide nursery conditions and potential for further successional development to forest compositions that incorporate mature forest canopy species representative of pre-human times.*	**Advanced Secondary = High; Secondary and Scrublands = Moderate**
		▪ The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA)		
		▪ Size, shape and buffering		
		▪ Condition and sensitivity to change		
		▪ Contribution of the site to ecological networks, linkages,		

		pathways and the protection and exchange of genetic material ▪ Species role in ecosystem functioning – high level, key species identification, habitat as proxy	*Some large areas of secondary broadleaved forest and scrub exist in on the slopes of the eastern rise and these areas stand out as having the highest values relating to ecological context (e.g., size, networks, linkages).*	
			Overall ecological value of advanced secondary broadleaved forest and broadleaved forest and scrublands	**Advanced Secondary = High Secondary and Scrublands = Moderate**

Table 6.A.8. Ecological values assessment of mature kānuka forest within the proposed designation area.

Ecological feature	Matters	Attributes to be considered	Assessment	Value level[12] (H, M, L, VL)
Kānuka forests (Type 8)	Representativeness	Vegetation habitats:		
		▪ Typical structure and composition ▪ Indigenous species dominate ▪ Expected species and tiers are present	*These secondary forests are kānuka dominant and have few broadleaved species in the understorey. Broadleaved species such as mahoe may be present in the canopy and rewarewa may be emergent.*	**Moderate**
		Species:		
		▪ Species assemblages that are typical of the habitat ▪ Indigenous species that occur in most of the guilds expected for the habitat type	*Species assemblages are typical of secondary lowland forests in this area of the Ecological District. Some species are missing (e.g., emergent rimu).*	
	Rarity/distinctiveness	Criteria for rare/distinctive vegetation and habitats:		
		▪ Naturally uncommon, or induced scarcity ▪ Amount of habitat or vegetation remaining ▪ Distinctive ecological features	*Mature kānuka forests have an induced scarcity and thus are recognised as regionally Threatened ecosystem type.* *The land environments in which the kānuka forests remain are poorly protected and are reduced in extent nationally (i.e., Acutely and Chronically Threatened Environments;*	**High**

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[12] Refer Table 6 of EIANZ (2018).

		▪ National priority for protection	*Walker et al., 2015), meaning that their protection is Priority 1 of Central Government's four national priorities for biodiversity protection (MfE, 2007).*	
		Criteria for rare/distinctive species or species assemblages:		
		▪ Habitat supporting Nationally-Threatened or At-Risk species, or locally uncommon species	*The kānuka forests are not known to support Threatened, At-Risk, or locally uncommon species, nor species at distribution limits, unusual species or assemblages or unusual levels of endemism. However, Threatened or At Risk fauna species may be present.*	
		▪ Regional or national distribution limits of species or communities		
		▪ Unusual species or assemblages		
		▪ Endemism		
	Diversity and pattern	▪ Level of natural diversity, abundance and distribution	*The kānuka forests have reduced levels of floristic diversity due to past and current land use impacts on forest regeneration processes. The forests have other areas of native forest within 1 km and form part of a fragmented landscape scale habitat network amongst other forest remnants north of the Manawatū Gorge.*	**Moderate**
		▪ Biodiversity reflecting underlying diversity		
		▪ Biogeographical considerations – pattern, complexity		
		▪ Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation		
	Ecological context	▪ Site history, and local environmental conditions which have influenced the development of habitats and communities	*The kānuka forests are communities that have assembled following partial or complete forest clearance. These forests are in gullies or on faces which are today still grazed. Forest condition is reduced by grazing and limited regeneration means that resilience and potential for successional development is impaired. The kānuka forests provide an important nursery for the development of future forests but the existing kānuka stands would need to be retired for this potential to be realised.*	**Moderate**
		▪ The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA)		
		▪ Size, shape and buffering		
		▪ Condition and sensitivity to change		
		▪ Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material		
		▪ Species role in ecosystem functioning – high level, key species identification, habitat as proxy		
			Overall ecological value of kānuka forest	**Moderate**

Table 6.A.9. Ecological values assessment of native shrublands within the proposed designation area.

Ecological feature	Matters	Attributes to be considered	Assessment	Value level[13] (H, M, L, VL)
Mānuka, Kānuka and Divaricating Shrublands (Type 10)	Representativeness	Vegetation habitats:		
		▪ Typical structure and composition	*Shrublands of manuka, kānuka, and small-leaved divaricates within an exotic grassland matrix. Species composition and dominance varies among sites. Often mixed with a minority of exotic woody species such as gorse or having invaded exotic grassland.*	**Low**
		▪ Indigenous species dominate		
		▪ Expected species and tiers are present		
		Species:		
		▪ Species assemblages that are typical of the habitat	*Species assemblages result from recent disturbance and are not representative of pre-human mature forest compositions. Of limited stature and cover.*	
		▪ Indigenous species that occur in most of the guilds expected for the habitat type		
	Rarity/distinctiveness	Criteria for rare/distinctive vegetation and habitats:		
		▪ Naturally uncommon, or induced scarcity	*The land environments in which the native shrublands remain are poorly protected and are reduced in extent nationally (i.e., Acutely and Chronically Threatened Environments; Walker et al., 2015), meaning that where indigenous cover is >50%, the protection of these areas is Priority 1 of Central Government's four national priorities for biodiversity protection (MfE, 2007).*	**Moderate**
		▪ Amount of habitat or vegetation remaining		
		▪ Distinctive ecological features		
		▪ National priority for protection		
		Criteria for rare/distinctive species or species assemblages:		
		▪ Habitat supporting Nationally-Threatened or At-Risk species, or locally uncommon species	*The native shrublands are not known to support Threatened, At-Risk, or locally uncommon species, nor species at distribution limits, unusual species or assemblages or unusual levels of endemism. However, Threatened or At Risk fauna species may be present.*	
		▪ Regional or national distribution limits of species or communities		
		▪ Unusual species or assemblages		

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[13] Refer Table 6 of EIANZ (2018).

		▪ Endemism		
	Diversity and pattern	▪ Level of natural diversity, abundance and distribution ▪ Biodiversity reflecting underlying diversity ▪ Biogeographical considerations – pattern, complexity ▪ Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation	*The shrublands have low levels of floristic diversity. The biodiversity of these ecosystems is limited by their relatively young age or the disturbance regime that prevents succession to more advanced and diverse states.*	**Low**
	Ecological context	▪ Site history, and local environmental conditions which have influenced the development of habitats and communities ▪ The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA) ▪ Size, shape and buffering ▪ Condition and sensitivity to change ▪ Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material ▪ Species role in ecosystem functioning – high level, key species identification, habitat as proxy	*The shrublands are communities that have assembled following recent vegetation clearance. These communities are on steep topography where stock browsing and other disturbance has been less and also amongst paddocks containing stock. The shrublands comprise mainly fast-growing, relatively light demanding species. Where shrublands can be retired they make an important contribution to the development of future forests, thus when sustainably managed form an important habitat and successional phase.*	**Low**
			Overall ecological value of native shrublands	**Low**

Table 6.A.10. Ecological values assessment of indigenous–dominated wetlands within the proposed designation area.

Ecological feature	Matters	Attributes to be considered	Assessment	Value level[14] (H, M, L, VL)
Raupō Dominated Seepage Wetlands (High Value); Indigenous-Dominated Seepage Wetlands (Moderate Value) (Types 6 & 9)	Representativeness	Vegetation habitats:		
		▪ Typical structure and composition	*In these locations, the seepage wetlands would once have supported tall swamp-forest species, thus the current herbaceous (e.g., raupō & carex) and woody (e.g., manuka) compositions do not clearly represent pre-human composition and structure. The exception to this is the raupō dominated seepage at CH4200 which features a remnant stand of swamp maire (Threatened-Nationally Critical) on its southern margin.*	**Raupō seepage (CH4200) = Moderate; remaining seepages = Low**
		▪ Indigenous species dominate		
		▪ Expected species and tiers are present		
		Species:		
		▪ Species assemblages that are typical of the habitat	*The species present are typical of seepage wetlands where swamp forest has been cleared and stock have had unrestricted access over prolonged periods. All seepage wetlands have a history of grazing which has simplified the species composition. The raupō seepage at CH4200 presents the greatest opportunity to support swamp birds (crake, Australasian bittern).*	
		▪ Indigenous species that occur in most of the guilds expected for the habitat type		
	Rarity/distinctiveness	Criteria for rare/distinctive vegetation and habitats:		
		▪ Naturally uncommon, or induced scarcity	*Seepage wetlands are a rare ecosystem type (One Plan Schedule F) within the Horizons region.* *The raupō dominated seepage at CH4200 features Threatened swamp maire.* *The protection of native vegetation associated with wetlands is Priority 2 of Central Government's four national priorities for biodiversity protection (MfE, 2007).*	**High**
		▪ Amount of habitat or vegetation remaining		
		▪ Distinctive ecological features		
		▪ National priority for protection		
		Criteria for rare/distinctive species or species assemblages:		
		▪ Habitat supporting Nationally-Threatened or At-Risk species, or locally uncommon species	*Those seepages embedded within pastoral surroundings are unlikely to support species of conservation concern. The raupō seepage at CH4200–4300 supports Threatened Swamp Maire and provides potential habitat for Threatened and At-Risk swamp bird species.*	
		▪ Regional or national distribution limits of species or communities		
		▪ Unusual species or assemblages		
		▪ Endemism		

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[14] Refer Table 6 of EIANZ (2018).

	Diversity and pattern	▪ Level of natural diversity, abundance and distribution ▪ Biodiversity reflecting underlying diversity ▪ Biogeographical considerations – pattern, complexity ▪ Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation	*The seepage wetlands are degraded by stock access and this has reduced the diversity, abundance and distribution of species.* *The raupō seepage at CH4200 provides potential habitat for Threatened and At-Risk swamp birds. All other seepage wetlands are of low value regarding their contribution to diversity and pattern.*	**Raupō seepage (CH4200) = High** **Other seepages = Low**
	Ecological context	▪ Site history, and local environmental conditions which have influenced the development of habitats and communities ▪ The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA) ▪ Size, shape and buffering ▪ Condition and sensitivity to change ▪ Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material ▪ Species role in ecosystem functioning – high level, key species identification, habitat as proxy	All seepage wetlands have been modified and had their condition degraded by ongoing stock access. Hydrosystems are intact. Seepages are small and lack buffering from adjacent pastoral land uses.	**Low**
			Overall ecological value of seepage wetlands	**Raupō seepage (CH4200) = High** **All other seepage wetlands = Moderate**

4.0 ECOLOGICAL SIGNIFICANCE ASSESSMENT

4.1 Assessment of One Plan Criteria

One Plan Policy 13–5 provides criteria for assessing the significance of, and the effects of activities on, an area of habitat. Policy 13–5 prescribes the following approach for classifying significant indigenous vegetation or significant habitats of indigenous fauna:

- *Rare habitats* are those that were originally (i.e., pre-human) uncommon within New Zealand, and supports an indigenous species or community of indigenous species (criterion (ii)(E))
- *Threatened habitats* are those indigenous habitat types that are under-represented (20% or less of known or likely former cover; criterion (i)(A)).
- *At Risk* habitats are those that have been reduced to 50% or less of their former extent.

Rare or threatened habitats may also be ecologically significant under one or more further criteria contained in Policy 13–5. The ten ecosystem types described in Table 6.A.4. follow the ecosystem types described in One Plan schedule F with some additions to account for seral or regenerating communities that do not represent pre-human forest compositions but still contribute to the level of current natural diversity. The ten ecosystem types can be regarded as habitats in terms of Policy 13-5, and their statutory significance is assessed as follows.

The alluvial and hill country old-growth forests, secondary forests containing conspicuous old-growth signatures, and kānuka forest represent compositions that occurred during pre-human times but are now underrepresented (<20% remaining) in the contemporary landscape. Thus, these ecosystem types are significant under Policy 13–5 (a) (i) (A).

The raupō seepage wetland is significant as at its southern margin it supports a remnant stand of swamp maire (Threatened–Nationally Critical) and as seepage wetlands were rare even before humans modified New Zealand's ecosystem pattern. Thus, the raupō seepage wetland at CH4200 is significant under both Policy 13–5 (a) (ii) (A) and (E). Other indigenous-dominated seepage wetlands are significant as they are rare ecosystem types (Policy 13–5 (a) (ii) (E).

The advanced secondary broadleaved forest at CH5700–5800, the secondary broadleaved forests and scrublands, and the native shrublands are not significant in terms of the criteria contained in Policy 13–5 (a).

Table 6.A.11. Ecological significance assessment (applying One Plan criteria) of indigenous ecosystem types located within the designation area.

Policy 13–5 (a)	Criteria Description	OG forests (A & H-C)	OG treeland	Secondary forest with OG signatures	Advanced secondary broadleaved forest	Raupō seepage wetland	Secondary broadleaved forest and scrublands	Kānuka forest	Other indigenous seepages	Native shrublands
Representativeness (i)	Habitat that:									
	(A) Comprises indigenous habitat type that is underrepresented (20% or less of known or likely former cover), or	Significant[15]	Significant	Significant				Significant		
	(B) Is an area of indigenous vegetation that is typical of the habitat type in terms of species composition, structure and diversity, or large relative to other areas in the Ecological District or Ecological Region, or has functioning ecosystem processes.									
Rarity and Distin	Habitat that supports an indigenous species or community that:									

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[15] Significance as defined by the One Plan Schedule F.

	(A) Is classed as threatened (as determined by the New Zealand Threat Classification System and Lists), or					Significant[16]				
	(B) Is distinctive to the region, or									
	(C) Is at a natural distributional limit, or									
	(D) Has a naturally disjunct distribution that defines a floristic gap, or									
	(E) Was originally (i.e. prehuman) uncommon within New Zealand, and supports an indigenous species or community of indigenous species.					Significant			Significant	
Ecological Context (iii)	Habitat that provides:									
	(A) Connectivity (physical or process connections) between two or more areas of indigenous habitat, or									
	(B) An ecological buffer (provides protection) to an adjacent area of indigenous habitat (terrestrial or aquatic) that is ecologically significant, or									
	(C) Part of an indigenous ecological sequence or connectivity between									

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[16] Relates to the seepage wetland containing a stand of Threatened-Nationally Critical swamp maire at c. CH4120.

different habitat types across a gradient (e.g. altitudinal or hydrological), or									
(D) Important breeding areas, seasonal food sources, or an important component of a migration path for indigenous species, or									
(E) Habitat for indigenous species that are dependent on large and contiguous habitats.									
Significance assessment results	**Significant**	**Significant**	**Significant**	Not significant	**Significant**	Not significant	**Significant**	**Significant**	Not significant

5.0 VEGETATATION CLEARANCE/MODIFICATION ACTIVITIES AND EFFECTS

5.1 Clearance or Modification of Indigenous Vegetation and Habitats

Permission is sought for the clearance of a subset of ecosystem types (Table 6.A.12.). The full extent of each class within the designation area could potentially be entirely cleared; while such an outcome may be unlikely, mitigation has been recommended to address the level of adverse effect that would result from their complete loss. The purpose of this approach is to allow flexibility within the designation area for works to proceed without being constrained by lower value ecosystems that can be replaced in relatively short timeframes through replacement planting. The replacement planting would be at the environmental compensation ratios (ECR) specified in Table 6.A.19. If, as part of the detailed design process, opportunities are identified to reduce the extent of effects from these assumed maxima, the replacement planting area required would reduce accordingly, through application of the respective ECRs to slope-corrected measures of affected vegetation. As such, further avoidance will be incentivised. Any such changes would need to respond to and be up to/within the level of effects specified in Table 6.A.19. A management regime is defined through the conditions that directs the management plan framework to take steps to avoid effects to animals inhabiting ecosystem types subject to this management regime.

For the other ecosystem types (Table 6.A.12) permission is sought for a discrete envelope of effects based on the preliminary design[17], including a provision for flexibility beyond the project footprint to allow for construction access. This aspect of the approach emphasises the importance of avoiding adverse effects to higher value ecosystem types and the conditions and management plan framework specify steps and measures to identify, demarcate, and physically protect these higher value ecosystem types.

Table 6.A.12. Ecosystem types for which full clearance is sought versus clearance constrained.

Full clearance	Constrained clearance
Full clearance allowed following pre-clearance fauna surveys. Replacement planting to be provided for the full area (Table 6.A.4.) of these	Clearance constrained by either an agreed effects envelope or condition and management plan provisions for minimisation of clearance. Agreed effects envelopes are specified in Section 5.3. Replacement planting and

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[17] In this report, both the “preliminary design” and “preliminary indicative design” are terms that refer to the preliminary 3D road design shown on the designation plans as lodged.

ecosystems occurring within the designation area. - Secondary broadleaved forests and scrublands, - Native shrublands.	offset measures are required for all ecosystems not constrained by one of the three effects envelopes. - Old-growth forests and treelands, - Secondary forests containing old-growth signatures, - Advanced broadleaved forest, - Kānuka forest, - Indigenous dominated seepage wetlands.

5.1.1 Habitat fragmentation and isolation

Efforts have been made in the designation and preliminary design to minimise the extent to which existing habitats are severed or left isolated from adjacent habitat areas (i.e., fragmented). Although a level of fragmentation is unavoidable, bridges assist with the maintenance of ecological connectivity, and a principle of landscape and ecological replacement planting and the ecological offset is to enlarge and connect remaining vegetation areas where the configuration of the project allows.

5.1.2 Edge effects

Where forest communities are partly cleared, the creation of a new forest edge exposes the forest habitat to climatic influences (Young & Mitchell, 1994) from the surrounding landscape (e.g., increased wind and solar radiation, reduced humidity) and these changes can lead to modification of the floristic composition and structure, including increased threats from light-demanding weed species. These changes can also alter the suitability of the edge habitat zone to animals inhabiting the forest habitat (Ewers & Didham, 2008). These effects will be addressed through buffer planting treatments at the patch edge to effectively seal and buffer the habitat patch from the surrounding landscape influences.

5.2 Magnitudes and Levels of Adverse Effects

Magnitudes and levels of adverse effects are described below for specific key areas. Refer Table 6.A.2. for specification of overall level of effect (EIANZ, 2018).

For the first of these areas, four potential 3D road alignment designs (representing a range of alignments, to the east and west, between the constraints of Parahaki Island and the MGSR) were assessed. For each potential alignment, the likely impacts of an embankment (i.e., a shorter Manawatū River crossing bridge transitioning to an embankment immediately on the north river bank) and a longer viaduct, with a pier or piers constructed beneath, were assessed. The options were proposed and examined in response to the Very High adverse levels of effects potentially arising at this site to multiple ecosystems (Figure

6.A.3 & Figure 6.A.4). Aspects of these analyses are presented in 5.2.1 below. These analyses of options provided the basis for the corresponding effects envelope.

5.2.1 Immediately north of the Manawatū River crossing (CH4000–4400)

Eastern (preliminary indicative design centreline) Embankment Option

The embankment option would result in the complete and permanent destruction of the remnant stand of swamp maire located at approximate CH4130. This stand is the only known remnant of swamp maire forest within proximity of the project, meaning that the embankment would result in total loss of swamp maire from the designation area and wider landscape. Swamp maire holds the threat classification Threatened-Nationally Critical, with the national population estimated to be undergoing a very high ongoing or predicted decline of >70% (de Lange et al. (2018); p. 24). The magnitude of effect resulting from the destruction of the swamp maire stand is Very High. The swamp maire stand is of Very High ecological value and is ecologically significant in terms of RMA (1991, s6(c)). This combination of Very High magnitude of effect to a Very High value feature would result in a permanent Very High adverse level of ecological effect. Following EIANZ (2018) best practice guidance, project activities resulting in Very High adverse levels of effect are not acceptable on ecological grounds alone and measures would be required to avoid or otherwise reduce the magnitude of adverse effects to the swamp maire stand.

The embankment option would result in the complete and permanent destruction of the 0.55 ha raupō dominated seepage wetland located at CH4200. Complete and permanent loss of the seepage wetland would result in a Very High magnitude of adverse effect. The seepage wetland is a regionally rare ecosystem, supporting a stand of threatened swamp maire and providing potential habitat for nationally Threatened and At-Risk swamp birds such as Australian bittern. The seepage wetland is ecologically significant in terms of RMA (1991, s6(c)). Central Government's non-statutory guidance identifies the protection of indigenous vegetation associated with wetlands to be a national priority (MfE, 2007), and is applicable to the seepage. The seepage is of Very High vulnerability (i.e., holding high rarity attributes) and irreplaceability (i.e., there are no options to recreate the seepage), meaning the seepage is of a Very High level of conservation concern[18]. The seepage is valued as High ecological value. The combination of Very High magnitude effects to a High value seepage ecosystem would result in a permanent Very High adverse level of effect. The seepage hydro system is fundamental to the formation and sustainability of the seepage wetland

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[18] In this context, Conservation Concern is defined as the combined levels of irreplacability and vulnerablity, after Pilgrim et al. (2013).

class, the hydro system cannot be recreated elsewhere, and thus the embankment would result in a permanent and irreplaceable loss of this type of wetland habitat from the region.

Embankment construction would potentially require up to a 20 m-wide[19] disturbance area extending laterally from the toe of the embankment. Together with the embankment footprint, this disturbance zone would result in permanent modification of the High value waterway between CH4100–4350. The assessed level of effect from this interaction is High–Very High, based on the linear length of waterway affected within the catchment (Miller, 2018).

On the western side of the embankment, the 20 m disturbance zone would extend into the alluvial old-growth forest resulting in 0.28 ha of direct forest clearance plus edge effects within the forest beyond the extent of disturbance. The alluvial old-growth forest represents forest types of which <2.5% remains regionally and exhibits high degrees of the structural development (e.g., emergent canopy tier) which take centuries to develop. The alluvial old-growth forest is of Very High ecological value and conservation concern (see Figure 6.A.7). Permanent clearance of the ecosystem over 0.28 ha would equate to a Very High magnitude of effect and a Very High adverse level of effect. This level of effect would be unacceptable on ecological grounds and signals that measures would be required to reduce the magnitude and duration of effects.

Approximately 1.5 ha of kānuka forest would be lost beneath the footprint between CH4000–4100. The magnitude of effect from the impact to kānuka forest would be Very High. A Very High magnitude effect to a Moderate Value feature would equate to a High level of effect.

In combination, the embankment option between CH4000–4400 would permanently destroy a Very High value (nationally threatened) swamp maire stand, 0.55 ha of rare High value seepage wetland, and 0.28 ha of Very High value alluvial swamp forest. An undefined quantity of High value stream habitat (depending on final construction footprint) would be permanently modified (Miller, 2018) and 1.5 ha of kānuka forest would be lost. The levels of effects on Very High and High Value ecosystems from the embankment option between CH4000–4400 are all Very High adverse. Permanent loss of vulnerable and irreplaceable seepage and alluvial old-growth ecosystems would result in adverse effects that fall beyond the bounds of offsetting in this landscape (see Section 6.3).

In summary, these levels of effect for the embankment option at this site are unsupportable on ecological grounds and alternative approaches (e.g., a viaduct) would be required to

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[19] A minimim of 17 m disturbance zone is required for vehicle access to enable embankment construction (Appendix E).

reduce the magnitude and duration of effects to levels that are acceptable on ecological grounds.

Western (Detailed Business Case (DBC) centreline) Embankment Option

An embankment along the DBC centreline would result in extensive impact on the alluvial old-growth forest, destroying all of the pukatea-kahikatea-tawa forest composition that exists on wet soils adjacent to the toe of the slope, and also the matai-tawa-titoki forest on the drier soils of the terrace riser and beyond to the west. Including provision for access, the embankment would result in 1.42 ha of permanent loss of Very High value old-growth forest. This impact would result in a Very High magnitude of effect to a Very High value forest ecosystem, with the outcome being a Very High adverse level of effect.

Given the unfavourable geotechnical conditions in the valley floor area, and to address the risk of lateral spread associated with the embankment option, extensive ground improvement works are likely to be required both beneath and beyond the embankment footprint (personal communication: Debbie Fellows (Geotechnical Engineer)) and this disturbance would extend to the east into the rare raupō seepage wetland. These works, in combination with embankment and construction access, would be widespread and destructive to ecosystems located on the valley floor. The embankment and construction access would result in direct loss to the raupō seepage and to the remnant swamp maire stand. There would also potentially be groundwater hydrology effects to any remnants of the wetland and the threatened swamp maire stand. Taking these activities into account, the worst-case scenario is that the entire raupō wetland and swamp maire stand would be permanently lost. On this basis, the adverse effects to the wetland and swamp maire would be of a Very High magnitude and the effect would be on features of High and Very High ecological value. This combination of effect magnitude and ecological value would result in a Very High adverse level of effects and effects would be of a permanent duration.

Given the inability to avoid or minimise the effect on the High value stream, an approximate length of 400 m would be directly and permanently affected. The affected stream reach would likely be subjected to a Very High magnitude of effect and this would result in a Very High adverse level of effect.

Overall, and compared to an embankment on the preliminary indicative design alignment, the effect of an embankment following the DBC alignment would result in greater amount of loss of old-growth alluvial forest, and the same effect (i.e., complete loss) to the seepage wetland and swamp maire. The effect on the High value stream would likely be of a Very High magnitude (Miller, 2018). Similar to an embankment following the preliminary indicative design centreline, the western embankment would result in Very High adverse effects on the old-growth forest, the rare seepage wetland and the Threatened – Nationally Critical remnant swamp maire (as well as the High value stream). The forest and seepage ecosystems are vulnerable and irreplaceable, and effects resulting from the severe, permanent loss of these ecosystems would be beyond the bounds of offsetting. This level of effect would be unacceptable on ecological grounds and signals that measures would be required to reduce the magnitude and duration of effects (e.g., elevate or reroute the structure).

Eastern (preliminary indicative design centreline) Viaduct Option

Provision of a viaduct structure located along the centreline of the preliminary indicative design alignment between CH4000–4400 would limit the effects on the threatened old-growth forest and the threatened swamp maire. If the viaduct alignment could be moved c. 15 m to the east of the centreline, the swamp maire would stand clear and to the west of the viaduct. This would mean natural patterns of lighting and precipitation could be maintained for the forest stand. A viaduct on the current alignment would result in the eastern half of the stand being located beneath the viaduct. In this scenario, the swamp maire stand might require some canopy pruning to provide adequate clearance for viaduct construction and maintenance – the extent and detail of this would be subject to detailed viaduct design. This would equate to a Low magnitude of effect to a Very High value feature, resulting in a Moderate level of effect. Restorative planting of swamp maire seedlings using seeds sourced from the affected stand would be a means of addressing the effects that are unable to be addressed (avoidance) through viaduct design and construction methodology.

The effect on the seepage wetland would be largely dependent on the need to install any supporting piers and foundations within the wetland. The road centreline runs approximately 90 m across the wetland, meaning that a pier within the centre of the wetland body could be avoided by adopting a 90 m viaduct span. Piers would need to be located near the edges of the wetland and may require substantial foundations depending on the ground conditions; however, any associated effects on the wetland could be minimised through design and suitable construction methodologies. This would mean that direct effects from construction to the rare seepage wetland ecosystem could be minimised aside from a small (0.02 ha) area along the seepage' western margin where access activities might encroach into wetland vegetation. This western fringe is transitional to wet pasture and is the least sensitive area of the wetland.

Effects of the viaduct from overhead shading could be reduced through design and restorative planting could be applied to incorporate wetland species adapted to the levels of partial shade that would occur beneath the viaduct. The effect of reduced precipitation is not considered a significant issue for long-term wetland health as the soils are permanently waterlogged across the wetland from groundwater sources (the wetland soil hydrology is not dependent on rainfall).

On the basis that the wetland could be largely spanned, that areas disturbed for access could be remediated and restorative planting could address shading effects to ensure a sustainable wetland vegetation cover, a Moderate magnitude of effect to the High value seepage wetland would result in a High level of effect. The High level of effect could be readily addressed through proximal high value wetland restoration treatments.

Effects to the Very High value alluvial old-growth forest would be avoided as the forest would be set back laterally more than 30 m[20] from the edge of the viaduct.

Based on the proximity of the viaduct and associated work area to the High value stream, it appears there would be a good possibility of avoiding permanent effects to the High value stream. Any permanent effects (e.g., diversion) would likely be localised to stream segments, and there is a better chance of stream values being restored to previous levels (or higher) after construction is complete (Miller, 2018).

The kānuka forest at CH4000–4100 would be impacted by pier installation and by the overhead cover of the viaduct. The magnitude of effect to kānuka forest would be High. A High magnitude effect to a Moderate value ecosystem would result in a Moderate level of effect. Although of a threatened status, the effects to the kānuka forest could be mitigated with a high degree of certainty.

In summary, with the eastern viaduct option, the effect to High and Very High value ecosystems would range from High to Low. Impacts to the kānuka forest would be Moderate, and this effect can be readily mitigated.

Western (DBC centreline) Viaduct Option

A western viaduct, assuming access from the eastern side of the structure, would encroach into the old-growth forest by approximately 0.06 ha along the forest's eastern edge. This interaction would likely require some loss of the emergent or canopy forest tiers for both construction and maintenance. This could be managed with expert arborist skills, and the sub-canopy and understorey components could be largely retained. Most disturbance would result from access for, and installation of, bridge piers. A strip with a maximum width of 20 m would need to be cleared for each pile, and a 30 m deep working platform would be required to the east to allow for crane and heavy vehicle access, orientated parallel to the viaduct structure. Assuming 90 m pier spans, a minimum of 70 m of forest could be retained between piers, and as no permanent structure is associated with the access strips to each pier, these areas could be remediated to allow a long-term regeneration to alluvial forest composition. Importantly, permanent and Very High magnitude effects could be avoided. The magnitude of effect from localised disturbance/loss of structural features would be Moderate (partial change in attributes compared to baseline). The duration would be long term (c. 25 years). A Moderate effect magnitude to a Very High value ecosystem equates to

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[20] A minimim of a 29 m setback from the viaduct would be required for crane and vehicle access (Appendix E).

a High level of effect. The effect would be concentrated along the forest margin, thus avoiding permanent effects associated with fragmentation and severance of the wider forest. The High level of effect would be within the limits of offsetting and could reasonably be addressed.

The effect of shading and reduced precipitation on the retained forest is somewhat uncertain. It is likely that the zone beneath the viaduct could be supplemented with seedlings of shade-tolerant species, and that the soils are naturally waterlogged and would still receive runoff from surrounding areas. The worst-case scenario would suppress some forest regeneration. Even in the case of repressed regeneration, ecological connectivity would be maintained and the magnitude of effect on the forest would be no more than Moderate.

Approximately 0.13 ha of the seepage wetland would be encroached upon for construction access platforms to the east of the structure. The effect on the wetland would be of Moderate magnitude. Following completion of works, the affected seepage area could be remediated, meaning the duration of effect would be medium term (c. 15 years). The resulting level of effect would be High. The swamp maire would fall within the 30 m construction platform, but it is feasible that this small forest stand could be avoided through a combination of detailed design and sympathetic construction access configuration.

It is likely that localised permanent works in the stream would be required to protect viaduct piers from erosion. The effect of these localised permanent works would be of Moderate or less magnitude, resulting in no greater than a High level of effect.

Some encroachment into the kānuka would likely be required. Allowing 0.1 ha of clearance would equate to a Low magnitude of effect and a Low level of effect.

In summary, with the western viaduct option, the effect to High and Very High value ecosystems would range from High to Low.

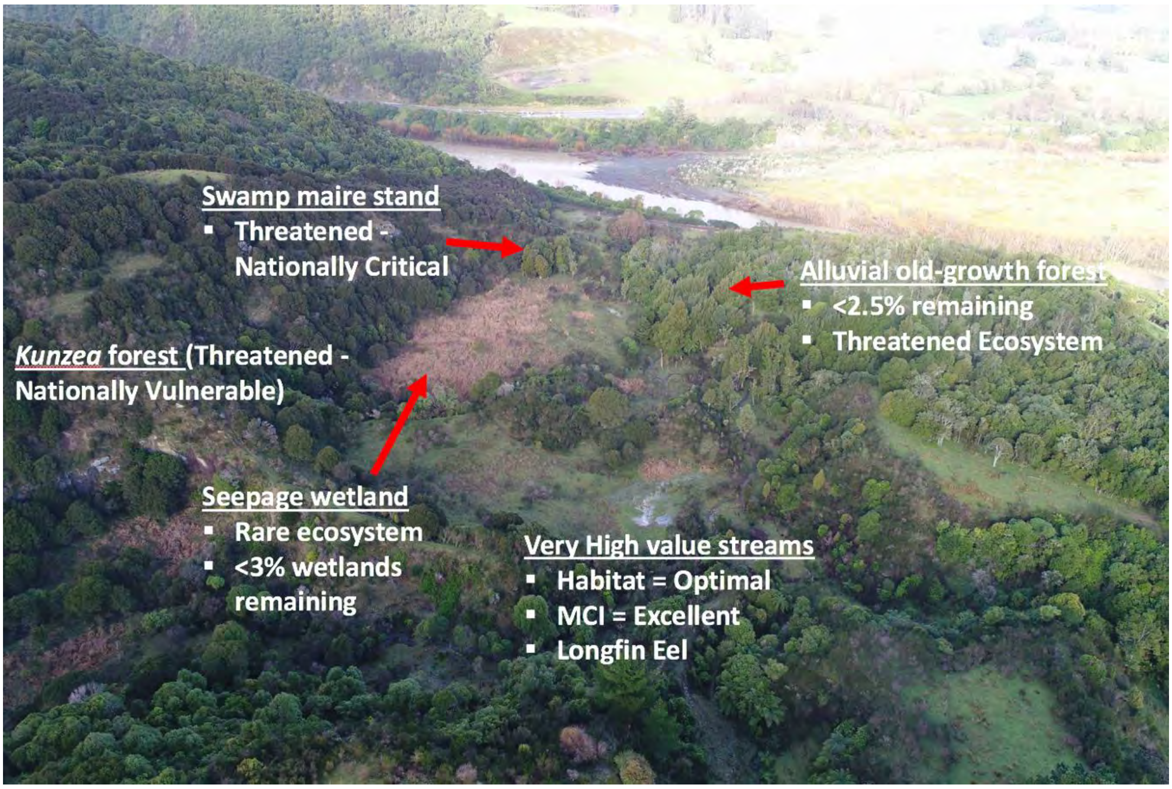

Figure 6.A.3. Key features of High and Very High ecological value located within the CH4000–4400 reach. Note, kānuka is the common name for a number of species in the genus *Kunzea*.

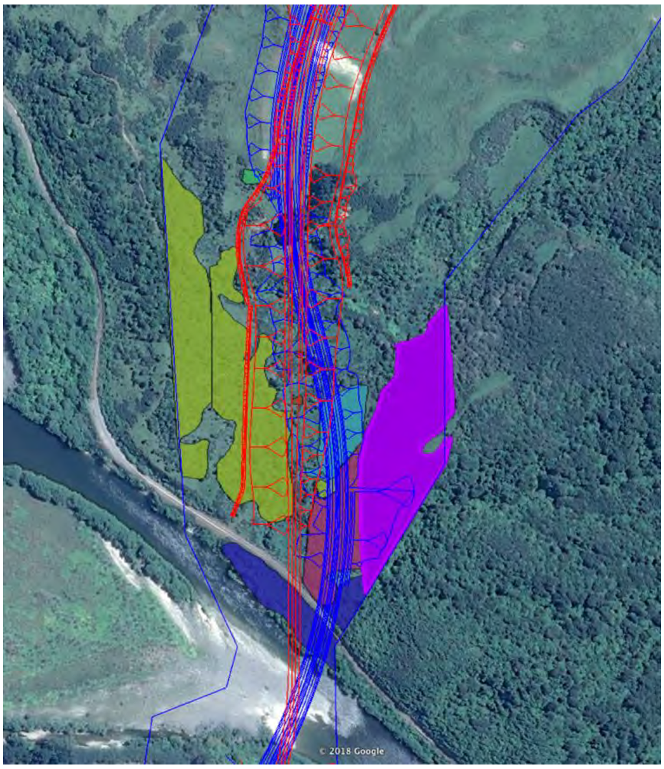

Figure 6.A.4. Embankment design options from preliminary indicative design (blue/easternmost) and detailed business case (DBC; red/westernmost) used for effects envelope predictions. The relevant vegetation polygons shown are green = old-growth forest (inc. swamp maire stand), blue = seepage, purple/red shades = kānuka.

Table 6.A.13. Summary of effects scenarios for embankment and viaduct options over CH4000–4400.

Ecosystem types	Embankment options (both preliminary indicative design & DBC alignments)	Eastern viaduct option – NoR preliminary indicative design alignment	Western viaduct option – DBC alignment
Old-Growth Forests	Option not supported on ecological grounds due to Very High levels of adverse effect to multiple High and Very High value ecosystems/species	▪ 0 ha (avoided).	▪ 0.06 ha of modification including localised permanent loss for pier footprint. ▪ Edge effects beyond forest edge. ▪ Moderate magnitude of effect, High level of effect. ▪ Long-term effect duration.
Swamp Maire Stand		▪ Retention of all swamp maire trees, some canopy pruning potentially required. ▪ Low magnitude of effect, Moderate level of effect.	▪ Retention of all swamp maire trees. ▪ Low-Negligible magnitude of effect, Moderate-Low level of effect.
Seepage Wetland		▪ 0.02 ha disturbance, all areas to be remediated other than areas affected by permanent structures (e.g., piers). ▪ Moderate magnitude of effect, High level of effect. ▪ Temporary duration (c. 15 yrs).	▪ 0.13 ha disturbance, all areas to be remediated other than areas affected by permanent structures (e.g., piers). ▪ Moderate magnitude of effect, High level of effect. ▪ Temporary duration (c. 15 yrs).
Kānuka Forest (*Kunzea* Forest)		▪ 1 ha clearance. ▪ High magnitude of effect, Moderate level of effect.	▪ 0.1 ha clearance. ▪ Low magnitude of effect, Low level of effect.
Stream		▪ To be confirmed on detailed design.	▪ To be confirmed on detailed design.

5.3 Effects envelopes

5.3.1 North of Manawatu River Crossing (CH4000–4400)

Within CH4000–4400 there are ecological grounds to avoid or otherwise minimise adverse effects to threatened and rare ecosystems/species and also to allow adequate flexibility for consideration of options and the development of an optimal detailed design solution. The approach taken here is to utilise the predicted effects from the above four scenarios to prescribe, for each ecological feature of importance, maximum allowable levels and durations of adverse effect (as assessed by EIANZ (2018) criteria), and a maximum physical extent of effect (also see summary in Table 6.A.16.).

Based on the level of value and conservation concern of ecosystems/species listed below, two essential requirements for any activities within this area would be to:

1. Cause no more than Moderate magnitude of adverse effect. This ensures that the Very High adverse effect level is avoided, and that the effects are likely to be supportable on ecological grounds with an appropriate mitigation/offsetting proposal, and
2. Cause effects that are not permanent in overall character. Effect duration should be long term (c. 25 years) or less.

Conforming to these requirements would imply the following envelope of acceptable ecological effects:

- **Threatened old-growth alluvial forests**: no more than 0.1 ha of Moderate effect magnitude/High level of effect, AND of no more than long-term (c. 25 years) duration. In practice, this would cover the limited loss of canopy or emergent tiers, or loss of forest vegetation. Crucially, the effect would not be permanent in overall character. The effects duration would be long-term or less in overall character and would be addressed through remediation plus restoration offsets.
- **Threatened Nationally – Critical swamp maire stand**: retention of all trees. Effects of canopy pruning to result in Low or Negligible magnitude of effect, and Moderate or Low level of effect. No permanent adverse effects.
- **Rare seepage wetland**: no more than 0.13 ha of Moderate effect magnitude/High level of effect, AND of no more than temporary (c. 15 years) duration. In practice this would allow for construction activities to directly modify no more than 0.13 ha of the seepage. The effects would be temporary in overall character and would be addressed through remediation plus restoration offsets.
- **Kānuka forest (Kunzea Forest)**: no more than 1 ha of clearance, with effects to be addressed through mitigation using the prescribed ECRs.

5.3.2 *Western QEII covenant (CH5600–5800)*

A bridge crossing the Western QEII covenant would result in no more than (i.e., maximum allowable) 1 ha of clearance of old-growth hill country forest and no more than 0.5 ha of advanced secondary broadleaved forest. Given the legal protected status of this vegetation area, and its level of value, clearance of any indigenous vegetation should be limited to 20 m beyond the extent of fill and 5 m beyond the extent of cut. With these minimisation measures applied, the impact on the old-growth forest would be of an extent that most of the old trees would be destroyed and the trees retained would be small fragments on either side of the alignment. The sites would be exposed to edge effects which would compromise the ecological integrity of the remaining old-growth forest stands. This would result in a major alteration to the form and function of the old-growth forest stand. The level of effect on the old-growth forest would be Very High, resulting from a Very High magnitude of effect to a Very High value ecosystem.

The magnitude of effect on the High Value Advanced Secondary Broadleaved Forest would be High, resulting in a Very High adverse effect. These levels of effect suggest that further measures are required at this location during detailed design to minimise the level of effect. Such measures could include use of retaining walls or further use/optimisation of bridges to reduce the extent of vegetation clearance required.

Table 6.A.14. Level of effect description (EIANZ, 2018) for Western QEII crossing.

Ecosystem types	Levels of value	Magnitudes of adverse effect					
		Very High	High	Moderate	Low	Negligible	Avoided
Old-Growth Forest	Very High	V. High	V. High	High	Moderate	Low	Nil
Advanced Secondary Broadleaved Forest	High	V. High	V. High	Moderate	Low	V. Low	Nil
Streams		V. High	V. High	Moderate	Low	V. Low	Nil

Table 6.A.15. Effects envelopes for Western QEII crossing CH5600–5800.

Ecosystem types	Northern & eastern tributaries
Old-Growth Forests	1 ha, with the retained forest to be protected
Advanced Secondary Broadleaved Forest	0.5 ha, with the retained forest to be protected

5.3.3 Eastern QEII covenant (CH6100–6400)

The combination of cut and fill through the Eastern QEII would result in loss of secondary broadleaved forest. Given the legally protected status of this vegetation area, clearance of indigenous vegetation should be limited to 20 m beyond the extent of fill and 5 m beyond the extent of cut. These limitations on clearance would mean that the High level of effect resulting from Very High effect magnitude on the Moderate value secondary broadleaved forest is limited in extent. At CH6100–6400 the effects envelope is the preliminary design footprint (NoR stage) plus the 20 m and 5 m buffer areas described above.

5.4 Designation wide (excluding mitigation and protected vegetation areas)

Activities that would occur across the designation area, along with their location, the temporal scale, magnitude and level of effect are described in Table 6.A.16. below. The fauna aspects of these effects are directly addressed in the Terrestrial Fauna Ecological Effects Assessment (Blayney & Sievwright, 2018).

It is assumed that 8–10 m wide corridors would be required to access the designation area in number of locations along the alignment. The sensitivities of access corridors would need to be considered and good practice measures to avoid or otherwise minimise effects would be undertaken. Where clearance of fauna habitats and vegetation cannot be avoided, the approach for addressing fauna and vegetation effects would follow the procedures and methods prescribed for effects management within the designation area. These procedures and methods will be detailed in the project's Ecological Management Plan.

Specific access is to be designated from the Saddle Road along the alluvial flats on S. Bolton's land and along an existing farm track to the CH4000–4400 area[21]. This activity would result in the upgrade of an existing farm track. It has been assumed there would be some minor additional forest clearance required to achieve the widened track.

The forest in this location represents the drier alluvial composition (podocarp/tawa-mahoe) and the forest is heavily impacted from grazing. A total of 0.05 ha of old-growth alluvial forest has been allowed for in the mitigation/offset calculations to address the effects of upgrading the existing track. To reduce the duration of effect, the track should be retired and remediated as far as practical on completion of works. The surrounding area is the retire, protect and gap plant treatment and this proximal restoration would assist in addressing adverse effects to this area.

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[21] Refer plan: 51-38113-C-902.

Table 6.A.16. Estimates of activities, their locations, and the resulting temporal scale, magnitude and level of adverse effects

Activities	Description	Location(s)	Temporal scale	Magnitude of effect	Level of effect[22]
Vegetation clearance and modification of lower value (Moderate–Low value) ecosystem types	Potential designation-wide clearance of secondary broadleaved forest and scrublands and native shrublands	Designation wide	Temporary (medium term – *c.* 15 years)	Potentially Very High, as all of these ecosystem types could be cleared within the designation area. Likely to be Moderate with avoidance measures applied.	High–Moderate
Vegetation clearance and modification of higher value (Moderate–Very High value) ecosystem types	Restricted clearance and modification of old-growth forests and treelands, secondary forests containing old-growth signatures, advanced broadleaved forest, kānuka and seepage wetlands	▪ 0.10 ha[23] of alluvial old-growth forest CH4000–4400[24],	Long term (*c.* 25 years)	Moderate	High
		▪ 1 ha of hill country old-growth forest CH5650,	Permanent (replacement not possible)	Very High (assuming the remaining area is avoided at CH5600)	Very High
		▪ 2.2 ha secondary forest containing old-growth signatures 7300, 10500–10700,	Long term (*c.* 25 yrs.)	High (assuming 0.41 ha avoided at CH6100)	Very High

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[22] Assessed prior to mitigation/offsetting.

[23] In addition, 0.05 ha has been allowed for minor old-growth forest clearance associated with the access track from Saddle Road across S. Bolton's land to the vicinity of CH4000.

[24] This quantity includes 0.05 ha of alluvial old-growth forest clearance for access track upgrading in the forest to the west of CH4000–4400 area.

Activities	Description	Location(s)	Temporal scale	Magnitude of effect	Level of effect[22]
		▪ 0.5 ha of advanced secondary broadleaved forest CH5700–5800,	Long term (*c.* 25 yrs.)	High (assuming the remaining area is avoided at CH5750–5850)	Very High
		▪ 1 ha of kānuka forest CH4200, 0.39 ha CH7300	Medium term (c. 15 years)	Moderate	Moderate
		▪ 0.13 ha of raupō seepage wetland CH4200[25],	Long term, (remediation possible)	Moderate, assuming direct effects avoided to remaining 0.42 ha	High
		▪ A remnant stand of 14 swamp maire CH4150	Long term (*c.* 25 yrs.)	Low or Negligible, assuming all swamp maire are retained, with some canopy pruning	Moderate or Low
Habitat fragmentation isolation	Severance of existing habitats resulting in one or more isolated habitat fragments	Dependent on final design	Permanent where replacement planting cannot remedy the severance or reconnect the fragment with an adjacent habitat	High, fragmentation and isolation would result in major loss and alteration of baseline conditions, attributes would be fundamentally changed	Very High–Low

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[25] In addition, permanent loss of 0.39 ha of moderate value seepage wetland is assumed in the effects and offset calculation.

Activities	Description	Location(s)	Temporal scale	Magnitude of effect	Level of effect[22]
Edge effects	Opening and exposing a forest edge to an open adjacent landscape	Dependent on final design	Temporary (medium term – 5–15 years)	Moderate, post-development character will be partially changed but minimised through buffer planting	Very High–Low

6.0 EFFECTS MANAGEMENT

6.1 Mitigation and Offsetting Principles and Frameworks

6.1.1 The mitigation hierarchy

Good practice effects management directs for practical steps to be taken to manage effects using the mitigation hierarchy.

As such, good practice (Business and Biodiversity Offsets Programme [BBOP], (2012)) specifies that practical measures must be taken as follows:

> **Avoidance**: avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity.
>
> **Minimisation**: reduce the duration, intensity and/or extent of impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as practically feasible.
>
> **Rehabilitation/restoration**: rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/or minimised.
>
> **Offset**: compensate for any residual significant, adverse impacts that cannot be avoided, minimised and/or rehabilitated or restored, in order to achieve no net loss or a net gain of biodiversity. Offsets can take the form of positive management interventions such as restoration of degraded habitat, arrested degradation or averted risk, protecting areas where there is imminent or projected loss of biodiversity.

In the event that residual significant adverse effects cannot be addressed through rigorous and exhaustive application of the mitigation hierarchy, a biodiversity offset may be an appropriate method of addressing residual effects. An offset is the last resort after all reasonable measures have been taken first to avoid and minimise the impact of a development project and then to restore biodiversity on-site (BBOP, 2012). The following principles and regional policy direct the parameters and acceptability of a biodiversity offset.

6.1.2 *BBOP (2012) biodiversity offsetting principles*

The BBOP (2012) principles establish a framework for designing and implementing biodiversity offset and verifying their success. The ten BBOP (2012) principles[26] are as follows:

1. **Adherence to the mitigation hierarchy**: A biodiversity offset is a commitment to compensate for significant residual adverse impacts on biodiversity identified after appropriate AVOIDANCE, minimisation and on-site rehabilitation measures have been taken according to the mitigation hierarchy.

2. **Limits to what can be offset**: There are situations where residual impacts cannot be fully compensated for by a biodiversity offset because of the irreplaceability or vulnerability of the biodiversity affected.

3. **Landscape context**: A biodiversity offset should be designed and implemented in a landscape context to achieve the expected measurable conservation outcomes taking into account available information on the full range of biological, social and cultural values of biodiversity and supporting an ecosystem approach.

4. **No net loss**: A biodiversity offset should be designed and implemented to achieve in situ, measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity.

5. **Additional conservation outcomes**: A biodiversity offset should achieve conservation outcomes above and beyond results that would have occurred if the offset had not taken place. Offset design and implementation should avoid displacing activities harmful to biodiversity to other locations.

6. **Stakeholder participation**: In areas affected by the project and by the biodiversity offset, the effective participation of stakeholders should be ensured in decision-making about biodiversity offsets, including their evaluation, selection, design, implementation and monitoring.

7. **Equity**: A biodiversity offset should be designed and implemented in an equitable manner, which means the sharing among stakeholders of the rights and responsibilities, risks and rewards associated with a project and offset in a fair and balanced way, respecting legal and customary arrangements. Special consideration

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[26] Where capitilisation occurs below, it is as per the source.

should be given to respecting both internationally and nationally recognised rights of indigenous peoples and local communities.

8. **Long-term outcomes**: The design and implementation of a biodiversity offset should be based on an ADAPTIVE MANAGEMENT approach, incorporating MONITORING AND EVALUATION, with the objective of securing outcomes that last at least as long as the project's impacts and preferably in PERPETUITY.
9. **Transparency**: The design and implementation of a biodiversity offset, and communication of its results to the public, should be undertaken in a transparent and timely manner.
10. **Science and traditional knowledge**: The design and implementation of a biodiversity offset should be a documented process informed by sound science, including an appropriate consideration of traditional knowledge.

6.1.3 One Plan biodiversity offset policy direction

One Plan Policy 13–4 directs for the mitigation hierarchy to be applied in relation to effects management of rare, threatened or at-risk habitats or significant indigenous vegetation or habitats. In the case that a biodiversity offset is required to address adverse effects that are residual following application of the mitigation hierarchy, Policy 13–4(i)(d) requires that a biodiversity offset must:

(i) Provide for a net indigenous biological diversity gain within the same habitat type, or where that habitat is not an area of significant indigenous vegetation or a significant habitat of indigenous fauna, provide for that gain in a rare habitat or threatened habitat type, and

(ii) Reasonably demonstrate that a net indigenous biological diversity gain has been achieved using methodology that is appropriate and commensurate to the scale and intensity of the residual adverse effect, and

(iii) Generally be in the same ecologically relevant locality as the affected habitat, and

(iv) Not be allowed where inappropriate for the ecosystem or habitat type by reason of its rarity, vulnerability or irreplaceability, and

(v) Have a significant likelihood of being achieved and maintained in the long term and preferably in perpetuity, and

(vi) Achieve conservation outcomes above and beyond that which would have been achieved if the offset had not taken place.

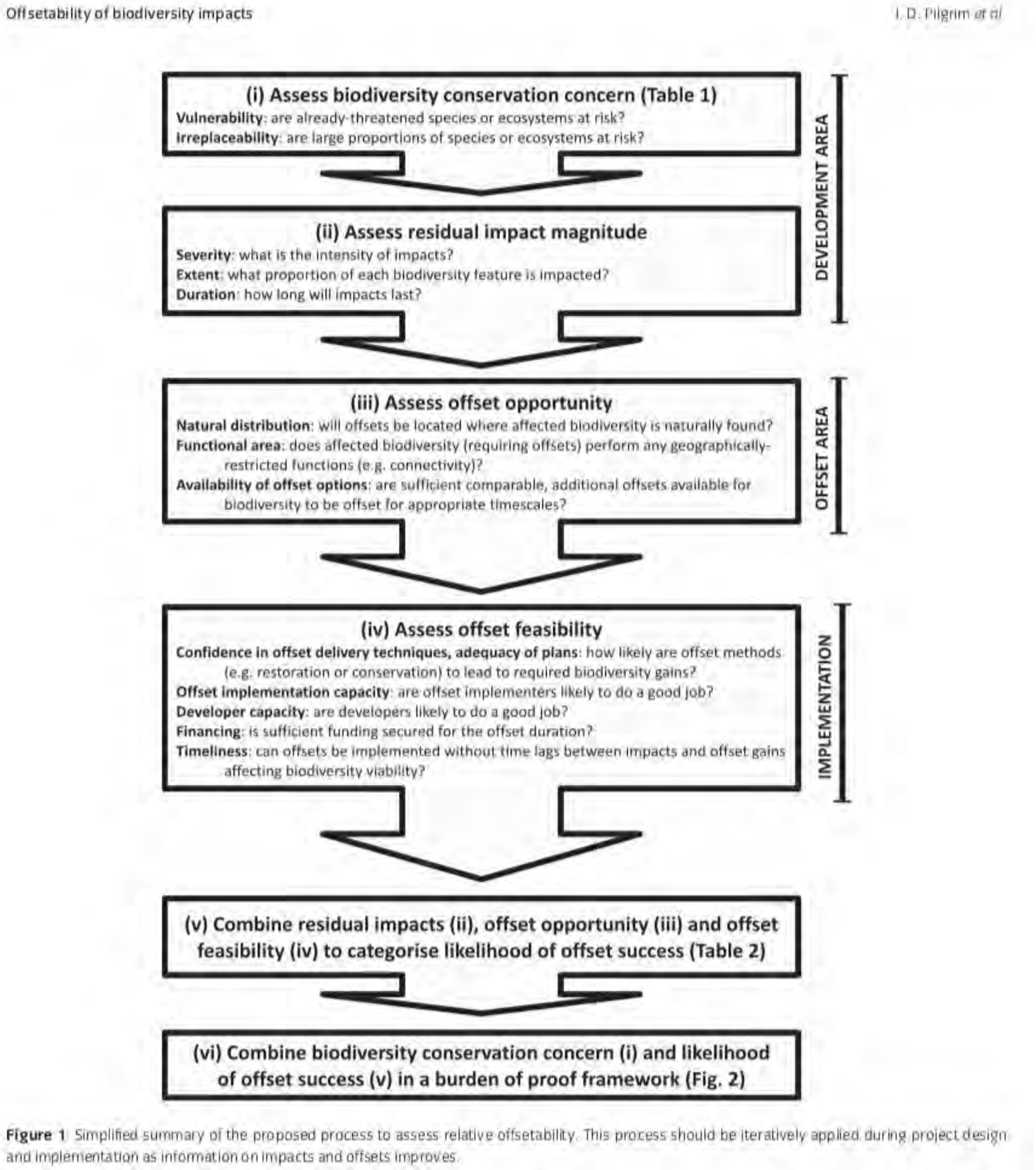
While an offset is a last resort option for addressing residual adverse effects, BBOP (2012) principle 2 (above) specifies there are limits to what can be offset, specifically where the residual adverse effects relate to biodiversity components of very high irreplaceability and vulnerability. Further, One Plan Policy 13–4(d)(iv) specifies that offsetting should not be allowed where inappropriate for the ecosystem or habitat type by reason of its rarity, vulnerability, or irreplaceability.

6.2 Assessment of Offsetability of Affected Ecosystem Types

An impartial process for assessing the offsetability of biodiversity impacts (Pilgrim *et al.*, 2013) was used to check, for the ecosystem types present within the designation area, whether there was biodiversity of a nature that extended beyond the limits of biodiversity offsetting. This is an important step given the intent of BBOP (2012) Principle 2 and One Plan Policy 13-4(d)(iv).

The Pilgrim et al. (2013) framework is referenced by DoC (2014) as the accepted method for assessing offsetability. An assessment of the offsetability of biodiversity impacts addresses the appropriateness of risks to biodiversity and the achievability of offsets. Key issues affecting offsetability are biodiversity conservation concern, residual impact magnitude, theoretical offset opportunity and practical offset feasibility (Pilgrim et al., 2013). The framework comprises the following components (also see Figure 6.A.5):

1. Assess levels of conservation concern for affected biodiversity.
2. Determine the residual impact magnitude.
3. Assess opportunities to offset.
4. Assess offset feasibility.
5. Combine residual impacts (2), offset opportunity (3) and offset feasibility (4) to categorise likelihood of offset success.
6. Combine biodiversity conservation concern (1) and likelihood of offset success (5) to determine offsetability.



Offsetability of biodiversity impacts

J. D. Pilgrim et al

(i) Assess biodiversity conservation concern (Table 1)
Vulnerability: are already-threatened species or ecosystems at risk?
Irreplaceability: are large proportions of species or ecosystems at risk?

(ii) Assess residual impact magnitude
Severity: what is the intensity of impacts?
Extent: what proportion of each biodiversity feature is impacted?
Duration: how long will impacts last?

DEVELOPMENT AREA

(iii) Assess offset opportunity
Natural distribution: will offsets be located where affected biodiversity is naturally found?
Functional area: does affected biodiversity (requiring offsets) perform any geographically-restricted functions (e.g. connectivity)?
Availability of offset options: are sufficient comparable, additional offsets available for biodiversity to be offset for appropriate timescales?

OFFSET AREA

(iv) Assess offset feasibility
Confidence in offset delivery techniques, adequacy of plans: how likely are offset methods (e.g. restoration or conservation) to lead to required biodiversity gains?
Offset implementation capacity: are offset implementers likely to do a good job?
Developer capacity: are developers likely to do a good job?
Financing: is sufficient funding secured for the offset duration?
Timeliness: can offsets be implemented without time lags between impacts and offset gains affecting biodiversity viability?

IMPLEMENTATION

(v) Combine residual impacts (ii), offset opportunity (iii) and offset feasibility (iv) to categorise likelihood of offset success (Table 2)

(vi) Combine biodiversity conservation concern (i) and likelihood of offset success (v) in a burden of proof framework (Fig. 2)

Figure 1 Simplified summary of the proposed process to assess relative offsetability. This process should be iteratively applied during project design and implementation as information on impacts and offsets improves.

Figure 6.A.5. Process of assessing offsetability (Figure 1 from Pilgrim et al. (2013), reproduced).

Within the framework, conservation concern of a biodiversity feature is defined as the combined level of vulnerability and irreplaceability.

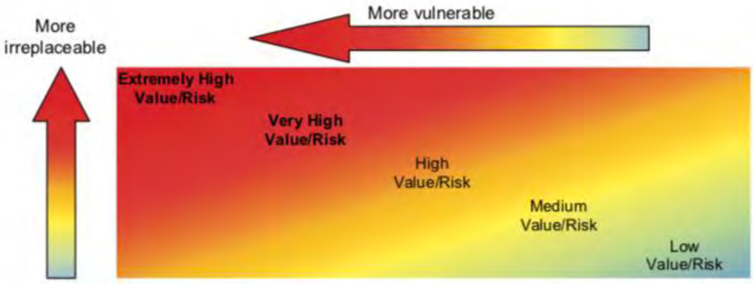


Figure 6.A.6. Reproduction of Figure 2 of DOC (2014), illustrating the format of ranking biodiversity conservation concern in terms of irreplaceability and vulnerability.

Vulnerability is measured in terms of existing formally recognised threat status. For the designation area, available data sources are One Plan ecosystem threat status listings (e.g., Schedule F) and for species national threat classification system lists (e.g., for flora, de Lange *et al*. 2018). In simple terms, the assessment of vulnerability asks the question – are already threatened species or ecosystems at risk? (Pilgrim et al., 2013).

An assessment of irreplaceability asks the question – within a region, what are the options for replacing the threatened species and habitats? Some biodiversity types have many options, other biodiversity types have no options.

The value of biodiversity increases as vulnerability and irreplaceability increase, and this also increases the risk that a biodiversity offset cannot be achieved (DOC, 2014).

An appraisal of residual impact magnitude, offset opportunities, and feasibility provides information to categorise likelihood of offset success. Offsetability can then be assessed as the combination of likelihood of success and conservation concern.

6.3 Limits to Offsetting for Ecosystems Within the Designation Area

The ecosystems within the designation area have a range of vulnerability and irreplaceability and this translates to a gradation in levels of conservation concern from low (native shrublands and seral broadleaved forests and scrublands) to high/extremely high (old-growth alluvial swamp forests and swamp maire). The various levels of conservation concern are presented in Figure 6.A.7 and broken down in Table 6.A.17. These data show that the old-growth alluvial forest ecosystem type and swamp maire stand are of greatest conservation concern. Therefore, these ecosystems are most at risk of falling beyond the limits of offsetability.

The kahikatea-pukatea-tawa and podocarp/tawa-mahoe forest compositions on alluvial surfaces, which are collectively referred to here as alluvial forest ecosystems, have 2.45% and 2.48% (respectively) of their former extent remaining regionally. Clearance of alluvial sites for land use conversions to agriculture (and other commercially productive land uses) has been widespread across New Zealand and the Horizons region provides a classic example of clearance of alluvial forests. In contemporary landscapes nationally, the alluvial forests are amongst the rarest forest compositions remaining, and regionally the alluvial forests are the most threatened forest types in the region (refer One Plan Schedule F). For this reason, the alluvial forests are of extremely high vulnerability. Old-growth forests are of the greatest value within the already rare alluvial subset. These old-growth stands hold attributes that cannot be replaced with restorative replacement planting treatments (e.g., high levels of structural diversity, an emergent forest tier). Thus, not only are most candidate sites for the restoration of alluvial forests occupied by commercially productive land uses, the old-growth attributes at risk are fundamentally irreplaceable. In the Horizons region, alluvial forests are restricted to few sites, are of limited extent, and there are few offset locations available for alluvial forest restoration[27], particularly within close proximity of the potential impact location (refer Policy 13–4 (d) (iii) above).

The severe national decline of swamp maire (Threatened–Nationally Critical) is such that the species is on a trajectory towards extinction. This attribute makes the species of extremely high vulnerability. Swamp maire is mostly found in riparian forest, in waterlogged ground, or on the margins of swamps and stream sides (or on hill slopes with impeded drainage; New Zealand Plant Conservation Network [NZPCN], 2018). These specific microhabitats are alluvial in nature and have been subjected to the same land use pressure and pattern of land conversion as described above for alluvial forest generally. These circumstances mean there are few sites suitable for restoration and conservation of the species elsewhere, thus the species is of very high irreplaceability.

The high value seepage wetland has a very high level of vulnerability in that <3% of wetlands remain in the Horizons region. The seepage has a very high level of irreplaceability as few other sites exist for conservation of the ecosystem and species supported.

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[27] One local option for restoration of alluvial forest is Ashhurst Domain.

Table 6.A.17. Relative levels of conservation concern (as defined by the combined rating of irreplaceability and vulnerability) of ecosystems within the proposed designation.

	Criteria	Swamp maire	Old-growth forest (alluvial)	Old-growth forest (hill country)	Secondary broadleaved forest with old-growth signatures	Old-growth treeland	Kānuka /Kunzea forest	Advanced secondary broadleaved forest	Indigenous dominated seepage wetland (high value)	Indigenous dominated seepage wetland (moderate value)	Secondary broadleaved forest and scrubland	Mānuka, kānuka, and divaricating shrubland
Conservation concern	Irreplaceability of affected biodiversity components (at the development site and beyond)	(VH) Restricted to few sites/limited extent, few offset locations	(VH) Restricted to few sites/limited extent, few offset locations	(H) Not commonplace but still several viable options for conserving elsewhere	(H) Not commonplace but still several viable options for conserving elsewhere	(H) Not commonplace but still several viable options for conserving elsewhere	(H) Not commonplace but still several viable options for conserving elsewhere	(M) Not commonplace but still several viable options for conserving elsewhere	(VH) Restricted to few sites/limited extent, few offset locations	(H) Not commonplace but still several viable options for conserving elsewhere	(L) Well-represented on many sites. Plenty of viable options for conserving this biodiversity elsewhere. Effective restoration techniques available	(L) Well-represented on many sites. Plenty of viable options for conserving this biodiversity elsewhere. Effective restoration techniques available
	Vulnerability of affected biodiversity components (at the development site and beyond)	(EH) Population has a very high ongoing or predicted decline of >70%	(EH) < 2.5% remains regionally. Nationally scarce	(VH) <19.5% remains regionally	(VH) <19.5% remains regionally	(VH) <19.5% remains regionally	(H) Threatened ecosystem, Threatened Nationally Vulnerable	(H) Negative trends are affecting biodiversity – significant proportion of sites under threat of degradation	(VH) <3% of wetland ecosystems remain regionally	(VH) <3% of wetland ecosystems remain nationally	(L) Species are widespread, not known to be threatened or declining, options to add conservation value through offsetting	(L) Species are widespread, not known to be threatened or declining, options to add conservation value through offsetting

Notes. L = Low, M = Moderate, H = High, VH = Very High, EH = Extremely High.

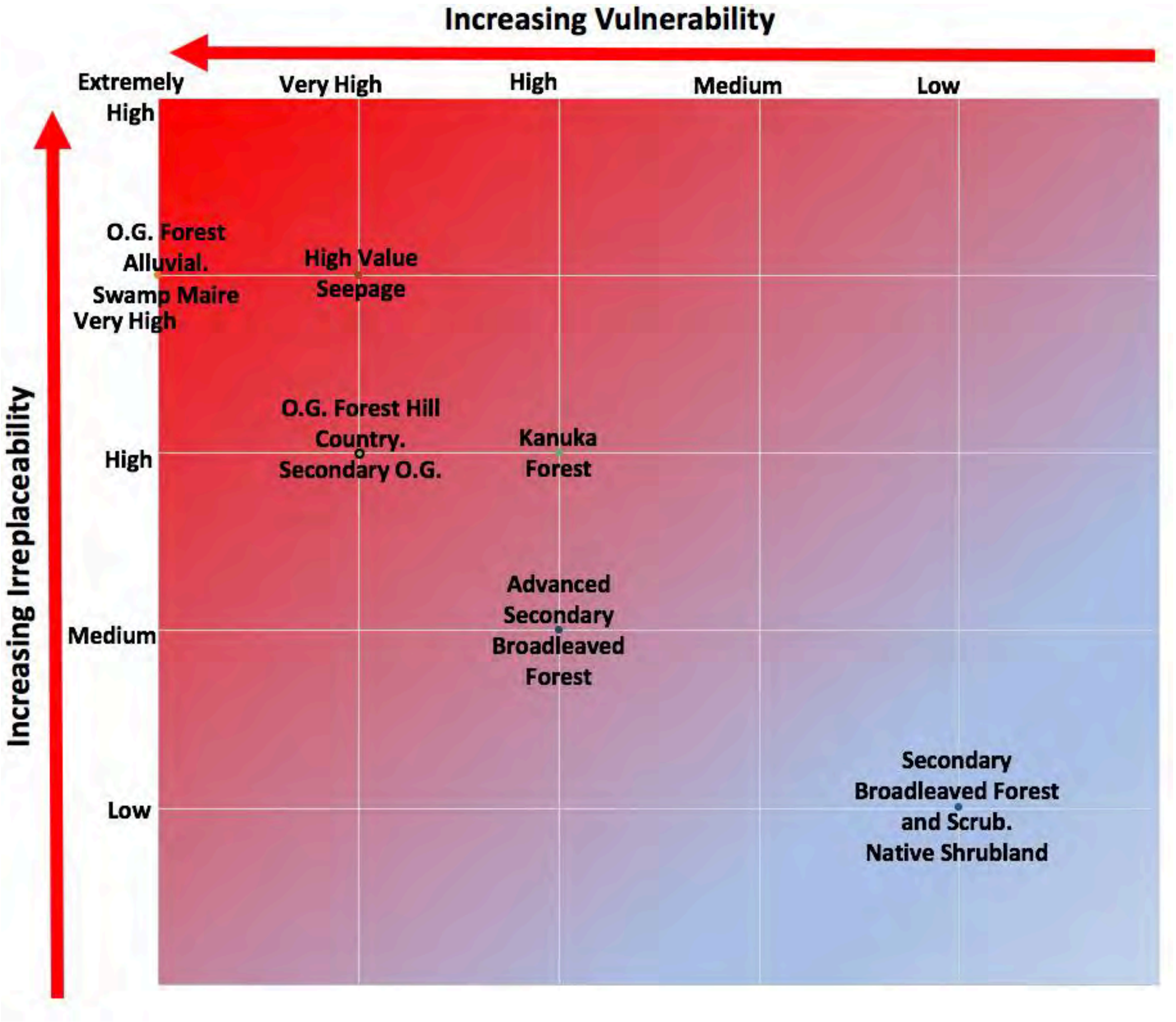

Figure 6.A.7. Levels of conservation concern for ecosystems within the proposed designation area as defined by the combination of vulnerability and irreplaceability (format follows Figure 6.A.6).

With an embankment option, impacts to the old-growth alluvial forest would likely be unavoidable. Impacts would be direct and would result in forest clearance. Given the scarcity of old-growth alluvial forests in proximity to the Project, clearance would result in a severe decline in old-growth alluvial forest biodiversity (Class 1, see Appendix F). As the land would be required for embankment placement, the duration of impact would be permanent. Both the severity and duration of alluvial old-growth forest loss rank as Class 1 and indicate the lowest likelihood of offset success.

The combination of Class 1 likelihood of success with an ecosystem of Very High/Extremely High conservation concern indicates that the biodiversity loss associated with severe and permanent loss of old-growth alluvial forest is beyond the limits of offsetting (Figure 6.A.7 & Figure 6.A.8).

In contrast, with a viaduct option, direct impacts to the old-growth alluvial forest could be avoided/minimised, in which case, effects management would be addressed early in the mitigation hierarchy and offsetting would not be necessary.

Assessment of likelihood of success for swamp maire and seepage wetland impacts are summarised in Table 6.A.18 below. For both swamp maire and seepage wetlands, the embankment would result in severe and permanent loss and this reduces the likelihood of successfully offsetting impacts to biodiversity. The reduced severity and duration of impacts associated with a viaduct arrangement mean that biodiversity impacts to the seepage wetland and swamp maire would be within the limits of offsetting.

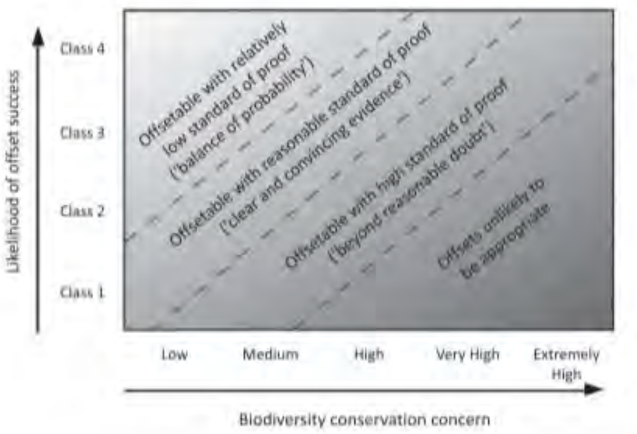

Figure 2 Burden of proof conceptualization of offsetability, combining biodiversity conservation concern and likelihood of offset success. A practical framework may thus, e.g. view offsets as unlikely to be appropriate for: Class 1 likelihood of offset success for areas of High, Very High, and Extremely High conservation concern; Class 2 for Very High and Extremely High concern; and Class 3 for Extremely High concern.

Figure 6.A.8. Offsetability as indicated by the relationship between conservation concern and likelihood of offset success. Taken from Figure 2 of Pilgrim *et al.* (2013).

Table 6.A.18. Summary comparison of likelihood of offsetting biodiversity loss from embankment versus viaduct options on the threatened-nationally critical swamp maire stand and the rare seepage ecosystem.

	Embankment (i.e., assuming complete and permanent loss)	**Viaduct (i.e., assuming localised disturbance with little or no permanent loss)**
	Likelihood of success (criteria defining class)	
Threatened swamp maire	Class 1 (Severity, Duration)	Severity and duration reduced to Class 4 (low magnitude[28] of effect)

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[28] Effect magnitude terminology in this table follows Pilgrim *et al*. (2013).

Rare seepage wetland	Class 1 (Severity, Duration)	Severity and duration reduced to Class 4 (low magnitude of effect)

6.4 Avoidance, Minimisation, Rehabilitation/Restoration, Offsetting Proposed

Specific effects envelopes have been defined for CH4000–4400, and two QEII protected areas to ensure that the levels of effect fall within the bounds of offsetting. Effects have been minimised in these locations and direct adverse effects beyond these envelopes are avoided. These avoidance and minimisation and remediation measures will be prescribed in conditions and in the Ecological Management Plan to be developed at the detailed planning stages of the project.

Rehabilitation and restoration will be required following works within seepage wetlands, to reinstate both wetland function and indigenous cover within disturbed areas. The effects on forest habitats from edge effects will be addressed through restorative edge buffer planting, to effectively seal the newly created forest edge. Effects from fragmentation and isolation would be addressed through the configuration of restorative replacement planting (creating linkages and corridors between existing habitats) and through the use of bridge structures that maintain a level of ecological connectivity beneath/past the road. The Western QEII site is particularly vulnerable to edge effects and treatments around that crossing point would be essential in order to reduce adverse effects on the forest.

Mitigation and offset activities will be additional to conservation actions that would have occurred without the Project. The replacement planting and offset package components would serve important extensions to existing habitat areas and would increase habitat availability and landscape scale connectivity between the Manawatū Gorge Scenic Reserve (Department of Conservation) and the surrounding existing QEII forested sites (private ownership), existing indigenous vegetation areas currently amongst farmland (private ownership), and the Ashhurst Domain (Palmerston North City Council).

Replacement planting mitigation treatments would be like-for-like in terms of the sites selected and the compositions chosen for planting. An important component of the offset replacement planting is the restoration of the low terrace alluvial site at Ashhurst Domain. This site provides a rare opportunity to restore alluvial forest within close proximity of the designation area. Given the highly reduced and threatened status of alluvial forests, it would be desirable for forest restoration at the Ashhurst Domain to be pursued even if alluvial forest effects are avoided through the project design. This could be considered a trading up, where less threatened vegetation assemblages are mitigated for with restoration of alluvial swamp forest of greater rarity. The Ashhurst Domain also presents opportunities for long-term community engagement. The QEII National Trust, the Department of Conservation, Iwi and relevant Councils (including Palmerston North City and Manawatū District Council regarding Ashhurst Domain) should be given opportunities to guide the detailed design of the ecological replacement plantings.

Restoration/replacement plantings relate to effects on the following ecosystem types contained in the first six rows of Table 6.A.19. The restoration treatments constitute replacement planting with recommended multipliers (Environmental Compensation Ratios; ECRs) applied to address the differing degrees of induced scarcity of existing ecosystem types and also the time lag required to replace the pre-existing qualities of affected ecosystems.

The resulting restoration/replacement planting area is 90.15 ha; and this quantity of mitigation replacement planting assumes clearance and mitigation of all the six mapped ecosystem type extents. The resource consent and management plan parameters will promote the minimisation of effects to these ecosystem types during construction. In addition, the offset package currently requires 13.44 ha of like-for-like replacement planting and *c*. 32 ha of retirement, protection and canopy gap planting of mature forest surrounding the CH4000–4400 area. Retirement and protection of these forests would secure the ecosystems for the long term and strengthen the ecological connectivity between existing vegetation/replacement plantings on the hill country with the Ashhurst area. Within the retire/protect areas, restorative planting to fill canopy gaps and clearings would be important to accelerate the restoration of forest structure and interior microclimate. All areas of restoration planting would be legally protected in perpetuity and receive integrated pest control in perpetuity, or a similar suitable alternative pest control biodiversity enhancement project, potentially a collaboration with Iwi, DOC and Horizons. The permanent duration of these positive effects is important, in that these offset components are recommended to address permanent loss of biodiversity, thus offset measures must also be enduring so that the net-gain biodiversity outcome is secure.

For the purposes of the NoR, the six mitigation and four offset replacement planting items/quantities are offered (see Section 5.1 of the Terrestrial Vegetation and Habitats Assessment report). Once the detailed design is available, any further avoidance of specific vegetation areas achieved can be confirmed, thus potentially reducing the required replacement planting quantity as calculated through application of the respective ECRs to slope-corrected measures of affected vegetation. Any such changes would need to respond to and be up to/within the level of effects specified in Table 6.A.19 below.

Direct impacts to swamp maire would be addressed through replacement planting. For any pruning or canopy damage, replacement planting with ecosourced seedlings (including from the affected stand) should be carried out in suitable locations at a rate of 100 replacement trees per tree that is modified. Should unforeseen complete loss occur, the replacement ratio is 200 trees per tree that is lost.

Table 6.A.19. Mitigation and offset quantities.

Mitigation quantities			
Ecosystem type	**Area actually/ potentially affected (ha)**	**ECR**	**Replacement planting requirement (ha)[29]**
Secondary Broadleaved Forests with Old-Growth Signatures	3.07	5	15.35
Old-Growth Treelands	0.41	5	2.05
Kānuka Forests	1.59	5	7.95
Advanced Secondary Broadleaved Forests	2.93	4	11.72
Secondary Broadleaved Forests and Scrublands	16.32	3	48.96
Manuka, Kānuka and Divaricating Shrublands	4.12	1	4.12
Mitigation replacement planting total area			90.15
Swamp maire mitigation planting are to be at the rates of 1:100 for damage (but retention); and 1:200 for unforeseen permanent loss			
Offset quantities			
Old-Growth Forests (Alluvial)^	0.15	12	1.8
Old-Growth Forests (Hill Country)^	1	10	10
Raupō Dominated Seepage Wetlands (High Value)	0.13	4	0.52
Indigenous-Dominated Seepage Wetlands (Moderate Value)	0.56	2	1.12
Offset replacement planting total area			13.44

Other treatments in the offset package	**Area required (ha)**
Retirement, protection and canopy gap planting	c. 32[30]
Integrated pest control[31] in perpetuity over the entire replacement planting and retirement, protection and gap planting treatment areas, or a similar suitable alternative pest control project	135.59

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[29] As above, these areas assume no further avoidance is achieved at detailed design.

[30] This quantity should include all indigenous forest that is unaffected by the project works in the wider vicinity of CH4000–4400. See Figure 6.A.9 for the extent of the retirement, protection and canopy gap treatment area. All of this area that remains post-detailed design should be retired, protected, and gap planted.

[31] It is my professional opinion that net gain would be achieved through animal pest control over the mitigation areas addressing brushtail possums and rats and maintaining the density of those species below a 5% residual trap catch/tracking index. If this monitoring method or target proves inappropriate for the configuration of control areas, an alternative outcome-related target (e.g., foliar browse) will be specified in the Ecological Management Plan. Plant pest control will target pest species that threaten the regeneration and/or long-term maintenance of forest plants (e.g., shade tolerant species (e.g., barberry) or light demanding vines (e.g., old man's beard); not gorse or broom).

6.5 Proposed Mitigation and Offset Areas

The land areas shown in Figure 6.A.9 have been identified as providing adequate area of ecologically suitable sites for the replacement planting treatments and the retirement, protection and gap planting treatment. Further work would be required to clarify the nature of existing constraints (e.g., wind turbines, land ownership) and to confirm the final configuration of mitigation/offset replacement planting areas.

The highest priority site for terrestrial restoration treatments would be Areas 1 and 2, the alluvial forest replacement planting area located both within Ashhurst Domain (green in Figure 6.A.9) and south of the point of Manawatū–Pohangina river convergence. These sites are representative of alluvial landforms and presents a rare opportunity to restore alluvial forest compositions. Site 1 also presents an opportunity to connect and enlarge with the existing alluvial remnant forest patch located within Ashhurst Reserve. Given these sites' ease of access, there are clear opportunities for community involvement in these restoration areas.

The third highest priority for terrestrial replacement planting would be Area 3, the area located between the Manawatū Gorge Scenic Reserve (MGSR) and the proposed road corridor (Figure 6.A.9). This area presents a significant opportunity to extend the regionally significant MGSR to the north, at the same time connecting with remnants of the affected QEII forest sites. The area would strengthen landscape connectivity and form part of a potential ecological corridor along the alignment.

Area 4 would serve similar roles and functions as Area 3.

Areas 5 and 6 would provide a major contribution to enhancing landscape connectivity and would act as a physical extension to the MGSR, this time to the west, and towards the existing grazed forests shown in green (Area 10). Area 7 would be valuable as a large revegetation area or as opportunities for riparian restoration.

The retirement, protection and gap planting of Area 10 would form a valuable part of the offset package, I recommend this be agreed with the relevant landowners. Restoration of these existing forests builds on the positive biodiversity effects provided by the replacement planting. The proximity of this treatment is also important in that existing forests immediately adjoining the impacted area of CH4000–4400 would be restored – the positive effects would be as close as practically possible to the adverse effects in this location. Sites 11 and 12 are further options for retirement, protection, and gap planting.

The existing seepage at CH4200 presents an opportunity to restore a rare wetland ecosystem type and this could include protecting, buffering and enlarging the swamp maire stand at CH4130.

Additional wetland mitigation opportunities exist within the existing wetland area of the Ashhurst Domain (orange polygon in Figure 6.A.9).

The above sites present an opportunity to fulfil the required mitigation and offset treatments and to achieve a net-gain biodiversity outcome.

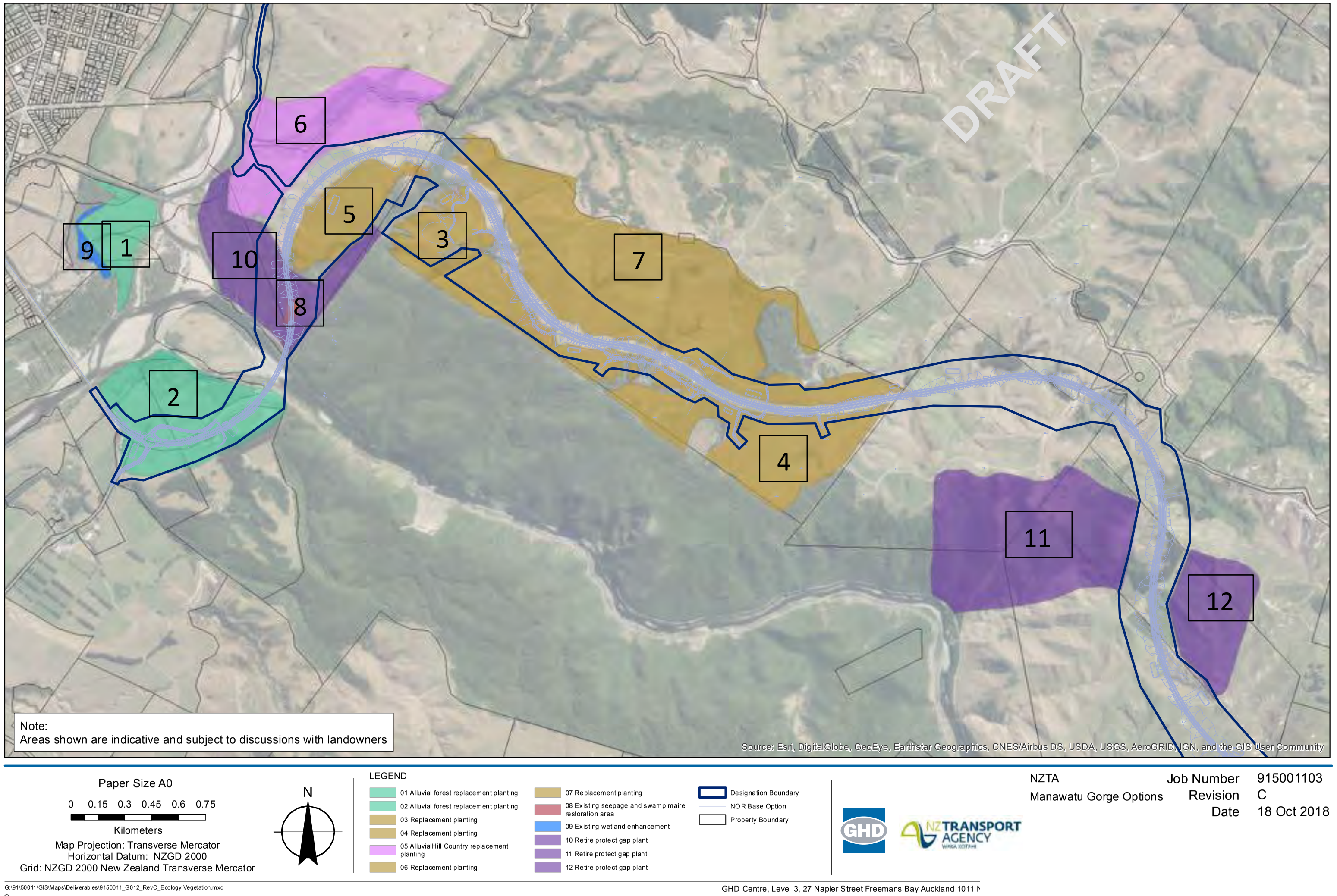


Figure 6.A.9. Potential mitigation/offset replacement planting and retirement areas. Treatments are numbered in order of preference applying ecological principles. More area is identified than would be needed.

6.0 RECOMMENDATIONS

An Ecological Management Plan should be prepared to encompass the ecological values and effects management measures described in this report.

Further work should be undertaken to confirm the mitigation and offset site locations and to confirm the associated restorative and protection treatments/mechanisms.

REFERENCES

BBOP. (2012). Standard on biodiversity offsets. Washington, D.C. BBOP. Retrieved from https://www.forest-trends.og/wp-content/uploads/imported/BBOP_Standard_on_Biodiversity_Offsets_1_Feb_2013.pdf

Blayney, A., & Sievwright, K. (2018). Terrestrial fauna ecological effects assessment technical report. Report prepared by Boffa Miskell Limited for New Zealand Transport Agency.

Clarkson, B. (2013). A vegetation tool for wetland delineation in New Zealand. Lincoln, Landcare Research.

de Lange, P.J., Rolfe, J.R., Barkla, J.W., Courtney, S.P., Champion, P.D., Perrie, L.R., Beadel, S.M., Ford, K.A., Breitwieser, I., Schonberger, I., Hindmarsh-Walls, R., Heenan, P.B., Ladley, K. (2018): Conservation status of New Zealand indigenous vascular plants, 2017. New Zealand Threat Classification Series 22. Wellington: Department of Conservation. Retrieved from: https://www.researchgate.net/publication/325556614_Conservation_status_of_New_Zealand_indigenous_vascular_plants_2017

DoC. (2014). Guidance on Good Practice Biodiversity Offsetting in New Zealand. Retrieved from https://www.doc.govt.nz/Documents/our-work/biodiversity-offsets/the-guidance.pdf

EIANZ. (2018). Ecological Impact Assessment (EcIA). EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems [2nd edition]. Retrieved from https://www.eianz.org/document/item/4447

Ewers, R. M., & Didham, R. K. (2008). Pervasive impact of large-scale edge effects on a beetle community. *Proceedings of the National Academy of Sciences*, *105*(14), 5426–5429.

Handford, P. (2004). The forest monitoring and assessment kit (Formak). Paekakariki, P. A. Handford and Associates Ltd.

Hurst, J. M., & Allen, R. B. (2007). The Recce Method for Describing New Zealand Vegetation – Field Protocols. Lincoln, Landcare Research.

Leathwick J.R., McGlone M., Walker S., & Briggs C.M. (2005). Predicted potential natural vegetation of New Zealand. Lincoln, Manaaki Whenua Press. [Poster]

MfE. (2007). Protecting our places: Information about the Statement of National Priorities for Protecting Rare and Threatened Biodiversity on Private Land. Wellington: Ministry for the Environment.

Miller, K. (2018). Te Ahu a Turanga: Freshwater – Ecological Impact Assessment. Report prepared by Boffa Miskell Limited for New Zealand Transport Agency.

Mueller-Dombois, D., & Ellenberg, H. (2002). Aims and Methods of Vegetation Ecology. Caldwell, New Jersey: The Blackburn Press.

NZPCN. (2018). New Zealand Plant Conservation Network [Website]. Accessed August 2018.

Pilgrim, J. D., Brownlie, S., Ekstrom, J. M., Gardner, T. A., von Hase, A., Kate, K. T., ... & Ussher, G. T. (2013). A process for assessing the offsetability of biodiversity impacts. *Conservation Letters, 6*(5), 376–384.

Roper-Lindsay, J., Fuller, S. A., Hooson, S., Sanders, M.D., & Ussher, G. T. (2018). Ecological Impact Assessment (EcIA). EIANZ Guidelines for use in New Zealand: Terrestrial and Freshwater Ecosystems (2nd Edition). Melbourne, Environment Institute of Australia and New Zealand Inc.

Singers, N. J., & Rogers, G. M. (2014). A classification of New Zealand's terrestrial ecosystems. Science for Conservation 325. Wellington: Department of Conservation.

Swingland, I. R. (2001). Biodiversity, definition of. *Encyclopedia of biodiversity, 1*, 377–391.

Terralink. (2004). New Zealand Land Cover Database (LCDB2). Wellington, Terralink International.

Walker, S., Cieraad, E., & Barringer, J. (2015). The Threatened Environments Classification for New Zealand 2012: A guide for users. Lincoln: Landcare Research.

Young, A., & Mitchell, N. (1994). Microclimate and vegetation edge effects in a fragmented podocarp-broadleaf forest in New Zealand. *Biological Conservation, 67*(1), 63–72.

Appendices

Appendix A: Photographs of Examples of Ecosystem Types within the Proposed Designation Area
Appendix B: Forest Dominance (Point-Centred Quarter) Survey Data
Appendix C: Recce Survey Data
Appendix D: Forest Condition (FORMAK) Assessment Data
Appendix E: Assumptions Regarding Construction Access Requirements
Appendix F: Assessment of Offsetability (following Pilgrim et al., (2013) Table 2)
Appendix G: Assessment of Threatened Flora (Singers & Bayler, 2018)

Appendix A: Photographic Examples of Ecosystem Types within the Proposed Designation Area

1: Old-Growth Forest (Alluvial)
2: Old-Growth Forest (Hill Country)
3: Secondary Broadleaved Forests with Old-Growth Signatures
4: Kānuka forest
5: Advanced Secondary Broadleaved Forests
6: Secondary Broadleaved Forests and Scrublands
7: Manuka, Kānuka and Divaricating Shrublands
8: Indigenous-Dominated Seepage Wetland (High Value)
9: Indigenous-Dominated Seepage Wetland (Moderate Value)

1: Old-Growth Forest (Alluvial) CH4000–4400. July 2018.

2: Old-Growth Forest (Hill Country) CH5650. July 2018.

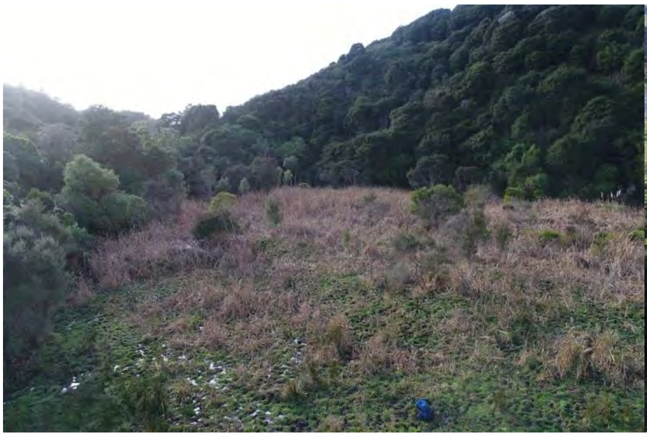
3: Secondary Broadleaved Forests with Old-Growth Signatures. (Left) Secondary forest containing mature tawa, hinau, and totara (CH7350). (Right) Secondary broadleaved forest containing mature tawa and pukatea (CH10500–10600). July 2018.


4: Kānuka forest (CH4000–4300). July 2018.


5: Advanced Secondary Broadleaved forest (CH5700–5800). July 2018.


6: Secondary Broadleaved Forests and Scrublands (CH10100). July 2018.


7: Manuka, Kānuka and Divaricating Shrublands (CH10200). July 2018.

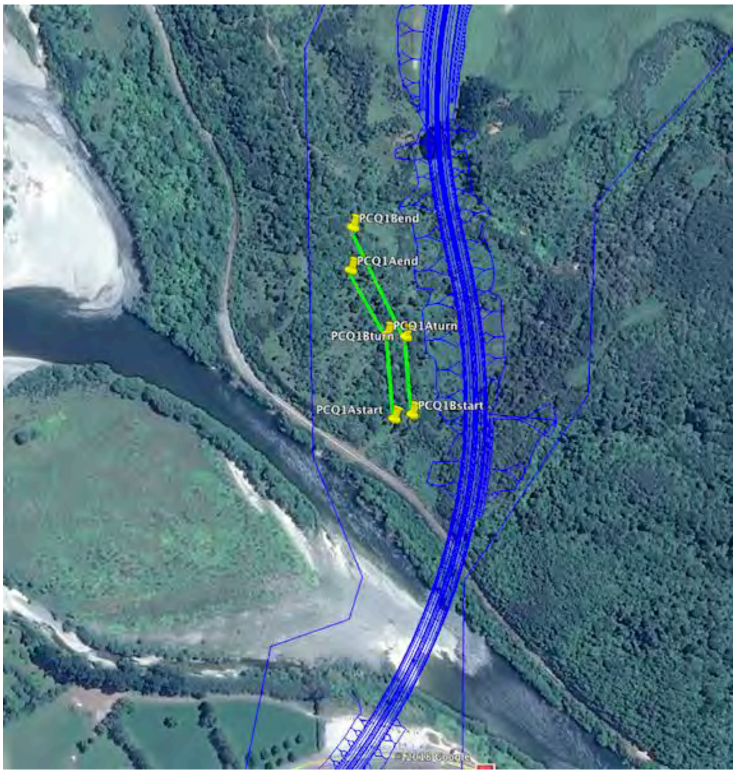

8: Indigenous-Dominated Seepage Wetland (High Value; CH4200). July 2018.


9: Indigenous-Dominated Seepage Wetland (Moderate Value; CH10100). July 2018.

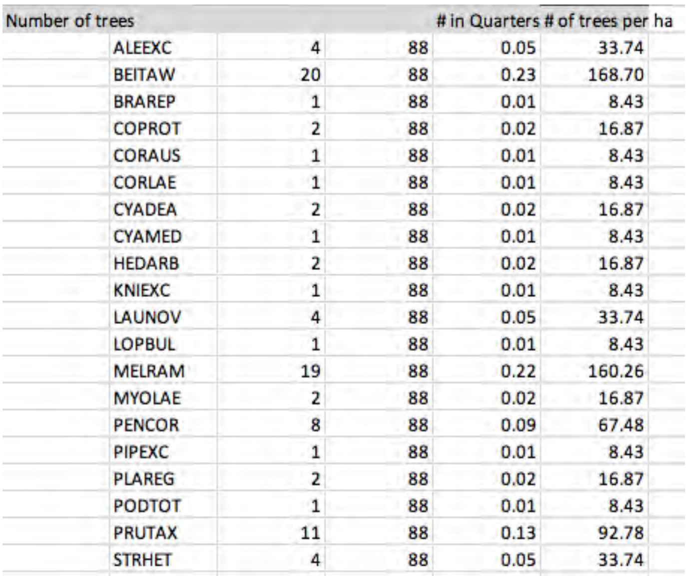
Appendix B: Forest Dominance (Point-Centred Quarter) Survey Data

P-C Q 1 A and B at c. CH4000–4400:

Transect locations:

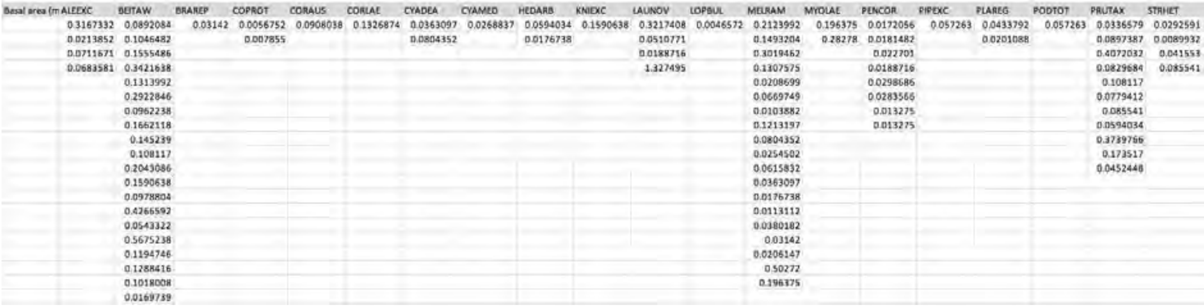


Tree stem density:



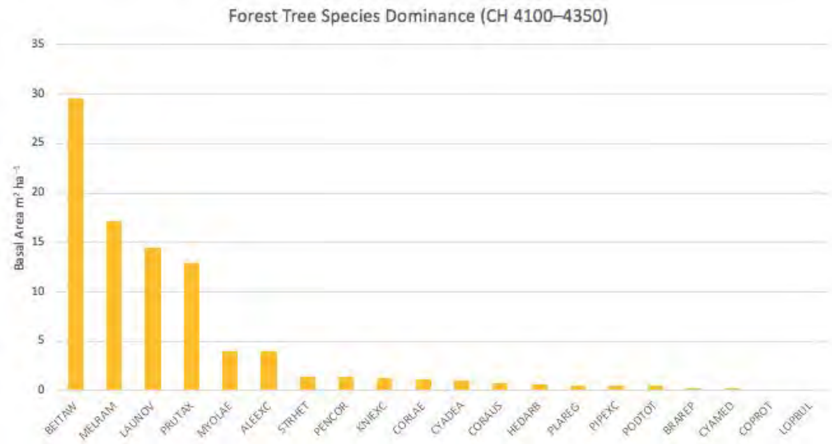
Number of trees				# in Quarters	# of trees per ha
	ALEEXC	4	88	0.05	33.74
	BEITAW	20	88	0.23	168.70
	BRAREP	1	88	0.01	8.43
	COPROT	2	88	0.02	16.87
	CORAUS	1	88	0.01	8.43
	CORLAE	1	88	0.01	8.43
	CYADEA	2	88	0.02	16.87
	CYAMED	1	88	0.01	8.43
	HEDARB	2	88	0.02	16.87
	KNIEXC	1	88	0.01	8.43
	LAUNOV	4	88	0.05	33.74
	LOPBUL	1	88	0.01	8.43
	MELRAM	19	88	0.22	160.26
	MYOLAE	2	88	0.02	16.87
	PENCOR	8	88	0.09	67.48
	PIPEXC	1	88	0.01	8.43
	PLAREG	2	88	0.02	16.87
	PODTOT	1	88	0.01	8.43
	PRUTAX	11	88	0.13	92.78
	STRHET	4	88	0.05	33.74

Basal area:



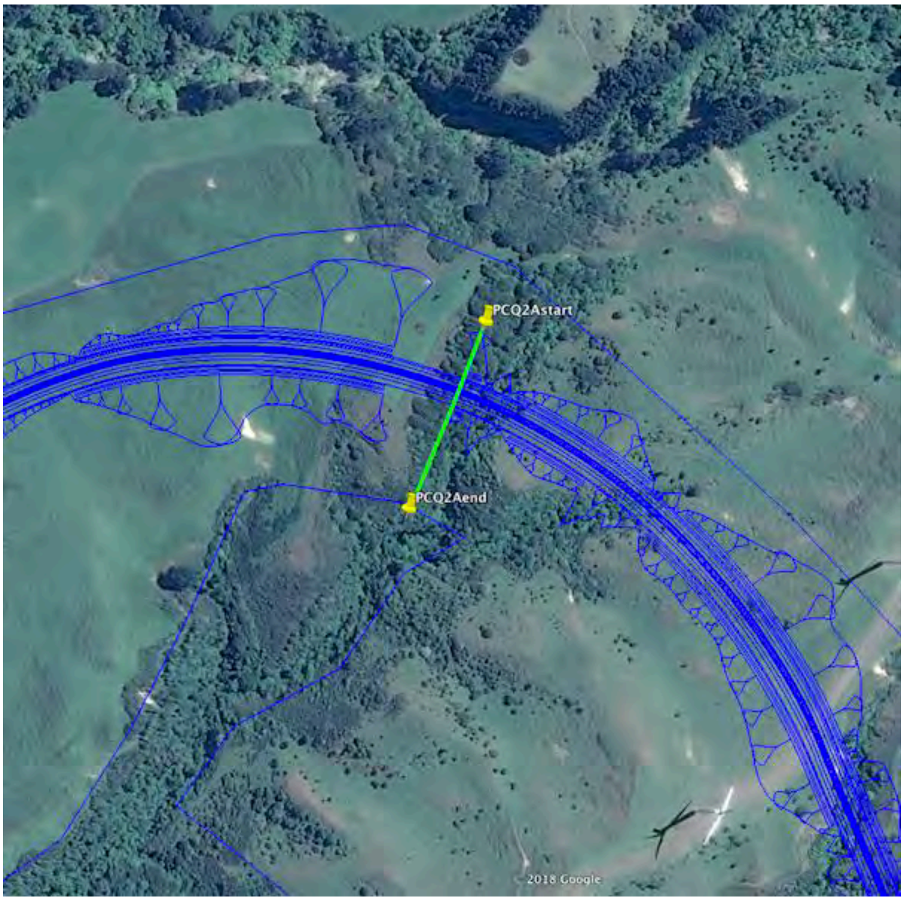
Basal area (m	ALEEXC	BEITAW	BRAREP	COPROT	CORAUS	CORLAE	CYADEA	CYAMED	HEDARB	KNIEXC	LAUNOV	LOPBUL	MELRAM	MYOLAE	PENCOR	PIPEXC	PLAREG	PODTOT	PRUTAX	STRHET
	0.3167332	0.0892084	0.03142	0.0056752	0.0908038	0.1326874	0.0363097	0.0268837	0.0594034	0.1590638	0.3217408	0.0046572	0.2123992	0.196375	0.0172056	0.057263	0.0433792	0.057263	0.0336579	0.0292591
	0.0213852	0.1046482		0.007855			0.0804352		0.0176738		0.0510771		0.1493204	0.28278	0.0181482		0.0201088		0.0897387	0.0089932
	0.0711671	0.1555486									0.0188716		0.3019462		0.022703				0.4072032	0.041553
	0.0683581	0.3421638									1.327495		0.1307575		0.0188716				0.0829684	0.085541
		0.1313992											0.0208699		0.0298686				0.108117	
		0.2922846											0.0669749		0.0283566				0.0779412	
		0.0962238											0.0103882		0.013275				0.085541	
		0.1662118											0.1213197		0.013275				0.0594034	
		0.145239											0.0804352						0.3739766	
		0.108117											0.0254502						0.173517	
		0.2043086											0.0615832						0.0452448	
		0.1590638											0.0363097							
		0.0978804											0.0176738							
		0.4266592											0.0113112							
		0.0543322											0.0380182							
		0.5675238											0.03142							
		0.1194746											0.0206147							
		0.1288416											0.50272							
		0.1018008											0.196375							
		0.0169739																		

Forest tree dominance (stem density & basal area):



P-C Q 2 A at c. CH5600:

Transect location:



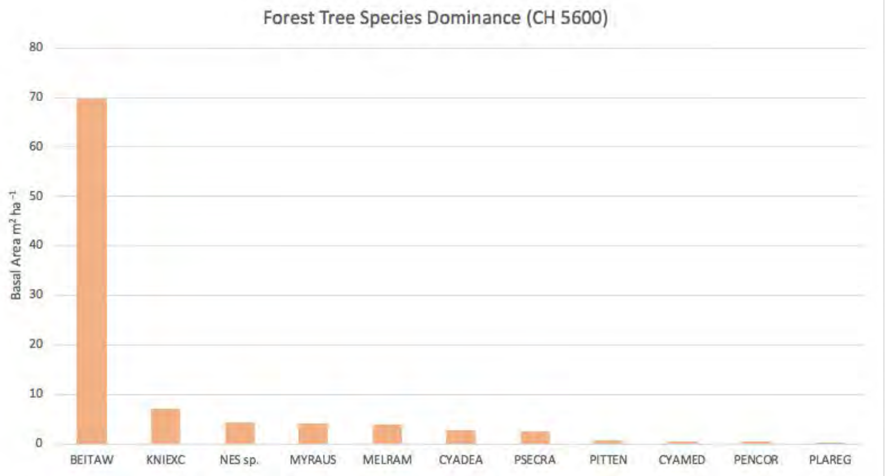
Tree stem density:

Number of trees				# in Quarters	# of trees per ha
	BEITAW	22	44	0.50	669.99
	CYADEA	2	44	0.05	60.91
	CYAMED	1	44	0.02	30.45
	KNIEXC	2	44	0.05	60.91
	MELRAM	3	44	0.07	91.36
	MYRAUS	3	44	0.07	91.36
	NES sp.	2	44	0.05	60.91
	PENCOR	1	44	0.02	30.45
	PITTEN	1	44	0.02	30.45
	PLAREG	1	44	0.02	30.45
	PSECRA	6	44	0.14	182.72

Basal area:

Basal area (m2)											
	BEITAW	CYADEA	CYAMED	KNIEXC	MELRAM	MYRAUS	NES sp.	PENCOR	PITTEN	PLAREG	PSECRA
	0.07646371	0.00950455	0.01767375	0.02405594	0.10579821	0.00554249	0.06202387	0.01389471	0.0237818	0.00950455	0.02630561
	0.10753495	0.0804352		0.2123992	0.0113112	0.01767375	0.0804352				0.00817234
	0.06027063				0.00950455	0.1134262					0.01207785
	0.007855										0.01188383
	0.04155295										0.00950455
	0.24370059										0.01431574
	0.07211597										
	0.05107714										
	0.02270095										
	0.01720559										
	0.20833424										
	0.03464055										
	0.05811443										
	0.24195364										
	0.10293506										
	0.13204255										
	0.1146233										
	0.196375										
	0.14863624										
	0.0201088										
	0.31176495										
	0.02243467										

Forest tree dominance (stem density & basal area):

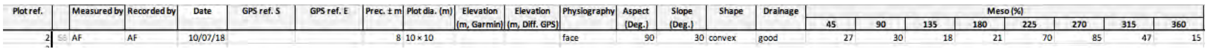


Appendix C: Recce Survey Data

Location: P-C Q 1 A&B at c. CH4000–4400

Plot photo:

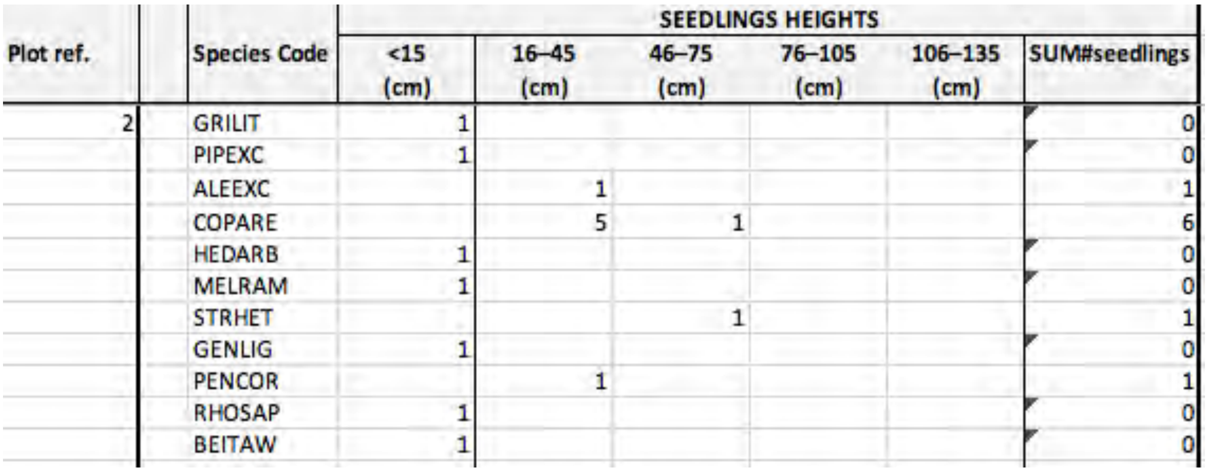
Plot data:



Plot ref.		Measured by	Recorded by	Date	GPS ref. S	GPS ref. E	Prec. ± m	Plot dia. (m)	Elevation (m, Garmin)	Elevation (m, Diff. GPS)	Physiography	Aspect (Deg.)	Slope (Deg.)	Shape	Drainage	Meso (%)							
																45	90	135	180	225	270	315	360
2	56	AF	AF	10/07/18			8	10 × 10			face	90	30	convex	good	27	30	18	21	70	85	47	15

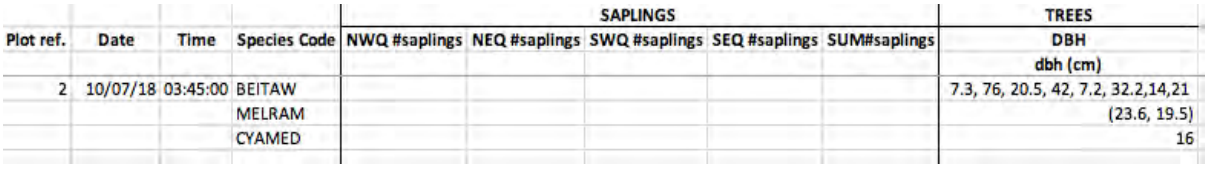
%bedrock & %broken rock	Broken rock < or > 30 cm	Broken rock trans.	Vege parameters of plot; % plot @ < 1.35 m covered by:						Average top height (m)	Total canopy cover (%) >1.35 m.a.g.l	Basal area (m^2/ha)	Additional cultural info:				
			liage, trunks	Non-vascula	Litter	Bare ground	Exposed rock	Sum >100?				Cultural	Fauna	Browse	Browse spp.	
0			10	0	80	5	5	100	35	95			Wood pigeo	heavy		Cattle access. Heavy browse

Seedlings:



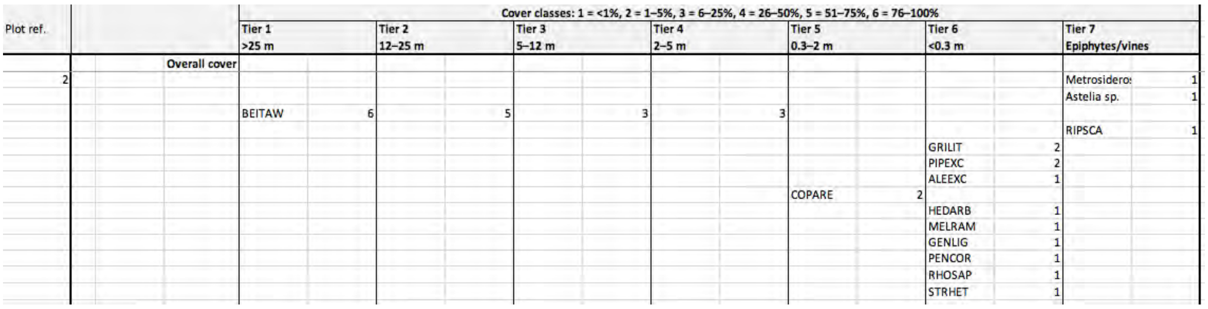
Plot ref.		Species Code	SEEDLINGS HEIGHTS					
			<15 (cm)	16–45 (cm)	46–75 (cm)	76–105 (cm)	106–135 (cm)	SUM#seedlings
2		GRILIT	1					0
		PIPEXC	1					0
		ALEEXC		1				1
		COPARE		5	1			6
		HEDARB	1					0
		MELRAM	1					0
		STRHET			1			1
		GENLIG	1					0
		PENCOR		1				1
		RHOSAP	1					0
		BEITAW	1					0

Saplings and Trees:



Plot ref.	Date	Time	Species Code	SAPLINGS					TREES
				NWQ #saplings	NEQ #saplings	SWQ #saplings	SEQ #saplings	SUM#saplings	DBH dbh (cm)
2	10/07/18	03:45:00	BEITAW						7.3, 76, 20.5, 42, 7.2, 32.2,14,21
			MELRAM						(23.6, 19.5)
			CYAMED						16

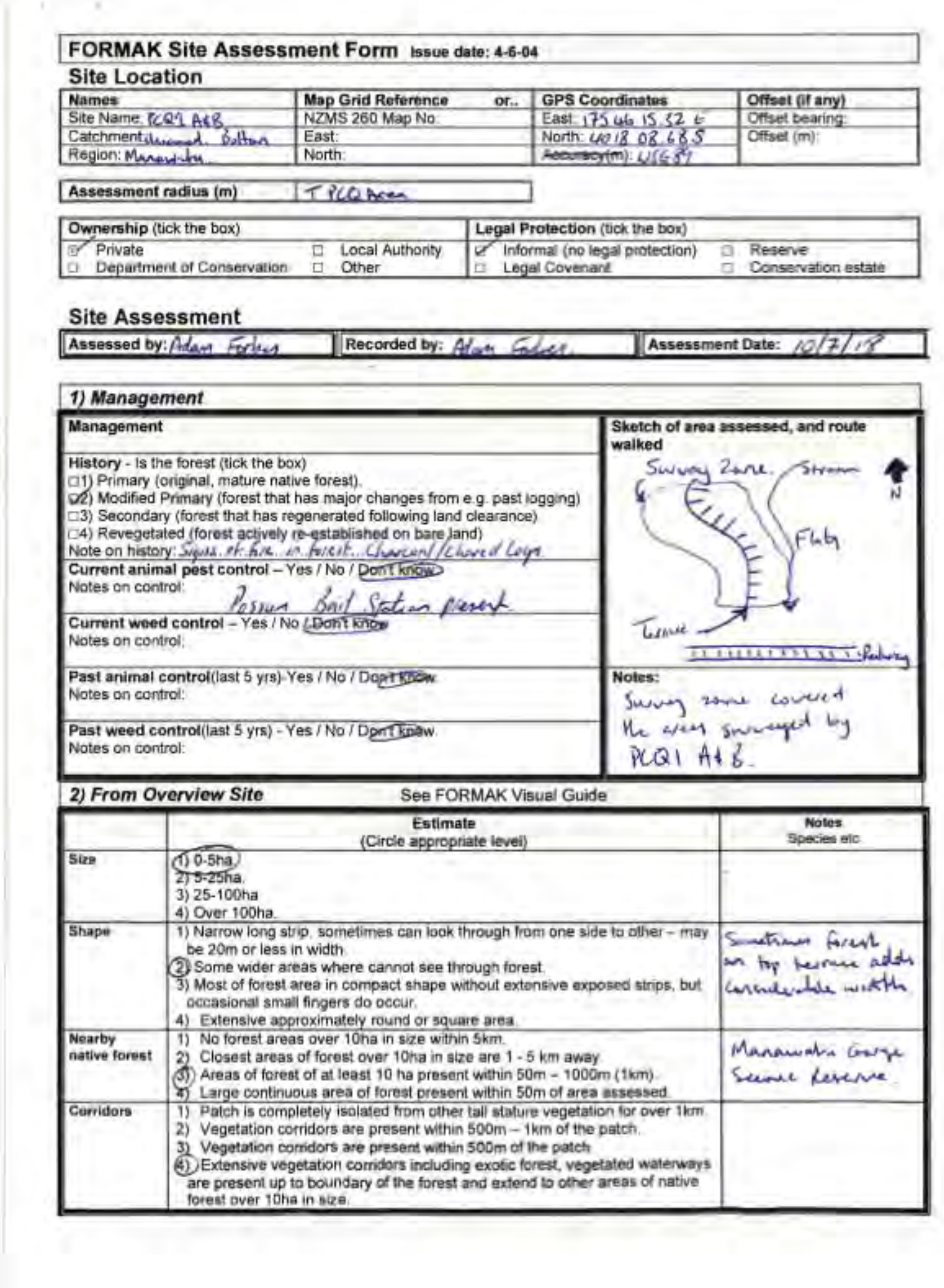
Composition:



Plot ref.			Cover classes: 1 = <1%, 2 = 1–5%, 3 = 6–25%, 4 = 26–50%, 5 = 51–75%, 6 = 76–100%													
			Tier 1 >25 m		Tier 2 12–25 m		Tier 3 5–12 m		Tier 4 2–5 m		Tier 5 0.3–2 m		Tier 6 <0.3 m		Tier 7 Epiphytes/vines	
		Overall cover														
2															Metrosidero	1
															Astelia sp.	1
			BEITAW	6		5		3		3						
															RIPSCA	1
													GRILIT	2		
													PIPEXC	2		
													ALEEXC	1		
											COPARE	2				
													HEDARB	1		
													MELRAM	1		
													GENLIG	1		
													PENCOR	1		
													RHOSAP	1		
													STRHET	1		

Appendix D: Forest Condition (FORMAK) Assessment Data

Location: P-C Q 1 A&B at c. CH4000–4400



FORMAK Site Assessment Form **Issue date: 4-6-04**

Site Location

Names	**Map Grid Reference or..**	**GPS Coordinates**	**Offset (if any)**
Site Name: PCQ1 A&B	NZMS 260 Map No:	East: 175 46 15.32 E	Offset bearing:
Catchment: [illegible] Bolton	East:	North: 40 18 08.68 S	Offset (m):
Region: Manawatu	North:	~~Accuracy(m)~~: WGS84	

Assessment radius (m) ~ PCQ Area

Ownership (tick the box)
☑ Private ☐ Local Authority
☐ Department of Conservation ☐ Other

Legal Protection (tick the box)
☑ Informal (no legal protection) ☐ Reserve
☐ Legal Covenant ☐ Conservation estate

Site Assessment

Assessed by: Adam Forbes
Recorded by: Adam Forbes
Assessment Date: 10/7/18

1) Management

Management

History - Is the forest (tick the box)
☐1) Primary (original, mature native forest).
☑2) Modified Primary (forest that has major changes from e.g. past logging)
☐3) Secondary (forest that has regenerated following land clearance)
☐4) Revegetated (forest actively re-established on bare land)
Note on history: Signs of fire in forest. Charcoal/Charred Logs

Current animal pest control – Yes / No / [✓ Don't know]
Notes on control: Possum Bait Station present

Current weed control – Yes / No / [✓ Don't know]
Notes on control:

Past animal control(last 5 yrs)-Yes / No / [✓ Don't know].
Notes on control:

Past weed control(last 5 yrs) - Yes / No / [✓ Don't know].
Notes on control:

Sketch of area assessed, and route walked

Notes:
Survey zone covered the area surveyed by PCQ1 A+B.

2) From Overview Site See FORMAK Visual Guide

	Estimate (Circle appropriate level)	**Notes** Species etc
Size	[✓ 1) 0-5ha.] 2) 5-25ha. 3) 25-100ha 4) Over 100ha.	
Shape	1) Narrow long strip, sometimes can look through from one side to other – may be 20m or less in width. [✓ 2)] Some wider areas where cannot see through forest. 3) Most of forest area in compact shape without extensive exposed strips, but occasional small fingers do occur. 4) Extensive approximately round or square area.	Sometimes forest on top terrace adds considerable width
Nearby native forest	1) No forest areas over 10ha in size within 5km. 2) Closest areas of forest over 10ha in size are 1 - 5 km away. [✓ 3)] Areas of forest of at least 10 ha present within 50m – 1000m (1km). 4) Large continuous area of forest present within 50m of area assessed.	Manawatu Gorge Scenic Reserve
Corridors	1) Patch is completely isolated from other tall stature vegetation for over 1km. 2) Vegetation corridors are present within 500m – 1km of the patch. 3) Vegetation corridors are present within 500m of the patch. [✓ 4)] Extensive vegetation corridors including exotic forest, vegetated waterways are present up to boundary of the forest and extend to other areas of native forest over 10ha in size.	

3) *On the Forest Edge* See FORMAK Visual Guide

	Estimate (Circle appropriate level)	**Notes** Species etc
Forest edge canopy	1) Major dieback in canopy, dead standing trees. 2) Areas of significant dieback, but all trees live. [✓ 3) Small areas of localised dieback.] 4) Canopy without dieback.	Extensive dieback on [illegible] [illegible] PCR [illegible]
Forest edge understorey	1) Understorey completely absent. [✓ 2) Some understorey present and occasional seedlings / saplings present close to the edge of the canopy.] 3) Considerable understorey and many seedlings / saplings around the edge of the canopy. 4) Vigorous, abundant understorey with a range of seedlings / saplings spreading well beyond the current extent of the canopy.	
Forest edge - weeds	1) Many weeds present along edge – weeds dominate understorey. 2) Weeds common as scattered patches and individuals along the boundary. [✓ 3) Few weeds forming isolated patches or individuals on edge. Local native vegetation dominates understorey.] 4) No weeds present.	wild broom, blackberry woolly nightshade
Fencing	1) No fencing [✓ 2) Some fencing, e.g. one side, or fence poorly maintained with large breaks] 3) Most of boundary fenced, includes all areas where stock access likely. Some small recent breaks. 4) Secure, intact fencing around whole area, or area where no possibility of stock entry (e.g. urban).	Stock access throughout.
Adjacent land use	[✓ 1) Livestock farming (note type)] Cattle 2) Exotic Forest 3) Residential / urban 4) Reserve (public or private reserve land)	Cattle

4) *Moving Through the Forest* See FORMAK Visual Guide

Doing Simple Counts (see end of this form)

State	**Estimate** (Circle appropriate level)	**Notes** Species etc
Canopy Condition	1) Very sparse foliage, many large holes, dieback covers more than 25% of tree crowns. 2) Foliage sparse in some areas, canopy holes common. Some dieback. [✓ 3) Foliage mostly dense, only occasional sparse areas, Canopy holes rare, very occasional dieback.] 4) Abundant dense foliage over whole canopy, no canopy holes or dieback.	
Canopy Browsing	1) Severe canopy browse: 75-100% of leaves browsed on possum preferred species. 2) Moderate: heavy canopy browse - 25-75% of leaves browsed on possum preferred species. 3) Light canopy browse: 1-25% of leaves browsed on possum preferred species. [✓ 4) No canopy browse.]	No sign of Canopy browse.
Understorey / Regeneration	1) Understorey completely bare of all species. [✓ 2) Very few plants preferred by deer / goats / stock are present in the knee to shoulder height range. Scattered seedlings of other species.] 3) Moderate numbers of plants preferred by deer / goats / stock are present in the knee to shoulder height range. Other species relatively abundant. 4) Abundant plants preferred by deer / goats / stock and other species may also occur.	mainly COPARE, ~~ME~~ PIPEXC, URTFER
Understorey Browsing	[✓ 1) Severe understorey browse. 75-100% of stems of deer/goat/stock preferred species are browsed. Understorey may be completely bare.] 2) Moderate – heavy understorey browse. 25-75% of stems of deer/goat/stock preferred species are browsed. 3) Light understorey browse. 1-25% of stems of deer/goat/stock preferred species are browsed. 4) No understorey browse.	
Ground Cover	[✓ 1) Bare soil, rock / gravel covers more than 20% of ground. Eroding soil common. Ground vegetation (ferns, moss, seedlings etc less than]	

State	Estimate (Circle appropriate level)	Notes Species etc
	50cm tall) absent or very uncommon. 2) Scattered bare soil and rock. Eroding soil uncommon. Ground veg (see definition in (1)) covers less than 20% 3) Bare soil, rock absent or very uncommon. No eroding soil. Ground veg (see definition in (1)) covers 20 – 50% of ground. 4) No bare soil, rock, or eroding soil. Ground veg (see definition in (1)), abundant, covering 50-100% of the ground.	
Bird Song	1) Bird song almost entirely absent. Only occasional calls heard. [✓ 2) Bird song present some of the time, but with extended breaks.] 3) Ongoing bird song but with occasional breaks. 4) Continuous bird song with no breaks.	

5) *Canopy Gaps*

See FORMAK Visual Guide

(Find gaps in the canopy, over 3m in diameter, and examine the understorey vegetation)

Canopy Gap	Estimate (Circle appropriate level)	Notes Species etc
Regeneration	1) No seedlings – area completely open. 2) Occasional seedlings – scattered individuals [✓ 3) Seedlings common – brush against you as you walk across area.] 4) Abundant, dense cover of seedlings and undergrowth – you have to continually push your way through.	
Species	1) No plants preferred by deer / goats / stock – dominated by tree ferns, pepperwood or other unpalatable species. [✓ 2) Occasional plants preferred by deer / goats / stock amongst dominant tree ferns, pepperwood or other unpalatable species.] 3) Common plants preferred by deer / goats / stock. Unpalatable species such as tree ferns, pepperwood etc also common. 4) Abundant plants preferred by deer / goats / stock dominate.	Very few palatable species present in understorey MAHOE, [illegible], LANCEWOOD present.

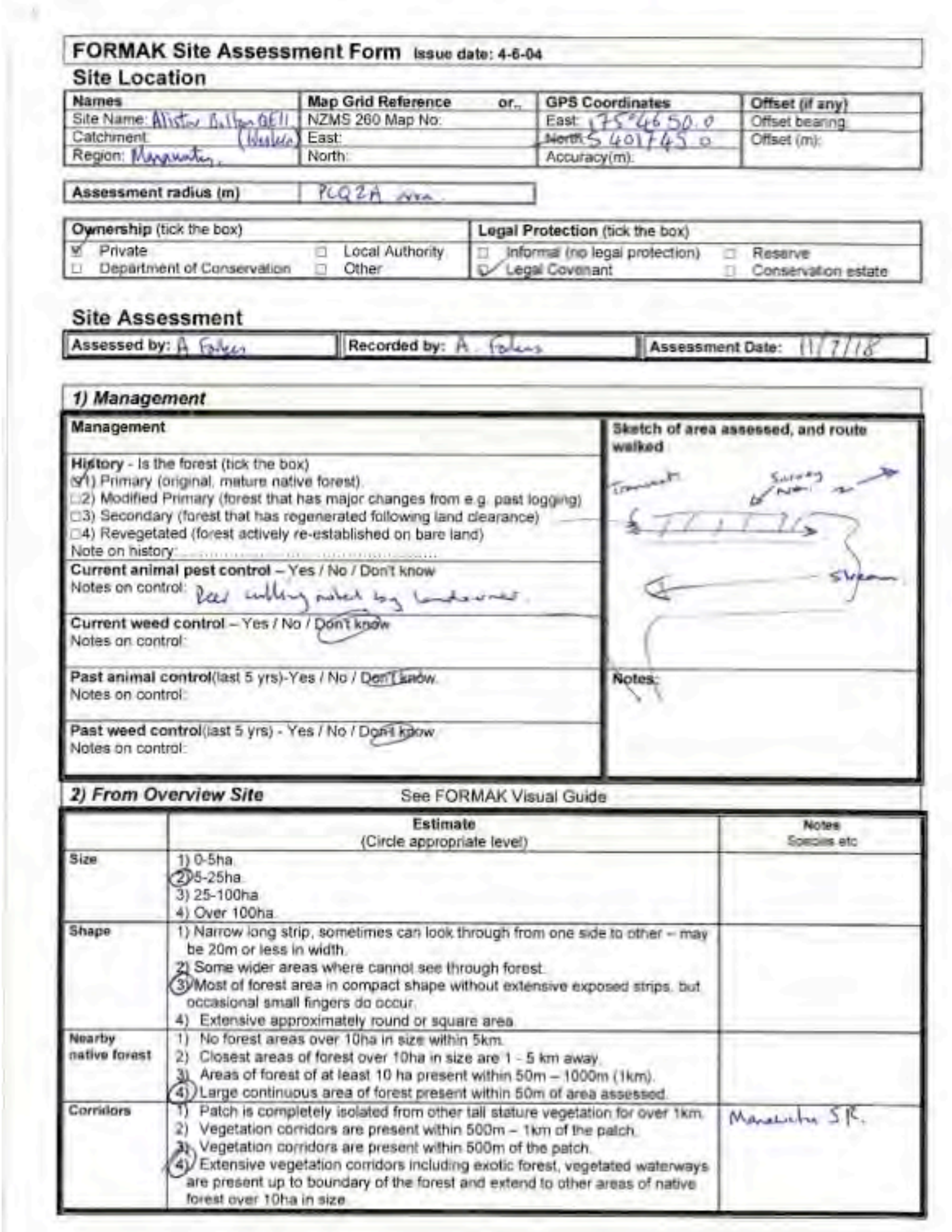
6) *Threats ?*

See FORMAK Visual Guide

Threat	Estimate (Circle appropriate level)	Notes Species etc
Vine Weeds	1) Very common, cover more than 50% canopy. 2) Common, 10 – 50% canopy. 3) Occasional, up to 10% canopy. [✓ 4) None present.]	
Shrub Weeds	1) Very common, more than 50% understorey or canopy. 2) Common, 10 – 50% understorey or canopy. 3) Occasional, up to 10% understorey or canopy. [✓ 4) None present.]	
Ground cover weeds	1) Very common, cover > 50% ground area. 2) Common, 10 – 50% ground area. 3) Occasional, up to 10% ground area. [✓ 4) None present.]	
Possums	1) Abundant fresh sign (droppings, pad runs, bark scratching / biting). 2) Common fresh sign but sometimes scattered. 3) Sign uncommon, often quite old. [✓ 4) Sign very rare or non existent.]	
Deer	1) Abundant fresh sign (droppings, major tracks & hoof prints). Occasional deer may be disturbed. 2) Common fresh sign but sometimes scattered. Sightings of deer uncommon. 3) Sign uncommon. Sign is often old. [✓ 4) No sign]	
Goats	1) Abundant fresh sign (droppings, major tracks & hoof prints). Goats commonly heard or seen. 2) Common fresh sign but sometimes scattered. Occasional goats heard or seen. 3) Sign uncommon. Sign is often old. [✓ 4) No sign]	
Stock	[✓ 1) Abundant fresh sign (droppings, major tracks & hoof prints). Stock heard or seen throughout area.] 2) Common fresh sign but sometimes scattered. Occasional stock heard or seen, generally confined to scattered areas on edge.	Lots of faeces, pugging & seen stock.

Threat	Estimate (Circle appropriate level)	Notes Species etc
	3) Sign uncommon. Sign is often old. Only near edges. 4) No sign	
Human Impacts	1) Widespread trampling, and other damage throughout area. 2) Common trampling and damage but limited to certain areas 3) Occasional localised minor damage [✓ 4)] No damage	

Location: P-C Q 2 at c. CH5600 (Western QEII)



FORMAK Site Assessment Form Issue date: 4-6-04

Site Location

Names	Map Grid Reference or..	GPS Coordinates	Offset (if any)
Site Name: Alistair Bolton QEII	NZMS 260 Map No:	East: 175°46 50.0	Offset bearing:
Catchment: (Western)	East:	~~North~~ S 40°17 45.0	Offset (m):
Region: Manawatu.	North:	Accuracy(m):	

Assessment radius (m)	PCQ2A area.

Ownership (tick the box)		**Legal Protection** (tick the box)	
☑ Private	☐ Local Authority	☐ Informal (no legal protection)	☐ Reserve
☐ Department of Conservation	☐ Other	☑ Legal Covenant	☐ Conservation estate

Site Assessment

Assessed by: A Folkes	**Recorded by:** A. Folkes	**Assessment Date:** 11/7/18

1) Management

Management

History - Is the forest (tick the box)

☑1) Primary (original, mature native forest).

☐2) Modified Primary (forest that has major changes from e.g. past logging)

☐3) Secondary (forest that has regenerated following land clearance)

☐4) Revegetated (forest actively re-established on bare land)

Note on history: ……………………………………

Current animal pest control – Yes / No / Don't know

Notes on control: Deer culling noted by landowner.

Current weed control – Yes / No / [✓ Don't know]

Notes on control:

Past animal control(last 5 yrs)-Yes / No / [✓ Don't know].

Notes on control:

Past weed control(last 5 yrs) - Yes / No / [✓ Don't know]

Notes on control:

Sketch of area assessed, and route walked

Notes:

2) From Overview Site

See FORMAK Visual Guide

	Estimate (Circle appropriate level)	**Notes** Species etc
Size	1) 0-5ha [✓ 2)] 5-25ha 3) 25-100ha 4) Over 100ha	
Shape	1) Narrow long strip, sometimes can look through from one side to other – may be 20m or less in width. 2) Some wider areas where cannot see through forest. [✓ 3)] Most of forest area in compact shape without extensive exposed strips, but occasional small fingers do occur. 4) Extensive approximately round or square area.	
Nearby native forest	1) No forest areas over 10ha in size within 5km. 2) Closest areas of forest over 10ha in size are 1 - 5 km away. 3) Areas of forest of at least 10 ha present within 50m – 1000m (1km). [✓ 4)] Large continuous area of forest present within 50m of area assessed.	
Corridors	1) Patch is completely isolated from other tall stature vegetation for over 1km. 2) Vegetation corridors are present within 500m - 1km of the patch. 3) Vegetation corridors are present within 500m of the patch. [✓ 4)] Extensive vegetation corridors including exotic forest, vegetated waterways are present up to boundary of the forest and extend to other areas of native forest over 10ha in size.	Manawatu S.R.

3) On the Forest Edge See FORMAK Visual Guide

	Estimate (Circle appropriate level)	**Notes** Species etc
Forest edge canopy	1) Major dieback in canopy, dead standing trees. 2) Areas of significant dieback, but all trees live. 3) Small areas of localised dieback. [✓ 4) Canopy without dieback.]	
Forest edge understorey	1) Understorey completely absent. 2) Some understorey present and occasional seedlings / saplings present close to the edge of the canopy [✓ 3) Considerable understorey and many seedlings / saplings around the edge of the canopy] 4) Vigorous, abundant understorey with a range of seedlings / saplings spreading well beyond the current extent of the canopy	
Forest edge - weeds	1) Many weeds present along edge – weeds dominate understorey. 2) Weeds common as scattered patches and individuals along the boundary. 3) Few weeds forming isolated patches or individuals on edge. Local native vegetation dominates understorey. [✓ 4) No weeds present]	
Fencing	1) No fencing 2) Some fencing, e.g. one side, or fence poorly maintained with large breaks 3) Most of boundary fenced, includes all areas where stock access likely. Some small recent breaks. [✓ 4) Secure, intact fencing around whole area, or area where no possibility of stock entry (e.g. urban).]	
Adjacent land use	[✓ 1) Livestock farming (note type)] Sheep / Beef 2) Exotic Forest 3) Residential / urban 4) Reserve (public or private reserve land)	Sheep & Beef.

4) Moving Through the Forest See FORMAK Visual Guide

Doing Simple Counts (see end of this form)

State	**Estimate** (Circle appropriate level)	**Notes** Species etc
Canopy Condition	1) Very sparse foliage, many large holes, dieback covers more than 25% of tree crowns. 2) Foliage sparse in some areas, canopy holes common. Some dieback. 3) Foliage mostly dense, only occasional sparse areas. Canopy holes rare, very occasional dieback. [✓ 4) Abundant dense foliage over whole canopy, no canopy holes or dieback.]	
Canopy Browsing	1) Severe canopy browse: 75-100% of leaves browsed on possum preferred species. 2) Moderate: heavy canopy browse - 25-75% of leaves browsed on possum preferred species 3) Light canopy browse: 1-25% of leaves browsed on possum preferred species. [✓ 4) No canopy browse.]	
Understorey / Regeneration	1) Understorey completely bare of all species. 2) Very few plants preferred by deer / goats / stock are present in the knee to shoulder height range. Scattered seedlings of other species. [✓ 3) Moderate numbers of plants preferred by deer / goats / stock are present in the knee to shoulder height range. Other species relatively abundant.] 4) Abundant plants preferred by deer / goats / stock and other species may also occur.	
Understorey Browsing	1) Severe understorey browse. 75-100% of stems of deer/goat/stock preferred species are browsed. Understorey may be completely bare. 2) Moderate – heavy understorey browse. 25-75% of stems of deer/goat/stock preferred species are browsed. [✓ 3) Light understorey browse. 1-25% of stems of deer/goat/stock preferred species are browsed.] 4) No understorey browse.	
Ground Cover	1) Bare soil, rock / gravel covers more than 20% of ground. Eroding soil common. Ground vegetation (ferns, moss, seedlings etc less than	

State	Estimate (Circle appropriate level)	Notes Species etc
	50cm tall) absent or very uncommon. 2) Scattered bare soil and rock. Eroding soil uncommon. Ground veg (see definition in (1)) covers less than 20% [✓ 3)] Bare soil, rock absent or very uncommon. No eroding soil. Ground veg (see definition in (1)) covers 20 – 50% of ground. 4) No bare soil, rock, or eroding soil. Ground veg (see definition in (1)), abundant, covering 50-100% of the ground.	
Bird Song	1) Bird song almost entirely absent. Only occasional calls heard. [✓ 2)] Bird song present some of the time, but with extended breaks. 3) Ongoing bird song but with occasional breaks. 4) Continuous bird song with no breaks.	

5) Canopy Gaps

See FORMAK Visual Guide

(Find gaps in the canopy, over 3m in diameter, and examine the understorey vegetation)

Canopy Gap	Estimate (Circle appropriate level)	Notes Species etc
Regeneration	1) No seedlings – area completely open. 2) Occasional seedlings – scattered individuals 3) Seedlings common – brush against you as you walk across area. [✓ 4)] Abundant, dense cover of seedlings and undergrowth – you have to continually push your way through.	PRUTAX & PRUFER regen.
Species	1) No plants preferred by deer / goats / stock – dominated by tree ferns, pepperwood or other unpalatable species. 2) Occasional plants preferred by deer / goats / stock amongst dominant tree ferns, pepperwood or other unpalatable species. [✓ 3)] Common plants preferred by deer / goats / stock. Unpalatable species such as tree ferns, pepperwood etc also common. 4) Abundant plants preferred by deer / goats / stock dominate.	

6) Threats ?

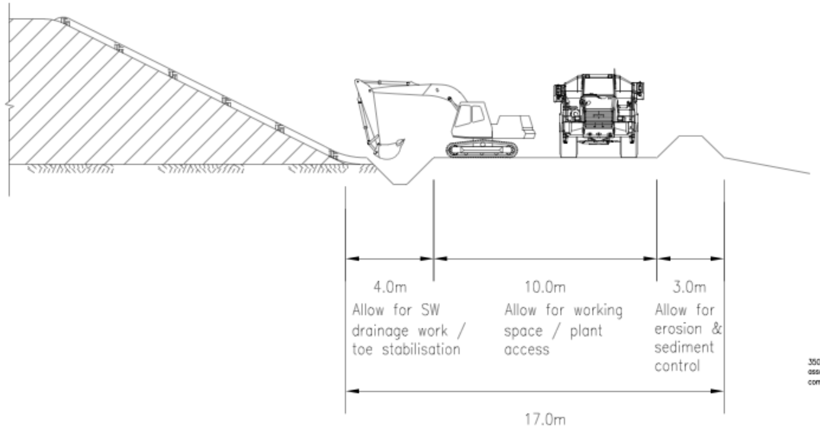
See FORMAK Visual Guide

Threat	Estimate (Circle appropriate level)	Notes Species etc
Vine Weeds	1) Very common, cover more than 50% canopy. 2) Common, 10 – 50% canopy. 3) Occasional, up to 10% canopy. [✓ 4)] None present.	
Shrub Weeds	1) Very common, more than 50% understorey or canopy 2) Common, 10 – 50% understorey or canopy 3) Occasional, up to 10% understorey or canopy [✓ 4)] None present.	
Ground cover weeds	1) Very common, cover > 50% ground area. 2) Common, 10 – 50% ground area 3) Occasional, up to 10% ground area [✓ 4)] None present.	
Possums	1) Abundant fresh sign (droppings, pad runs, bark scratching / biting) 2) Common fresh sign but sometimes scattered. 3) Sign uncommon, often quite old [✓ 4)] Sign very rare or non existent.	
Deer	1) Abundant fresh sign (droppings, major tracks & hoof prints). Occasional deer may be disturbed 2) Common fresh sign but sometimes scattered. Sightings of deer uncommon. 3) Sign uncommon. Sign is often old [✓ 4)] No sign	
Goats	1) Abundant fresh sign (droppings, major tracks & hoof prints). Goats commonly heard or seen. 2) Common fresh sign but sometimes scattered. Occasional goats heard or seen. 3) Sign uncommon. Sign is often old [✓ 4)] No sign	
Stock	1) Abundant fresh sign (droppings, major tracks & hoof prints). Stock heard or seen throughout area. 2) Common fresh sign but sometimes scattered. Occasional stock heard or seen, generally confined to scattered areas on edge.	

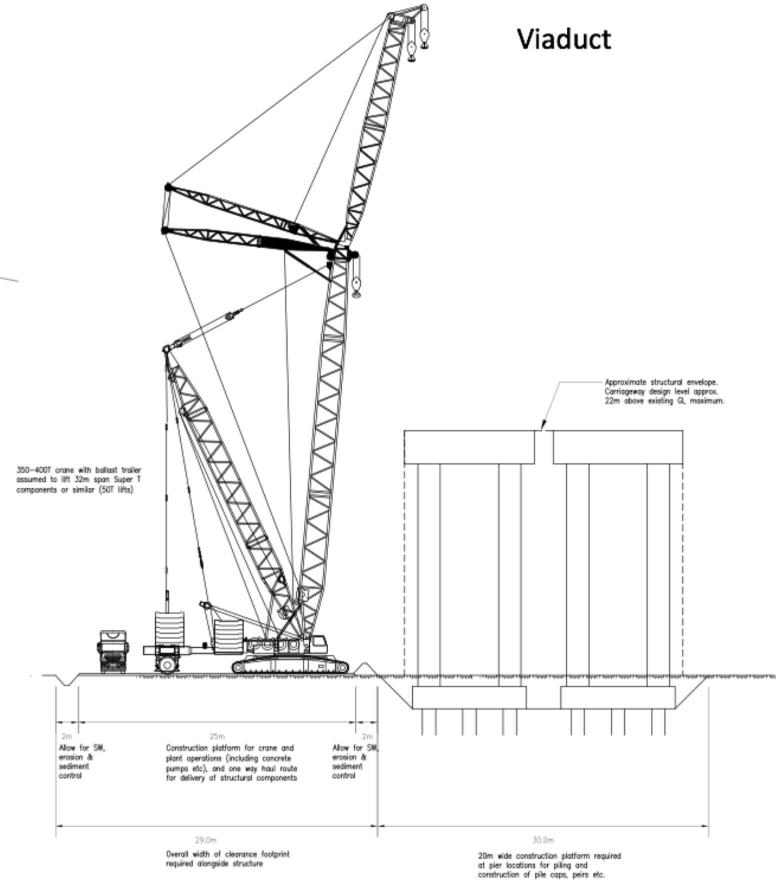
Threat	**Estimate** (Circle appropriate level)	**Notes** Species etc
	3) Sign uncommon. Sign is often old. Only near edges. 4) No sign	
Human impacts	1) Widespread trampling, and other damage throughout area. 2) Common trampling and damage but limited to certain areas 3) Occasional localised minor damage [✓ 4) No damage]	

Appendix E: Diagrams Demonstrating Assumptions Regarding Construction Access Requirements

Embankment



Viaduct



Appendix F: Assessment of Offsetability (following Pilgrim et al., (2013) Table 2)

Example assessment of residual impact magnitude, offset opportunity, and offset feasibility for the alluvial old-growth forest located at CH4000–4400 when compared between generic embankment and viaduct options.

Issue	Sub-issue	Criterion	Embankment				Viaduct			
			Lowest likelihood		Highest likelihood		Lowest likelihood		Highest likelihood	
			Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
Residual impact magnitude	Severity	Declines of each biodiversity feature at a set scale (per km)	Severe						Moderate	
	Extent	Proportion of range/population of each biodiversity feature impacted			Small					V. small
	Duration	Length of impacts, relative to viability of affected biodiversity	Permanent						Medium	
Offset opportunity	Options	Potential for restoring affected biodiversity functions elsewhere		Possible				Possible		
		Offset options within natural range		Limited				Limited		

		For restoration offsets, condition to which offset can be restored compared to impacted feature			Equal or better				Equal or better	
		For averted loss offsets, landscape-level condition of affected biodiversity	-	-	-	-				
Offset feasibility	Technical	Availability of proven relevant methods for restoration, protection, etc			Some proven methods				Some proven methods	
		Adequacy of long-term offset implementation plans	[TBD]	[TBD]	[TBD]	[TBD]				
		Adequacy of long-term offset monitoring plans	[TBD]	[TBD]	[TBD]	[TBD]				
	Financial	Funding for long-term offset implementation		Post impacts				Post impacts		

		Funding for long-term offset monitoring				Includes funding for independent input				Includes funding for independent input
	Temporal	Time after impacts until offset gains replace affected biodiversity, relative to viability		Medium-term				Medium term		
	Capacity	Capacity of offset implementer for relevant methods at necessary scale			Some				Some	
		Capacity of developer to keep residual impacts within predicted magnitudes			Some				Some	
Overall likelihood of offset success			Class 1					Class 2		

Notes. Following Pilgrim *et al.* (2013), the overall likelihood of offset success is indicated by the lowest class for which a project is ranked on any table row, from Class 1 (lowest likelihood of success) to Class 4 (highest likelihood of success).

Appendix G: Assessment of Threatened Flora (Singers & Bayler, 2018)

6.B

TERRESTRIAL FAUNA ECOLOGICAL EFFECTS ASSESSMENT

Te Ahu a Turanga; Manawatū Tararua Highway project

Report 6B: Terrestrial fauna ecological effects assessment technical report
Prepared for NZ Transport Agency

26 October 2018

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Cover photograph: Looking East along designation, © Boffa Miskell Limited, 2018]

CONTENTS

6.B.1. Introduction 1

- 6.B.1.1 Scope of this Report 1
- 6.B.1.2 Project Description 1
- 6.B.1.3 Study Area 1

6.B.2. Methodology 1

- 6.B.2.1 Faunal Information & determining their value 1
- 6.B.2.2 Data Limitations and Assumptions 6
- 6.B.2.3 Evaluation of the level of ecological effects 8

6.B.3. Terrestrial fauna ecological values – Desktop Review 11

- 6.B.3.1 Herpetofauna 11
- 6.B.3.2 Terrestrial Invertebrates 13
- 6.B.3.3 Bats 15
- 6.B.3.4 Avifauna 16

6.B.4. Terrestrial fauna habitats – Site Investigations 20

- 6.B.4.1 Habitat of Herpetofauna 20
- 6.B.4.2 Terrestrial Invertebrates 34
- 6.B.4.3 Bats 36
- 6.B.4.4 Avifauna 38

6.B.5. Ecological Values 51

- 6.B.5.1 Herpetofauna 51
- 6.B.5.2 Terrestrial Invertebrates 51
- 6.B.5.3 Bats 52
- 6.B.5.4 Avifauna 52
- 6.B.5.5 Summary 55

6.B.6. Assessment of Effects 56

- 6.B.6.1 Herpetofauna 57
- 6.B.6.2 Terrestrial Invertebrates 58
- 6.B.6.3 Bats 61
- 6.B.6.4 Avifauna 61

6.B.7. Recommendations to avoid, remedy or mitigate 64

6.B.7.1 General recommendations 64
6.B.7.2 Herpetofauna 64
6.B.7.3 Terrestrial Invertebrates 65
6.B.7.4 Bats 66
6.B.7.5 Avifauna 67

6.B.8. Conclusions and recommendations 69

6.B.9. References 71

Appendix 6.B.1: Manawatū Gorge SH3 - Summer Ecology Survey – Herpetofauna – Boffa Miskell Limited 2018 75

Appendix 6.B.2: GHD & NZTA Manawatū Gorge Realignment. Option 3: South of Saddle road Bats & Bird Habitat and Species Surveys. 76

Appendix 6.B.3: OSNZ Bird Atlas Squares that Encompass the Designation Corridor (Robertson et al, 2007) 77

Appendix 6.B.4: Project Te Apiti Saddle Road, Manawatū – ecological assessment – Boffa Miskell Limited 2003 78

Appendix 6.B.5: Report on Avian Mortality at Te Apiti Wind Farm – Boffa Miskell Limited & Golder Associates 2009 79

Figures

Figure 6.B.1: Peripatoides novaezealandiae found previously in the Manawatū Gorge. Photo taken 29-08-2010. 14

Figure 6.B.2: An Acanthoxyla sp. observed along the proposed designation near the Manawatū Gorge during nocturnal herpetological surveys - March 2018. 15

Figure 6.B.3. Five minute bird count and acoustic recording device deployment sites throughout the original designation corridor (Kessels & Associates Ltd, 2018) 18

Figure 6.B.4: MGSR walk carpark showing felled pine forest in background and native plantings and scrubby vegetation in the foreground. 21

Figure 6.B.5: Area of established canopy trees with interspersed kānuka and divaricate shrubs in western rise area (west side) of Project corridor. 22

Figure 6.B.6: Area of established canopy trees with limited understory of divaricate Coprosma shrubs in western rise area (west side) of Project corridor. 23

Figure 6.B.7: Large kānuka with patches of raupō in western rise area (east side). 23

Figure 6.B.8: Large area of Raupō surrounded by large kānuka in western rise area (east side) of Project corridor. Located South of area depicted in Figure 6.B.7. 24

Figure 6.B.9: Established tawa forest (background) and secondary broadleaved forest (foreground) at point of corridor crossing gully in western rise area. 24

Figure 6.B.10: Emergent rewarewa in established tawa forest with complex epiphyte habitat in western rise area. 25

Figure 6.B.12: Gully of kānuka and broadleaved regenerating forest. Approximately Ch 6000 to 6400. 26

Figure 6.B.13: Limited kānuka scrub and canopy trees in cross over point of corridor. Looking from approximately Ch 6700 to 7100. 27

Figure 6.B.14: Gully area at Ch 7200-7400 with kānuka- broadleaved regenerating forest. 27

Figure 6.B.15: Highly disturbed and grazing impacted stream side vegetation at approximately Ch 9100. 28

Figure 6.B.16: Low stature divaricate Coprosma vegetation amongst grazed pasture. 29

Figure 6.B.17: Kānuka and fern dominated secondary vegetation at Ch 9900-10000. 30

Figure 6.B.18: Rush and sedges in seep with Kānuka scrub surrounding at approximately Ch 10200. 30

Figure 6.B.19: Looking down potentially impacted gully of secondary broadleaved forest. Ch 10500-10700. 31

Figure 6.B.20: Immature pine plantation at Ch 10900 to 11000 32

Figure 6.B.21: Large area of regenerating secondary broadleaved and fern forest with kānuka and divaricate Coprosma scrub. Photo taken of contiguous area to the north of the affected area at Ch 11000. 32

Figure 6.B.22: Regenerating broadleaved forest on eastern rise. Photo looking towards face directly impacted by designation. 33

Figure 6.B.23: Immature pine plantation with blackberry understory (between 12500-12700). 34

Figure 6.B.24: Understory showing canopy closure and developing ground cover flora and habitat in forest patch located at Ch 11000 to 11900...36

Figure 6.B.25: Old pine trees with broken branches and small cavities. Photo taken approximately Ch 9700. 38

Figure 6.B.26. Manawatū River gravel/shingle riverbed habitat, willows on the northern bank of the river and indigenous vegetation. 43

Figure 6.B.27. Gravel/shingle riverbed habitat within the designation corridor where the bridge across the Manawatū River is proposed to go...44

Figure 6.B.28. The raupō wetland is within the orange polygon..................45

Figure 6.B.29. A pugged area of the raupō wetland where the raupō is less dense and interspersed with grass. 45

Figure 6.B.30. A more dense area of the raupō wetland with large Carex species. 46

Figure 6.B.31. One of the two farms ponds (the eastern one) between approximately Ch 9200 and Ch 9600. 48

Figure 6.B.32. One of the two farm ponds (the western one) between approximately Ch 9200 and Ch 9600. 48

Figure 6.B.33. One of the two farm ponds (the western one) between approximately Ch 9200 and Ch 9600. The orange polygon indicates a small area of raupō on the pond margin. 49

Figure 6.B.34. The wetland area between approximately Ch 10200 and Ch 10280 by Saddle Road. 50

Figure 6.B.35. The wetland area between approximately Ch 10200 and Ch 10280 by Saddle Road. 50

6.B.1. Introduction

6.B.1.1 Scope of this Report

The scope of this technical report is to provide a description of the existing ecological values for terrestrial fauna (herpetofauna, terrestrial invertebrates, bats and avifauna) along the proposed designation corridor of the Te Ahu a Turanga; Manawatū Tararua Highway Project (the "Project"). Following this is an assessment of the likely and potential effects of the Project on these ecological values, and recommendations to avoid, remedy and/or mitigate/offset adverse effects. Where ecological values, magnitude of effect, and overall level of ecological effects are stated within this report they relate only to terrestrial fauna. As such, they should not be interpreted in isolation of the overall ecology assessment prepared by Dr Adam Forbes of which this terrestrial fauna assessment contributes to.

6.B.1.2 Project Description

A comprehensive Project description is provided in Volume 2 of the AEE, Part C Description of the Project.

6.B.1.3 Study Area

The detailed area of the Project is shown in Volume 4 of the AEE, Drawings and Plans (all chainage references within this report refers to the maps in this appendix). The Project is located to the south of Saddle Road and the north of the Manawatū Gorge, on the southern foot hills of the Ruahine range.

6.B.2. Methodology

6.B.2.1 Faunal Information & determining their value

6.B.2.1.1 Herpetofauna

A desktop review largely informed by the Manawatū Gorge SH3 Summer Ecology Survey - Herpetofauna (Boffa Miskell Ltd, 2018) (referred to as “the previous herpetofauna survey” and provided in Appendix 6.B.1) was undertaken to determine likely herpetofauna species present and the potential habitat onsite. The previous report accessed the DOC Bioweb herpetofauna database for records within 40km of the Manawatū Gorge (accessed 23 February 2018).

A site walk over was then carried out on 17 and 18 July 2018. That allowed the habitat characterisation from the previous surveys to be confirmed within the updated Project corridor, and for qualitative assessments of habitat quality and likely ecological value for herpetofauna to be made. These qualitative assessments were based on habitat preferences of the potentially present herpetofauna as described by the previous herpetofauna survey (Boffa Miskell Ltd, 2018), as well as ecological context factors such as connectivity to other forest patches (especially the large contiguous Manawatū Gorge Scenic Reserve ("MGSR") south of much of the designation).

Native lizards often occupy habitats of otherwise low ecological value (i.e. weedy vegetation, vegetation margins) (Anderson, Bell, Chapman, & Corbett, 2012). Therefore to attribute ecological value to habitat for this assessment, the threat status (following Hitchmough et al. (2016)) of the potentially present herpetofauna species in each area based on habitat preference was used to assess ecological value for herpetofauna of habitats across the designation.

6.B.2.1.2 Terrestrial Invertebrates

A desktop investigation was carried out to search for any relevant survey data, inventories, or scientific literature available (published or unpublished) regarding the terrestrial invertebrate communities and/or at risk or threatened invertebrates that may be located within or near to the designation.

The assessment of ecological value for terrestrial invertebrates was based on a qualitative assessment of habitats. Habitats were given values based on ecosystem factors known to affect terrestrial invertebrate community assemblages. The factors considered within this assessment are:

- Browsing and grazing mammals (Bromham, Cardillo, Bennett, & Elgar, 1999; Lövei & Cartellieri, 2000; Wardle, Barker, Yeates, Bonner, & Ghani, 2001);
- Forest patch size, shape, and associated edge effects (Ewers & Didham, 2008);
- Vascular plant diversity (Crisp, Dickinson, & Gibbs, 1998; Toft, Harris, & Williams, 2001);
- Isolation of forest fragments (Lövei & Cartellieri, 2000);
- Invasion by non-native plants (Toft et al., 2001);
- Presence of mammalian predators (Lövei & Cartellieri, 2000); and
- “Spill over effects” from forest patches into adjacent exotic pasture (Derraik, Rufaut, Closs, & Dickinson, 2005).

Based on the above factors an ecological value scoring process was devised for terrestrial invertebrate communities for the Project corridor (Table 6.B.1). The scoring guide prioritises potentially intact forest invertebrate communities, as those communities that:

- are most likely to have conservation important taxa;
- will be the hardest to replace/restore; and
- are rarest within the wider area.

While exotic pasture and sparse scrub/pasture habitats can contain diverse invertebrate communities, these habitats are relatively common in the landscape and relatively easily replaced/replicated.

This scoring guide is conservative as there is a lack of knowledge in New Zealand on forest invertebrate communities and their make-up, and methods to provide for their restoration.

The replacement of sufficient vegetative diversity is not standard in mitigation practices, and standard revegetation approaches are unlikely to achieve the restoration of the invertebrate communities lost (Lövei & Cartellieri, 2000) in a timely fashion. As such, sufficient knowledge is not available to effectively ensure the restoration of those invertebrate communities lost or impacted by human activities. Additionally, for most of the terrestrial invertebrates in New Zealand there has not been enough taxonomic or population study to provide an assessment on a threat status of individual species. For this reason, at-risk and threatened species have been suggested within the scoring guide to contribute to a very-high ecological value.

Assessment of the referenced concepts of “naturalness”, “diversity and pattern”, and “ecological context” follows guidance provided by Davis, Head, Myers, & Moore (2015). Terrestrial invertebrate ecological values are assessed for habitats based on a best fit approach to the habitat attributes stated in Table 6.B.1. I.e. to score “High” a habitat does not have to meet all the criteria stated but must fit best within the descriptors for that category of effect, compared to those provided for other scores.

Table 6.B.1: Project corridor qualitative ecological value scoring guidance for terrestrial invertebrates.

Terrestrial invertebrate ecological value attributed to habitat	**Habitat attributes:**
Very High	– Habitat as described below for high ecological value but contains confirmed at-risk or threatened species.
High	– Mature forest ecosystem with high naturalness, diversity and pattern. – Established and protected remnant natural wetland. – Little to no grazing pressure (effectively fenced from stock). – Intact sub-canopy, epiphyte, and ground cover flora composition. – Intact and undisturbed forest floor with leaf litter, woody debris, and high habitat complexity. – Ecological context: Large patch size of compact shape connected to, or linked by corridors, to established intact forest ecosystem (such as the MGSR).
Moderate	– Secondary forest ecosystems with moderate-low naturalness, diversity and pattern. – Grazing pressure low or large discrete areas protected from grazing by topology/stock access. – Developing sub-canopy and ground cover flora composition with large areas of full canopy closure and absence of pasture grasses. – Forest floor with small amounts of leaf litter, woody debris. – Ecological context: Small-medium patch size or complex of patches. Poor linkage to established intact forest ecosystem (such as the MGSR).
Low	– Regenerating scrub or broadleaved ecosystems with low naturalness, diversity and pattern. – Regenerating or remnant wetland in poor condition. – Grazing pressure moderate to high with possible small discrete areas protected from grazing by topology. – Little to no sub-canopy and ground cover other than pasture grasses or bare open ground. – Disturbed forest floor with negligible amounts of leaf litter, woody debris.

Terrestrial invertebrate ecological value attributed to habitat	Habitat attributes:
	− Ecological context: Small-medium patch size or complex of patches. Poor linkage to established intact forest ecosystem (such as the MGSR).
Negligible	− Short grazed pasture or widely spaced grazing tolerant shrubs with low-negligible naturalness, diversity and pattern. − Pine plantations. − High grazing pressure. − No sub canopy or ground cover. − Ground cover dominated by pasture grasses and occasional graze tolerant shrub or bare due to grazing pressure. − Ecological context: Predominately grazed pasture matrix between forest patches.

6.B.2.1.3 Bats

A desktop review informed by the previous automatic bat monitor survey report (Kessels & Associates Ltd, 2018) (provided in Appendix 6.B.2) was undertaken to assess the likelihood of bats to be present within the Project corridor. A site walk over was then carried out on 17 and 18 July 2018 where a qualitative assessment of the habitat suitability onsite was carried out. The assessment of habitat suitability was based on long-tailed bat habitat preferences such as forest edge habitats, open spaces between forest patches, and riparian habitats (C. F. O'Donnell, 2000; C. F. O'Donnell, Christie, & Simpson, 2006; Rockell, Littlemore, & Scrimgeour, 2017). Long-tailed bats which roost within the forest also immediately leave the forest after emerging at dusk to feed on open forest edges (C. F. O'Donnell et al., 2006).

Long-tailed bats' home range is potentially very large (657-1589 ha in other populations) and the bats frequently change roosts utilising a wide network of roosts across their home range (Rockell et al., 2017). The habitat suitability assessment was carried out on a landscape scale basis rather than the corridor section scale utilised for other terrestrial fauna.

During the site walk over potential roost trees were visually inspected from the ground for suitable roost features such as cavities, hollow limbs, loose bark and epiphytes. There is no formal guidance for categorising the roost potential of trees for New Zealand bats therefore the above categories are based on the experience of bat specialists and studies that have been undertaken on roosting behaviour and roost selection by long-tailed bats (Colin F. J. O'Donnell & Sedgeley, 1999; Sedgeley, 2001; Sedgeley & O'Donnell, 1999, 2004). Features of potential roost trees that were considered during the categorisation of bat roost potential include:

- Type of roost features available – Studies undertaken in unmodified native forest have shown that long-tailed bats preferentially roost in knot-hole cavities with small entrance holes compared to cavities available throughout the forest. This has been linked to the more stable thermal characteristics within knot-hole cavities. Epiphytes, loose bark, and broken limbs can also provide roost features.
- The size (diameter at breast height) of the tree – New Zealand bats preferentially roost in the largest trees available as such trees generally have preferred thermal characteristics;

- Height of roost feature(s) – long-tailed bats generally roost high in trees, >15 m above the ground (Colin F. J. O'Donnell & Sedgeley, 1999), potentially an adaptation to avoid predators;
- Canopy closure – Long-tailed bats are edge-specialists and are not adapted to flying in cluttered spaces. It has been demonstrated that they preferentially roost in trees with more open canopies.

It should be noted that the majority of long-tailed bat roost-selection studies are undertaken in pristine forest where roost trees are not a limiting resource compared to the modified landscape of the Project corridor.

Evidence of use by bats such as staining, scratches and guano around cavities and at the base of the tree were to be noted if they were present. Some potential roost trees found were inaccessible (either by topography and vegetation or time constraint) and in this circumstance their position was noted, or a forest patch was assessed as having potential roost value based on several trees bearing roost features in the patch.

Due to time constraints the roost assessment focused on assessing the presence of potential roost features across the site rather than a comprehensive tree-by-tree identification of potential roosts. This approach is appropriate for the purposes of assessing the available habitat for this assessment. However, in later stages of the Project, if bats are confirmed to be present a tree-by-tree survey will be required prior to felling (this is addressed by the recommendation provided within section 6.B.7.4)

6.B.2.1.4 Avifauna

A desktop review was carried out, largely based on:

- the previous ecological survey report (GHD & NZTA Manawatū Gorge Realignment – Option 3: South of Saddle Road Bats and Bird Habitat and Species Surveys) (Kessels & Associates Ltd, 2018) (Appendix 6.B.2);
- data from the Ornithological Society of New Zealand's atlas that were collated from the two 10x10 km grid squares (274, 609 and 275, 609) (Robertson, Hyvonen, Fraser, & Pickard, 2007) which encompass the Project corridor (Appendix 6.B.3); and
- data from the Te Āpiti wind farm ecological assessment (Project Te Āpiti Saddle Road, Manawatū: Ecological assessment) (Boffa Miskell Ltd, 2003) (Appendix 6.B.4) and post-construction avifauna mortality report (Report on avian mortality at Te Āpiti wind farm) (Boffa Miskell Ltd & Golder Associates, 2009) (Appendix 6.B.5).

Scientific literature (published and unpublished) and websites were also reviewed. The data collated served as a base list of avifauna species that have been observed in the Project corridor or that may potentially use habitats present at or in the vicinity of the Project corridor.

A site walkover and avifauna surveys were conducted within the Project corridor on 17 and 18 July 2018 by ecologists from Boffa Miskell. The site walkover involved traversing the designation, observing the different habitats available for avifauna species and determining what species the different areas potentially provide habitat for (i.e. a determination of likely ecological values for birds). Factors considered included:

- the species present/potentially present;
- size, shape and condition of the habitats;

- connectivity to other habitats (particularly proximity or degree of connectedness to the MGSR for native bush habitats);
- stock access; and
- vegetation composition, complexity and approximate age.

Playback surveys for spotless crake and marsh crake were also opportunistically conducted at two wetland areas within the Project corridor. One wetland was adjacent to Saddle Road at approximately Ch 10200 to Ch 10280 and the other was a raupō wetland north of the proposed Manawatū River bridge site at approximately Ch 4130 and Ch 4230. At the raupō wetland, a playback for Australasian bittern was also conducted. These surveys involved playing recorded calls of these species through an iPod and speakers, listening for a response, then repeating the playback.

Three observational surveys (at different times of the day) were also conducted for species using gravel/shingle riverbed habitat within the Project corridor where the Manawatū River is proposed to be bridged. Observations were also made at two downstream areas of the Manawatū River that contained similar gravel/shingle riverbed habitat as well as at similar habitat by the Saddle Road bridge that crosses the Pohangina River.

A roaming inventory was compiled of all bird species seen on site.

For avifauna, species and habitat value scores have been combined to give one overall value score for each section of the Project corridor. This overall score takes into consideration factors such as:

- the likelihood of At Risk and Threatened species being present, and if so, the quality of this habitat;
- the importance of this habitat for avifauna (i.e. its rarity); and
- what activities species undertake in this habitat (e.g. breeding, foraging and/or roosting).

An example of this scoring application, is that a corridor section that contains a moderate value habitat that is used, or may be used, by a very high value species occasionally or in small numbers may be moderated to have an overall value score of high.

In general, higher combined value scores have been assigned to sections that provide suitable nesting habitat for At Risk and/or Threatened species. This is because disturbance/mortality risks are higher during nesting, particularly if eggs/chicks are present. Conversely, in general, lower combined values have been assigned to areas that do not provide suitable nesting habitat for At Risk and/or Threatened species. This is because disturbance/mortality risks are lower in such areas, as the species considered in this assessment are mobile and can fly away if disturbed.

6.B.2.2 Data Limitations and Assumptions

- This is an initial assessment based on consideration of the proposed Project corridor and noting the final road design within that corridor is not yet confirmed. The type and magnitude of effects (and level of ecological effects) are subject to change depending on the final design of the designation and proposed construction methods. Therefore, this effect assessment should be considered a worst case scenario, based on the envelope of effects on habitats defined by Forbes (2018) and outlined in section 6.B.6.

It should also be appreciated that the level of effect is to fauna or to a specific taxon of fauna; and in considering the overall effect of the Project, this report only reflects a subset of the many aspects to be considered. The EIANZ (2018) indication as to avoiding very high adverse effects is tempered by the taxa thusly affected where that is the case, as well as the wider set of levels of effects. A "very high" level effect on a very small area of high value habitat may not require avoidance and it is up to the ecological team to justify where and what adverse effects are not sustainable.

- Time limitations of this assessment mean that it is likely that there exists information not reviewed within this assessment that would further contribute to the assessment. To account for this possibility a precautionary approach to the presence of fauna and potential effects has been taken as detailed in the following points.
- Terrestrial fauna: This ecological assessment is based on existing literature, of which there is little, on previous ecological field surveys and qualitative assessment of habitats. Detailed field surveys in all identified areas of vegetation loss have not been carried out (and should not be in winter). As such there is a possibility that species are present that have not been considered within this report. For those reasons, this report has not considered the possibility of individual at risk or threatened invertebrate species that may be present along the designation.
- Herpetofauna: The previous surveys for herpetofauna were conducted at a small number of representative sites only, and did not detect any lizards. This approach was appropriate to identify high density, and therefore easily detectable, populations that would be most appropriately avoided. However, herpetofauna survey methods currently available have poor detection rates at low population densities, as herpetofauna species have cryptic colouration and behaviour/activity patterns (Anderson et al., 2012). The presence of low-density populations of herpetofauna in appropriate habitats within the corridor therefore cannot be ruled out. Therefore, the assessment of ecological value for herpetofauna takes a precautionary approach and assumes where suitable habitat occurs the potential herpetofauna species are present.
- Avifauna: Australasian bittern, spotless crake and marsh crake are cryptic species that are generally only responsive to playback calls during the breeding season. Given the difficulty of detecting these species and that playback surveys were conducted outside of the breeding season, the presence or absence of these species within the designation corridor cannot be conclusively determined. As such, a precautionary approach has been taken in that we have assumed their potential presence within the raupō wetland habitats that provide marginal habitat for these species.
- Avifauna: The observational surveys for avifauna, using the gravel/shingle riverbed habitat along the Manawatū River within the area proposed to be bridged, were conducted very early in the breeding season for braided river bird species such as dotterels. Likewise, the acoustic recorder in this area was also set up outside of the main breeding period for these species. Consequently, the presence or absence of such species within this habitat cannot be conclusively determined. As such, a precautionary approach has been taken in that we have assumed their potential presence within the habitat.
- Avifauna: The best seasons to survey for avifauna are spring and summer. A summer survey was conducted (2017-2018 summer) however, given the time constraints of the project, a spring survey has not been conducted. As such, some avifauna species that potentially use habitats within the designation may not have been detected. To address this possibility, a conservative approach has been used in this assessment in that we

have assumed the presence of some species not detected in summer but that may use the habitats present in the Project corridor at other times of the year.

6.B.2.3 Evaluation of the level of ecological effects

The methodology for assessing the significance of the ecological effects associated with the proposal was based on the Environment Institute of Australia and New Zealand's (EIANZ) Ecological Impact Assessment Guidelines (EIANZ, 2018).

In summary, this method required an assessment of:

- Ecosystem/habitat and species values as described in Table 6.B.2 and Table 6.B.3, Section 6.B.2.3.1;
- The magnitude of effect using the criteria listed in Table 6.B.4, Section 6.B.2.3.2; and
- The level of ecological effect using the decision matrix presented in Table 6.B.5, Section 6.B.2.3.3, which determines the level of effect based on the ecological value of the ecosystems or species assessed and the magnitude of effect.

The assessment of magnitude of effects for terrestrial fauna in this report are at a designation corridor scale. This scale was chosen to remain consistent with the approach taken within the vegetation and habitat report by Forbes (2018).

6.B.2.3.1 Assigning ecological value to habitats for fauna species

Each of the fauna groups considered within this report have been assigned an ecological value based on the methodology described within the above sections (6.B.2.1.1, 6.B.2.1.2, 6.B.2.1.3, and 6.B.2.1.4). These scores and methodology have been informed by the EIANZ (2018) guidelines for assigning ecological value which are described below.

For fauna habitats, EIANZ (2018) provides guidance on matters to be considered when assigning ecological value outlined in Table 6.B.2 (summarised from (EIANZ, 2018)). For individual animal species EIANZ (2018). For individual animal species EIANZ (2018) also provides guidance on scoring of ecological value based on the national threat status (Table 6.B.3).

For this report the focus is on fauna only. Therefore, scoring primarily relates to rarity/distinctiveness and the ecological values provided should be considered a component of a site's/habitat's overall ecological value. This assessment is then used to inform the overall ecological assessment (Terrestrial Ecology Assessment # 6 (Forbes, 2018)).

Table 6.B.2: Matters to be considered when assigning ecological value to vegetation and habitats (adapted from EIANZ (2018)).

Matter	Assessment considerations
Representativeness	Extent to which area is typical or characteristic Size
Rarity/distinctiveness	Amount of habitat or vegetation remaining Supporting nationally or locally threatened, at risk or uncommon species

Matter	Assessment considerations
	Regional or national distribution limits Endemism Distinctive ecological features Natural rarity
Diversity and pattern	Level of natural diversity Biodiversity reflecting underlying diversity
Ecological context	Contribution to network, buffer, linkage, pathways Role in ecosystem functioning Important fauna habitat Contribution to ecosystem services

Table 6.B.3: Assigning value to species for assessment purposes (adapted from EIANZ (2018)).

Threat category	Assigned Value
Threatened – Nationally Critical, Endangered or Vulnerable	Very High
Nationally At Risk – Declining	High
Nationally At Risk – Recovering, Relict or Naturally Uncommon	Moderate
Locally (ED) uncommon or distinctive species	Moderate
Nationally and locally common indigenous species	Low
Exotic species, including pests, species having recreational value	Negligible

6.B.2.3.2 Assessing magnitude of effect

Once ecological value had been determined, the magnitude of the effect on ecological values was assessed. The magnitude of the effect was a measure of the extent, or scale, of the effect, its duration, and the degree of change that it will cause. A typical scale of magnitude ranged from very high to negligible, as shown in Table 6.B.4.

Table 6.B.4: Criteria for describing magnitude of effect (from EIANZ (2018)).

Magnitude	Description
Very High	Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR

Magnitude	Description
	Loss of a moderate proportion of the known population or range of the element/feature
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature

6.B.2.3.3 Assessing level of ecological effect

The overall level of the effect was determined by applying the following matrix (Table 6.B.5), which combined the ecological value of the site or species (Table 6.B.2 and Table 6.B.3) and the magnitude of effect (Table 6.B.4).

Table 6.B.5: Criteria for describing overall level of effect (From EIANZ (2018)).

		ECOLOGICAL VALUE				
		Very High	**High**	**Moderate**	**Low**	**Negligible**
MAGNITUDE	**Very High**	Very High	Very High	High	Moderate	Low
	High	Very High	Very High	Moderate	Low	Very Low
	Moderate	High	High	Moderate	Low	Very Low
	Low	Moderate	Low	Low	Very Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low	Very Low
	Positive	Net gain	Net gain	Net gain	Net gain	Net gain

The EIANZ (2018) guidelines note that the level of effect can be used as a guide to the extent and nature of ecological response (e.g., mitigation) required.

For example from EIANZ (2018):

- "Project effects in the 'Very High adverse' category are unlikely to be acceptable on ecological grounds alone (even with compensation proposals). Activities having very high adverse effects should be avoided. It is not the ecologist's role to make determinations with regard to project viability. The ecologist should present an objective and scientifically robust assessment of the effects of the project to assist the applicant in coming to an informed decision about project viability. Where very high adverse effects cannot be avoided, a net biodiversity gain would be appropriate.
- Options in the 'High and Moderate adverse' category represent a level of effect that requires careful assessment and analysis of the individual case. Such an effect could be managed through avoidance, design, or extensive offset or compensation actions.

Wherever adverse effects cannot be avoided, no net loss of biodiversity values would be appropriate

- Low and Very Low categories should not normally be of concern, although normal design, construction and operational care should be exercised to minimise adverse effects. If effects are assessed taking impact management developed during project shaping into consideration, then it is essential that prescribed impact management is carried out to ensure Low or Very Low level effects".

It is important to recognise that the above descriptors and responses to level of effects detailed within the EIANZ (2018) guidelines refer to an overall ecological level of effect. This report deals solely with terrestrial fauna and, like ecological values above, the level of effects need to be considered as a component of a wider assessment of the level of ecological effect. It would therefore be inappropriate to consider, in isolation, the effect levels stated within this report against the above descriptors. The EIANZ (2018) guidelines do not provide interpretative guidance for assessing the level of effect for only a subset of a site's ecological value.

6.B.3. Terrestrial fauna ecological values – Desktop Review

6.B.3.1 Herpetofauna

6.B.3.1.1 Habitat

During previous survey high value habitats for native herpetofauna were identified along the Project corridor, including (Boffa Miskell Ltd, 2018):

- native and non-native scrub;
- regenerating forest in gullies;
- areas of complex ground cover such as woody debris and leaf litter; and
- mature broadleaved forest.

The MGSR was identified as a particularly high-quality habitat and potential source for lizards to colonise regenerating and scrub habitats.

6.B.3.1.2 Species

The summary of potential species present and their general habitat preference is provided by the previous herpetofauna survey (Boffa Miskell Ltd, 2018) and is provided below:

> "Threat classifications and common names follow Hitchmough et al. (2016) for lizard species and Newman et al. (2013) for frog species. Habitat descriptions are summarised to describe likely habitats within the survey area – many species have wider habitat preferences, such as coastal areas, which do not occur within the survey area.

Three native lizard species have been detected within the MGSR[1] (which occurs both sides of the Manawatū River through the Manawatū Gorge). They are:

Barking gecko (*Naultinus punctatus*) – At risk – declining.

> A diurnal arboreal species which lives in forest and scrub. Generally, found amongst foliage in the canopy.

Ngahere gecko (*Mokopirirakau* "southern North Island") – At risk – declining.

> A nocturnal (although often discovered basking during the day) arboreal species which lives in forest and scrubland. Generally, found on trunks and branches of trees and can be found nearer the ground in shrubs, ferns, and crevices.

Raukawa gecko (*Woodworthia maculatus*) – Not threatened

> A nocturnal arboreal and terrestrial species that can occur in forest, creviced rock outcrops, scree slopes, scrubby areas, and in any dense vegetation.

Additional to the above species, within 15km of the proposed designation footprint there are records of:

Pacific gecko (*Dactylocnemis pacificus*) – At risk – relict.

> A nocturnal arboreal and terrestrial species with similar habitat requirements to above common gecko. In southern North Island most often found in hill country forest.

Glossy brown skink (*Oligosoma zelandicum*) – At risk – declining.

> A secretive diurnal terrestrial species found in damp lowland areas such as forest, scrub, and farmland.

Ornate skink (*Oligosoma ornatum*) – At risk – declining.

> A very secretive crepuscular species which lives in forest or open areas that provide stable cover such as deep leaf litter or rock piles. This species seldom emerges from cover.

Northern grass skink (*Oligosoma polychroma*) – Not threatened.

> A diurnal species which inhabits grasslands, rock piles, scree, wetlands and scrub. Often seen basking.

No further species of extant[2] native species had been previously detected within 40km of the designations footprint.

Also recorded within the wider area are:

- Several records of unidentified gecko species (some attribute genus only to records).
- One record of unidentified frog species in the northern end of the Tararua range.

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[1] The quoted text here refers to previous surveys undertaken in the area, which were not associated with the Project.

[2] There are bone records of the extinct Markham's frog (*Leiopelma markhami*) located in this wider area.

- Records of three non-native frog species; brown tree frog (*Litoria ewingii*), growling grass frog (*Ranoidea raniformis*), and green and golden bell frog (*R. aurea*).”

The nocturnal visual encounter survey carried out a total of 9.16 person hours of survey effort across 6 different representative areas across the designation and nearby (descriptions and maps of areas surveyed are provided by Boffa Miskell Ltd (2018) in Section 3.3.2 and Appendix 6.B.1 of the report). No lizards were found but weather was an issue in two out of three nights surveying. The survey concluded that “*The habitats along the corridor had high value for native lizards and generally have good connectivity to the MGSR which has previous confirmed detections of several native lizard species and could act as a source of lizards into regenerating scrubland*.”

The report also acknowledged New Zealand lizards are difficult to detect, and that despite the non-detection within the nocturnal surveys it is very likely At-risk lizard species occur within the Project corridor. We agree with this assessment and consider it very likely the species previously detected within the MGSR (barking gecko and ngahere gecko) would be present within the Project corridor.

6.B.3.2 Terrestrial Invertebrates

6.B.3.2.1 Habitat

Desktop review of aerial photography, previous site photos and descriptions in surveys for herpetofauna, bats, and birds showed the presence of several potentially high-quality habitats for terrestrial invertebrates near the Project corridor. These include:

- older regenerating secondary forest which has achieved canopy closure in the eastern rise section (Ch 9900-12800) of the Project corridor;
- mature forest in the western rise section (Ch 4100 – 5900) of the corridor; and
- the MGSR.

6.B.3.2.2 Species

The desktop review of available information regarding terrestrial invertebrates within or near to the Project corridor found little to no information regarding the presence of at-risk or threatened invertebrates. The only reference to rare or threatened species potentially present was a rare large Carabid beetle (*Megadromus turgidiceps*) - not classified (Leschen et al., 2012) found in the MGSR (“Into the Gorge,” 2008).

During the nocturnal herpetofauna surveys, two phasmid species were noted:

- common stick insect (*Clitarchus hookeri*) which was common amongst kānuka scrub across the corridor; and
- occasionally, an *Acanthoxyla* sp. was observed (Figure 6.B.2).

Both the common stick insect and all of the described *Acanthoxyla* sp. are not threatened (Buckley, Hitchmough, Rolfe, & Stringer, 2016).

Wellington tree weta (*Hemideina crassidens*) were also found to be common in more intact and established forest patches along the corridor (per. obs.). It is possible that Auckland tree weta (*Hemideina thoracica*) are also present as the corridor is within an area of potential overlap of both species (Trewick & Morgan-Richards, 1995). However, none were noted during the survey[3]. Both tree weta species are not threatened (Trewick, Johns, Hitchmough, Rolfe, & Stringer, 2016).

The MGSR also contains Onchyphora (peripatus) within the species complex of *Peripatoides novaezealandiae* (identified by lack of ovipositor, 15 pairs of legs, and colour – Not threatened (Trewick, Hitchmough, Rolfe, & Stringer, 2018)) (pers. Obs. found in 29-8-2010) (Figure 6.B.1).

Figure 6.B.1: Peripatoides novaezealandiae found previously in the Manawatū Gorge. Photo taken 29-08-2010.

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[3] The nocturnal herpetofauna survey did not focus on invertebrates and these observations are incidental only.

Figure 6.B.2: An Acanthoxyla sp. observed along the proposed designation near the Manawatū Gorge during nocturnal herpetological surveys - March 2018.

6.B.3.3 Bats

6.B.3.3.1 Bat Habitat

The previous bat survey report identifies that there are trees present within the Project corridor that have potential roost cavities (large tawa forest specifically identified within the report) (Kessels & Associates Ltd, 2018). The Kessels report also suggests that the high wind levels in the Manawatū Gorge could be a barrier to long-tailed bat use of the site.

Desktop review of aerial photography, previous site photos and descriptions in surveys for herpetofauna and birds showed the presence of several potentially high-quality habitats for bats within the corridor and across the wider landscape. These include riparian and forest edge habitats in gullies, with nearby mature forest feature providing potential roosting sites. There is also a significant mature broadleaved forest and pasture edge along the MGSR boundary on the southern side of the corridor.

6.B.3.3.2 Species

The bioacoustics survey carried out by Kessels & Associates Ltd (2018) did not detect long-tailed bats over 1431 effective survey hours from 27 February to 13 March 2018. The survey report concluded:

- there was no suitable habitat for the central lesser short-tailed bat (*Mystacina tuberculata rhyacobi*) along the Project corridor; and
- while the presence of the threatened – nationally critical (C. F. J. O'Donnell et al., 2018) long-tailed bat (*Chalinolobus tuberculatus*) could not be ruled out, there is low possibility of their presence within the Project corridor.

The closest known populations of long-tailed bat are listed within the Kessels report as Tararua Forest Park to the south (the northern extent of forest contiguous with the Tararua Forest park is within 13km of the southernmost point of the Project corridor), the Ruahine Forest Park to the north (the southern extent of the Ruahine Forest park is within 5km of the northern most point of the Project corridor) and in forested areas approximately 40 km to the south-east.

6.B.3.4 Avifauna

6.B.3.4.1 Avifauna Habitat

During the previous survey, the highest value habitats identified for indigenous and notable bird species included wetlands, indigenous vegetation, including tawa forest and forested gullies and riparian margins of the Manawatū River (Kessels & Associates Ltd, 2018). The Manawatū River is considered a riparian site of significance for banded dotterel and black-fronted dotterel (Horizons Regional Council, 2007).

The designation corridor is very close to the MGSR, which is a large, contiguous, area of remnant and regenerating podocarp-broadleaved (Boffa Miskell Ltd, n.d.). Most of this reserve lies on the south side of the Manawatū River (the Project corridor is to the north of the Manawatū River). This area provides habitat for a diversity of bird species; two At Risk species, North Island rifleman and North Island kākā have occasionally been recorded in the reserve (Boffa Miskell Ltd, 2003).

Bolton Bush is a QEII covenanted area of indigenous vegetation that is within the western rise section of the Project corridor, between approximately Ch 5500 to Ch 5900. The covenanted area is 7.3 ha in size and has regionally representative forest that is in good condition. The covenanted land contains vegetation similar to that of MGSR (Boffa Miskell Ltd, 2003) and is contiguous with the Reserve.

6.B.3.4.2 Species

6.B.3.4.2.1 Kessels & Associates Ltd Survey

An avifauna survey was conducted by ecologists from Kessels & Associates Ltd between 26 February and 13 March 2018 as part of the previous ecological work conducted within and near the Project corridor.[4]

Thirteen 5-minute bird counts were conducted within different habitat types at ten locations across the corridor. Five automatic recording devices (ARDs) were also set up in different habitats and were set to record all sounds from before sunset until after sunrise (5 pm and 9 am) for 14to 15 consecutive nights (800 hours were recorded and analysed using Raven Pro 1.5.0 software developed by Cornell Lab of Ornithology Bioacoustics Research Programme) (Figure 6.B.3). A roaming inventory was also compiled of all bird species seen and heard

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[4] At that time the corridor was in the same location as the current Project corridor but was wider.

outside of the formal 5-minute count periods. During these surveys, 32 species were recorded, including 17 indigenous species and 15 introduced species.

The most commonly recorded species were magpie, fantail, blackbird, goldfinch, house sparrow, grey warbler, silvereye, harrier hawk and tūī.

The highest species diversity was recorded at:

- the raupō wetland site (KB21/KA6 site in Figure 6.B.3; 22 species were recorded);
- the pond site that was surrounded by pasture, pine forest and indigenous vegetation (KB10/KS19 site in Figure 6.B.3; 22 species were recorded); and
- the Manawatū River site (KB33/KA14 site in Figure 6.B.3; 21 species were recorded).

The highest numbers of native species were recorded at the Manawatū River site and the pond site.

No Threatened species were detected. One At Risk species, the New Zealand falcon, was detected. Four other At Risk or Threatened species not detected but that could occasionally be present within the Project corridor were noted: North Island kākā, spotless crake, banded dotterel and black-fronted dotterel.

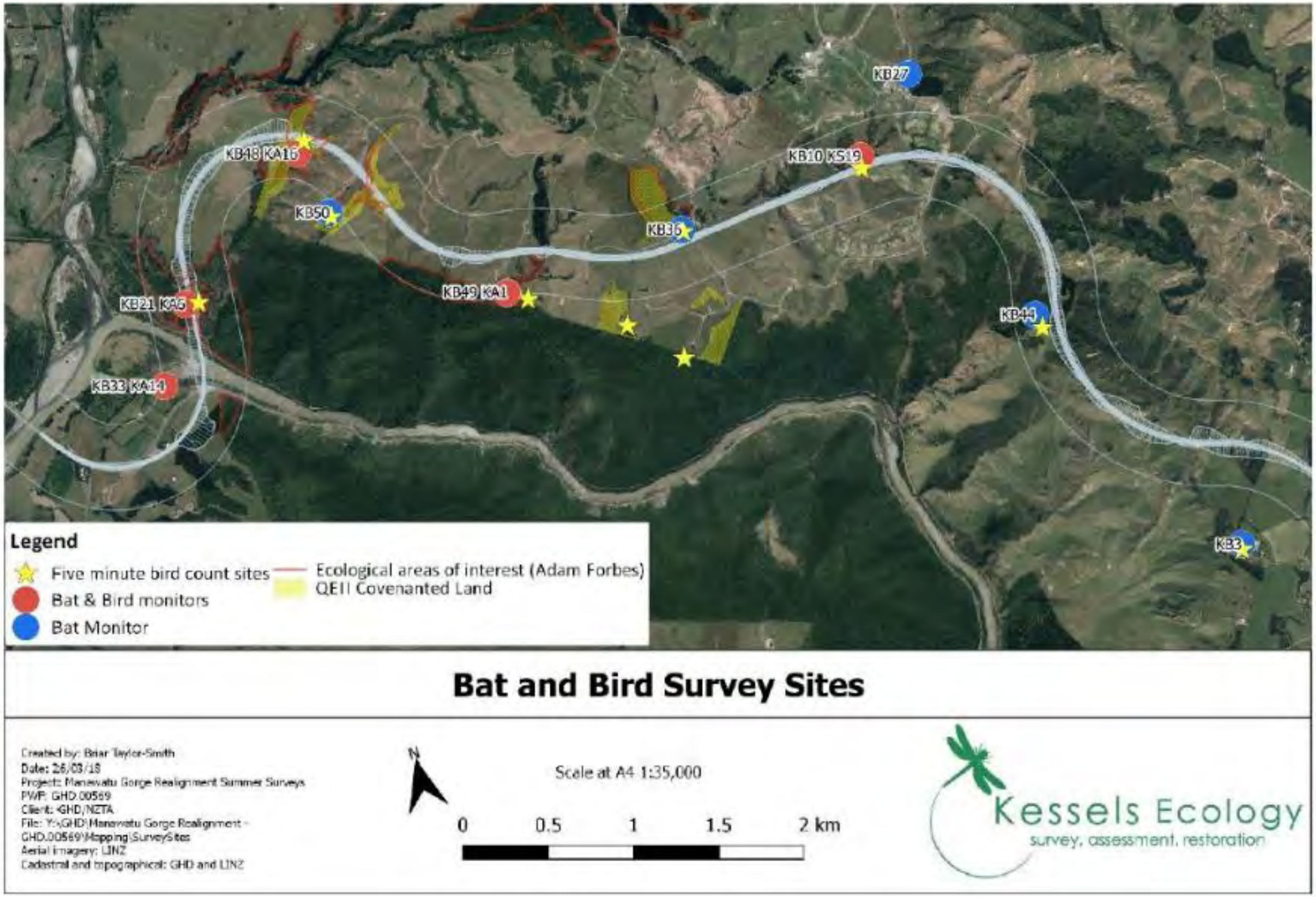

Figure 6.B.3. Five minute bird count and acoustic recording device deployment sites throughout the original designation corridor (Kessels & Associates Ltd, 2018)

6.B.3.4.2.2 Te Apiti Wind Farm Surveys

Comprehensive avifauna surveys have also been conducted within the Te Āpiti wind farm site (which encompasses approximately 4.4 km of the Project corridor between approximately Ch 5550 and 9900). These surveys were conducted for the baseline ecological assessment for wind farm consenting purposes (Boffa Miskell Ltd, 2003), and for post-construction monitoring of avifauna mortality (Boffa Miskell Ltd & Golder Associates, 2009).

During the 2003 baseline ecological survey 25 bird species were recorded within the wind farm footprint. No At Risk or Threatened bird species were observed. Although not recorded at the site, a number of vagrant species are reported that may use habitats on site from time to time such as North Island kākā, bush falcon, North Island rifleman, grey teal and Australasian shoveler. It was also speculated that some wetland bird species such as marsh crake, Australasian bittern and New Zealand dabchick, which are known to occur in the Manawatū area, may pass through the Saddle Road site as they move seasonally between wetlands on either side of the ranges. It is noted though, that perhaps these migratory bird species would be more likely to use the Manawatū Gorge and river terraces as their migratory route (Boffa Miskell Ltd, 2003).

During the mortality survey 31 bird species were recorded within the wind farm footprint, including three At Risk species (New Zealand pipit (30 observations), black shag (two observations of birds flying overhead) and New Zealand falcon (2 observations of birds flying overhead). The most commonly observed birds were Australian magpie, paradise shelduck, spur-winged plover and Australasian harrier hawk (Boffa Miskell Ltd & Golder Associates, 2009).

6.B.3.4.2.3 Other Literature

In addition to the 40 species recorded during other survey work within the area (the aforementioned Kessels Ecology survey and surveys associated with the Te Āpiti wind farm), 29 other species were also identified in the review of other relevant literature (e.g. NatureWatch, eBird, published and unpublished reports, the OSNZ atlas data (refer to Appendix 6.B.3 for the OSNZ atlas grid square locations)) that may potentially use habitats within the Project corridor and/or the wider surrounding area.

These 69 species, of which 45 are native and 24 are introduced (Table 6.B.6 in Section 4.4.1), provide an indication of species that have been recorded using habitat within the Project corridor, or which may potentially do so (e.g. some species have been observed in the MGSR and, given that this area is contiguous with areas of the Project corridor, may use this connection to move between sites).

With regards to the OSNZ atlas data, it must be noted that the data were collected by multiple observers over a five year period (1999-2004), from an area of 200 km^2, with no standardisation regarding effort and timing. Therefore, this data provides only a broad indication of species presence or absence.

In Section 4.4.1 below, this base list of 69 species is reviewed and species of interest/key native species that have been observed within the Project corridor, or that may use habitats within the Project corridor, are identified.

6.B.4. Terrestrial fauna habitats – Site Investigations

Chainage (Ch) references relate to those depicted in the maps in Volume 4 of the AEE, Drawings and Plans.

6.B.4.1 Habitat of Herpetofauna

The habitat along the entire designation can be broadly characterised by a pasture dominated matrix with deeply incised gullies containing varying ages of regenerating areas of native broadleaved, fern, and scrub species with commonly present scrubby pest plants such as broom and gorse. Within this matrix there are discrete areas of established tawa forest and areas of remnant canopy trees such as rimu, kahikatea, tītoki, and mataī. Additionally, there are discrete areas of non-native plantation forests and small farm ponds with surrounding native and non-native vegetation.

Habitat characterisation, based on previous field surveys (Boffa Miskell Ltd, 2018) with further updates and refinement from site walkover for this report, is detailed below.

6.B.4.1.1 Bridge to bridge area. Ch 2500 – 3800.

Within the area of Ch 3400-3800 a large area of felled pine trees exists leaving a large amount of wood debris (aerial images show these pines still standing). There are also young native plantings and older dense roadside vegetation in this area. The area is connected to the MGSR and provides habitat that would allow terrestrial skinks or geckos on the edge of the reserve, which could spill over into these areas (Figure 6.B.4).

Figure 6.B.4: MGSR walk carpark showing felled pine forest in background and native plantings and scrubby vegetation in the foreground.

6.B.4.1.2 New Manawatū River Crossing. Ch 3800 – 4100.

Riverbank vegetation on the true left side of the Manawatū River has similar indigenous habitat condition and values to those described in the above section 6.B.4.1.1. The true right side of the river is densely vegetated with native trees and shrubs and connected to the MGSR and secondary and old growth forests further up the gully. It contains a diverse and high-quality range of habitats suitable for native lizards.

6.B.4.1.3 Western Rise. Ch 4100 – 5900.

Habitat within the area of Ch 4100-4500 consists of predominately grazed mature forest dominated by tawa, māhoe, pukatea, and mataī with little understory, interspersed with areas of kānuka and low stature divaricate *Coprosma* shrubs which is highly impacted by grazing stock on the western side of the Project corridor (Figure 6.B.5 & Figure 6.B.6). The eastern side of the Project corridor in this area consists of a large area of large kānuka, with occasional large canopy trees (of tawa, māhoe, pukatea, and mataī) and a large area of raupō on a terrace above the stream (Figure 6.B.7 & Figure 6.B.8).

Both the west and east side of the Project corridor contain relatively diverse habitats suitable for native lizards, and are relatively contiguous with the MGSR (a source of lizards).

At Ch 5500 to 5900 the corridor crosses an incised gully with established tawa forest on the western side of the gully and secondary broadleaved and kānuka forest on the eastern side of the gully (Figure 6.B.9). The established tawa forest contains large emergent canopy trees with complex epiphyte habitats (Figure 6.B.10). This area is continuous with the MGSR and contains a diverse and high-quality range of habitats suitable for native lizards.

Figure 6.B.5: Area of established canopy trees with interspersed kānuka and divaricate shrubs in western rise area (west side) of Project corridor.

Figure 6.B.6: Area of established canopy trees with limited understory of divaricate Coprosma shrubs in western rise area (west side) of Project corridor.

Figure 6.B.7: Large kānuka with patches of raupō in western rise area (east side).

Figure 6.B.8: Large area of Raupō surrounded by large kānuka in western rise area (east side) of Project corridor. Located South of area depicted in Figure 6.B.7.

Figure 6.B.9: Established tawa forest (background) and secondary broadleaved forest (foreground) at point of corridor crossing gully in western rise area.

Figure 6.B.10: Emergent rewarewa in established tawa forest with complex epiphyte habitat in western rise area.

6.B.4.1.4 Western access designation - ~Ch4700 – North

Extending north from approximately CH4700 a proposed access road follows the designation of an existing farm track towards Saddle Road. Habitats available in this area are restricted primarily to grazed pasture with a small amount of kānuka near the stream crossing; beyond this there is non-native vegetation along the flat and kānuka occurring again as the track nears Saddle Road.

This area contains relatively small amount of habitats suitable for native lizards.

6.B.4.1.5 Te Āpiti Wind Farm and ridge. Ch 5900 - 9900.

A large gully dominated by kānuka scrub with scattered broadleaved and emergent larger rewarewa is crossed at Ch 6000-6400. Mature kānuka occurs mostly at the gully bottom with younger kānuka occurring up the gully sides (Figure 6.B.11). Habitat is diverse and connected to the MGSR and would provide high value habitat to native lizards potentially present at site.

The corridor crosses another gully at Ch 6700-7000. This area has limited kānuka scrub in the gully bottom with scattered larger trees (Figure 6.B.12). Connectivity to MGSR is patchy with short grazed pasture predominant ground cover. There is limited habitat diversity and high disturbance from grazing in this area. However, barking gecko may be present in scrub as a small remnant population or individuals.

A further gully crossing occurs at Ch 7200-7400. Within the gully at this point is kānuka broadleaved regenerating forest. Stock grazing impacts are high, and the understory is dominated by grazed pasture grasses (Figure 6.B.13). Habitat is connected and, in the area the corridor crosses the gully, is relatively close to the MGSR. Incidental individual lizards may be present, but this area is unlikely to support large populations.

Figure 6.B.11: Gully of kānuka and broadleaved regenerating forest. Approximately Ch 6000 to 6400.

Figure 6.B.12: Limited kānuka scrub and canopy trees in cross over point of corridor. Looking from approximately Ch 6700 to 7100.

Figure 6.B.13: Gully area at Ch 7200-7400 with kānuka- broadleaved regenerating forest.

Along the top of the corridor within a gully running east-west from Ch 8800 to 9900 is an area of predominately pasture with highly disturbed and grazing impacted short statured divaricate *Coprosma* on the southern side of the corridor (Figure 6.B.14 & Figure 6.B.15), and a farm pond with kānuka scrub and scattered broad leaf species on the pond margins. Additionally, along this section there are discrete patches of exotic pine trees. This area is relatively disconnected from the MGSR and has high grazing impacts, low habitat diversity, high habitat complexity, and predominately low stature. However, the lizards potentially present such as northern grass skink and barking gecko can be found within these types of disturbed habitats, and exotic frog species could potentially be found in the pond.

Figure 6.B.14: Highly disturbed and grazing impacted stream side vegetation at approximately Ch 9100.

Figure 6.B.15: Low stature divaricate Coprosma vegetation amongst grazed pasture.

6.B.4.1.6 Eastern Rise. Ch 9900-12800

As the corridor starts to drop into the eastern rise section, it traverses a patch of kānuka scrub and fern dominated secondary vegetation at Ch 9900-10000 (Figure 6.B.16). There is some habitat potential for arboreal species, but little refugia for others. Northern grass skink and glossy brown skink may be able to utilise small patches of denser vegetation on the edge or areas where stock cannot access.

In the area of Ch 10100 to 10300 the Project passes through a small area of wet pasture with patchy sedges and rushes in a seep with kānuka scrub surrounding the seep (Figure 6.B.17). This area contains potential habitat for barking gecko and the northern grass skink. There is sparse connectivity to the MGSR along fragmented scrub and secondary forest. The presence of these two species beyond potentially isolated individuals at this location is unlikely due to the young age and lack of connectivity of the vegetation.

At Ch 10500 to 10700 the Project corridor crosses the head of a secondary broadleaved dominated gully (Figure 6.B.18). The vegetation within this gully has little grazing impacts and has a relatively diverse ground cover flora. Habitats range from divaricate *Coprosma* and broom on the edge, and kiekie and fern understory, providing high value habitat for all the potentially present lizards species at this location.

Figure 6.B.16: Kānuka and fern dominated secondary vegetation at Ch 9900-10000.

Figure 6.B.17: Rush and sedges in seep with Kānuka scrub surrounding at approximately Ch 10200.

Figure 6.B.18: Looking down potentially impacted gully of secondary broadleaved forest. Ch 10500-10700.

A pine forest stand is located from Ch 10900 to 11000 (Figure 6.B.19). The plantation is relatively young and contains little habitat value to lizards.

Figure 6.B.19: Immature pine plantation at Ch 10900 to 11000

Adjacent to these pines on the eastern side of the Project corridor there is an area of kānuka/divaricate Coprosma scrub and regenerating broadleaved/fern forest. This area is contiguous with a large regenerating secondary broadleaved and fern forest (Figure 6.B.20) that connects to the Manawatū Scenic Reserve. This fragment provides habitat complexity and habitat diversity suitable for all the lizard species potentially present in the Project corridor.

Figure 6.B.20: Large area of regenerating secondary broadleaved and fern forest with kānuka and divaricate Coprosma scrub. Photo taken of contiguous area to the north of the affected area at Ch 11000.

From Ch 11000 to 11900 the corridor descends the western side of the range through a large area of secondary broadleaved forest (Figure 6.B.21). This regenerating forest gives way to gorse/broom scrub from Ch 11900 to 12300. The corridor between Ch 11900 and 12200 progresses to the southwest of the forested/scrub gully, continuing through the forested and scrubby area. All of these areas, other than short grazed pasture, may contain all of the potentially present lizard species.

Figure 6.B.21: Regenerating broadleaved forest on eastern rise. Photo looking towards face directly impacted by designation.

As the corridor reaches the bottom of the eastern slope it passes over a small immature pine forest plantation (Ch 12500- 12700) with blackberry as the primary ground cover (Figure 6.B.22). This area provides limited value to lizards that prefer arboreal and forest habitats, but the highly complex blackberry ground cover could be utilised by glossy brown skink and northern grass skink.

Figure 6.B.22: Immature pine plantation with blackberry understory (between 12500-12700).

6.B.4.1.7 Woodville gateway. Ch 12800 - 14000

The eastern end of the corridor passes over predominately cropped and grazed pasture with little habitat complexity. Potential habitat is limited to a small area of pine trees at Ch 12900, which has a grazed and relatively bare understory. This entire section has little to no habitat value and is unsuitable for the lizard species.

6.B.4.2 Terrestrial Invertebrates

Habitat descriptions provided within this section are for the most part brief summaries of the habitat descriptions provided within Section 6.B.4.1 for Herpetofauna. That section should be referred to for more general detail. Information is only detailed within this section when specifically required to provide context for attributed ecological value with regards to terrestrial invertebrates.

6.B.4.2.1 Bridge to bridge area. Ch 2500 – 3800.

Habitats within this area are characterised by small areas of planted (young) native vegetation near the Manawatū River, a small area of cutover pine forest, and large areas of grazed pasture.

6.B.4.2.2 New Manawatū River Crossing. Ch 3800 – 4100.

Riverbank vegetation on either side of the Manawatū River with similar habitat attributes for terrestrial invertebrates to those described for the previous and later sections to this crossing. Flooding and disturbance may be a limitation on this area for terrestrial invertebrates.

6.B.4.2.3 Western Rise. Ch 4100 – 5900.

The area of grazed mature forest, scrub, and raupō wetland on the east and west side of the corridor at Ch 4100-4500 contains limited ground cover beyond grazing tolerant *Coprosma* shrubs and small areas of ferns where stock cannot access (ref; Figure 6.B.5, Figure 6.B.6 and Figure 6.B.7).

The established tawa forest at Ch 5500 to 5900 contains a diversity of ground cover habitats as well as epiphytes (Figure 6.B.10). Like the area described above it is also well connected to the MGSR.

6.B.4.2.1 Western access designation - ~Ch4700 – North

Area predominately grazed pasture with small amounts of kānuka present. Little to no habitat attributes of value for terrestrial invertebrates.

6.B.4.2.2 Te Apiti Wind Farm and ridge. Ch 5900 - 9900.

The two regenerating forest areas of kānuka and broadleaved at Ch 6000-6400 and 7200-7400 (Figure 6.B.11 & Figure 6.B.13) contain very little habitat complexity and underdeveloped sub-canopy or groundcover.

The rest of the features described within this section are habitats that have little habitat attributes for terrestrial invertebrates.

6.B.4.2.3 Eastern Rise. Ch 9900-12800

The more mature and intact secondary forest patches in the areas of Ch 10500-10700 and 11000 to 11900 have little grazing pressure beyond the edges, good canopy closure, and a developing ground cover flora with small amounts of leaf litter and woody debris (Figure 6.B.23). They do not have direct connection to a large established forest, however they lie within a landscape of multiple areas of regenerating forest.

The rest of the habitats described in this section of the corridor are all either highly disturbed and dominated by pest plants, or lack understory habitats.

Figure 6.B.23: Understory showing canopy closure and developing ground cover flora and habitat in forest patch located at Ch 11000 to 11900.

6.B.4.2.4 Woodville gateway. Ch 12800 - 14000

Limited to no, habitat for indigenous terrestrial invertebrates beyond grazed pasture.

6.B.4.3 Bats

6.B.4.3.1 Habitat suitability

The landscape the Project corridor falls within contains many habitat features that are suitable and preferred by long-tailed bats such as forest edges, riparian gullies, and open space habitats between forest patches.

Particularly high quality potential habitat was found in the western rise section within the gully system that contains established tawa forest at its northern end and a matrix of open, wetland, scrub, riparian, and large tree habitats at the Manawatū River end of the gully. This gully also terminates in Manawatū Gorge, which would allow foraging and commuting through to the MGSR forest habitats. This area is also largely protected from the strong prevailing westerly wind in the area, if this is a limiting factor for bat presence as noted by the Kessels report (Kessels & Associates Ltd, 2018).

The rest of the corridor may be utilised by long-tailed bats flying through gullies or forested edges for foraging or commuting, such as the northern edge of the MGSR in the Te Āpiti Wind Farm and ridge section and edges of pine forest in the eastern rise section.

Overall, the habitat quality within the Project corridor is highest at the western end with a full suite of preferred habitat features and potential roost sites. The rest of the corridor has potential habitat predominately consisting of edge habitats suitable for foraging and commuting.

6.B.4.3.2 Potential roost sites

The designation contains three potential roost types/localities:

- Large native canopy trees and established tawa forest which contain a mixture of loose bark (large kānuka in area), epiphytes, and cavities in the western rise section (example shown in Figure 6.B.10). Most large trees observed are likely to be suitable for solitary roosts. However, the potential for maternity roosts could not be ruled out without a comprehensive survey and monitoring.
- Large pine trees located at Ch 10500-10600 and 9600-9900, and a deciduous exotic tree at 12000, which contained limited roost features such as broken branches and some cavities (Figure 6.B.24). However, these trees are on ridgelines exposed to the prevailing strong westerly wind and may have unsuitable thermal characteristics for roosting.
- Large secondary broadleaved forest patches which, while lacking large trees, do have large numbers of tree ferns, and in the western area nīkau palms, which long-tailed bats could utilise as solitary roosts by roosting amongst the crowns of the ferns/palms.

Other potential roosts surveyed such as the pine forest plantations along the corridor and isolated native tree species were generally too young to have potential roost features and none were visible at the time of the survey (ref Figure 6.B.19 & Figure 6.B.22 for pine plantations).

No signs of bat presence were observed such as staining or scratch marks around cavities. However, this is not usual even in areas of frequent bat roosting and should not be considered an indication of the absence of long-tailed bats.

Figure 6.B.24: Old pine trees with broken branches and small cavities. Photo taken approximately Ch 9700.

6.B.4.4 Avifauna

During the current avifauna survey 32 avifauna species, comprising 17 indigenous species, 14 introduced species and one hybrid species were recorded within the Project corridor (Table 6.B.6). Two species are classified as At Risk (bush falcon and New Zealand pipit).

One Threatened species (Caspian tern) and two At Risk species (banded dotterel and black shag) were also observed using shingle/gravel bed habitat on the Manawatū River approximately 600m downstream of similar habitat (~Ch 3900) where the Manawatū River is proposed to be crossed within the Project corridor.

Our field survey did not identify any new species in the corridor that had not been recorded in the literature or previous surveys. We therefore consider the 45 native species and 24 introduced bird species listed in the OSNZ atlas and in other sources (predominantly the previous field work conducted on site) to represent the full suite of birds potentially present within the Project corridor (Table 6.B.6).

Table 6.B.6. Bird species recorded within the Project corridor or within 200 sq km of the corridor based on the literature review and surveys conducted at the site (including the current survey, the Te Āpiti wind farm AEE and mortality survey and the Kessels & Associates Ltd survey). Conservation status and habitat preferences are included for each species. Primary habitat/s is indicated by dark green shading and secondary habitat/s is indicated by light green shading.

SPECIES – Robertson et al. 2012	**SCIENTIFIC NAME**	**CONSERVATION STATUS Robertson et al 2017**	**HABITAT TYPE**								**SURVEY OBS.**	
			Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Oceanic	Urban/Residential	Current Survey	Other Surveys on Site
Australasian bittern	*Botaurus poiciloptilus*	Threatened – Nat. Crit.					■	▨				
White heron	*Ardea modesta*	Threatened – Nat. Crit.					■	▨				
Grey duck	*Anas s. superciliosa*	Threatened – Nat. Crit.				▨	■					
Black-billed gull	*Larus bulleri*	Threatened – Nat. Crit.				▨	■	▨				
Banded dotterel	*Charadrius bicinctus bicinctus*	Threatened – Nat. Vul.					▨	■				
Caspian tern	*Hydroprogne caspia*	Threatened – Nat. Vul.					▨	■			✓	
Red-billed gull	*Larus novaehollandiae scopulinus*	At Risk – Dec.				▨	▨	■				
Whitehead	*Mohoua albicilla*	At Risk – Dec.	■	▨	▨							
Spotless crake	*Porzana t. tabuensis*	At Risk – Dec.					■	▨				
New Zealand pipit	*Anthus n. novaeseelandiae*	At Risk – Dec.				■	▨	▨			✓	✓
North Island rifleman	*Acanthisitta chloris*	At Risk – Dec.	■	▨	▨							
South Island pied oystercatcher	*Haematopus finschi*	At Risk – Dec.				▨	■	▨				
Marsh crake	*Porzana pusilla affinis*	At Risk – Dec.					■	▨				
New Zealand dabchick	*Poliocephalus rufopectus*	At Risk – Rec.					■					
North Island kaka	*Nestor meridionalis septentrionalis*	At Risk – Rec.	■	▨								
Bush falcon	*Falco novaeseelandiae*	At Risk – Rec.	■	▨	▨						✓	✓
Pied shag	*Phalacrocorax varius varius*	At Risk – Rec.					■	▨				
Black shag	*Phalacrocorax carbo novaehollandiae*	At Risk – Nat. Unc.					■	▨				✓
Little black shag	*Phalacrocorax sulcirostris*	At Risk – Nat. Unc.					■	▨				
Black-fronted dotterel	*Charadrius melanops*	At Risk – Nat. Unc.				▨	■	▨				
Royal spoonbill	*Platalea regia*	At Risk – Nat. Unc.					▨	■				
Australian coot	*Fulica atra australis*	At Risk – Nat. Unc.				▨	■	▨				
Australasian pied stilt	*Himantopus h. leucocephalus*	Not Threatened					■	▨				
Little shag	*Phalacrocorax melanoleucos brevirostris*	Not Threatened					■	▨				
White-faced heron	*Egretta novaehollandiae*	Not Threatened				▨	▨	■			✓	✓

Black swan	*Cygnus atratus*	Not Threatened				▨	🟩	▨				
Paradise shelduck	*Tadorna variegata*	Not Threatened				▨	🟩				✓	✓
Grey teal	*Anas gracilis*	Not Threatened				▨	🟩	▨				✓
Australasian harrier	*Circus approximans*	Not Threatened				🟩					✓	✓
Pukeko	*Porphyrio m. melanotus*	Not Threatened				▨	🟩				✓	✓
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened				🟩	▨				✓	✓
Southern black-backed gull	*Larus d. dominicanus*	Not Threatened				▨		🟩			✓	✓
Morepork	*Ninox n. novaeseelandiae*	Not Threatened	🟩	▨	▨	▨						✓
New Zealand scaup	*Aythya novaeseelandiae*	Not Threatened					🟩	▨				
Kereru	*Hemiphaga novaeseelandiae*	Not Threatened	🟩		▨						✓	✓
Shining cuckoo	*Chrysococcyx l. lucidus*	Not Threatened	🟩		▨							✓
New Zealand kingfisher	*Todiramphus sanctus vagans*	Not Threatened	🟩		▨	▨	🟩				✓	✓
Welcome swallow	*Hirundo n. neoxena*	Not Threatened				🟩	░				✓	✓
Grey warbler	*Gerygone igata*	Not Threatened	▨	▨	🟩					▨	✓	✓
North Island fantail	*Rhipidura fuliginosa placabilis*	Not Threatened	🟩	▨	▨					▨	✓	✓
North Island tomtit	*Petroica macrocephala toitoi*	Not Threatened	🟩	▨	▨							
Silvereye	*Zosterops lateralis lateralis*	Not Threatened	▨	▨	🟩					▨	✓	✓
Bellbird	*Anthornis m. melanura*	Not Threatened	🟩	▨	▨					▨	✓	✓
Tui	*Prosthemadera n. novaeseelandiae*	Not Threatened	🟩		▨						✓	✓
New Zealand shoveler	*Anas rhynchotis variegata*	Not Threatened					🟩	▨			✓	✓
Yellowhammer	*Emberiza citrinella*	Introduced			▨	🟩					✓	✓
Chaffinch	*Fringilla coelebs*	Introduced	▨	▨	▨	🟩				▨	✓	✓
Greenfinch	*Carduelis chloris*	Introduced		▨	▨	🟩				▨	✓	✓
Goldfinch	*Carduelis carduelis*	Introduced			▨	🟩				▨	✓	✓
Redpoll	*Carduelis flammea*	Introduced			▨	🟩				▨		✓
House sparrow	*Passer domesticus*	Introduced				🟩				▨	✓	✓
Starling	*Sturnus vulgaris*	Introduced				🟩				▨	✓	✓
Myna	*Acridotheres tristis*	Introduced				🟩				▨		✓
Australian magpie	*Gymnorhina tibicen*	Introduced		▨		🟩				▨	✓	✓
Rook	*Corvus frugilegus*	Introduced		▨		🟩						✓
Feral goose	*Anser anser*	Introduced				▨	🟩	▨				
Mallard duck	*Anas platyrhynchos*	Introduced				▨	🟩				✓	✓
Feral turkey	*Meleagris gallopavo*	Introduced				🟩					✓	✓
Rock pigeon	*Columba livia*	Introduced				▨				🟩		
Eastern rosella	*Platycercus eximius*	Introduced	▨	▨	🟩						✓	✓
Skylark	*Alauda arvensis*	Introduced				🟩					✓	✓
Hedge sparrow	*Prunella modularis*	Introduced	▨	▨	▨	🟩				▨		✓
Blackbird	*Turdus merula*	Introduced	▨	▨	🟩	▨				▨	✓	✓
Song thrush	*Turdus philomelos*	Introduced	▨	▨	▨	🟩				▨	✓	✓
Canada goose	*Branta canadensis*	Introduced				🟩	▨	▨				✓

Ring-necked pheasant	*Phasianus colchicus*	Introduced			🟩							✓
Mute swan	*Cygnus atratus*	Introduced				▨	🟩	▨				
California quail	*Callipepla californica*	Introduced			🟩	▨						
Cattle egret	*Ardea ibis coromanda*	Migrant				🟩	▨					

6.B.4.4.1 Identification of Key Native Species

We have considered the 24 introduced species recorded locally (Table 6.B.6), and none are believed to make an important contribution to the local ecology or local biodiversity. They are therefore not considered further.

Of the 45 native species observed or potentially present at the site or wider area (based on the literature review), 23 are Not Threatened. With respect to an effects assessment these species are considered to have Low Ecological Value as they are common and widespread species. Given that the Project corridor does not provide crucial habitat for any of these species and there is ample suitable habitat available in the wider area that these mobile species can use if displaced (i.e. surrounding farmland, scrub/shrub habitats, ponds and forest and gully habitats (including the MGSR)). Furthermore, any potential effects on these species will not occur at a population level (i.e. individuals may be affected but this will not have a negative impact on the population). Consequently, these species are not considered further in this assessment.

Of the remaining 22 native species, 6 are Threatened (Australasian bittern, Caspian tern, white heron, grey duck, banded dotterel and black-billed gull) and 16 have a threat status of At Risk.

Of those 22 species, it is highly unlikely that white heron and royal spoonbill use habitat within the Project corridor (as habitat in the wider 200 km^2 in which they have been detected, is more suitable for these species than that available within the Project corridor). Consequently, these species are not considered further in this assessment. Grey duck is also not considered further, given that the biggest threat to grey duck is hybridisation with mallard ducks rather than human activities, and it is near impossible to identify pure grey ducks without DNA analysis. The Project corridor also does not provide core habitat for this species.

Consequently, it has been determined that the Project corridor is potentially utilised by 19 notable indigenous species for various activities (such as nesting, foraging and/or roosting), including 4 Threatened species and 15 At Risk species (Table 6.B.7). These species are considered to have Very High (Threatened species) or High Ecological Value (At Risk species) and are considered further in this report.

Table 6.B.7.Indigenous bird species with recognised ecological value requiring assessment. With respect to habitat use, F=Foraging, R=Roosting/Resting and N=Nesting.

SPECIES - Robertson et al. 2012	**SCIENTIFIC NAME**	**CONSERVATION STATUS Robertson et al 2017**	**OBSERVED OR POTENTIAL HABITAT USE**	Native forest	Exotic Forest	Scrub / shrubland	Farmland / open country	Freshwater / wetlands	Coastal / Estuary	Oceanic	Urban/Residential
Black-billed gull	*Larus bulleri*	Threatened – Nat. Crit.	R				▨	■	▨		
Australasian bittern	*Botaurus poiciloptilus*	Threatened – Nat. Crit.	F, R					■	▨		
Caspian tern	*Hydroprogne caspia*	Threatened – Nat. Vul.	R					▨	■		
Banded dotterel	*Charadrius bicinctus bicinctus*	Threatened – Nat. Vul.	N, F, R					▨	■		
Red-billed gull	*Larus novaehollandiae scopulinus*	At Risk – Dec.	R				▨	▨	■		
Whitehead	*Mohoua albicilla*	At Risk – Dec.	N, F, R	■	▨	▨					
Spotless crake	*Porzana t. tabuensis*	At Risk – Dec.	F, R					■	▨		
New Zealand pipit	*Anthus n. novaeseelandiae*	At Risk – Dec.	N[5], F, R				■	▨	▨		
North Island rifleman	*Acanthisitta chloris*	At Risk – Dec.	F, R	■	▨	▨					
South Island pied oystercatcher	*Haematopus finschi*	At Risk – Dec.	F, R				▨	■	▨		
Marsh crake	*Porzana pusilla affinis*	At Risk – Dec.	F, R					■	▨		
New Zealand dabchick	*Poliocephalus rufopectus*	At Risk – Rec.	F, R					■			
North Island kākā	*Nestor meridionalis septentrionalis*	At Risk – Rec.	F, R	■	▨						
New Zealand falcon	*Falco novaeseelandiae*	At Risk – Rec.	F, R	■	▨	▨					
Pied shag	*Phalacrocorax varius varius*	At Risk – Rec.	F, R					■	▨		
Australian coot	*Fulica atra australis*	At Risk – Nat. Unc.	F, R				▨	■	▨		
Black shag	*Phalacrocorax carbo novaehollandiae*	At Risk – Nat. Unc.	F, R					■	▨		
Little black shag	*Phalacrocorax sulcirostris*	At Risk – Nat. Unc.	F, R					■	▨		
Black-fronted dotterel	*Charadrius melanops*	At Risk – Nat. Unc.	N, F, R				▨	■	▨		

6.B.4.4.2 Habitat Descriptions

Habitat descriptions provided within this section are for the most part brief summaries of the habitat descriptions provided within Section 6.B.4.1 for Herpetofauna. That section should be referred to for more general detail. Information is only detailed within this section when specifically required to provide context for attributed ecological value with regards to avifauna.

6.B.4.4.2.1 Bridge to bridge area. Ch 2500 – 3800.

The habitats within this area include grazed pasture (dominant), immature, planted native vegetation and an area of cutover pine that is now dominated by weeds. Of the 19 notable species identified above, the habitats within this area might potentially be used by New Zealand

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[5] The pasture habitats within the Project corridor are currently grazed and as such do not provide suitable nesting habitat for pipit. However, if stock are removed and the grass becomes rank (i.e. is not mowed/maintained) this may provide suitable nesting habitat for pipit. As such, potential nesting is noted for this species.

falcon (one was observed in a pine tree within this section during the current field survey) and New Zealand pipit. Both species are likely to forage and roost in the area.

6.B.4.4.2.2 New Manawatū River Crossing. Ch 3800 – 4100.

The habitats within this area include gravel/shingle riverbed habitat, planted, immature native vegetation, regenerating native vegetation and a few exotic trees on the river edge (willows) (Figure 6.B.25 and Figure 6.B.26). No At Risk or Threatened species were observed using the gravel/shingle riverbed habitat within the corridor at the bridge location.

However, of the 19 identified notable species, two Threatened species (banded dotterel and Caspian tern) and one At Risk species (black shag) were observed in very similar gravel/shingle habitat on the Manawatū River downstream of the proposed bridge location. Consequently, it has been assumed that these highly mobile species may also use the habitat within the corridor for foraging, roosting and in the case of banded dotterel, nesting.

Black-fronted dotterel, red-billed gull, black-billed gull, little black shag, pied shag and South Island pied oystercatcher may occasionally also use this habitat for foraging and/or roosting, and in the case of black-fronted dotterel, possibly nesting.

Figure 6.B.25. Manawatū River gravel/shingle riverbed habitat, willows on the northern bank of the river and indigenous vegetation.

Figure 6.B.26. Gravel/shingle riverbed habitat within the designation corridor where the bridge across the Manawatū River is proposed to go.

6.B.4.4.2.3 Western Rise. Ch 4100 – 5900.

The habitats between approximately Ch 4100 to Ch 4500 include mature native forest (with little understory due to stock grazing), regenerating indigenous vegetation (kānuka and low stature divaricate *Coprosma* shrubs) and a raupō-dominated wetland.

The habitat between approximately Ch 5500 to Ch 5900 is indigenous vegetation, including mature forest and secondary forest. This vegetation, known as Bolton Bush, has a QEII covenant.

Within this section there are also areas of grazed pasture.

Of the 19 identified notable species, Australasian bittern, marsh crake and spotless crake may use the raupō wetland habitat between approximately Ch 4130 and Ch 4230 for foraging and roosting (Figure 6.B.27, Figure 6.B.28 and Figure 6.B.29). This habitat is highly grazed, pugged by stock and has very little surface water (the latter factor is required for foraging), however a few more dense areas of raupō are present with occasional large *Carex* species interspersed. Based on these characteristics, the potential of this habitat is considered marginal for these species. It is unlikely to provide suitable nesting habitat.

Figure 6.B.27. The raupō wetland is within the orange polygon.

Figure 6.B.28. A pugged area of the raupō wetland where the raupō is less dense and interspersed with grass.

Figure 6.B.29. A more dense area of the raupō wetland with large Carex species.

North Island kaka, North Island rifleman and whitehead may use the native forest habitats within this section. This section and the Western access designation (discussed below) are the only areas along the Project corridor that has been identified as potentially providing suitable habitat for these species. Bolton Bush is likely to provide better potential habitat than the grazed forest between approximately Ch 4100 and Ch 4500 as it is fenced, contains areas of mature tawa and rewarewa (with a dense and diverse understory) as well as secondary broadleaved and kānuka forest, and is connected to the MGSR so provides a corridor for these species to a very large forest remnant (600 ha).

These species may forage and roost in this habitat. Whitehead may also nest in this area. It is unlikely North Island kākā and rifleman nest in this area; they are more likely to nest in mature trees in the MGSR.

New Zealand falcon may potentially forage within this section. New Zealand pipit may also use the pasture habitat for foraging and roosting.

6.B.4.4.2.4 Western access designation - ~Ch4000 – North

The main habitat in this section is grazed pasture with small amounts of kānuka present. New Zealand falcon may forage within this section. New Zealand pipit may also use the grazed pasture habitat for foraging and roosting.

6.B.4.4.2.5 Te Āpiti Wind Farm and ridge. Ch 5900 - 9900.

The main habitat in this section is grazed pasture. There are a few gullies in this section that are dominated by indigenous scrub (mainly kānuka) with occasional scattered broadleaved and larger emergent rewarewa trees. There are a few small, discrete patches of pine forest in this section as well as two farm ponds between approximately Ch 9200 and Ch 9600. The farm ponds are bordered by pasture, kānuka scrub, scattered, immature broadleaved species and occasional rushes.

New Zealand pipit were observed using the grazed pasture habitat within this section. This section also provides foraging and potentially roosting habitat for New Zealand falcon.

Given the general immaturity of the indigenous vegetation within this section (predominantly scrub), the small size of these areas and the tenuous connectivity to the MGSR forest, we consider that this habitat does not provide suitable habitat for North Island kākā, North Island rifleman or whitehead.

The farm ponds, if used by Australian coot and New Zealand dabchick, are likely to provide only marginal habitat for these species given the lack of grassy islands or edges (the edges were grazed) and the sparsity of emergent aquatic vegetation and rushes (cover/shelter) around the pond in which to nest or anchor nests to (there were two small areas of raupō) (Figure 6.B.30, Figure 6.B.31 and Figure 6.B.32). These species were not observed on the ponds and were not recorded by the acoustic recorder deployed in the area.

The recorder was set for two weeks during the breeding season of both of these species (the time at which they are most vocal). However, both species have long breeding seasons (between September and March for Australian coot and year round for New Zealand dabchick with territorial displays during June and July and egg laying mainly during August-February (Heather & Robertson, 2005)) and potential pairs at the site may not have commenced nesting during this two week window, or the site may be visited by non-breeding or vagrant birds. The latter is speculated for New Zealand dabchick in the Te Āpiti wind farm assessment; it is noted that migrating birds may use wetland habitats along Saddle Road (Boffa Miskell Ltd, 2003). As such, to be conservative, we assume the potential use of this habitat by these species for foraging, but it is unlikely they use this habitat for breeding.

Figure 6.B.30. One of the two farms ponds (the eastern one) between approximately Ch 9200 and Ch 9600.

Figure 6.B.31. One of the two farm ponds (the western one) between approximately Ch 9200 and Ch 9600.

Figure 6.B.32. One of the two farm ponds (the western one) between approximately Ch 9200 and Ch 9600. The orange polygon indicates a small area of raupō on the pond margin.

6.B.4.4.2.6 Eastern Rise. Ch 9900-12800

The habitats within this section include scrub (indigenous and exotic), immature pine forest, grazed pasture, a wetland, and regenerating and secondary broadleaved forest.

This section provides foraging habitat for New Zealand falcon (this is the section in which a New Zealand falcon was observed during the Kessels & Associates Ltd (Kessels & Associates Ltd, 2018) survey). Grassland areas within this section provide foraging and roosting habitat for New Zealand pipit.

It is highly unlikely that marsh crake and/or spotless crake use the wetland habitat at approximately Ch 10200 to Ch 10280. This is because the area is small, grazed and pugged and the wetland vegetation is reasonably sparse (i.e. not dense for cryptic species to hide in) and interspersed by pasture grass. There is also no standing water within the area (Figure 6.B.33 and Figure 6.B.34).

Figure 6.B.33. The wetland area between approximately Ch 10200 and Ch 10280 by Saddle Road.

Figure 6.B.34. The wetland area between approximately Ch 10200 and Ch 10280 by Saddle Road.

6.B.4.4.2.7 Woodville gateway. Ch 12800 – 14000

The habitats within this section are predominantly cropped and grazed pasture. This section potentially provides foraging habitat for New Zealand falcon. Grassland areas within this section provide foraging and roosting habitat for New Zealand pipit.

6.B.5. Ecological Values

6.B.5.1 Herpetofauna

Across the Project corridor there are discrete patches of native and non-native scrub, secondary regenerating forest, and established mature tawa forest within a grazed pasture matrix. Many of these discrete habitats are attached to or very close to the MGSR. All of these identified habitats are suitable for one or more at risk species of native lizard. Given the confirmed presence of several at risk species within the MGSR and lack of intensive lizard surveys it is appropriate to use habitat as proxy for species presence in this area.

Therefore, (as potential habitat for at risk species) the designation (other than the Woodville gateway section) has **High** ecological value for native herpetofauna except for-raupō dominated wetlands and grazed pasture habitats. This ecological value is consistent with the assumptions and methodology provided in section 6.B.2.1.1 by considering the threat status of the herpetofauna potentially present in the area and the presence of suitable habitat.

6.B.5.2 Terrestrial Invertebrates

There are several patches of mature and regenerating secondary forest within the Project corridor that contain habitat attributes that would contribute to healthy, relatively intact terrestrial invertebrate assemblages described within Table 6.B.1. The areas of ecological value with regard to terrestrial invertebrates are:

- The grazed mature native forest, scrub and wetland which have **Moderate-Low** ecological values in the western rise area (or western access track) due to having a mixture of habitat attributes outlined in Table 6.B.1 including:
    - Grazing pressure moderate to high with possible small discrete areas protected from grazing by topology.
    - Disturbed forest floor with negligible amounts of leaf litter, woody debris.
    - Small-medium patch size or complex of patches. Poor linkage to established intact forest ecosystem (such as the MGSR).
    - Developing sub-canopy and ground cover flora composition with large areas of full canopy closure and absence of pasture grasses.
- The intact tawa forest stand has **High** ecological values, having habitat attributes outlined in Table 6.B.1 including:
    - Mature forest ecosystem with high naturalness, diversity and pattern.
    - Little to no grazing pressure (effectively fenced from stock).
    - Intact sub-canopy, epiphyte, and ground cover flora composition.
    - Intact and undisturbed forest floor with leaf litter, woody debris, and high habitat complexity.
    - Ecological context: Large patch size of compact shape connected to, or linked by corridors, to established intact forest ecosystem (such as the MGSR).
- The relatively mature regenerating secondary forest in the eastern rise area has **Moderate** ecological value due to having habitat attributes outlined in Table 6.B.1 including:

    - Secondary forest ecosystems with moderate-low naturalness, diversity and pattern.
    - Grazing pressure low or large discrete areas protected from grazing by topology/stock access.
    - Developing sub-canopy and ground cover flora composition with large areas of full canopy closure and absence of pasture grasses.
    - Forest floor with small amounts of leaf litter, woody debris.
- The rest of the designation area is of **Low-Negligible** value for terrestrial invertebrates due to having a mixture of habitat attributes outlined in Table 6.B.1 including:
    - Short grazed pasture or widely spaced grazing tolerant shrubs with low-negligible naturalness, diversity and pattern.
    - Grazing pressure moderate to high with possible small discrete areas protected from grazing by topology.
    - Little to no sub-canopy and ground cover other than pasture grasses or bare open ground.
    - Predominately grazed pasture matrix between forest patches.

6.B.5.3 Bats

The Project corridor is located within potential foraging and commuting habitat for long-tailed bats with potential roosting habitat in a few locations. There exists particularly good habitat potential in the gully associated with the western rise area which contains established tawa forest at its northern end and a matrix of open, wetland, scrub, riparian, and large tree habitats at the Manawatū River end of the gully. This would contribute to an ecological value with regard to bats of **Very High** if they are present.

However, initial bioacoustics surveys did not detect long-tailed bat presence and concluded a low-possibility of long-tailed bat presence along the corridor. The Kessels report also identified environmental constraints such as the high wind levels as a potential restriction to long-tailed bat utilisation of the habitats present (Kessels & Associates Ltd, 2018). We agree with this assessment of low-possibility of long-tailed bat presence and do not consider that habitat should be used as a proxy for long-tailed bat presence in this area.

An approach recommended to address this uncertainty and ensure any potential/actual effects on long-tailed bats are avoided, remedied, or mitigated is discussed in the below section 6.B.7.4.

6.B.5.4 Avifauna

The Project corridor provides several different habitats of varying quality for At Risk and Threatened avifauna as described below. These descriptions are based on the attributes to be considered when assigning ecological value or importance to a site or area of vegetation/habitat/community as described in Table 4 of the EIANZ (2018) guidelines (summarized in Table 6.B.2 above). The attributes considered and overall conclusions of the ecological value of these habitats are:

Gravel/boulder riverbed habitat within the proposed bridge corridor:

- representative of natural habitat of riverine avifauna;

- provides habitat for native avifauna (potentially including nesting habitat for At Risk and Threatened species);
- distinct habitat with linkage for avifauna to other such nearby habitat;
- small size relative to amount of similar habitat available nearby; and
- sensitive to flooding and exposed to wind which may impact avifauna nesting success.

Overall, we conclude this habitat has **moderate ecological value** for avifauna.

Grazed under native forest (Ch 4100-4500)

- diversity of mature native canopy trees, a rare habitat type in the area for native avifauna;
- provides older growth habitat for native avifauna (including At Risk and Threatened species) but nesting opportunities are reduced because some expected canopy trees are missing and because of the lack of understory/density due to grazing; and
- linkage for native avifauna to habitat in the MGSR and Bolton Bush QEII covenant.

Overall, we conclude this habitat has **moderate ecological value** for avifauna.

Raupō wetland (Ch 4130-4230):

- rare habitat type in the area for native avifauna but in poor condition due to stock access;
- plant diversity not representative of pre-human state so limited habitat diversity for avifauna;
- potential stepping stone/stopover habitat for migrating native wetland avifauna;
- provides habitat for native avifauna but only marginal habitat for At Risk and Threatened native wetland avifauna species due to poor condition (unsuitable nesting habitat for wetland avifauna); and
- survey to date has not confirmed the absence of At Risk and Threatened species in this area, but if present, then the habitat value would be elevated to moderate or high depending on the species present.

Overall, we conclude this habitat has **low ecological value** for avifauna.

Bolton bush in western rise:

- reasonably representative of pre-human state (but mature canopy species missing);
- good diversity of vegetation and habitats for native avifauna (including intact understory);
- good linkage for native avifauna to habitat in the MGSR;
- provides habitat for native avifauna (potentially including At Risk and Threatened species); and
- provides specific life stage resources, especially for breeding.

Overall, we conclude this habitat has **high ecological value** for avifauna.

Native scrub with scattered broadleaf and larger emergent rewarewa trees (Te Āpiti wind farm and eastern rise):

- provides some habitat diversity for native avifauna;
- small patches, some isolated and exposed to edge effects;
- limited habitat connectivity between areas for avifauna;
- vegetation not representative of pre-human state; and
- good insect resource for insectivores but limited for other guilds.

Overall, we conclude this habitat has **low-moderate ecological value** for avifauna.

Grazed pasture:

- exotic habitat;
- not representative of pre-human state;
- not a diverse or rare habitat for avifauna (common in wider agricultural landscape); and
- does provide habitat for some native avifauna (including foraging and roosting habitat for two At Risk species).

Overall, we conclude this habitat has **low ecological value** for avifauna.

Farm ponds:

- not a rare habitat for avifauna (common in wider agricultural landscape);
- condition of pond margins degraded from stock access;
- some areas of native vegetation around margins, but exotic vegetation also common;
- no submerged or emergent aquatic vegetation for avifauna to nest in or upon (limited diversity); and
- does provide habitat for some native avifauna (potentially including foraging and roosting habitat for two At Risk species).

Overall, we conclude this habitat has **low ecological value** for avifauna.

Immature planted native vegetation, pine and scrub:

- provides habitat for some native avifauna with limited resource;
- common habitats types for native avifauna in the landscape;
- lack of structure or habitat diversity for avifauna; and
- pine habitats are exotic and not representative of pre-human state.

Overall, we conclude this habitat has **low ecological value** for avifauna.

6.B.5.5 Summary

A broad summary of ecological values for fauna broken down to designation section is provided below in Table 6.B.8.

Table 6.B.8: Summary of fauna ecological value by designation section.

Designation section	Herpetofauna	Terrestrial invertebrates	Bats[6]	Avifauna
Bridge to bridge (Ch 2500 - 3800)	High	Low-Negligible	Potentially Very High - foraging and commuting habitat	Low
New Manawatū River Crossing (Ch 3800 - 4100)	High	Low-Negligible	Potentially Very High - foraging and commuting habitat	High[7]
Western Rise (Ch 4100 - 5900)	High	High	Potentially Very High - foraging, roosting and commuting habitat	High
Western access designation (~Ch4700 - North)	High[8]	Low-Negligible	Potentially Very High - foraging, roosting and commuting habitat	Low
Te Āpiti Wind Farm and Ridge (5900 - 9900)	High	Low-Negligible	Potentially Very High - foraging, roosting and commuting habitat	Low-Moderate
Eastern Rise (Ch 9900 - 12800)	High	Moderate	Potentially Very High - foraging, roosting and commuting habitat	Low-Moderate
Woodville gateway (Ch 12800 - 14000)	Negligible	Negligible	Potentially Very High - foraging and commuting habitat	Low

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[6] Bats are considered unlikely to be found to be present, but habitat values are presented here in any case.

[7] The habitat is considered Moderate value but the highest value species that may use the habitat (banded dotterel) is scored Very High, giving an averaged potential value of High.

[8] While there are small amounts of high value herpetofauna habitat peripheral to this access designation the vast majority of the area is grazed pasture.

6.B.6. Assessment of Effects

The assessment of effects below is based on the assumed total loss of all indigenous shrublands, secondary broadleaved forests and scrublands within the Project corridor detailed within Volume 4 of the AEE, Drawings and Plans, except for the areas that are described below.

Within the areas of moderate or greater value vegetation types, avoidance and minimisation are proposed through specific effects envelopes and minimal-disturbance management protocols:

- old-growth forests and treelands;
- secondary forests containing old-growth signatures;
- advanced broadleaved forests;
- kānuka forests;
- raupō seepage wetland at Ch4200; and
- moderate value seepage wetlands.

The effects envelopes are detailed in section 5.3 of Forbes (2018).

The summary of types of vegetation classes across the entire designation and the quantity of each that could potentially be directly affected is listed in Table 6.B.9.[9] This table is based on Forbes (2018) quantification of vegetation and habitats.

Table 6.B.9: Summarised potential vegetation/habitat loss for entire Project summarised from Forbes (2018).

Ecosystem classification	**Area (ha) within proposed designation boundaries**	**Area (ha) potentially impacted**
Old-Growth Forests (Alluvial)	4.23	0.15
Old-Growth Forests (Hill Country)	1.78	1.00
Secondary Broadleaved Forests with Old-Growth Signatures	3.07	2.2
Old-Growth Treelands	0.41	0.41
Kānuka Forests	4.52	1.39
Advanced Secondary Broadleaved Forests	2.93	0.5
Secondary Broadleaved Forests and Scrublands	16.32	16.32
Mānuka, Kānuka and Divaricating Shrublands	4.12	4.12
Raupō Dominated Seepage Wetlands	0.55	0.13
Indigenous-Dominated Seepage Wetlands	0.56	0.39
Total	38.49	26.61

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[9] This table only accounts for vegetative habitat. In circumstances such as where woody debris is identified as potential habitat, this is identified and accounted for within the comments and descriptions below.

6.B.6.1 Herpetofauna

The potential effects on herpetofauna from the construction and operation of the road within the proposed designation are:

- Mortality of lizards during vegetation clearance and earthworks;
- Permanent loss of lizard habitat; and
- Modification of remaining lizard habitat, such as:
    - Habitat fragmentation and isolation (including, potentially, crossing deaths).
    - Increased levels of noise and disturbance during both construction and operation.
    - Introduction of forest/scrub - road edges introducing edge effects such as altering the composition and habitat value of adjacent vegetation.

These potential effects are assessed below in Table 6.B.10.

Table 6.B.10: Potential effects on Herpetofauna described based on designation section.

Designation section	**Habitat types**	**Ecological value**	**Potential magnitude of effect (ref Table 6.B.4)**	**Level of ecological effect (ref Table 6.B.5) prior to mitigation**	**Comments**
Bridge to bridge (Ch 2500 - 3800)	Pine forest slash and roadside vegetation.	High	Low	Low	Removal of an assumed small amount of roadside vegetation and wood debris. Lizards present likely very low density.
New Manawatū River Crossing (Ch 3800 - 4100)	River bank vegetation and native scrub.	High	Low	Low	Small amount of riparian vegetation lost. Flooding likely a major constraint for lizard presence for most of this area.
Western Rise (Ch 4100 - 5900)	Grazed	High (excluding raupō wetland)	High	Very High	Loss of a large amount of high quality habitat (habitat loss somewhat constrained by effects envelope) that has high connectivity to large intact forest remnants to both the east and west including the MGSR. Permanent reduction of remaining habitat value due to fragmentation, disturbance, and edge effects.

Designation section	Habitat types	Ecological value	Potential magnitude of effect (ref Table 6.B.4)	Level of ecological effect (ref Table 6.B.5) prior to mitigation	Comments
Western access designation – (~Ch4700 – North)	Small areas of kānuka forest.	High	Low	Low	Habitats of high value peripheral to designation and a majority of habitats avoided.
Te Āpiti Wind Farm and Ridge (5900 - 9900)	Kānuka scrub and secondary broadleaved forest in gullies, pondside vegetation and divaricate Coprosma vegetation.	High	High	Very High	Loss of a strip of 200-300m of gully vegetation across all vegetated gullies along designation. Habitat includes kānuka and divaricate scrub, which is most areas connected to Manawatū scenic reserve. Habitat loss and road permanently fragments habitats; isolating vegetation to the north of the designation from MGSR and reducing the value of remaining habitats.
Eastern Rise (Ch 9900 - 12800)	Kānuka and fern vegetation, kānuka and rush seep, secondary broadleaved forest, and pine forest.	High	High	Very High	Loss of large area of regenerating broadleaved forest and native and non-native scrub. Habitat loss and road permanently fragments habitats reducing the value of remaining habitats.
Woodville gateway (Ch 12800 - 14000)	Small area of pine trees and grazed pasture.	Negligible	Negligible	Very low	Little to no habitat present or impacted. Loss of grazed pasture and a small amount of pine trees with little to no woody debris. Unlikely to impact native lizard species potentially present.

6.B.6.2 Terrestrial Invertebrates

The potential effects on terrestrial invertebrates from the construction and operation of the road within the proposed designation are:

- Direct mortality;

- Permanent loss of habitat; and
- Modification of remaining habitat such as:
    - Reduction of habitat connectivity through fragmentation and isolation.
    - Creation of edge effects such as altering the composition and habitat value of adjacent vegetation, modifying the microclimates within created edge habitats, and changing terrestrial invertebrate community composition.
    - Increased presence and likelihood of invasion by non-native plant and invertebrate species due to increased human activity and access.

These potential effects are assessed below in Table 6.B.11.

Table 6.B.11: Potential effects on terrestrial invertebrates described based on designation section.

Designation section	Habitat types	Ecological value	Potential magnitude of effect (ref Table 6.B.4)	Level of ecological effect (ref Table 6.B.5) prior to mitigation	Comments
Bridge to bridge (Ch 2500 - 3800)	Pine forest slash and roadside vegetation.	Low-Negligible	Low	Very Low	Small amount of marginal and disturbed habitat lost. Existing invertebrate community likely to be tolerant of disturbance and able to colonise new habitats.
New Manawatū River Crossing (Ch 3800 - 4100)	River bank vegetation and native scrub.	Low-Negligible	Low	Very Low	Small amount of marginal and disturbed habitat lost. Existing invertebrate community likely to be tolerant of disturbance and able to colonise new habitats.
Western Rise (Ch 4100 - 5900)	Grazed mature native forest, kānuka forest, raupō wetland, secondary broadleaved forest, and mature tawa forest.	High	High	Very High	Native canopy trees, kānuka forest, and raupō wetland lost (habitat loss somewhat constrained by effects envelope). However, greatest effect is the loss of up to 1ha established mature tawa forest. Significant fragmentation, creation of a new barrier between habitats, and creation of edge effects to remaining habitat. Invertebrate communities currently present in grazed mature native forest, scrub and raupō likely tolerant of disturbance due to stock access and relative lack of understory habitat. However, invertebrate communities in established tawa forest potentially remnant and sensitive to disturbance, additional edge effects and may have

Designation section	Habitat types	Ecological value	Potential magnitude of effect (ref Table 6.B.4)	Level of ecological effect (ref Table 6.B.5) prior to mitigation	Comments
					limited dispersal and colonisation abilities.
Western access designation – (~Ch4700 – North)	Small areas of kānuka forest.	Low-Negligible	Negligible	Very Low	Minimal impact beyond grazed pasture and small areas of kānuka and therefore little to no impact on terrestrial invertebrates of ecological value.
Te Āpiti Wind Farm and Ridge (5900 - 9900)	Kānuka scrub and secondary broadleaved forest in gullies, pondside vegetation and divaricate *Coprosma* vegetation.	Low-Negligible	Moderate	Low	Habitat lost either recently protected or subject to significant pressure from stock grazing and trampling. Little habitat of value impacted. However, the new road will introduce a new barrier between large amounts of native vegetation to the north and the MGSR.
Eastern Rise (Ch 9900 - 12800)	Kānuka and fern vegetation, kānuka and rush seep, secondary broadleaved forest, and pine forest.	Moderate	Moderate	Moderate	Area of secondary broadleaved forest with relatively stable and diverse understory habitats lost. Reduces the size of the remaining forest patch increasing edge effects and introduces a new barrier between existing habitats and vegetation to the east, noting that there are significant habitats located also to the north and north east. Existing invertebrate community likely to be moderately tolerant of disturbance and able to colonise new habitats. However, community may include species that colonise in later stage succession.
Woodville gateway (Ch 12800 - 14000)	Small area of pine trees and grazed pasture.	Negligible	Low	Very Low	Small amount of marginal and disturbed habitat lost. Existing invertebrate community likely to be tolerant of disturbance and able to colonise new habitats.

6.B.6.3 Bats

It is inappropriate, in this instance, to use habitat presence as a proxy for bat presence. At this stage, the presence of bats is not confirmed and the probability of finding them is low. To assess impacts on long-tailed bats, further work to determine their presence will need to be undertaken. If bats are confirmed to be present, how they are using the habitat and what specific habitat features are being used would need to be identified and impacts on these assessed. An effective assessment of effects cannot be conducted without this information. An approach to address this uncertainty and ensure any potential/actual effects on long-tailed bats are avoided, remedied, or mitigated is discussed in the below section 6.B.7.4.

6.B.6.4 Avifauna

Potential adverse ecological effects on avifauna associated with construction of the Project include:

- Mortalities of nesting birds (including eggs and chicks);
- Disturbance;
- Permanent habitat loss;
- Modification of remaining habitat such as:
    - Reduction of habitat connectivity through fragmentation and introduction of new barriers that may cause habitat isolation for species with limited mobility.
    - Creation of edge effects such as altering the composition and habitat value of adjacent vegetation, modifying the microclimates within created edge habitats and thus altering food supply.
    - During construction potential sedimentation effects on foraging areas along the Manawatū River could reduce prey abundance and/or foraging efficiency of dotterels. While this is a potential effect associated with the resource consent application process (to be lodged later), it is nevertheless a potential ecological effect on an identified value that is related to the designation’s spatial location (i.e. where future works are being planned). Mitigation for this impact should be considered at the time those applications are developed.

Potential adverse ecological effects on avifauna associated with operation of the Project include:

- Traffic-related mortalities during road operation.
- Disturbance, including effective habitat loss.

These potential effects are assessed below in Table 6.B.12.

Table 6.B.12: Potential effects on avifauna described based on designation section.

Designation section	Habitat types	Ecological value	Magnitude of effect (ref Table 6.B.4)	Potential level of ecological effect (ref Table 6.B.5) prior to mitigation	Comments
Bridge to bridge (Ch 2500 - 3800)	Grazed pasture, planted native vegetation, weed-dominated cutover pine.	Low	Negligible	Very low	No nesting or core habitats for at-risk or threatened birds in section and large amounts of suitable habitats nearby. Small amount of marginal and disturbed habitat lost.
New Manawatū River Crossing (Ch 3800 - 4100)	Manawatū River and gravel/boulder riverbed habitat.	High	Moderate	High	Potential disturbance, temporary reduction in food quality, and mortality of breeding banded and/or black- fronted dotterels on gravel/shingle habitats. Potential loss of small amounts of gravel habitat depending on bridge design and pier location. No nesting or core habitats for other At Risk or Threatened species; if displaced by construction works, plentiful, suitable habitat is available nearby. Level of ecological effect will be reduced to Low if suggested mitigation is implemented (especially nesting deterrence mechanisms).
Western Rise (Ch 4100 - 5900)	Kānuka forest, raupō wetland, secondary broadleaved forest, and mature tawa forest.	High	Moderate	High	Potential disturbance and mortality of low numbers of breeding whitehead in established forest areas. Extensive, alternative nesting habitat available in contiguous MGSR. Potential disturbance of foraging/roosting cryptic marsh birds in raupō wetland. Loss of relatively small amount of wetland and forest habitats which may be used only occasionally by at risk or threatened birds. Level of ecological effect will be reduced to Low if suggested mitigation is implemented.
Western access designation – (~Ch4700 – North)	Grazed pasture and small amounts of kānuka	Low	Negligible	Very Low	No nesting or core habitats for at-risk or threatened birds in section. Loss of a relatively small amount of agricultural habitat and kānuka which are common and dominant in the landscape.

Designation section	Habitat types	Ecological value	Magnitude of effect (ref Table 6.B.4)	Potential level of ecological effect (ref Table 6.B.5) prior to mitigation	Comments
Te Āpiti Wind Farm and Ridge (5900 - 9900)	Native scrub with scattered broadleaf and larger emergent rewarewa trees.	Low-Moderate	Low	Very Low-Low	No nesting or core habitats for at-risk or threatened birds in section and large amounts of suitable habitats nearby. Loss of relatively small amount of scrub and secondary forest habitats which are used occasionally by at risk or threatened birds.
Eastern Rise (Ch 9900 - 12800)	Regenerating, secondary broadleaf forest.	Low-Moderate	Low	Very Low-Low	No nesting or core habitats for at-risk or threatened birds in section and large amounts of suitable habitats nearby. Loss of relatively small amount of secondary forest habitats, which are used occasionally by at risk or threatened birds.
Woodville gateway (Ch 12800 - 14000)	Cropped and grazed pasture.	Low	Negligible	Very Low	No nesting or core habitats for at-risk or threatened birds in section. Loss of a relatively small amount of agricultural habitats, which are common and dominant in the landscape.

6.B.7. Recommendations to avoid, remedy or mitigate

6.B.7.1 General recommendations

To reduce the level of potential effects on the fauna present along the corridor there should be an emphasis during later design stages to avoid or minimise impacts to native habitats (those assessed as having greater than low level for habitat value). This applies in particular to the mature tawa forest in the western rise area, older regenerating kānuka scrub patches in the Te Āpiti wind farm and ridge area and regenerating broadleaved forest in the eastern rise area. Avoidance mechanisms for these areas could include (but are not limited to):

- Realignment of indicative designation within the proposed designation;
- Bridging;
- Minimisation of cut and fill extents; and
- Rationalisation of access routes and points, spoil dump areas, and compound areas.

To address habitat lost for all fauna, the mitigation using the environmental compensation ratios recommended by the terrestrial vegetation and habitats assessment (Forbes, 2018) will provide habitat value and adequately replace the fauna habitat lost. Criteria for habitat to be created within these mitigation planting areas should be stipulated within an ecological management plan for this Project.

Where the Project does not impact on existing native vegetation and habitats that are not already protected from stock access, fencing and permanently excluding grazing stock to allow natural regeneration could be considered (as part of any mitigation package). This protection would improve the ecological value of the remaining habitats.

Any area that may be subject to predator control, as part of a package designed to achieve net biodiversity gain in terms of One Plan policy 13-4, may suffer from significant re-invasion pressure from pest species and may struggle to achieve and maintain pests at low densities. Therefore, the value of this pest control for fauna mitigation comes from the flora values (which provide habitat) created, protected, and maintained and it is the increase in-habitat area (through the operation of ecological compensation ratios) that is primarily considered to provide mitigation for the impacts on fauna that will eventually return an ecological gain.

6.B.7.2 Herpetofauna

Beyond the replacement/improvement of habitat and pest control described above, the salvage of individual lizards within the impacted areas should also be implemented to reduce the potential for injury or mortality of native lizards due to construction of the road.

All native lizard species are ‘absolutely protected’ under the Wildlife Act (1953, s63 (1) (c)) Department of Conservation (DOC). A Wildlife Act Authority to capture, handle, transfer lizards, and incidentally kill protected wildlife (even non-threatened species) as part of construction works is required for this project due to the presence of lizard habitats and the potential for absolutely protected wildlife to be present and management that will require handling and relocation of lizards.

With regard to lizard management, it should be noted that lizard survey methods currently available have poor detection rates as a consequence of typically low population densities, species cryptic colouration, difficulty in surveying preferred habitats and behaviour/activity patterns (Anderson et al., 2012). These limitations are particularly evident when attempting to locate cryptic, arboreal, species in tall growth trees. As such we recommend the following approach when habitat is confirmed as being impacted:

- Areas of low growth scrub should be surveyed[10] prior to vegetation clearance to determine the presence of native lizards. If native lizards are confirmed to be present salvage should be carried out.
- Areas of tall stature canopy trees, regenerating broadleaved forest, and mature tawa forest should be salvaged in all cases including destructive searches of the canopies of trees and epiphytes once felled.

A lizard management plan should be drafted for the site detailing the survey and salvage methodology, establishment times of survey equipment, timing for surveys and salvage, a release site for salvaged lizards, and requirements to enhance or protect the release site from predation and disturbance. A lizard management plan will be required to support a Wildlife Act Authority application. Wildlife Act authority permits can take a significant amount of time to process and should be applied for at the earliest opportunity to prevent delays.

With the proposed mitigation planting to replace habitat and pest control that will reduce the predation rates on the remaining populations of native lizards, the effects of the designation will have a **Low** magnitude of effect for all sections of the designation for herpetofauna within the site. This coupled with the **High** to **Negligible** ecological values across the designation would result in a **Low** or **Very Low** level of ecological effect. In the long term, as a result of increased habitat availability, there is likely to be a net gain in the populations of native lizards within the wider area.

6.B.7.3 Terrestrial Invertebrates

The primary response for mitigation for terrestrial invertebrates is to create new habitats, and enhance remaining habitats, such as the MGSR. The enhancement should focus on increasing ecosystem health factors such as reducing edge effects, mammalian predation, and grazing disturbance. This can be achieved through fencing off vegetation, conducting predator control, and ensuring mitigation plantings are contiguous with large, established, high value habitats.

Salvage and transportation of woody debris or other complex habitats is not recommended as not enough is known about the terrestrial invertebrate communities present to ensure there are no negative flow on effects on resident communities or the inadvertent spread of non-native species.

With the proposed planting to replace and protect habitats and to protect and improve the value of existing habit, the designation will have a **Low** magnitude of effect for all sections for terrestrial invertebrates within the site. This coupled with the **High** to **Negligible** ecological values across the designation would result in a **Low** or **Very Low** level of ecological effect. In the long term, as a result of increased habitat availability and potential predator control

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[10] Survey effort should be on a case by case basis and determined by an appropriately qualified and experienced herpetologist as sufficient to have a realistic chance of detecting lizards if present (within the limitations of the survey tools and techniques available).

improving habitat value and ecological health, there is likely to be a net gain in terms of the ecological value of terrestrial invertebrates within the wider area.

6.B.7.4 Bats

The previous bat surveys undertaken[11] did not detect any bats, but were only conducted to a level to allow detection of high density populations of long-tail bats and/or core habitats such as maternal and communal roosts. Such values, if present, would be significant. However, the surveys do not give enough information to determine the presence of long tailed bats if at low-density, and so an effects assessment cannot be completed. Given the threatened – nationally critical- status of long-tailed bats it is important that even impacts on low density populations or habitats used infrequently are addressed.

Understanding the effects of construction and operation of roads on long-tailed bats is reliant on understanding the patterns of bat activity across the landscape and what habitat features are important to the population. Further work (the detection surveys explained below) is required to provide an understanding of:

- Whether bats at low density are present in the area; and
- If they are present in the area how they are using the habitat, what features are being used and whether it is a resident population.

We consider the likelihood of long-tailed bats being present at low densities within the Project area to be low. However, to gain further understanding and inform the required mitigation for long-tailed bats we recommend further intensive bioacoustics surveys are carried out under a bat survey plan developed by an appropriately qualified and experienced ecologist. These surveys should include two survey periods during:

- **November-December** - this monitoring period is during the breeding season. Breeding female bats and their dependant young occupy maternity roosts that generally occur in the most productive habitat within their colony's range (Pryde, O'Donnell, & Barker, 2005). Consequently, if high levels of bat activity are recorded in the project area during this period it is likely the project area is near core habitat for a bat colony; and
- **March** - this is generally considered a time when the home range of young bats is at its largest and therefore surveying during this period will maximise the likelihood of detecting bats.

These surveys should target identified potential high value long-tailed bat habitats described within this report with a high density of bioacoustic recorders to increase the probability of detecting bats if present. If the recommended surveys detect long-tailed bats a long-tailed bat management plan should be drafted. This plan should include (but not be limited to):

- Understood bat use patterns of the impacted habitats such as areas of potential roosting, foraging or commuting corridors;
- Further survey work needed if any to confirm bat use of the habitats;
- Activity levels detected in each potential habitat area;
- Analysis of effect on bats as a result of the proposed designation;

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[11] This previous survey by Kessels & Associates Ltd (2018) was carried out 27 February to 13 March 2018 included 10 survey locations within or close to the current designation.

- A detailed approach to avoid, remedy, or mitigate the assessed effect of the road designation on bats; and
- A post mitigation level of effect on long-tailed bats and how any residual effects will be managed.

If no bats are detected within the identified habitats during the intensive bioacoustic surveys an incidental detection protocol should be developed (or integrated into an environmental management plan for the site) to outline the process that is followed if a bat is incidentally encountered during vegetation removal. It is acknowledged that a lack of detection does not indicate a lack of presence. However, if intensive surveys fail to detect long-tailed bats it would indicate that long-tailed bats are below detection density. As such monitoring potential roost trees prior to felling with automatic detection equipment or dusk surveys would be very unlikely to avoid disturbance on potentially present individual long-tailed bats and an accidental discovery protocol would be the most appropriate mechanism to manage effects.

This approach should ensure that long-tailed bats are appropriately managed in this area if present and their habitat use patterns are understood before a level of effect and required mitigation is assessed.

This uncertainty does not allow recommendations for the avoidance of long-tailed bat habitat specifically. The avoidance of native vegetation, lizard habitat, and high value terrestrial invertebrate habitats where practicable will translate to the avoidance of potential long-tailed bat habitats. This will provide interim guidance for avoidance of potential long-tailed bat habitat during the period of uncertainty between the publication of this report and the development of a long-tailed bat management plan, if bats are found to be present onsite.

6.B.7.5 Avifauna

Beyond the replacement of habitat described above, the following actions or periods of action are recommended to be avoided where practicable. None of the following are required (because of the assessed values) avoidance, but are methods to reduce effects and present opportunities to avoid effects:

6.B.7.5.1 Habitat avoidance consideration

- Minimise clearance of the raupō wetland within the western rise section. The habitat is degraded, but wetlands are rare and potential habitat to specialist species, so avoidance is recommended and where necessary clearance minimised. This area could serve as an important mitigation/offset opportunity and be greatly enhanced through stock exclusion/fencing.
- Minimise effects/avoid the gravel/shingle riverbed habitat within the designation corridor where the Manawatū River is proposed to be bridged in the breeding season to avoid potential mortality of river birds that may nest in this habitat.
- Minimise effects/avoid the farm ponds between approximately CH9200 and CH9600 to reduce potential impacts on avifauna species using this habitat. This area also has restoration/enhancement and mitigation/offset potential through stock exclusion and planting of indigenous plant species, although because the land farmland and will remain part of the farm in the long term, this benefit is unlikely to be able to be realised.

- If works are to be conducted in grassland habitat during the breeding season for New Zealand pipit (August to March), efforts should be made to avoid letting grass become rank (as this may provide suitable nesting habitat for pipit). Currently the grass is grazed, but if stock are removed, it may become rank. Regular mowing is a suitable alternative maintenance method if stock are removed (very regular mowing to prevent birds nesting should be done prior to and during pipit breeding season).
- Minimise effects/clearance of the Bolton Bush QEII area (CH5600-5800). Bridging this vegetation would be a preferred option.
- If clearance of the raupō wetland does occur then pre-clearance surveys (by a suitably qualified ecologist) for cryptic bird species potentially using the raupō wetland habitat should be undertaken to avoid potential bird death.
- If works are to be conducted during the breeding season for black-fronted and banded dotterels (broadly between July and March), measures should be implemented in the non-breeding season before works to deter these species from nesting in the works area. A successful method that is recommended to deter New Zealand dotterels from nesting in a works area is the erection of silt fences. By erecting these at knee height in rows spaced 5-10 m apart, the birds' views are blocked; this makes the area unattractive for nesting. Deterrence methods are likely to be suitable for banded dotterel and black-fronted dotterel. Potentially displaced birds would be able to use the abundant, nearby shingle/gravel bed habitat. After implementing these measures, a pre-construction survey (by a suitably qualified ecologist) for nesting dotterels would still need to be conducted to check the success of these deterrence mechanisms. If nesting birds are detected within the area, an exclusion zone would need to be erected around the nest, and works should not be conducted in this area until nesting activities are completed, or chicks have been safely herded away (by a suitably qualified ecologist) if this mechanism is approved via an authority under the Wildlife Act 1953.
- Pre-clearance surveys (by a suitably qualified ecologist) for whitehead if vegetation clearance in the western rise and western access designation is to occur during the breeding season for this species (September to January). If nesting birds are detected, an exclusion zone should be erected around the tree the nest is in, as well as a buffer of nearby trees, and works should not be conducted in the area until nesting activities are completed. An authority under the Wildlife Act 1953 could also be sought to move nests to a safe location outside of the works area.
- If grassland habitat is not maintained and becomes rank, this may provide potential nesting habitat for New Zealand pipit. If there are areas of rank grass that need to be cleared during the pipit breeding season (August to March), a pre-clearance check (by a suitably qualified ecologist) for nesting pipit should be conducted. If nesting pipit are identified, an exclusion zone should be erected around the nest until nesting activities are completed. An authority under the Wildlife Act 1953 could also be sought to move nests to a safe location outside of the works area.
- An avifauna management plan should be drafted for the site detailing pre-clearance survey methods (including the timing of such surveys), implementation of deterrence measures and the construction of exclusion zones if required.

The implementation of these avoidance and mitigation actions (as well as the general recommendations for all fauna) will result in the proposed designation corridor having a **Negligible** to **Low** magnitude of effect on avifauna present (or potentially present) across the site. This, coupled with the **High** to **Low** ecological values, results in **Low** to **Very Low** overall levels of ecological effect on avifauna. In the long term, as a result of increased habitat availability and potential predator control improving habitat value and ecological health, there is likely to be a net gain in terms of the ecological value of avifauna within the wider area.

6.B.8. Conclusions and recommendations

The proposed designation corridor includes a number of habitats for terrestrial fauna (herpetofauna, invertebrates, bats, avifauna), including actual and potential habitat for a variety of At Risk and Threatened species. The highest value habitats for terrestrial fauna in the designation are the intact tawa forest in the western rise area (Bolton Bush QEII site (CH5600-5800)), the mature, regenerating secondary forest in the eastern rise area, and the matrix of open, wetland, riparian and large tree habitats at the Manawatū River end of the western rise gully. This ecological assessment is based on existing literature, of which there is little, on previous ecological field surveys and qualitative assessment of habitats, which was limited. As such, a conservative approach has been taken in assigning ecological values.

A number of actual and potential adverse effects on terrestrial fauna values are associated with the proposed designation corridor. These include:

- construction and operational-induced mortality of terrestrial fauna;
- permanent loss of fauna habitat;
- modification of fauna habitat (e.g. fragmentation, isolation, noise, construction, introducing edge effects and operational disturbance); and
- increased presence and likelihood of invasion by non-native plant and invertebrate species due to increased human activity and access.

Without avoidance and mitigation, the magnitude of these effects varies between **Negligible** and **High** on terrestrial fauna, resulting (once the value of effects is considered) in the overall level of effects ranging between **Very Low** and **Very High**. This effects assessment is based on a corridor and not a design of the actual road to be built. As such, there is significant uncertainty on effects and we have therefore taken a conservative approach to the effects assessment.

These effects (or the level of them) can generally be avoided or mitigated by:

- avoiding impacting native habitats;
- producing fauna management plans that detail methodologies for pre-clearance fauna surveys, deterrence measures for seasonally present species, and relocation where required;
- undertaking vegetation clearance outside of the breeding season for selected avifauna species;
- undertaking further intensive bioacoustic surveys for bats under a bat survey plan; and
- implementing the habitat and revegetation mitigation recommended by Forbes' (2018) ecological impact assessment where identified valued habitat is lost.

The implementation of these avoidance, mitigation, and offsetting actions will reduce the magnitude of potential effects on terrestrial fauna, resulting in **Very Low-Low** overall levels of ecological effect. In the long term because of increased habitat (based on the ECR's advanced), reduced predation of native fauna, and increased ecosystem health there is likely to be a net gain in terms of the ecological value of terrestrial fauna within the wider area.

6.B.9. References

Anderson, P., Bell, T., Chapman, S., & Corbett, K. (2012). *SRARNZ New Zealand lizards conservation toolkit: A resource of conservation management of the lizards of New Zealand*. Society for Research on Amphibians and Reptiles of New Zealand.

Boffa Miskell Ltd. (2003). *Project Te Apiti Saddle Road, Manawatū: Ecological assessment* (No. W02020) (p. 34).

Boffa Miskell Ltd. (2018). *Manawatū Gorge SH3: Summer Ecology Survey - Herpetofauna*. Report prepared by Boffa Miskell Limited for GHD and the New Zealand Transport Authority.

Boffa Miskell Ltd, & Golder Associates. (2009). *Report on avian mortality at Te Apiti wind farm* (pp. 1–34). Prepared by Boffa Miskell Ltd and Golder Associates for Meridian Energy Limited.

Bromham, L., Cardillo, M., Bennett, A. F., & Elgar, M. A. (1999). Effects of stock grazing on the ground invertebrate fauna of woodland remnants. *Australian Journal of Ecology*, *24*(3), 199–207.

Buckley, T. R., Hitchmough, R., Rolfe, J., & Stringer, I. (2016). *Conservation status of New Zealand stick insects, 2014* (New Zealand Threat Classification Series No. 15). Wellington: Department of Conservation.

Crisp, P. N., Dickinson, K. J. M., & Gibbs, G. W. (1998). Does native invertebrate diversity reflect native plant diversity? A case study from New Zealand and implications for conservation. *Biological Conservation*, *83*(2), 209–220.

Davis, M., Head, N. J., Myers, S. C., & Moore, S. H. (2015). *Department of Conservation guidelines for assessing and identifying significant ecological values*. Christchurch: Department of Conservation.

Derraik, J. G. B., Rufaut, C. G., Closs, G. P., & Dickinson, K. J. M. (2005). Ground invertebrate fauna associated with native shrubs and exotic pasture in a modified rural landscape, Otago, New Zealand. *New Zealand Journal of Ecology*, *29*(1), 129–135.

EIANZ. (2018). *Ecological impact assessment (EcIA): EIANZ guidelines for use in New Zealand: Terrestrial and freshwater ecosystems. 2nd EDITION.* Melbourne: Environment Institute of Australia and New Zealand.

Ewers, R. M., & Didham, R. K. (2008). Pervasive impact of large-scale edge effects on a beetle community. *Proceedings of the National Academy of Sciences*, *105*(14), 5426–5429.

Forbes, A. (2018). *Te Ahu a Turanga – The Manawatū Gorge Replacement Project Assessment of Terrestrial Vegetation and Habitats* (Report prepared for the New Zealand Transport Agency).

Heather, B., & Robertson, H. A. (2005). *The field guide to the birds of New Zealand*. Auckland: Penguin Books.

Hitchmough, R., Barr, B., Lettink, M., Monks, J., Reardon, J., Tocher, M., … Rolfe, J. (2016). *Conservation status of New Zealand reptiles, 2015* (New Zealand Threat Classification Series No. 17). Wellington: Department of Conservation.

Horizons Regional Council. (2007). *Riparian sites of significance based on habitat requirements of selected bird species: Technical report to support Policy development*.

Into the Gorge. (2008). Horizons Regional Council and Department of Conservation.

Kessels & Associates Ltd. (2018). *GHD & NZTA Manawatū Gorge Realignment - Option 3: South of Saddle Road Bats & Bird Habitat and Species Surveys*.

Leschen, R. A. B., Marris, J. W. M., Emberson, R. M., Nunn, J., Hitchmough, R. A., & Stringer, I. A. N. (2012). The conservation status of New Zealand Coleoptera. *New Zealand Entomologist*, *35*(2), 91–98.

Lövei, G. L., & Cartellieri, M. (2000). Ground beetles (Coleoptera, Carabidae) in forest fragments of the Manawatū, New Zealand: Collapsed assemblages? *Journal of Insect Conservation*, *4*(4), 239–244.

Newman, D. G., Bell, B. D., Bishop, P. J., Burns, R. J., Haigh, A., & Hitchmough, R. A. (2013). *Conservation status of New Zealand frogs, 2013* (New Zealand Threat Classification Series No. 5). Wellington: Department of Conservation.

O’Donnell, C. F. (2000). Influence of season, habitat, temperature, and invertebrate availability on nocturnal activity of the New Zealand long-tailed bat (Chalinolobus tuberculatus). *New Zealand Journal of Zoology*, *27*(3), 207–221.

O’Donnell, C. F., Christie, J. E., & Simpson, W. (2006). Habitat use and nocturnal activity of lesser short-tailed bats (Mystacina tuberculata) in comparison with long-tailed bats (Chalinolobus tuberculatus) in temperate rainforest. *New Zealand Journal of Zoology*, *33*(2), 113–124.

O’Donnell, C. F. J., Borkin, K. M., Christie, J. E., Lloyd, B., Parsons, S., & Hitchmough, R. A. (2018). *The conservation status of New Zealand bats, 2017* (New Zealand Threat Classification Series No. 21). Wellington: Department of Conservation.

O’Donnell, Colin F. J., & Sedgeley, J. A. (1999). Use of roosts by the long-tailed bat, *Chalinolobus tuberculatus*, in temperate rainforest in New Zealand. *Journal of Mammalogy*, *80*(3), 913–923.

Pryde, M. A., O’Donnell, C. F. J., & Barker, R. J. (2005). Factors influencing survival and long-term population viability of New Zealand long-tailed bats (*Chalinolobus tuberculatus*): Implications for conservation. *Biological Conservation*, *126*(2), 175–185.

Robertson, C. J. R., Hyvonen, P., Fraser, M. J., & Pickard, C. J. (2007). *Atlas of bird distribution in New Zealand: 1999-2004*. Wellington: Ornithological Society of New Zealand.

Rockell, G., Littlemore, J., & Scrimgeour, J. (2017). *Habitat preferences of long-tailed bats* Chalinolobus tuberculatus *along riparian corridors of the forested Pikiariki Ecological Area, Pureora Forest Park* (DOC Research & Development Series No. 349). Wellington: Department of Conservation.

Sedgeley, J. A. (2001). Quality of cavity microclimate as a factor influencing selection of maternity roosts by a tree-dwelling bat, Chalinolobus tuberculatus, in New Zealand. *Journal of Applied Ecology*, *38*, 424–438.

Sedgeley, J. A., & O’Donnell, C. F. J. (1999). Roost selection by the long-tailed bat, *Chalinolobus tuberculatus*, in temperate New Zealand rainforest and its implications for the conservation of bats in managed forests. *Biological Conservation*, *88*(2), 261–276. https://doi.org/10.1016/S0006-3207(98)00069-X

Sedgeley, J. A., & O'Donnell, C. F. J. (2004). Roost use by long-tailed bats in South Canterbury: examining predictions of roost-site selection in a highly fragmented landscape. *New Zealand Journal of Ecology*, *28*(1), 1–18.

Toft, R. J., Harris, R. J., & Williams, P. A. (2001). Impacts of the weed Tradescantia fluminensis on insect communities in fragmented forests in New Zealand. *Biological Conservation*, *102*(1), 31–46.

Trewick, S., Hitchmough, R., Rolfe, J., & Stringer, I. (2018). *Conservation status of New Zealand New Zealand Onychophora ('peripatus' or velvet worm), 2018* (New Zealand Threat Classification Series No. 26). Wellington: Department of Conservation.

Trewick, S., Johns, P., Hitchmough, R., Rolfe, J., & Stringer, I. (2016). *Conservation status of New Zealand Orthoptera, 2014* (New Zealand Threat Classification Series No. 16). Wellington: Department of Conservation.

Trewick, S., & Morgan-Richards, M. (1995). On the distribution of tree weta in the North Island, New Zealand. *Journal of the Royal Society of New Zealand*, *25*(4), 485–493.

Wardle, D. A., Barker, G. M., Yeates, G. W., Bonner, K. I., & Ghani, A. (2001). Introduced browsing mammals in New Zealand natural forests: aboveground and belowground consequences. *Ecological Monographs*, *71*(4), 587–614.

6.B.1

SUMMER ECOLOGY SURVEY - HERPTOFAUNA - BOFFA MISKELL LTD

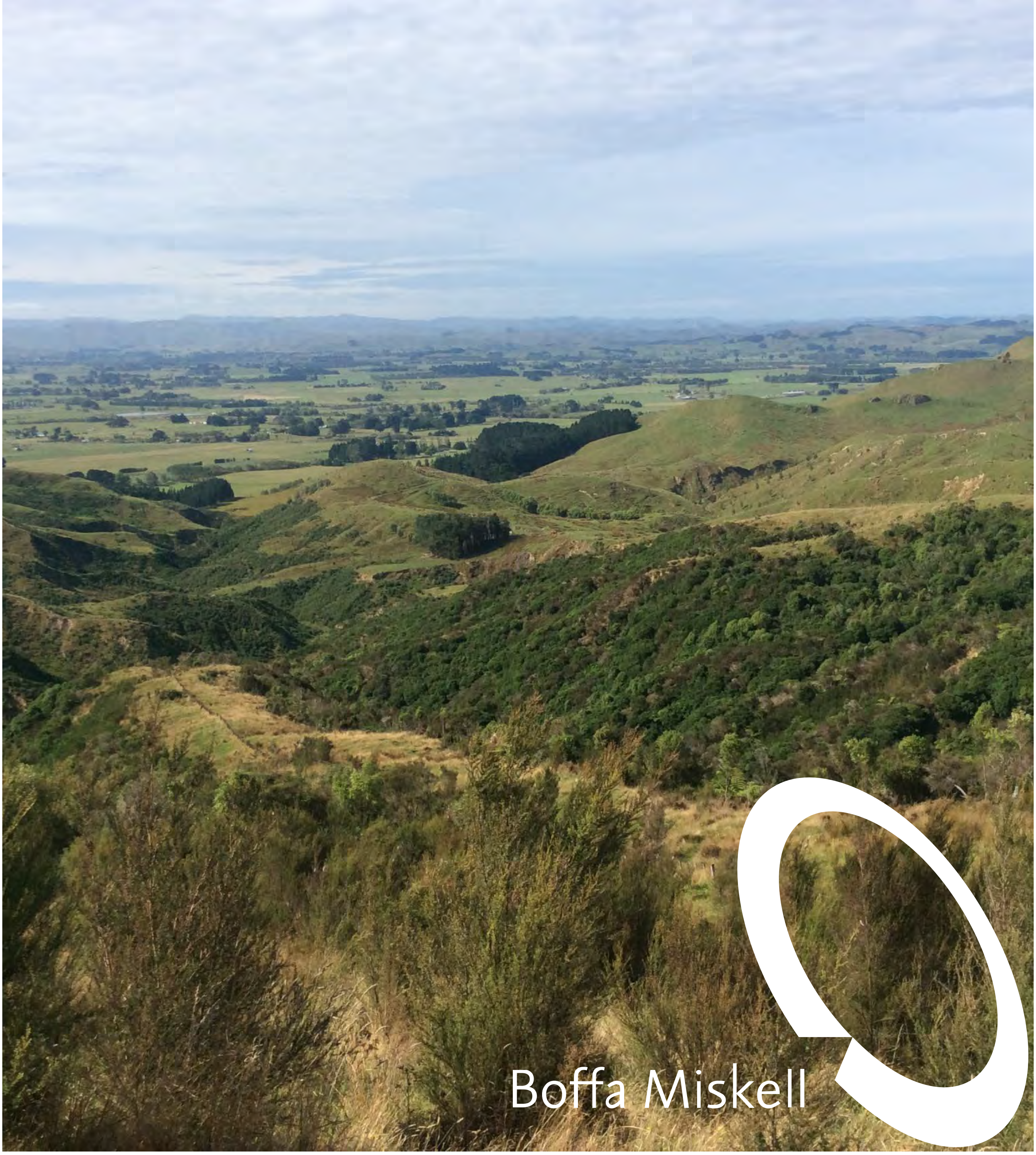
21 MARCH 2018

Appendix 6.B.1: Manawatū Gorge SH3 - Summer Ecology Survey – Herpetofauna – Boffa Miskell Limited 2018

Manawatu Gorge SH3

Summer Ecology Survey - Herpetofauna
Prepared for GHD and the New Zealand Transport Authority

21 March 2018



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Cover photograph: [Manawatu Gorge foot hills looking east, Boffa Miskell, 2018]

Contents

1.0 Introduction 2

2.0 Methodology 2

3.0 Results 3

- 3.1 Desktop assessment 3
- 3.2 Habitat characterisation 4
  - 3.2.1 Manawatu Gorge scenic reserve and contiguous areas contained within rail and road corridors. 5
  - 3.2.2 Area 01 5
  - 3.2.3 Areas 02, 03, and 04 6
  - 3.2.4 Areas 05 7
  - 3.2.5 Area 06 8
  - 3.2.6 Area 07 9
  - 3.2.7 Areas 08 and 09 10
  - 3.2.8 Areas 10 and 11 10
  - 3.2.9 Area 12 11
- 3.3 Visual encounter surveys 13
  - 3.3.1 Daytime VES 13
  - 3.3.2 Night-time VES 13

4.0 Summary 14

5.0 References 15

6.0 Appendix 1 – Lizard habitat maps. 16

1.0 Introduction

New Zealand Transport Agency (NZTA) with GHD Ltd commissioned Boffa Miskell Ltd (BML) to undertake summer ecology surveys for herpetofauna for the preferred proposed new alignment of SH3. The purpose of the surveys is to characterise the habitat available for herpetofauna and conduct a rapid visual and spotlighting survey across representative areas to attempt to confirm the presence of native herpetofauna within the preferred corridor and proposed associated infrastructure to inform future ecological assessments.

2.0 Methodology

A desktop assessment and review of previous herpetofauna records in the Manawatu gorge area was carried out by accessing the Department of Conservation's (DOC) BioWeb herpetofauna database. Records were gathered from within 40km of the Manawatu gorge to capture all species potentially present in the area. Additional to these records landowners and staff encountered during field visits were questioned on any lizard sightings in the area.

Field surveys were carried out with day time surveys across the entire alignment to characterise the habitat available for the lizard species found to be potentially present in the area. Habitat characterisations focused on factors which would influence the likelihood of native herpetofauna occurring such as; approximate vegetation age, composition, complexity, connectivity, amount of natural and/or artificial debris, evidence of pests, land use, stock access, and the presence of microhabitats important to native lizards (rocky outcrops, boulder banks, scree, woodpiles, rotten logs, dense under growth, etc.). Visual encounter surveys (VES) were also carried out during the habitat characterisation surveys. This survey was non-randomised and biased towards areas which potentially contain the target species identified in the desktop assessment.

Representative habitats which were accessible and identified during habitat characterisation survey to have potential habitat value for nocturnal lizards were returned to at night to carry out nocturnal VES. These searches used LED spotlights periodically assisted by binoculars to expand survey area beyond the vegetation edge. The nocturnal VES primarily focused on the edge of vegetation features where the canopy was visible and binoculars could be used to survey further in from the edge of the features across the canopy. However, where able to, searches extended under the canopy and surveyed the sub-canopy, forest floor, and epiphytes. As with the daytime VES this survey was non-randomised and biased towards areas which potentially contain the target species identified in the desktop assessment.

3.0 Results

3.1 Desktop assessment

The DOC herpetofauna database was accessed on 23 February 2018. Listed below are the species previously recorded in the area. Threat classifications and common names follow Hitchmough et al. (2016) for lizard species and Newman et al. (2013) for frog species. Habitat descriptions are summarised to describe likely habitats within the survey area – many species have wider habitat preferences such as coastal areas which do not occur within the survey area.

Three native lizard species have been detected within the Manawatu scenic reserve which occurs both sides of the Manawatu river through the Manawatu gorge. They are:

Barking gecko (*Naultinus punctatus*) – At risk – declining.

> A diurnal arboreal species which lives in forest and scrub. Generally found amongst foliage in the canopy.

Ngahere gecko (*Mokopirirakau* "southern North Island") – At risk – declining.

> A nocturnal (although often discovered basking during the day) arboreal species which lives in forest and scrubland. Generally found on trunks and branches of trees and can be found nearer the ground in shrubs, ferns, and crevices.

Raukawa gecko (*Woodworthia maculatus*) – Not threatened

> A nocturnal arboreal and terrestrial species that can occur in forest, creviced rock outcrops, scree slopes, scrubby areas, and in any dense vegetation.

Additional to the above species within 15km of the proposed alignment footprint there are records of:

Pacific gecko (*Dactylocnemis pacificus*) – At risk – relict.

> A nocturnal arboreal and terrestrial species with similar habitat requirements to above common gecko. In southern North Island most often found in hill country forest.

Glossy brown skink (*Oligosoma zelandicum*) – At risk – declining.

> A secretive diurnal terrestrial species found in damp lowland areas such as forest, scrub, and farmland.

Ornate skink (*Oligosoma ornatum*) – At risk – declining.

> A very secretive crepuscular species which lives in forest or open areas that provide stable cover such as deep leaf litter or rock piles. This species seldom emerges form cover.

Northern grass skink (*Oligosoma polychroma*) – Not threatened.

> A diurnal species which inhabits grasslands, rock piles, scree, wetlands and scrub. Often seen basking.

No further species of extant[1] native species had been previously detected within 40km of the alignments footprint.

Also recorded within the wider area are:

- Several records of unidentified gecko species (some attribute genus only to records).
- One record of unidentified frog species in the northern end of the Tararua range.
- Records of three non-native frog species; brown tree frog (*Litoria ewingii*), growling grass frog (*Ranoidea raniformis*), and green and golden bell frog (*R. aurea*).

While not recorded within the DOC Bioweb herpetofauna database; personal experience indicates that the invasive plague skink (*Lampropholis delicata*) is present in abundance in Palmerston North close to the railway corridor and it is likely they extend beyond the city limit along this corridor.

While onsite several landowners confirmed encountering lizard species either in vegetation in the surrounding area or periodically in their homes. The descriptions given for these species match those species previously recorded in the area such as the barking gecko (described as a green gecko), and either the ngahere gecko or raukawa gecko (described as a grey/brown gecko).

3.2 Habitat characterisation

The habitat along the entire alignment can be broadly characterised by a pasture dominated matrix with deeply incised gullies containing varying ages of regenerating areas of native broad-leaf, fern, and scrub species with scrubby pest plants such as broom and gorse common. Additional to this there are discrete areas of non-native plantation forests and small farm ponds with surrounding native and non-native vegetation.

In general, much of the vegetation present has good habitat values for most of the potential species present in the area. With large amounts of available habitat available for arboreal geckos such as the barking gecko and the more grassland dwelling species such as the northern grass skink. Also, within several secondary forest/scrub patches there are areas of habitat that would be suitable for other species that rely on more complex refugia. A lot of the vegetation is also well connected to the Manawatu scenic reserve which has several lizard species confirmed to be present and would provide a source of lizards into the regenerating vegetation.

Assessments of habitat suitability are based on accepted and understood habitat preferences for relevant species, however, species are regularly detected in areas outside of these understood habitat preferences and therefore the below stated habitat suitability should be a guide only.

During the habitat characterisation fieldwork two stoats and one feral cat were observed in the alignment area, both are potential predators of native lizards.

Below areas have been broadly grouped to distinct areas or gullies and their habitat value briefly described. Area numbers and descriptions refer to habitat maps in Appendix 1:

---

[1] There are bone records of the extinct Markham's frog (*Leiopelma markhami*) located in this wider area.

3.2.1 Manawatu Gorge scenic reserve and contiguous areas contained within rail and road corridors.

These areas consist of a large contiguous mature broad-leaf dominated forest with kanuka, broom, and divaricate *Coprosma* species common along the pasture edge (Figure 1) and in some larger areas at the western end of the gorge (Figure 2). The undergrowth and epiphytes provide complex microhabitats. There is evidence of stock intrusion into the area with grazing and trampling on the forest edge. Habitat suitable for all species potentially present in the area with habitat suitable for arboreal, sub-canopy and terrestrial species. One of the few areas where the leaf litter and cover is stable and deep enough to be considered suitable for ornate skinks.

Figure 1: Broad-leaf dominated forest on pasture edge. Manawatu Scenic Reserve and surrounds.

Figure 2: Scrub dominated vegetation associated with Manawatu Reserve and surrounds on western end of Manawatu gorge.

3.2.2 Area 01

Area which was previously pines but has now been harvested leaving considerable woody debris behind with regenerating scrub species now covering the area. Well connected to the Manawatu gorge scenic reserve and could provide habitat for terrestrial skinks or geckos on the edge of the reserve (see area indicated in red in Figure 3).

Figure 3: Area of woody debris and scrub after felling pine trees. Manawatu Gorge.

3.2.3 Areas 02, 03, and 04

Steeply incised gullies with a relatively mature secondary vegetation with tall kanuka, broad-leaf species, fern species, nikau, cabbage tree, and broom and gorse on the edges. Area 3 appears to be the oldest of the areas with higher kanuka and greater amounts of broad-leaf species present. All areas well connected to the Manawatu Scenic reserve but contain predominately pasture undergrowth but in areas of canopy closure does have some diversity of refugia and undergrowth. Epiphyte cover and complexity is high in some areas. Areas are not fenced from stock. Potentially suitable microhabitats for all potential species in these areas with large amounts of suitable habitat for barking gecko in the scrub and broad leaf canopy. Example photos provided in Figure 4-6.

Figure 4: Looking up the gulley within Area 02 showing relatively mature kanuka/ broadleaf secondary vegetation.

Figure 5: Area 03 relatively mature kanuka/ broadleaf secondary vegetation with extensive tall kanuka scrub.

Figure 6: Area 04 with kanuka scrub vegetation of a younger age than areas 02 and 03.

3.2.4 Areas 05

Steeply incised gully of relatively young, short statured native (kanuka) and non-native scrub species in the northern end of the gully which then progresses into areas of taller scrub and broad-leaf native species towards the southern end. Divaricate *Coprosma* species on the edges common. Wild pines scattered throughout area particularly in the northern end. Ground cover is predominately pasture grasses. Has connectivity to the Manawatu scenic reserve that could act as a source for native lizards. Habitat suitable for barking gecko and northern grass skink with potential for refugia and cover complexity that would be suitable for other species in the southern end of the gully amongst older vegetation.

Figure 7: Area 05 showing low stature native scrub in the northern section of the gully with taller kanuka and broadleaf species in the southern end.

3.2.5 Area 06

Forest patch consisting of older broadleaf-dominated canopy (Figure 8). Has good diversity of refugia in the undergrowth with dense vegetation and leaf litter present including some areas of non-native species such as bamboo which provide a thick dense leaf litter (Figure 9). Suitable microhabitats for all potential species in the area.

Figure 8: Area 06 forest patch with dense broad-leaf canopy.

Figure 9: Area 06 dense leaf litter under non-native bamboo that would provide suitable refugia for native lizards.

3.2.6 Area 07

Small area of planted natives adjacent to a farm pond that is surrounded in non-native vegetation including pines. Small area of planted native is effectively fenced from stock and the undergrowth is dense fern and scrub (Figure 11). Potential for habitat for gecko species in planted native patch but this is disconnected from other vegetation. Limited habitat values around farm pond but still potential for lizard utilising rank grass and non-native scrub vegetation.

Figure 10: Area 07 farm pond and surrounds showing rank pasture and planted non-native species.

Figure 11: Area 07 planted native patch showing dense undergrowth.

3.2.7 Areas 08 and 09

Areas of patchy regenerating kanuka scrub, tree fern, and broad-leaf native species. Broom, and gorse common on edges with patches of pine trees and scattered induvial pines present. Grazing extensive under canopy with little refugia or habitat complexity other than small amounts of woody debris present. Habitat potential for arboreal species but little refugia for others. Northern grass skink may be able to utilise small patches of denser vegetation on edge or areas where stock cannot access.

Figure 12: Area 09 showing area of scrub and fern dominated secondary vegetation.

3.2.8 Areas 10 and 11

Areas of relatively mature secondary vegetation with tall kanuka, broad-leaf species, fern species, nikau, cabbage tree, and divaricate *Coprosma* species on the edges. Broom and gorse also common on pasture edge. Area 10’s canopy has a greater proportion of native broad-leaf species than Area 11 (Figure 13 and Figure 14). Both areas have grazing access but this appears to be limited as there is still good cover of undergrowth which likely provide diverse refugia for lizards. Within the core of Area 10 there was also kiekie and other complex sub-canopy species. Potentially suitable microhabitats for all potential species in these areas with large amounts of suitable habitat for barking gecko in the scrub and broad leaf canopy.

Figure 13: Area 10 looking from top of gully to the bottom showing intact broad-leaf dominated canopy.

Figure 14: Area 11 showing kanuka dominated scrub canopy.

3.2.9 Area 12

Steeply incised gully with relatively young, short stature, kanuka scrub, scattered native broad-leaf species, and few non-native scrub species in the northern end of the gully (Figure 15).

Vegetation then progressively turns to non-native dominated scrub vegetation (broom and gorse) (Figure 16). Divaricate *Coprosma* species on the edges common. Ground cover is predominately pasture grasses. Habitat suitable for barking gecko and northern grass skink with potential for refugia and cover complexity that could be suitable for other species in the northern end of the gully amongst older native dominated vegetation.

Figure 15: Northern end of Area 12 showing low stature kanuka scrub with scatter broad-leaf vegetation.

Figure 16: Photo showing Area 12 progressing from native scrub in the north to non-native scrub to the south. Approximate area where gorse and broom dominate is indicated in red.

3.3 Visual encounter surveys

3.3.1 Daytime VES

Due to the large area in which surveys were to cover daytime VES were opportunistic and carried out during habitat characterisation surveys which occurred on 26, 27, and 28 February 2018. Scrub vegetation was visually searched and the limited amount of woody debris found was lifted to look for lizards. No lizards were found during these surveys. While no detections during daytime VES is not uncommon when searching for the highly cryptic and secretive species potentially present in this area, contributing to this was sub-optimal weather conditions during most of the survey period. Weather conditions varied across the survey period; 26 February consisted of rain with occasional heavy periods, 27 February consisted of strong winds across the survey area, and 28 February weather was fine and warm. Survey hours or effort was not captured for the daytime VES as the searches were sporadic and opportunistic and it is considered inappropriate to attribute a defined time or person hour of effort to the searches.

3.3.2 Night-time VES

Night-time VES was hampered by the previous day's rain during the night of 26 February as the wet foliage reflects light making spotlighting lizards difficult. Twenty minutes of spotlighting by two people occurred in the vicinity of Area 02 before it was decided to abandon the night's survey. Despite the wet vegetation the night-time weather conditions were suitable for spotlighting with light wind and a temperature of ~15°C. Survey effort: 0.66 person hours. No lizards found.

On the night of 27 February Areas 10 and 11 were surveyed. Conditions were initially suitable for spotlighting with light winds, temperature of ~15°C, and prey species such as moths were abundant. Complex scrub habitat on the pasture edge was searched in both areas as well as the sub-canopy, epiphytes, and forest floor in areas of Area 10 by two people. 1.5 hours into the survey light rain began to fall turning to steady rain by 1.75 hours when the survey was stopped. Survey effort: 3.5 person hours. No lizards found.

On the night of 28 February sections of the Manawatu gorge scenic reserve and Areas 04,05 and 06 were surveyed. Conditions were suitable through the survey period with little wind, temperature of ~16°C, with prey species such as moths common throughout the survey period. During this night's survey an additional person from Meridian Energy accompanied the survey team and assisted with the spotlighting – this person has not been included in the calculation of survey effort. Survey summary:

- Area 04: broad-leaf southern section of area surveyed. Large amount of epiphytes visually searched.1.7 person hours. No lizards found.
- Area 05 and Manawatu Scenic Reserve edge: southern end of area 05 and pasture edge of Manawatu Scenic Reserve heading towards area 04 surveyed. Large amounts of divaricate and scrub species. Area almost entirely sheltered from wind. 2.3 person hours. No lizards found.
- Area 06: southern pasture edge surveyed. Large amounts of broad-leaf canopy and trunks and branches of edge vegetation. Area sheltered from wind. 1 Person hour. No lizards found.

4.0 Summary

There are several native lizard species known to be present within the wider area that could potentially be present within the preferred alignment corridor. These species include several arboreal and terrestrial geckos and skinks which have a threat classification of At risk.

The habitats within the corridor have high value for native lizards and generally have good connectivity to the Manawatu Scenic reserve which has previous confirmed detections of several native lizard species and could act as a source of lizards into regenerating scrubland.

Due to the large area to be covered surveys targeted key area that were representative and were considered to have the highest likelihood of encountering native lizards. Lizard survey methods currently available have poor detection rates as a consequence of typically low population densities, species' cryptic colouration and behaviours, and behaviour/activity patterns (Anderson, Bell, Chapman, & Corbett, 2012).

Although survey of the area failed to detect native lizards we consider it very likely that At risk native geckos and skinks occur at low densities within the alignment area, given the confirmed presence of native species in the nearby Manawatu gorge scenic reserve and large areas of potential habitat available within the corridor. It is not uncommon to not detect native lizard species even where they are present. We would propose avoidance and mitigation measures for construction phase including:

- Minimise loss of shrub and forest patches where practicable through design.
- Early development of a lizard management plan for all preliminary and construction works detailing the required processes to follow when carrying out works. This management plan should also identify a suitable release site for each potential species – the Manawatu scenic reserve is likely the best candidate for this and there should be areas suitable for all species present.
- The lizard management plan should be used to support a Wildlife Act Authority application to the Department of Conservation. This authority will allow the survey, handling, and potentially translocation of affected herpetofauna. There should be a priority put on applying for this authority early as processing times can be significant (six months plus).
- Intensive surveys for native lizards in confirmed areas of vegetation loss to establish appropriate mitigation measures.
- Salvage and/or habitat enhancement where native lizards are affected by construction.

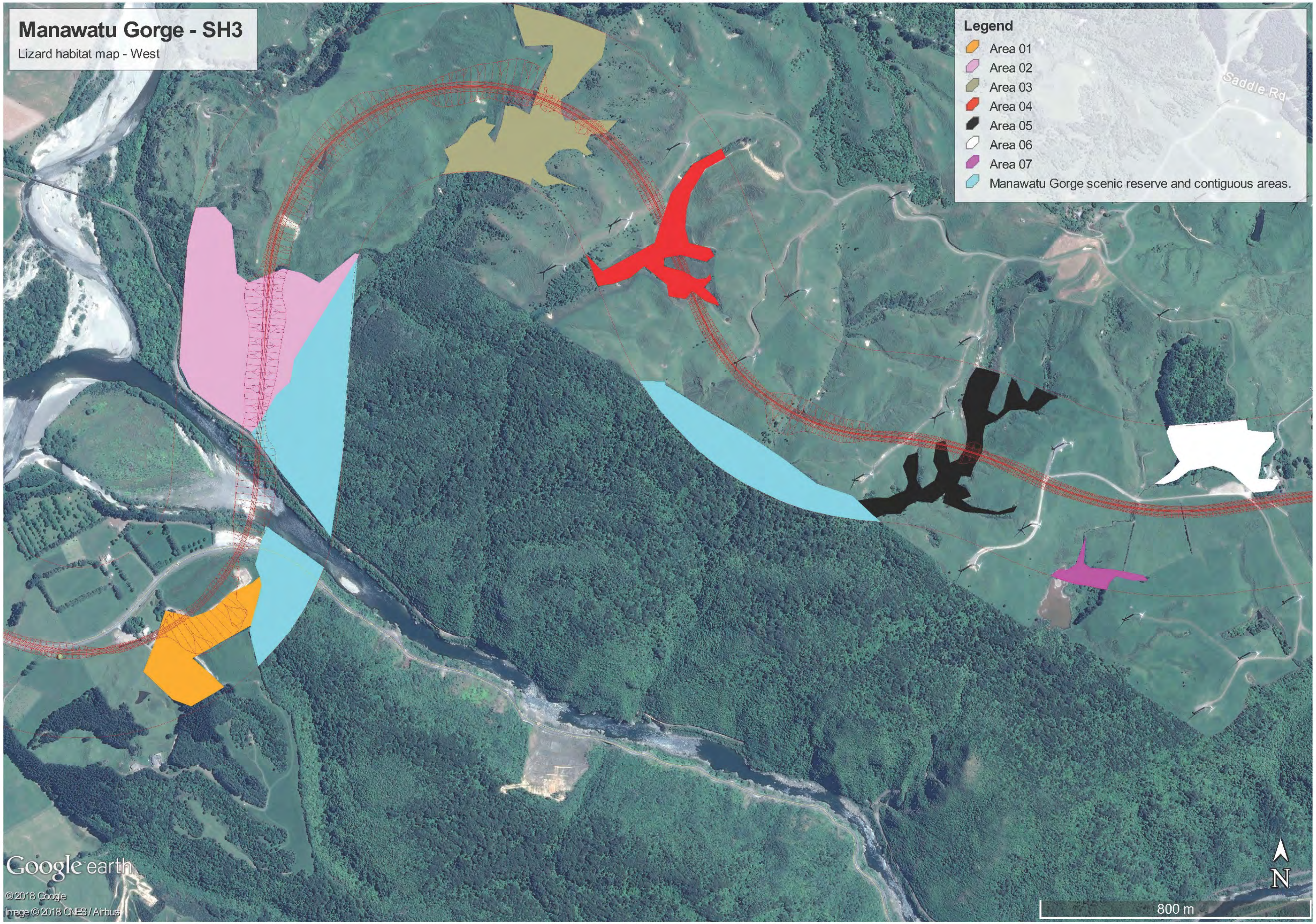
5.0 References

Anderson, P., Bell, T., Chapman, S., & Corbett, K. (2012). *SRARNZ New Zealand lizards conservation toolkit: A resource of conservation management of the lizards of New Zealand*. Society for Research on Amphibians and Reptiles of New Zealand.

Hitchmough, R., Barr, B., Lettink, M., Monks, J., Reardon, J., Tocher, M., … Rolfe, J. (2016). *Conservation status of New Zealand reptiles, 2015* (New Zealand Threat Classification Series No. 17). Wellington: Department of Conservation.

Newman, D. G., Bell, B. D., Bishop, P. J., Burns, R. J., Haigh, A., & Hitchmough, R. A. (2013). *Conservation status of New Zealand frogs, 2013* (New Zealand Threat Classification Series No. 5). Wellington: Department of Conservation.

6.0 Appendix 1 – Lizard habitat maps.



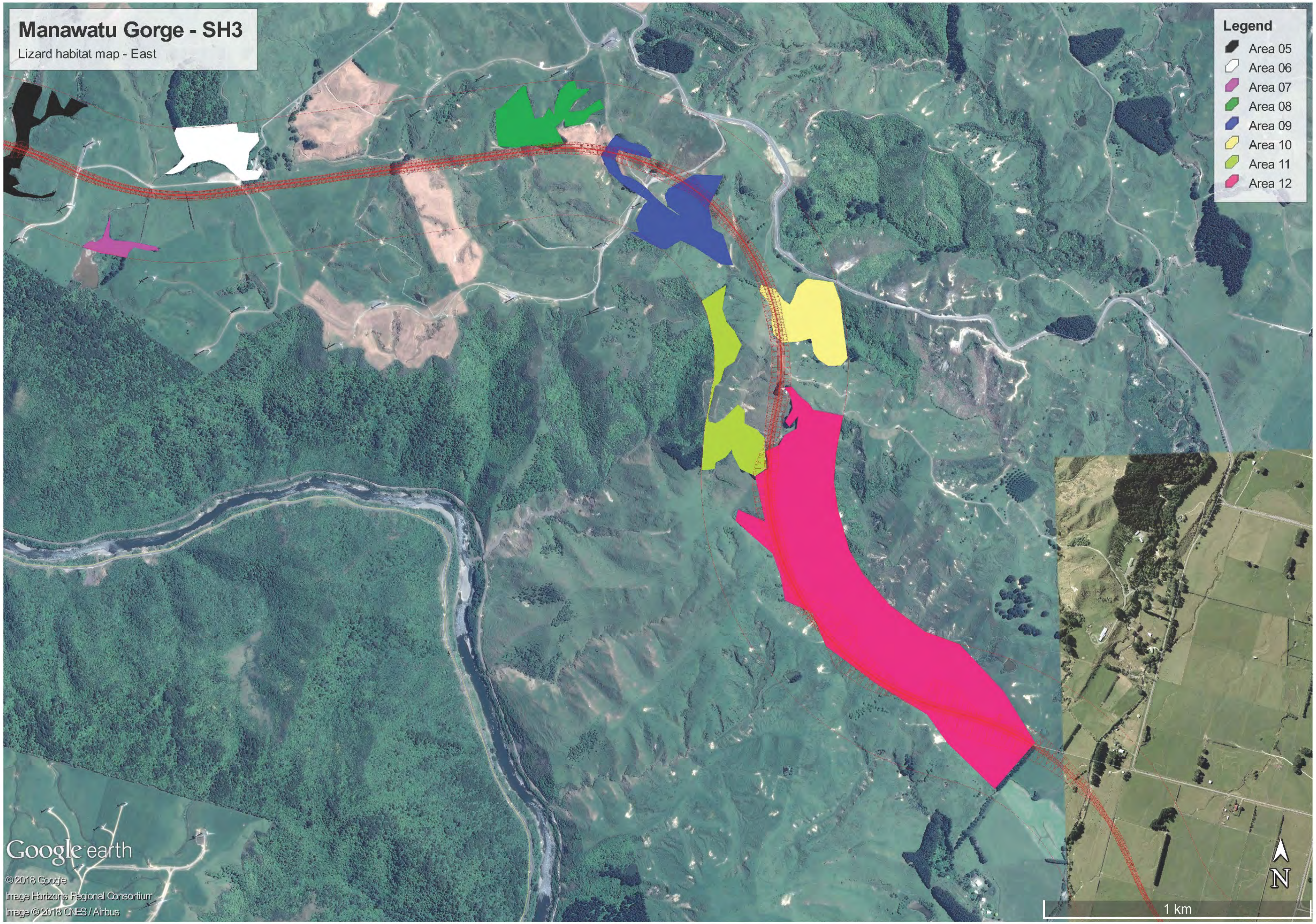

Manawatu Gorge - SH3
Lizard habitat map - East
Legend
Area 05
Area 06
Area 07
Area 08
Area 09
Area 10
Area 11
Area 12
N
1 km
Google earth
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Image © 2018 CNES / Airbus

6.B.2

GHD & NZTA MANAWATŪ GORGE REALIGNMENT OPTION 3: SOUTH OF SADDLE ROAD BATS & BIRD HABITAT & SPECIES SURVEYS

Appendix 6.B.2: GHD & NZTA Manawatū Gorge Realignment. Option 3: South of Saddle Road Bats & Bird Habitat and Species Surveys.

GHD & NZTA
Manawatu Gorge Realignment

Option 3: South of Saddle Road
Bats & Bird Habitat and Species Surveys

Kessels Ecology
survey, assessment, restoration

Table of Contents

Executive Summary 2
1 Introduction 3
2 Methodology 4
  2.1 Background Literature Review 4
  2.2 GIS Mapping 4
  2.3 Bird surveys 5
  2.4 Bat surveys 6
3 Results 6
  3.1 Bird Surveys 6
  3.2 Bat Surveys 13
4 Conclusions and recommendations 14
5 References 15
Appendix I: Survey Sites 16
Appendix II: Site Photos 18
Appendix III: Five Minute Bird Count Data Sheets 27
Appendix IV: Rainfall – 24 hrs (mm) 32

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PWF Ref: GHD.00569

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Executive Summary

Kessels Ecology has been engaged by GHD, on behalf of the New Zealand Transport Agency, to carry out initial species and habitat surveys for bats and birds within and in the vicinity of the proposed Manawatu Gorge Realignment preferred option (Option 3: South of Saddle Road). The proposed realignment would cross through pasture-dominated farmland and part of Te Apiti Wind Farm. Within this landscape there are a number of indigenous forest and scrubland fragments, streams and wetlands which may provide habitat for a range of indigenous birds and possibly long-tailed bats. The purpose of the surveys is to establish potential presence, absence and distribution of these targeted indigenous birds and long-tailed bats within the corridor and areas affected by this. These surveys will inform future ecologists commissioned to prepare the Assessment of Ecological Effects in understanding the existing ecological value of the project area.

Bat and bird surveys were conducted from 26th February to 13th March 2018. For bats, static digital recorders (Automatic Bat Monitors; ABMs) were deployed in areas assessed to be potential bat habitat to detect bat activity in the form of echolocation calls during the night. For birds, five-minute bird counts (5MBCs) were used in conjunction with Automatic Recording Devices (ARDs) that recorded all sounds from before sunset until after sunrise for the duration of the period. Detectors were left on site for fourteen consecutive nights to establish presence or absence of bats and birds.

Acoustic surveys and 5MBCs revealed the presence of 32 bird species within the proposed Manawatu Gorge realignment corridor, comprising seven endemic species, ten native species, and 15 introduced species. A densely vegetated wetland surrounded by indigenous vegetation and two wetlands with open water recorded the highest levels of endemism with five endemic species recorded at each. High numbers of native species were recorded adjacent to the Manawatu River.

The field survey identified the presence of only one notable bird species in the project area - the At risk-recovering New Zealand falcon, New Zealand's only extant endemic raptor. Other bird species detected include five endemic but not-threatened species. Four notable bird species not detected during the surveys, but which could be present on occasion due to the available habitat are: North Island kaka; spotless crake; and two dotterel species.

Overall, the results indicate that the alignment traverses a largely an agricultural land space, with habitats of greatest value to indigenous (and notable) birds within the survey corridor are the wetlands, riparian margins of the Manawatu River, and indigenous vegetation including tawa forest and forested gullies. Additional surveys are recommended within these habitats, in particular to detect wetland birds and dotterel species.

No long-tailed bats were detected within the corridor; however non-detection does not equate absence and additional surveys are recommended in areas requiring pre-construction vegetation removal.

1 Introduction

Kessels Ecology has been engaged by GHD on behalf of the New Zealand Transport Agency to carry out initial species and habitat surveys for bats and birds within and in the vicinity of the proposed Manawatu Gorge Realignment preferred option. The purpose of the surveys is to establish potential presence, absence and distribution of indigenous birds and long-tailed bats within the preferred corridor and areas affected by this to inform future ecologist(s) commissioned to prepare the Assessment of Ecological Effects in understanding the existing ecological value of the project area.

The Manawatu Gorge is located to the east of Palmerston North and forms a passage running between the Tararua Range in the north and the Ruahine Range in the south. The Gorge is unique in that it is a water gap with the Manawatu River flowing directly from the east to the west. At the western end of the gorge, the Manawatu River is joined by the Pohangina River, a wandering river (i.e. a transitional pattern between a braided river and a single-thread meandering channel). The northern and southern slopes of the gorge are covered in indigenous vegetation ranging from regenerating scrub to tawa forest. The surrounding countryside is predominantly farmland, with multiple windfarms situated along the ridges.

The Manawatu Gorge Road (State Highway 3) links the eastern and western regions of the southern North Island; however, it has been closed for much of the past ten years due to recurring rockfall. The Saddle Road to the north and the Paihiatua Track to the south have been used as alternative routes but in their current state are inadequate as permanent alternatives to the Manawatu Gorge.

Four possible options have been proposed to replace the gorge:

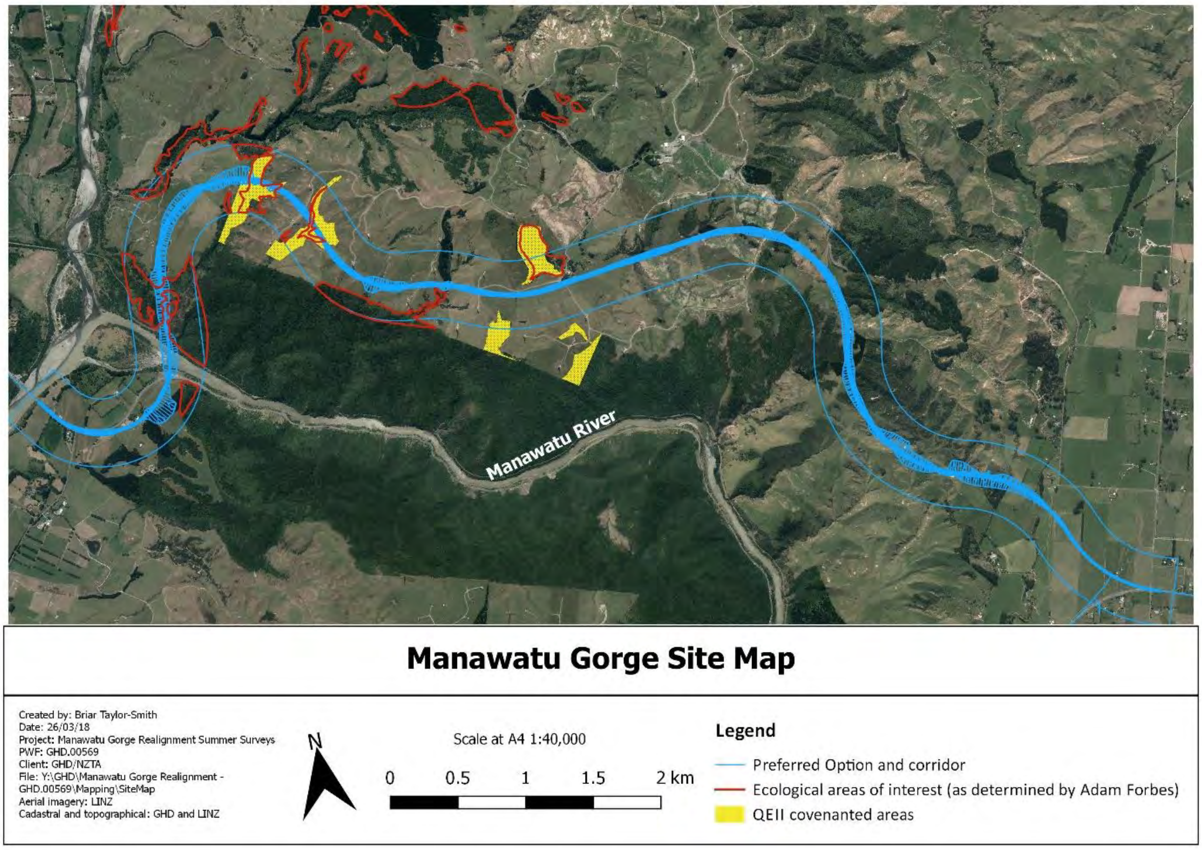
- Option 1: North of Saddle Road;
- Option 2: Saddle Road Upgrade;
- Option 3: South of Saddle Road; and
- Option 4: South of Gorge.

Currently Option 3: South of Saddle Road is the preferred option (Figure 1). The building of the new road will take 5 – 6 years to complete the 12.4 km length that will run through Te Apiti Wind Farm, farmland, and several “ecologically significant” areas. The sites of “ecological significance” include forest, treeland and wetland and were determined during an initial assessment by the ecologist, Adam Forbes, and polygons were provided to us by the client.

Bat and bird surveys were conducted from 26th February to 13th March 2018 to determine the extent and use of these habitats by birds and bats. For bats, static digital recorders were employed to detect bat activity in the form of echolocation calls during the night. For birds, 5MBCs were used in conjunctions with Automatic Recording Devices (ARDs) that recorded all sounds from before sunset until after sunrise for the duration of the period. Detectors were left on site for fourteen consecutive nights to establish presence or absence of bats and birds.

This report provides the results of bat and bird surveys undertaken within and around the proposed corridor of Option 3. The report presents methodology and results of the surveys, and recommendations for additional work to support an Assessment of Ecological Effects for the proposed road.

Figure 1. Manawatu Gorge realignment preferred option and corridor. Ecological areas of interest (as previously determined) are also highlighted.



2 Methodology

2.1 Background Literature Review

Existing information on bats and avifauna in the vicinity of the Manawatu Gorge were reviewed to inform on the potential presence, absence and distribution within the preferred corridor and potentially affected areas.

The following documents and databases were reviewed for the survey planning:

- The Ornithological Society of New Zealand (OSNZ) Atlas of Bird Distribution in New Zealand 1999–2004;
- Naturewatch;
- BioWeb; and
- Various consulting reports.

Any nationally threatened or at risk threatened species found were recorded and their threat status checked against the relevant national threatened species classification lists (O'Donnell et al., 2018; Robertson et al., 2017).

2.2 GIS Mapping

The extent of Short list Option 3 – South of Saddle Road and its 300 m corridor (provided by the client) was projected using QGIS 2.18.7. Sites of "ecological significance", as determined during an initial assessment by ecologist Adam Forbes, were provided as a layer by the client.

2.3 Bird surveys

2.3.1 Point surveys and incidental observations

Five-minute bird counts were undertaken in accordance with the methodology described by Dawson & Bull (1975). No bird was knowingly recorded twice within the five-minute time period and no bird was assumed to be present (e.g. only the accurate number of birds heard calling or seen were recorded, not the size of the flock estimated to be present by the amount of calling heard). All incidental bird observations while on-site were recorded.

Five-minute bird count sites are shown in Figure 2. Specific locations are shown in Appendix I.

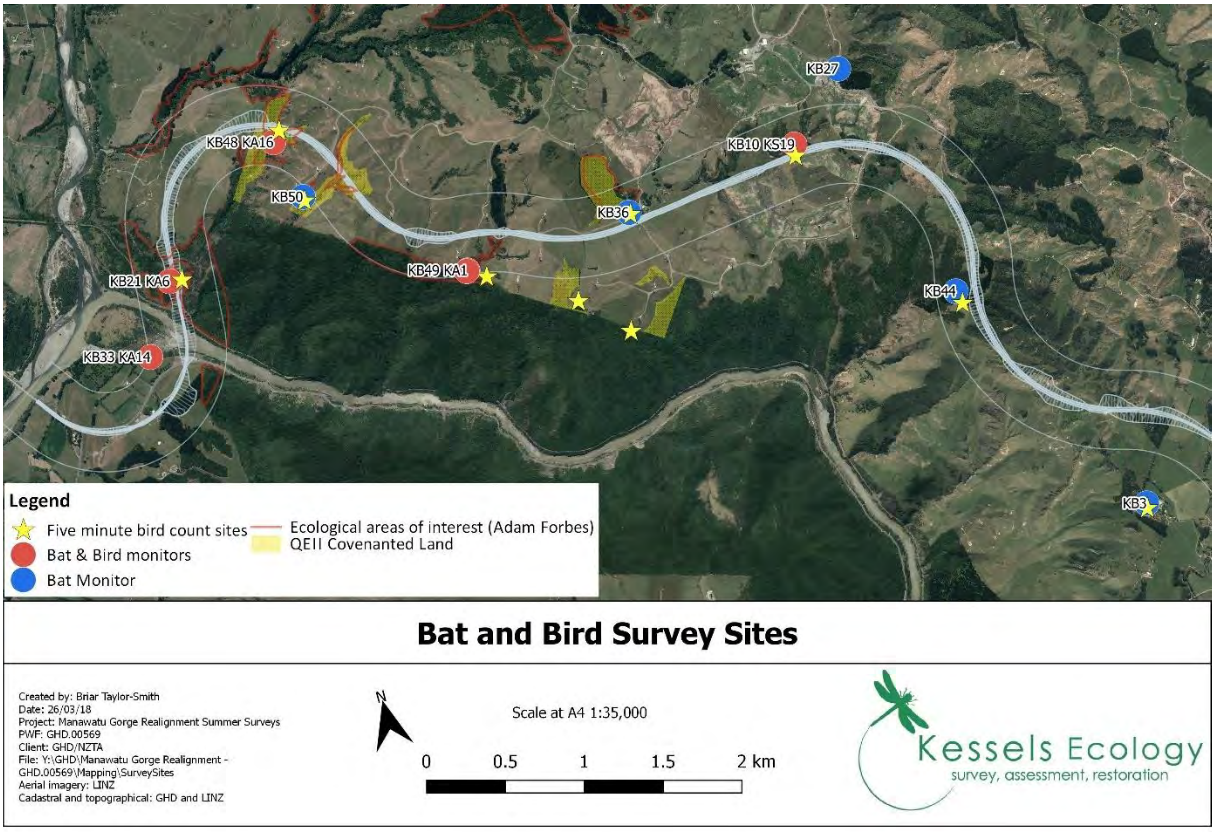


Figure 2. Five-minute bird count and acoustic recording device deployment sites throughout the Manawatu Gorge realignment Option 3 corridor.

2.3.2 Bioacoustic surveys

Bird surveys were conducted using ARDs at selected locations along the corridor. Bioacoustics are a useful method to identify vocal migratory, nocturnal or cryptic species, which require long monitoring periods to ensure detection and often migrate or move between feeding and roosting locations at night. For example, cryptic wetland species, such as spotless crake and bitterns, call very early in the morning, often well before dawn.

An array of four Department of Conservation (DOC) automated digital sound recorders (Version D.2) were deployed across the site (Figure 2, specific locations shown in Appendix I). The recorders were deployed over the length of the corridor at selected locations offering a range of bird habitats. They were pre-set on “low” (0 - 4 kHz) and set to record between the hours of 5:00 pm and 9:00 am to monitor crepuscular and nocturnal birds that could not be detected during our daytime bird surveys. One ARD was deployed on 26th February 2018. Four ARDs were deployed on 27th February. ARDs recorded from their deployment date until 9:00am on March 13th 2018 (14 – 15 nights).

The sound files were analysed using Raven Pro 1.5.0 software, developed by Cornell Lab of Ornithology Bioacoustics Research Programme. Calls were manually classified on the basis of their audible characteristics and by comparison of spectrograms.

2.4 Bat surveys

A survey to detect the presence of bats in the vicinity of the project site was conducted over 14 nights from 27th of February 2018 until 13th March 2018.

An array of ten DOC designed and built ABMs were deployed across the site from 27 February to 13 March 2017 (Figure 2, Appendix I). ABMs record anything that may be an 'echo-location call' generated by either of the two extant New Zealand bat species. ABMs were deployed in locations near water or on the edge of natural corridors where bats are likely to feed and travel (Borkin & Parsons, 2009; O'Donnell, 2000; Dekrout, 2009). The ABMs were used in accordance with protocols prescribed by Lloyd (2009) and each was set to record bat echolocation calls between the hours of 6:45 pm and 8:00 am to monitor for bats one hour either side of sunset and sunrise for the entire survey period.

The data was analysed visually using BatSearch 3.11, software that was developed to help quickly view the files and create data from them. The frequency spectrum covered ranges from 0 Hz to 88 kHz and images represent 1-6 seconds of recording. Long-tailed bat passes show up as clicks centred at about 40 KHz extending upwards, but may show spikes extending downwards when the clicks are so loud that they overwhelm the sensor and cause an artificial frequency image.

3 Results

3.1 Bird Surveys

The Atlas of bird distribution in New Zealand (1999-2004) forms a relevant set of data on the birds of the locality (Robertson et al., 2007). These records, along with additional reports and databases, provide an indication of the bird species present in a region. The literature review indicated the presence of 68 bird species within the vicinity of the Manawatu Gorge. Table 1 provides a complete list of all bird species recorded within the vicinity of the Manawatu Gorge and their conservation status (Robertson et al., 2017).

Table 1. Bird species recorded within the vicinity of the Manawatu Gorge and their conservation status (Robertson et al., 2017).

Common name	Scientific name	Threat status
New Zealand pipit	*Anthus novaeseelandiae*	Declining
Red-billed gull	*Larus novaehollandiae*	Declining
South Island pied oystercatcher	*Haematopus finschi*	Declining
Spotless crake	*Porzana tabuensis*	Declining
Whitehead	*Mohoua albicilla*	Declining
Blackbird	*Turdus merula*	Introduced
California quail	*Callipepla californica*	Introduced
Canada goose	*Branta canadensis*	Introduced
Chaffinch	*Fringilla coelebs*	Introduced
Common redpoll	*Carduelis flammea*	Introduced
Eastern rosella	*Platycercus eximius*	Introduced
Goldfinch	*Carduelis carduelis*	Introduced
Greenfinch	*Carduelis chloris*	Introduced
Greylag goose	*Anser anser*	Introduced

Hedge sparrow	*Prunella modularis*	Introduced
House sparrow	*Passer domesticus*	Introduced
Magpie	*Gymnorhina tibicen*	Introduced
Mallard	*Anas platyrhynchos*	Introduced
Mute swan	*Cygnus olor*	Introduced
Myna	*Acridotheres tristis*	Introduced
Ring-necked pheasant	*Phasianus colchicus*	Introduced
Rock pigeon	*Columba livia*	Introduced
Rook	*Corvus frugilegus*	Introduced
Skylark	*Alauda arvenis*	Introduced
Song thrush	*Turdus philomelos*	Introduced
Starling	*Sturnus vulgaris*	Introduced
Wild turkey	*Meleagris gallopavo*	Introduced
Yellow hammer	*Emberiza citrinella*	Introduced
Cattle egret	*Ardea ibis*	Migrant
Australasian bittern	*Botaurus poiciloptilus*	Nationally critical
Black-billed gull	*Larus bulleri*	Nationally critical
Grey duck	*Anas superciliosa*	Nationally critical
White heron	*Ardea modesta*	Nationally critical
Banded dotterel	*Charadrius bicinctus*	Nationally vulnerable
Caspian tern	*Hydroprogne caspia*	Nationally vulnerable
Australian coot	*Fulica atra*	Naturally uncommon
Black shag	*Phalacrocorax carbo*	Naturally uncommon
Black-fronted dotterel	*Elseyornis melanops*	Naturally uncommon
Little black shag	*Phalacrocorax sulcirostris*	Naturally uncommon
Royal spoonbill	*Platalea regia*	Naturally uncommon
Australasian shoveler	*Anas rhynchotis*	Not threatened
Bellbird	*Anthornis melanura*	Not threatened
Black swan	*Cygnus atratus*	Not threatened
Grey teal	*Anas gracilis*	Not threatened
Grey warbler	*Gerygone igata*	Not threatened
Little shag	*Phalacrocorax melanoleucos*	Not threatened
Morepork	*Ninox novaeseelandiae*	Not threatened
New Zealand fantail	*Rhipidura fuliginosa*	Not threatened
New Zealand pigeon	*Hemiphaga novaeseelandiae*	Not threatened
New Zealand scaup	*Aythya novaeseelandiae*	Not threatened
NZ Kingfisher	*Todiramphus sanctus*	Not threatened
Paradise shelduck	*Tadorna variegata*	Not threatened
Pied stilt	*Himantopus novaezelandiae*	Not threatened
Pukeko	*Porphyrio melanotus*	Not threatened
Shining cuckoo	*Chrysococcyx lucidus*	Not threatened
Silvereye	*Zosterops lateralis*	Not threatened
Southern black-backed gull	*Larus dominicanus*	Not threatened
Spur-winged plover	*Vanellus miles*	Not threatened
Swamp harrier	*Circus approximans*	Not threatened

Tomtit	*Petroica macrocephala*	Not threatened
Tui	*Prosthemadera novaeseelandiae*	Not threatened
Welcome swallow	*Hirundo neoxena*	Not threatened
White-faced heron	*Egretta novaehollandiae*	Not threatened
New Zealand dabchick	*Poliocephalus rufopectus*	Recovering
New Zealand falcon	*Falco novaeseelandiae*	Recovering
North Island kaka	*Nestor meridionalis*	Recovering
Pied shag	*Phalacrocorax varius*	Recovering
Black stilt x Pied stilt hybrid	*Himantopus himantopus x novaezelandiae*	NA (Hybrid)

3.1.1 Summary results

Thirteen five-minute bird counts were carried out at ten locations throughout the alignment (Figure 2; Appendices II, III) on February 27th and March 13th between the hours of 9:30 am and 3:20 pm. Acoustic monitoring took place in five different locations over the length of the corridor (Figure 2) and recorded for a total of 800 hours. A total of 32 species were recorded within the realignment corridor comprising seven endemic species, ten native species, and 15 introduced species (Table 2). Between sites the proportion of total indigenous species ranged from 40% (Site 4) to 83% (Site 11; Figure 3). Sixty-two percent of 5MBCs showed a greater abundance of indigenous birds than introduced birds (Figure 4).

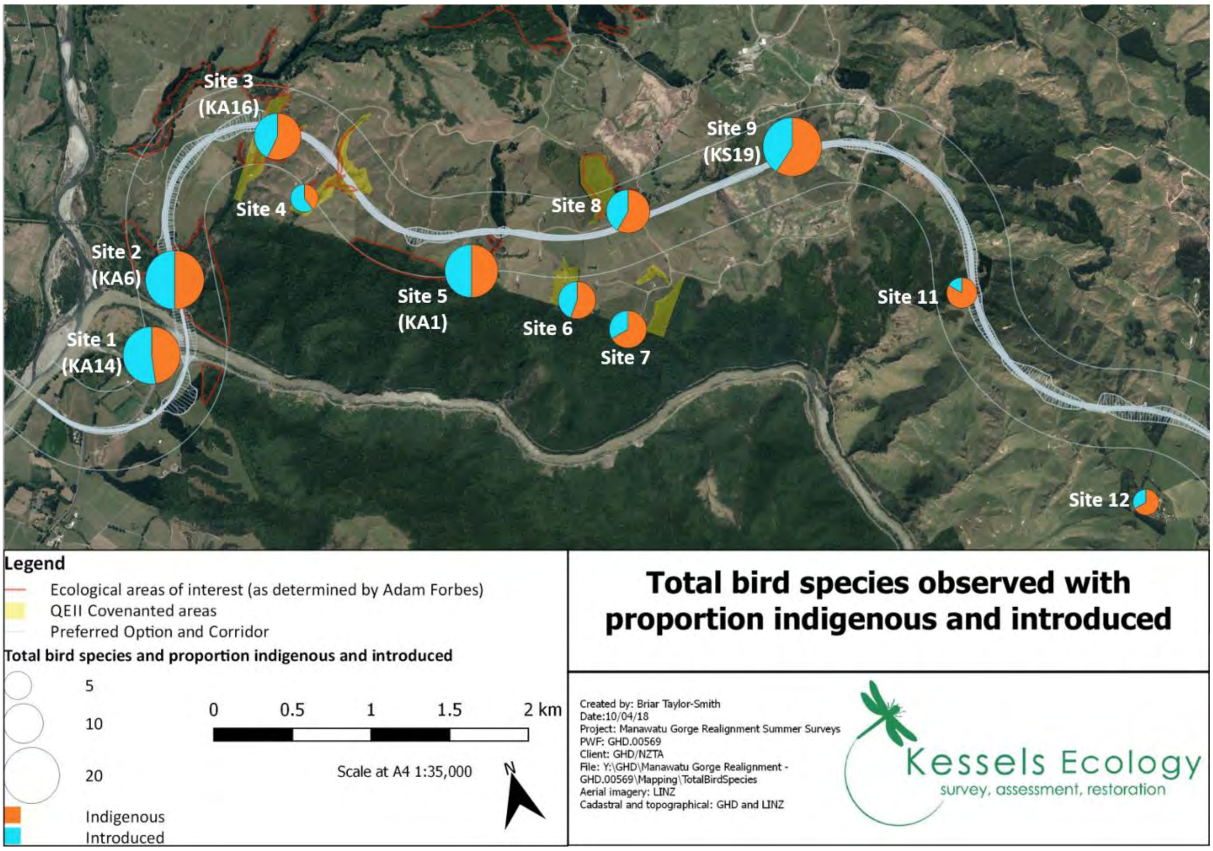


Figure 3. Bird surveys sites (numbered) showing total bird species observed and proportion indigenous and introduced. Included in these counts are birds observed during 5MBCs and acoustic recordings and incidental. Site 10 is not shown as it was a bat survey site only.

Table 2. List of bird species observed within the vicinity of the realignment, with threat status as defined by Robertson et al. (2017). Method of detection is shown in the final two columns.

Common name	Scientific name	Threat status	Acoustic Recording Device	Five-minute bird count site (Sites listed in Appendix I)
Blackbird	*Turdus merula*	Introduced	KA1, KA6, KA14, KS19	S4, S5, S7, S8, S9
Chaffinch	*Fringilla coelebs*	Introduced	KA1, KA6, KA14, KA16, KS19	S3, S5, S9
Eastern rosella	*Platycercus eximius*	Introduced	KA6, KA14, KS19	S8
Goldfinch	*Carduelis carduelis*	Introduced	KA1, KA6, KA14, KS19	S3, S4, S9, S12
Greenfinch	*Carduelis chloris*	Introduced	KA1, KA6, KA14, KS19	S5, S6, S9
Hedge sparrow	*Prunella modularis*	Introduced	KA6	No
House sparrow	*Passer domesticus*	Introduced	KA1, KA6, KA14, KA16, KS19	S2, S5, S7, S8, S9
Magpie	*Gymnorhina tibicen*	Introduced	KA1, KA6, KA14, KA16, KS19	S2, S3, S4, S6, S7, S8, S9, S11
Mallard	*Anas platyrhynchos*	Introduced	KA1, KA6, KA14, KS19	S6, S9
Myna	*Acridotheres tristis*	Introduced	KA1	No
Ring-necked pheasant	*Phasianus colchicus*	Introduced	KA6, KA14	No
Song thrush	*Turdus philomelos*	Introduced	KA6, KA14	No
Starling	*Sturnus vulgaris*	Introduced	KA1, KA6, KA14, KA16, KS19	S3
Wild turkey	*Meleagris gallopavo*	Introduced	No	Incidental - Near S3
Yellow hammer	*Emberiza citrinella*	Introduced	No	S8
Australasian shoveler	*Anas rhynchotis*	Not threatened	No	S9
Bellbird	*Anthornis melanura*	Not threatened	KA1, KA6, KA14, KA16	S2, S7
Grey teal	*Anas gracilis*	Not threatened	KA14	NA
Grey warbler	*Gerygone igata*	Not threatened	KA1, KA6, KA14, KA16, KS19	S2, S3, S5, S7, S8, S9, S11
Morepork	*Ninox novaeseelandiae*	Not threatened	KA1, KA6, KA14, KA16, KS19	No
New Zealand fantail	*Rhipidura fuliginosa*	Not threatened	KA6, KA14, KA16	S2, S3, S4, S5, S7, S8, S9, S11, S12
New Zealand pigeon	*Hemiphaga novaeseelandiae*	Not threatened	KA6	S7, S8
NZ Kingfisher	*Todiramphus sanctus*	Not threatened	KA1, KA6, KA14, KS19	No
Paradise shelduck	*Tadorna variegata*	Not threatened	No	S6, S9
Pukeko	*Porphyrio melanotus*	Not threatened	KA1, KA6, KA14	S2, S6
Silvereye	*Zosterops lateralis*	Not threatened	KA1, KA6, KA14, KA16, KS19	S3, S5, S8, S9, S11
Spur-winged plover	*Vanellus miles*	Not threatened	KA1, KA6, KA14, KA16, KS19	No
Swamp harrier	*Circus approximans*	Not threatened	KA6, KA14, KS19	S3, S6, S7, S8, S9, S11
Tui	*Prosthemadera novaeseelandiae*	Not threatened	KA1, KA6, KA14, KA16, KS19	S2, S3, S4, S5, S6, S7, S8, S12
Welcome swallow	*Hirundo neoxena*	Not threatened	No	S6, S8, S9
Southern black-backed gull	*Larus dominicanus*	Not threatened	KS19	No
New Zealand falcon	*Falco novaeseelandiae*	Recovering	No	S11

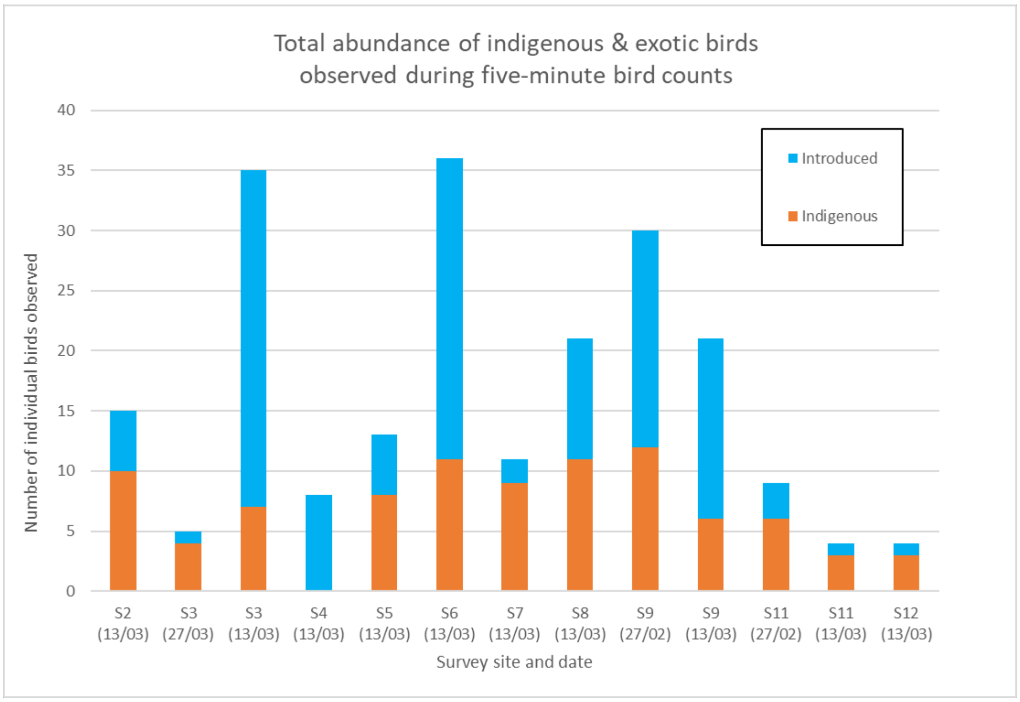


Figure 4. Total abundance of indigenous and exotic birds observed during five-minute bird counts.

The most commonly recorded species were fantails (endemic) and magpies (introduced), recorded at 10 of the 11 bird surveys sites within the alignment (Figure 5; Figure 6) . Other commonly recorded species included blackbird, goldfinch, house sparrow, grey warbler, silver eye, swamp harrier and tui. The site 2 wetland (amongst indigenous vegetation), site 6 (open pasture near forest and wetland) and site 9 (open wetland surrounded by pasture, pine forest and indigenous vegetation) recorded the highest levels of endemism with five endemic species recorded at each. The greatest numbers of native species were recorded at sites 1 (adjacent to the Manawatu River) and site 9 (wetland). The wetlands at sites 2 and 9 also had the highest species diversity with 22 species recorded. Site 1 by the Manawatu River also had high species diversity with 21 species recorded.

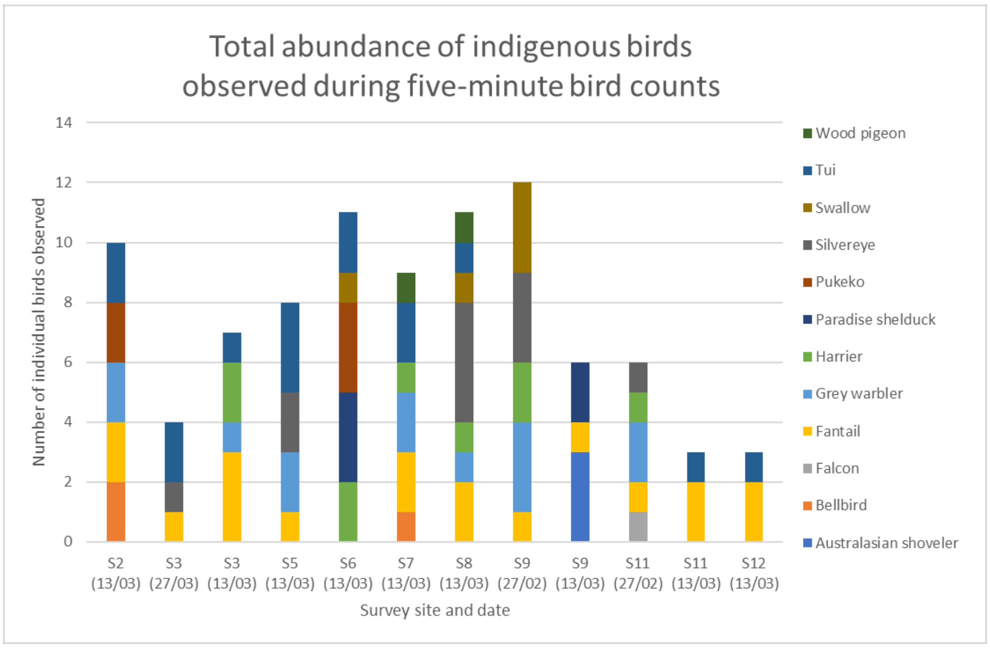


Figure 5. Total abundance of indigenous birds observed during five-minute bird counts. Note that Site 4 had no indigenous birds and is not shown.

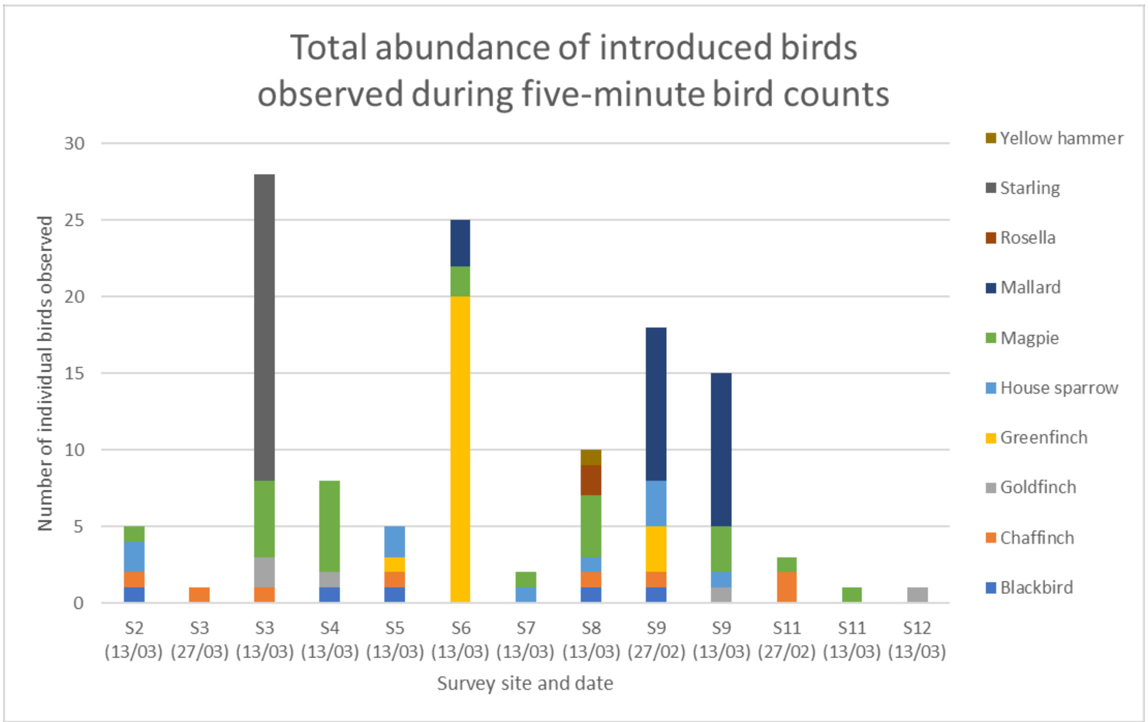


Figure 6. Total abundance of introduced birds observed during five-minute bird counts.

The greatest number of birds was recorded at site 6 (pasture overlooking wetland at the edge of indigenous vegetation), with 36 birds. The high numbers were due to the presence of a flock of greenfinches. Site 12 (indigenous and exotic vegetation near house) had the lowest abundance of birds, with four individuals recorded. The highest abundance of endemic birds was recorded at site 2 (wetland) and site 7 (tawa forest) with eight endemic birds each.

One 'At risk – recovering' species, the New Zealand falcon, was recorded flying over pasture at site 11 and has been recorded in the Ashhurst area directly to the west of the alignment (Robertson et al., 2007).

Overall, these results indicate that the habitats of greatest value to indigenous birds within the survey corridor are the wetlands, river margin, and indigenous vegetation including tawa forest and forested gullies.

3.1.2 Notable bird species

The field survey identified the presence of notable bird species in the project area (Table 3), including New Zealand falcon, New Zealand's only extant endemic raptor. NZ falcons are adapted to hunting within forests but are also found in open areas such as farmland where they hunt small birds on the wing and occasionally small mammals and insects. NZ falcons are susceptible to habitat modification and degradation, predation by introduced pests, and electrocution. Other notable species detected include five endemic but not-threatened bird species (tui, bellbird, grey warbler, NZ pigeon and fantail). Details on the distribution, behaviour, breeding and ecological significance of these species can be found in Table 3. Paradise shelduck is also a not-threatened endemic species recorded on open water at two wetland sites within the corridor. It is not considered notable as in recent decades it has undergone a dramatic increase in abundance and is now widely distributed on farmland, parks and lake shorelines throughout New Zealand (Williams 2013).

Four species were not detected during the surveys but may utilise this locality due to the available habitat. These species are North Island kaka (Recovering, endemic), which have been seen utilising the lowland forest habitats on a seasonal basis in the bush areas immediately south in the Tararua ranges (Robertson et al., 2007). Found throughout native forest, including within the Ruahine Ranges to the north, they can be regarded as vagrant visitors to this locality. Kaka travel long distances to forage and can be cryptic when alone. Spotless Crake (declining, native) are widely distributed, but patchy, throughout the North Island where they live amongst dense wetland vegetation as found at Site 2. These birds are secret and crepuscular.

The riparian margin of the Manawatu Gorge has been identified as a riparian site of significance for banded dotterel and black-fronted dotterel (Lambie 2007). Banded dotterel, an endemic and nationally vulnerable species, nest on gravel and sand on seashores, estuaries, and riverbeds, travelling to estuaries and coastal wetlands once the July to January breeding season is over. Black-fronted dotterel, a native and naturally uncommon species, is found in small numbers in the Manawatu region beside waterways and ponds; however, they are cryptic birds.

The habitats of greatest value to notable birds within the survey corridor include forested areas, wetland and riparian margins of the Manawatu River.

Table 3. Notable bird species present or with suitable habitat within the alignment corridor.

Notable species	Field survey findings	Habitat, behaviour, breeding and ecological significance
New Zealand falcon, Threatened – recovering, endemic	A single New Zealand falcon, was recorded flying over pasture at Site 11.	Is adapted to hunting within forests but also found in open areas such as farmland. Hunt small birds on the wing, but occasionally hunt small mammals and insects. Breed in spring and summer nesting in trees, rocky outcrops and on the ground. New Zealand's only extant endemic raptor.
Bellbird, not threatened, endemic	Bellbirds were recorded at six locations throughout the corridor including on farmland, in native and exotic vegetation surrounding wetlands, in gullies and within tawa forest.	Inhabits native and exotic forest, scrub, farm shelterbelts, parks and gardens. Territorial during the breeding season, but nomadic and solitary after. Mainland bellbirds lay in September-January. Important pollinator and seed disperser.
Grey warbler, not threatened, endemic	Grey warblers were recorded at eight locations within the corridor throughout all habitat types surveyed.	Prefers dense vegetation in both rural and urban areas through New Zealand. Pairs remain within their territories year-round. Breed in spring and summer.
New Zealand fantail, not threatened, endemic	Fantails were recorded at all but one bird survey site within the corridor.	Has a wide distribution and habitat preferences, including both native and exotic forest and shrubland habitats. Fantails are locally common. Breeding season is variable but tends to be long. Important seed-disperser.
New Zealand pigeon, not threatened, endemic	New Zealand pigeons were recorded at three sites within and adjacent to native vegetation within the corridor.	Widespread and locally common. Will defend food trees and can travel long distances to feed. Have been recorded breading year-round.
Tui, not threatened, endemic	Detected at nine sites within the corridor throughout all habitat types surveyed.	Widespread passerine found in forest and urban areas. Aggressive, territorial birds that often commute to good nectar sources. Tui lay in September-January. Important pollinators and seed disperser.
Banded dotterel, nationally vulnerable, endemic	Not detected during the surveys likely due to the season, but the riparian margin of the Manawatu Gorge has been identified as a riparian site of significance based on the habitat requirements of banded dotterel (Lambie 2007)	Widespread on mainland New Zealand during breeding season (July – January), where they nest gravel and sand on seashores, estuaries, and riverbeds. Inland-breeding birds travel to estuaries and coastal wetlands post-breeding.
Black fronted dotterel, naturally uncommon, native	Not detected during the surveys, but the riparian margin of the Manawatu Gorge has been identified as a riparian site of significance based on the habitat requirements of black-fronted dotterel (Lambie 2007)	Found in small numbers in the Manawatu region beside waterways and ponds. Cryptic birds seen in pairs of small flocks. Breeding season is August to March.
Spotless Crake, declining, native	Although not detected by ARDs, 'At Risk-Declining' spotless crake may be present amongst the dense wetland vegetation at Site 2.	Widely distributed, but patchy, throughout the North Island where it lives amongst dense wetland vegetation. Secret, crepuscular and territorial birds. Breeding season from August to January.
North Island kaka, recovering, endemic	Not detected during surveys but have been seen utilising the lowland forest habitats on a seasonal basis in the bush areas immediately south in the Tararua ranges (Robertson et al., 2007).	Found throughout native forest and are present in both the Tararua Ranges and Ruahine Ranges. Can be regarded as vagrant visitors to this locality from their strongholds further south. Travel long distances to forage and can be cryptic when alone. Breed in spring and summer.

3.2 Bat Surveys

Critically threatened (O'Donnell et al., 2018) long-tailed bats (*Chalinolobus tuberculatus*) have been recorded in both the Tararua Forest Park to the south (Arkins, 1999), the Ruahine Forest Park to the north (Kessels et al., 2013) and in forested areas approximately 40 km to the south-east (Shaw and van Meeuwen-Dijkgraaf, 2011). Unidentified bat species were recorded within the vicinity of the gorge prior to 1960 (Daniel and Williams, 1984). The south-eastern Tararua Ranges now contain the only known short-tailed bat population in the southern North Island (Arkins, 1999), but it is considered highly unlikely that short-tailed bats will be found in the vicinity of the proposed alignment, as the habitat is unsuitable (G Kessels, pers com).

Monitoring took place in ten different locations over the length of the corridor (Figure 2). These sites were deemed to contain suitable bat foraging, roosting or commuting habitat based on the presence of roosting trees, the degree of habitat connectivity and vicinity to water (See table in Appendix I; photos in Appendix II). Seven of the ten ABMs recorded successfully for the full fourteen nights of monitoring while three ABMs only recorded data for 8 - 12 nights, giving a total recording period of 1815 hours.

Bats are more active during calm, warm weather with low rainfall. Weather data (Table 4) was sourced from the closest weather station to the gorge which was a NIWA/AgResearch weather station in Palmerston North (-40.38195, 175.6092). Based on these conditions 11 of the 14 survey nights were optimal for bat emergence (O'Donnell, 2000): daily rainfall exceeded 2 mm in the two hours immediately after sunset on one occasion (6 March); the minimum temperature during the four hours after sunset was never below 10°C; maximum wind speed exceeded 60 km/h on two nights (8 – 9 March); and the average nightly wind speed exceeded 20 km/h on one occasion (March 8). Based on this Palmerston North derived weather data,1431 hours of recording can be deemed effective. Note however that weather within the realignment corridor is likely more extreme than weather in Palmerston North (pers obs, Appendix IV).

No bats were detected any of the locations.

Table 4. Weather data from Palmerston North. Data obtained from NIWA/AgResearch CliFlo database, station number 21963.

Date	Minimum temperature to 4 hrs after sunset (°C)	Maximum overnight wind gust (Km/hr)	Mean overnight wind speed (Km/hr)	Rainfall 2 hours after sunset (mm)
Feb-27	11.9	41.4	12.4	0.5
Feb-28	14.1	33.8	14.0	0
Mar-01	18.3	24.5	8.3	0
Mar-02	18.6	14.8	6.11	0
Mar-03	18.2	22.7	7.1	0
Mar-04	15.8	20.9	5.8	0
Mar-05	16.8	10.8	4.0	0
Mar-06	17.0	13.3	3.2	10.8
Mar-07	15.3	43.2	10.4	0.2
Mar-08	14.7	77	32.3	0.3
Mar-09	12.0	65.5	16.7	0
Mar-10	10.4	35.3	11.8	0
Mar-11	11.3	23.8	8.9	0
Mar-12	14.8	16.6	5.4	0

4 Conclusions and recommendations

Acoustic surveys and 5MBCs revealed the presence of 32 bird species within the proposed Manawatu Gorge realignment corridor, comprising seven endemic species, ten native species, and 15 introduced species. A densely vegetated wetland surrounded by indigenous vegetation and two wetlands with open water recorded the highest levels of endemism with five endemic species recorded at each. High species diversity of indigenous birds was also recorded adjacent to the Manawatu River.

The field survey identified the presence of notable bird species in the project area and included the At Risk-recovering New Zealand falcon, New Zealand's only extant endemic raptor. Other notable bird species detected include five endemic but not-threatened forest residents. Four species not detected during the surveys are considered notable due to the available habitat and/or threat status of the birds: North Island kaka; spotless crake; and two dotterel species. Kaka can be considered a vagrant species that may feed within the gorge while migrating between the ranges to the north and south. Spotless crake may be utilising the densely vegetated wetland north of the Manawatu River at the eastern end of the alignment (Site 2). Banded and black-fronted dotterel may be nesting within the riparian margin of the Manawatu River at the site where the preferred corridor crosses the river.

Overall, the results indicate that the habitats of greatest value to indigenous (and notable) birds within the survey corridor are the wetlands, riparian margins of the Manawatu River, and indigenous vegetation including tawa forest and forested gullies. Additional surveys are recommended within these habitats, in particular to detect cryptic wetland birds and dotterel species and other species that may be present (Table 2).

An array of ten ABMs were deployed across the site in areas deemed to be suitable bat roosting, feeding and/or commuting habitat. Weather data from Palmerston North, indicated that 11 of 14 nights were suitable for bat emergence; however no bats were detected. The non-detection does not necessarily equate absence and there are multiple reasons why bats may not have been detected. A likely confounding factor is that weather conditions within the gorge are likely worse than conditions in Palmerston North, and this may reduce bat emergence or deter bats from using the site. In fact no bats have been detected within the vicinity of the gorge in recent times. In the Netherlands, the number and distribution of feeding sites that provide shelter from wind are a major constraint on the density of common pipistrelles (*Pipistrellus pipistrellus*), especially in very windy locations (Verboom & Huitema 2010). If long-tailed bats are similarly affected by wind, then bat densities in very windy locations, such as the Manawatu Gorge, may be very low, if indeed they are present at all. Given that potential bat roost trees were observed (Appendix II) and that there is still a low possibility that bats may be present given the survey constraints, we recommend that additional surveys are carried out in all areas requiring pre-construction vegetation removal to provide absolute surety that this Critically Endangered species is not present and there is minimal risk of any individuals being harmed during tree felling.

5 References

Arkins, A.M., 1999. Tararua Forest Park Bat Survey, 1998/1999 (Unpublished). Department of Conservation, Masterton.

Borkin, K.M.; Parsons, S. 2009. Long-tailed bats' use of a *Pinus radiata* stand in Kinleith Forest: Recommendations for monitoring. New Zealand Journal of Forestry 53: 38-43.

Daniel MJ, Williams GR. 1984. A survey of the distribution, seasonal activity and roost sites of New Zealand bats. New Zealand Journal of Ecology :9-25.

Dawson DG and Bull PC (1975) Counting birds in New Zealand forests. Notornis Volume 22(2): 101-109.

Dekrout, A. 2009. Monitoring New Zealand long-tailed bats (*Chalinolobus tuberculatus*) in urban habitats: ecology, physiology and genetics. Unpublished PhD thesis, University of Auckland.

Kessels G, Deichmann B, Stewart P, Hasenbank M, Riddell D, Clark R, and Brandes, U. 2013. Terrestrial Ecology Assessment of Ecological Effects - Ruataniwha Water Storage Scheme.

Lambie, J. 2007. Riparian Sites of Significance Based on the Habitat Requirements of Selected Bird Species: Technical Report to Support Policy Development. Horizons Regional Council.

Lloyd BD 2009b. Bat Call Identification Manual for use with Digital Bat Recorders & BatSearch Software. 21 p.

O'Donnell, C.F.J. 2000. Influence of season, habitat, temperature, and invertebrate availability on nocturnal activity of the New Zealand long- tailed bat (*Chalinolobus tuberculatus*). New Zealand Journal of Zoology 27: 207-221.

O'Donnell, C., Borkin, K., Christie, J., Lloyd, B., Parsons, S. and Hitchmough, R. (2018). Conservation status of New Zealand bats, 2017. New Zealand Threat Classification Series 21. Department of Conservation, Wellington. Retrieved from http://www.doc.govt.nz/Documents/science-and-technical/nztcs21entire.pdf

Robertson, C.J.R., Hyvönen, P., Fraser, M.J., Pickard, C.R., 2007. Atlas of bird distribution in New Zealand 1999-2004. Ornithological Society of New Zealand, Wellington.

Robertson, H.A., Baird, K., Dowding, J.E., Elliott, G., Hitchmough, R., Miskelly, C., McArthur, N., O'Donnell, C.F.J., Sagar, P.M., Scofield, R.P., Taylor, G.A., New Zealand, Department of Conservation, 2017. Conservation status of New Zealand birds, 2016.

Shaw, W and van Meeuwen-Dijkgraaf, A. 2011. Ecological Effects Assessment - Castle Hill Wind Farm (No. Genesis Energy Contract Report No.2260d).

Verboom B and Huitema HH, 2010. The influence of treeline structure and wind protection on commuting and foraging common pipistrelles (*Pipistrellus pipistrellus*). Lutra 53(2):63-80

Williams, M.J. 2013. Paradise shelduck. In Miskelly, C.M. (ed.) New Zealand Birds Online. www.nzbirdsonline.org.nz

Appendix I: Survey Sites

ARD Deployment Sites

Site Code	Device	Site name and brief description	Latitude (°)	Longitude (°)
1	KA14	Shannon property. Paddock edge above river. Pasture and exotic vegetation	-40.306115	175.768159
2	KA6	Wetland amongst indigenous vegetation on Stuart Bolton's property	-40.302346	175.771628
3	KA16	Steep gully at western end of Graeme Bolton's property. Indigenous vegetation – predominantly kanuka	-40.296124	175.781181
5	KA1	Gully on Graeme Bolton's property. Indigenous veg on edge of pasture	-40.306095	175.792586
9	KS19	Pond surrounded by pasture, pine forest and indigenous vegetation on Meridian property	-40.304089	175.818191

ABM Deployment Sites

Site code	Device	Site name and brief description	Latitude (°)	Longitude (°)	Bat habitat type
1	KB33	Shannon property. Paddock edge above river. Pasture and exotic vegetation	-40.306115	175.768159	Commuting; feeding. Large trees present – potential cavities
2	KB21	Wetland amongst indigenous vegetation on Stuart Bolton's property	-40.302346	175.771628	Commuting; feeding. Large trees present – potential cavities
3	KB48	Steep gully at western end of Graeme Bolton's property. Indigenous vegetation – predominantly kanuka	-40.296124	175.781181	Commuting; feeding.
4	KB50	Gully on Graeme Bolton's property. Indigenous veg on edge of pasture	-40.299555	175.782252	Commuting; feeding.
5	KB49	Gully on Graeme Bolton's property. Indigenous veg on edge of pasture	-40.306095	175.792586	Commuting; feeding.
8	KA36	Indigenous vegetation, large pines and other exotics near old house site on Graeme Bolton's property	-40.305217	175.805450	Commuting; feeding. Large trees present – potential cavities
9	KB10	Pond surrounded by pasture, pine forest and indigenous vegetation on Meridian property	-40.304089	175.818191	Commuting; feeding. Large trees present – potential cavities
10	KB27	Pine forest east of Saddle Road with indigenous scrub understory on edge of pasture	-40.300399	175.823318	Commuting; feeding. Large trees present – potential cavities

11	KB44	Pine forest and scrub at top of Andrew Bolton’s Property	-40.314359	175.827496	Commuting; feeding.
12	KB3	Indigenous and exotic vegetation with some large trees near house on Andrew Bolton’s Property	-40.314359	175.827496	Commuting; feeding. Large trees present – potential cavities

Five-Minute Bird Count Sites

Site Code	Site name and brief description	Latitude (°)	Longitude (°)
2	Wetland amongst indigenous vegetation on Stuart Bolton’s property	-40.302346	175.771628
3	Steep gully at western end of Graeme Bolton’s property. Indigenous vegetation – predominantly manuka/kanuka	-40.296124	175.781181
4	Gully on Graeme Bolton’s property. Indigenous veg on edge of pasture	-40.299555	175.782252
5	Gully on Graeme Bolton’s property. Indigenous veg on edge of pasture	-40.306095	175.792586
6	Pasture overlooking wetland on Graeme Bolton’s property at the edge of indigenous vegetation	-40.309206	175.800160
7	Old tawa forest below Graeme Bolton’s property	-40.311866	175.803808
8	Indigenous vegetation, large pines and other exotics near old house site on Graeme Bolton’s property	-40.305217	175.805450
9	Pond surrounded by pasture, pine forest and indigenous vegetation on Meridian property	-40.304089	175.818191
11	Pine forest and scrub at top of Andrew Bolton’s Property	-40.314359	175.827496
12	Indigenous and exotic vegetation with some large trees near house on Andrew Bolton’s Property	-40.314359	175.827496

Appendix II: Site Photos

See Appendix I for location coordinates and property owners.

Site 1: Looking north from paddock edge above river. Pasture and exotic vegetation

Site 2: Wetland north of river

Facing west

Facing east

Facing south.

Farmland east of wetland

Site 3: On cliff edge in steep gully.

Looking south from above site 3 towards sites 1 and 2.

ARD deployed in steep gully.

Site 4: Indigenous vegetation on pasture edge

Site 5: Gully with indigenous vegetation on edge of pasture

Site 6: Pasture overlooking wetland at the edge of indigenous vegetation

Site 7: Old tawa forest

Facing south

Trees with potential bat roost cavities within the tawa forest

Site 8: Indigenous vegetation, large pines and other exotics

Site 9: Water body surrounded by indigenous vegetation, pine forest and pasture.

Site 10: Pine forest on edge of Saddle Road with indigenous scrub understory

Site 11: Pine forest and scrub at the head of a gully leading to the gorge

Site 12: Indigenous and exotic vegetation with some large trees

Appendix III: Five Minute Bird Count Data Sheets

Observer: Andree Hickey-Elliott, Briar Taylor-Smith

General location	Site no.	GPS	GPS	Date	Start time	Species	Seen	Heard	Temperature	Wind	Other noise	Sun (minutes)	Precipation value
Wetland amongst indigenous vegetation on Meridian Property	S9	-40.304089	175.818191	27/02/2018	10:28 AM	Swallow	1	2	mild, 11-15°C	Leaves and branches in constant motion (Beaufort 3+4)	Moderate	0	0
						Sparrow	2	1					
						Greenfinch	1	2					
						Fantail		1					
						Grey warbler		3					
						Mallard	10						
						Harrier	2						
						Blackbird		1					
						Silver eye		3					
						Chaffinch		1					
Steep gully at western end of Graeme Bolton's property. Indigenous vegetation – predominantly kanuka	S3	-40.2961240	175.781181	27/02/2018	12:30 PM	Finch		1	warm, 16-22°C	Leaves and branches in constant motion (Beaufort 3+4)	moderate	5	0
						Silver eye		1					
						Tui	1	1					
						Fantail	1						
Pine forest and scrub at top of Andrew Bolton's Property	S11	-40.3143590	175.827496	27/02/2018	2:45 PM	Fantail	1		warm, 16-22°C	Leaves rustle (Beaufort 2)	Not important	0	0
						Silver eye	1						
						Grey warbler	2						
						Finch		2					
						Magpie		1					
						Harrier	1						
						Falcon	1						
Wetland amongst indigenous vegetation on	S9	-40.304089	175.818191	13/03/2018	9:30 AM	Paradise shelduck	2		mild, 11-15°C	Branches or trees sway (Beaufort 5-7)	Moderate	0	0
						Sparrow	1						
						Magpie		3					

Meridian Property						Fantail		1					
						Australasian shoveler	3						
						Mallard	10						
						Goldfinch	1						
Indigenous vegetation, large pines and other exotics near old house site on Graeme Bolton's property	S8	-40.305217	175.80545	13/03/2018	10:10	Fantail		2	Mild, 11-15°C	Branches or trees sway (Beaufort 5-7)	Loud	0	0
						Silvereye		4					
						Magpie		4					
						Swallow	1						
						Rosella	2						
						Tui	1						
						Finch	1						
						Sparrow		1					
						Grey warbler		1					
						Blackbird		1					
						Harrier	1						
						Wood pigeon	1						
						Yellowhammer	1						
Pasture overlooking wetland on Graeme Bolton's property at the edge of indigenous vegetation	S6	-40.309206	175.80016	13/03/2018	10:30	Magpie	2		Cool, 6-10°C	Branches or trees sway (Beaufort 5-7)	Moderate	0	0
						Swallow	1						
						tui		2					
						harrier	2						
						Greenfinch	20* estimate						
						Pukeko	3						
						Mallard	2	1					
						Paradise shelduck	3						
Old tawa forest below Graeme Bolton's property	S7	-40.311866	175.803808	13/03/2018	10:50	Fantail		2	Cool, 6-10°C	Branches or trees sway	Loud	0	0
						Magpie	1						
						tui		2					

						Sparrow	1			(Beaufort 5-7)			
						Grey warbler		2					
						Harrier	1						
						Wood pigeon	1						
						Bellbird		1					
Gully on Graeme Bolton’s property. Indigenous veg on edge of pasture	S5	-40.306095	175.792586	13/03/2018	11:20	Fantail		1	Mild, 11-15°C	Branches or trees sway (Beaufort 5-7)	Loud	0	0
						Silvereye		2					
						Tui		3					
						Chaffinch		1					
						Sparrow		2					
						Grey warbler		2					
						Blackbird		1					
						Greenfinch		1					
Steep gully at western end of Graeme Bolton’s property. Indigenous vegetation – predominantly kanuka	S3	- 40.2961240	175.781181	13/03/2018	12:30	Fantail	1	2	Mild, 11-15°C	Branches or trees sway (Beaufort 5-7)	Loud	0	0
						Magpie		5					
						Tui		1					
						Goldfinch		2					
						Chaffinch		1					
						Greywarbler		1					
						Harrier		2					
						Starling	20* estimate						
Gully on Graeme Bolton’s property. Indigenous veg on edge of pasture	S4	-40.299555	175.782252	13/03/2018	13:10	Goldfinch	1		Mild, 11-15°C	Branches or trees sway (Beaufort 5-7)	Loud	0	0
						Magpie	5	1					
						Blackbird	1						
Wetland amongst indigenous vegetation on	S2	-40.304572	175.818547	13/03/2018	14:40	Magpie		1	Mild, 11-15°C	Leaves and branches in	Moderate	0	0
						Tui		2					
						Pukeko		2					

Stuart Bolton's property						Fantail	1	1		constant motion (Beaufort 3+4)			
						Grey warbler		2					
						Blackbird		1					
						Sparrow		2					
						Chaffinch	1						
						Bellbird	1	1					
Indigenous and exotic vegetation with some large trees near house on Andrew Bolton's Property	S12	-40.314359	175.827496	13/03/2018	15:20	Goldfinch		1	Mild, 11-15°C	Leaves and branches in constant motion (Beaufort 3+4)	Not important	0	0
						Tui		1					
						Fantail	2						
Pine forest and scrub at top of Andrew Bolton's Property	S11	- 40.3143590	175.827496	13/03/2018	15:20	Magpie		1	Mild, 11-15°C	Leaves and branches in constant motion (Beaufort 3+4)	Not important	0	0
						Tui		1					
						Fantail	1	1					

Appendix IV: Rainfall – 24 hrs (mm)

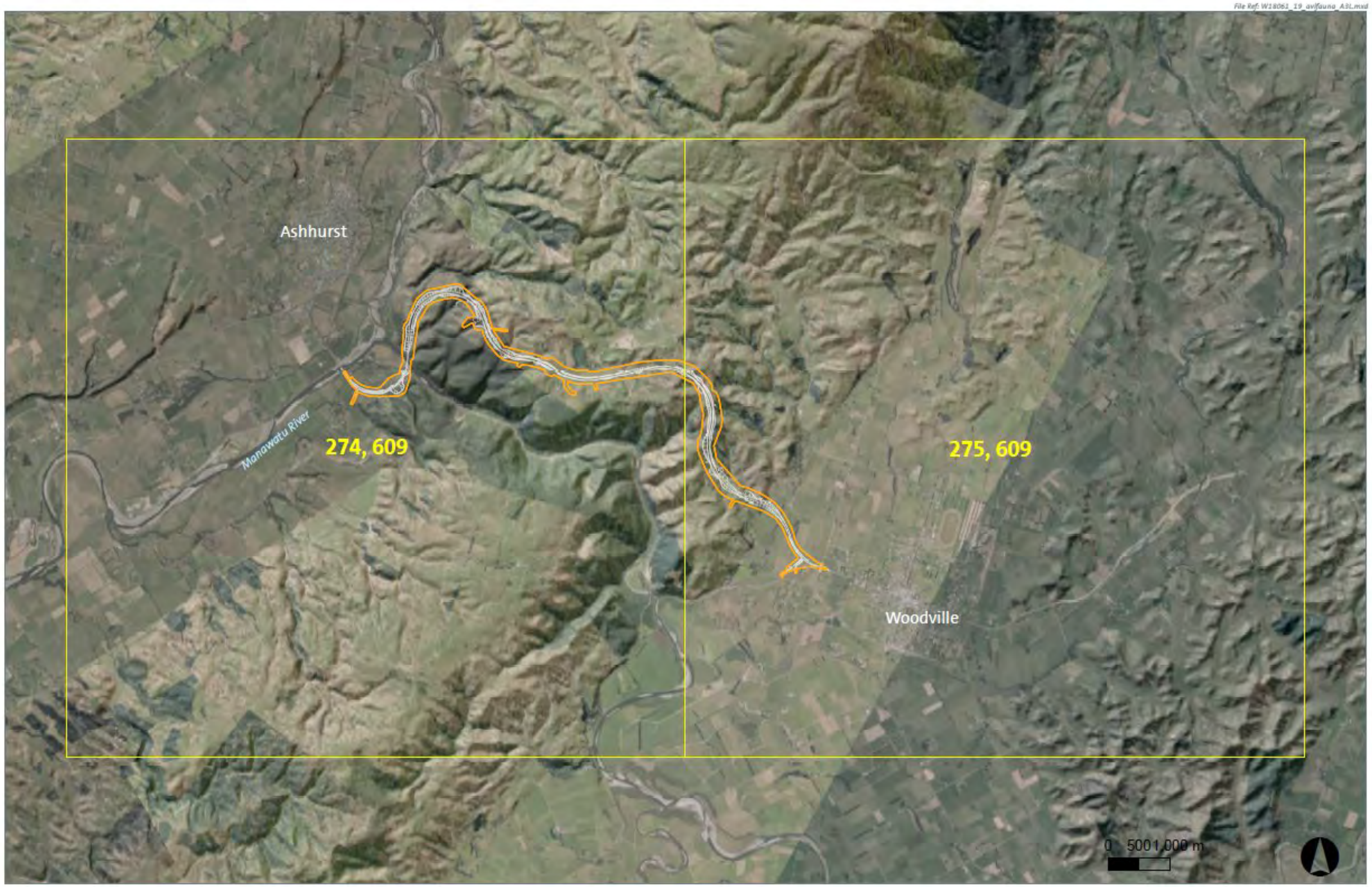
Rainfall in Palmerston North compared to rainfall within the realignment corridor

Date	Total rainfall – 24 hours (mm)	
	NIWA/AgResearch weather station in Palmerston North	Ballantrae Farm within the realignment corridor
Feb-27	12.4	27
Feb-28	1.8	0
Mar-01	0	0
Mar-02	0	0
Mar-03	0	0
Mar-04	0	0
Mar-05	0	0
Mar-06	0.4	1.5
Mar-07	20.4	40
Mar-08	10.2	25
Mar-09	6.4	39
Mar-10	0	0
Mar-11	0	0
Mar-12	0	0

6.B.3

OSNZ BIRD ATLAS SQUARES THAT ENCOMPASS THE DESIGNATION CORRIDOR

Appendix 6.B.3: OSNZ Bird Atlas Squares that Encompass the Designation Corridor (Robertson et al, 2007)



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Data Sources: Horizons RC, MDC, PNCC, TDC, DoC, LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

☐ OSNZ Atlas Grid
— Designation

TE AHU A TURANGA PROJECT
OSNZ Atlas Avifauna Observation Squares
Date: 15 August 2018 | Revision: 0
Plan prepared by Boffa Miskell Limited
Project Manager: **boyden.evans@boffamiskell.co.nz** | *Drawn:* HHu | *Checked:* BEv

6.B.4

PROJECT TE ĀPITI SADDLE ROAD, MANAWATŪ- ECOLOGICAL ASSESSMENT - BOFFA MISKELL LTD 2003

Appendix 6.B.4: Project Te Apiti Saddle Road, Manawatū – ecological assessment – Boffa Miskell Limited 2003

PROJECT TE ĀPITI SADDLE ROAD, MANAWATU

ECOLOGICAL ASSESSMENT

BOFFA MISKELL LIMITED

Meridian Energy

BOFFA MISKELL
planning • design • ecology

Project Te Apiti
Saddle Road, Tararua

Assessment Of Ecological Effects

Prepared for

Meridian Energy

By

Boffa Miskell Limited

June 2003

CONTENTS

1 EXECUTIVE SUMMARY 1

2 INTRODUCTION 2
- 2.1 LOCATION AND GENERAL DESCRIPTION 2
- 2.2 THIS ASSESSMENT 2
- 2.3 OBJECTIVES 2
- 2.4 METHODOLOGY 3

3 CONSULTATION 4

4 RELEVANT PLANNING & POLICY 5
- 4.1 CONSERVATION MANAGEMENT STRATEGY (CMS) 5
- 4.2 PROTECTED NATURAL AREA PROGRAMME (PNAP) 5
- 4.3 MANAGEMENT PLANS 5

5 PHYSICAL ENVIRONMENT 6
- 5.1 GENERAL DESCRIPTION 6
- 5.2 TOPOGRAPHY 6
- 5.3 WATERBODIES 7
- 5.4 SUMMARY 7

6 ECOLOGICAL ENVIRONMENT 8
- 6.1 PROTECTED NATURAL AREAS 8
- 6.2 VEGETATION 8
- 6.3 WILDLIFE 9
- 6.4 FRESHWATER HABITAT 12
- 6.5 CORRIDORS 12
- 6.6 SUMMARY 13

7 SCOPE OF WORKS 14

8 POTENTIAL IMPACTS ON WILDLIFE 15
- 8.1 INTERNATIONAL EXPERIENCE 15
- 8.2 NEW ZEALAND SITUATION 16
- 8.3 TE APITI WIND FARM 16
- 8.4 SUMMARY 18

9 ASSESSMENT OF ECOLOGICAL EFFECTS 19
- 9.1 INTRODUCTION 19
- 9.2 PROTECTED NATURAL AREAS 19
- 9.3 EFFECTS ON INDIGENOUS VEGETATION 19
- 9.4 EFFECTS ON AVI-FAUNA 20
- 9.5 FRESHWATER HABITAT 20
- 9.6 CORRIDORS 22
- 9.7 SUMMARY 22

10 CONCLUSIONS 23

11 RECOMMENDATIONS 25

12 REFERENCES 26
- 12.1 WEB SITES 27

13 Plants Species Names used in Text and their Latin Equivalents. 29

List of Tables

Table 3.1. Organisations Involved in Consultation 4
Table 5.1. Land Form Descriptions 6
Table 6.1. Known Resident Bird Species 10
Table 6.2. Likely Vagrants 11
Table 8.1. Risk Factors for Collision & Displacement 16
Table 8.2. At Risk Bird Groups 17
Table 13.1. Listing of bird species likely to be present or liable to occur seasonally at the site. Sorted by national status (threat classification) and by likely occurrence at site. 32

List of Figures

Figure 1: Locality Map 2
Figure 2: Proximity of Windfarm to Protected Natural Areas 8
Figure 3: Vegetation Map 8
Figure 4: Wildlife Corridors 12
Figure 5: Location of Photo Reference Points 31
Figs 6 – 12: Photographs of vegetation and significant areas 33

1 EXECUTIVE SUMMARY

Introduction

Meridian Energy proposes to construct and operate a wind farm on the high terraces to the north of Manawatu gorge. This is an assessment of the potential ecological effects of this proposal. The assessment includes a literature review, interviews with local experts, and site visits by a suitably qualified ecologist.

This report describes significant ecological features in and around the proposed wind farm, assesses the conservation significance of these features, identifies potential environmental effects due to the proposal, and suggests ways in which potential effects can be avoided, remedied and/or mitigated.

The Te Apiti Wind Farm Site

The proposal is on private land that is largely in pasture but also includes small areas of exotic woodlots. It contains one area of significant vegetation a QEII covenant.

The site lies between two significant conservation areas, the Ruahine Forest Park to the north and the Manawatu Gorge Scenic Reserve to the south. These protected natural areas contain species of wildlife that have the potential to interact with the windfarm. The site lies within the Manawatu River watershed, a river with significant ecological values.

Results

No areas of significant vegetation or habitats will be affected by the construction of the windfarm.

The specifics of the site combined with the proposed design and layout of the wind farm give this proposal a range of attributes that make it a low risk for bird strike. In our view, there is a minimal and acceptable risk of interactions between the windfarm and any indigenous wildlife species that are endangered, vulnerable, or in serious decline.

It is unlikely that the wind farm will act as a barrier for movement of birdlife between the Manawatu Gorge Scenic reserve to the south and the Ruahine Forest Park to the north. Within the site, most natural vegetation has been cleared. The best forest corridors in the area are found in deep gullies to the west of the site and these will not be affected by the wind farm proposal.

Sediment movement from areas of excavation has the potential to impact on local streams and rivers. The measures for erosion and sediment control, which are detailed in the Opus Consultants construction report, are appropriate to manage this risk.

Conclusion

The results show that the proposed Te Apiti windfarm is ideally sited to avoid or reduce effects such as vegetation loss and habitat impacts. The specifics of the site ensure that critical wildlife are unlikely to interact with the wind turbines, and the proposed layout and design of the wind farm complies with international guidelines for minimising effects on wildlife generally. The adverse ecological effects of the proposed wind farm on the local ecology will therefore be minor. A number of recommendations are made which will assist in the avoidance, remedy or mitigation of potential effects.

2 INTRODUCTION

2.1 *LOCATION AND GENERAL DESCRIPTION*

Meridian Energy is seeking to develop a wind farm (55 turbines) on a number of properties in the Tararua District, which is generally known as the Te Apiti wind farm.

The proposal is on private land that is largely in pasture but also includes small areas of forestry. The site lies between three significant conservation areas, the Ruahine Forest Park to the north and the Tararua Forest Park and Manawatu Gorge Scenic Reserve to the south.

2.2 *THIS ASSESSMENT*

This report comprises an assessment of the ecological effects of this proposal with particular regard to the ecological matters identified in Parts 6 & 7 of the Act:

- Matters of national importance, specifically: - the protection of areas of **significant indigenous vegetation** and **significant habitats of indigenous fauna**;
- Other matters, specifically: - **intrinsic values** of ecosystems, maintenance and enhancement of the **quality of the environment**, any **finite characteristics** of natural and physical resources, the protection of the habitat of **trout and salmon**.

This assessment looks broadly at the range of potential direct and indirect effects, which could occur because of the construction and operation of this wind farm.

Direct effects relate to actual loss of habitat because of construction of the turbines and associated works (roads, cut and fill) and to the possible death of native bird species through collisions with the turbines or their blades. Indirect effects relate to downstream issues such as sediment movement and the potential for displacement of bird species by the windfarm.

2.3 *OBJECTIVES*

The objectives of this assessment are:

1) Describe the ecological features in and adjacent to the site.
2) Assess the conservation value of these features.
3) Describe the characteristics of the construction and operation of the wind farm including discharges, hazardous substances and installations.
4) Identify actual or potential effects on the ecological environment, plants, animals or habitats.
5) If potential adverse effects are identified, recommend ways such effects can be avoided, remedied or mitigated.
6) Determine whether ongoing monitoring is required.

2.4 METHODOLOGY

The methodology used to achieve these objectives was:

- A review of international and national literature on wind farms and their effects.
- A review of available information on the biology of the site, its flora and fauna, and of the adjacent ecological districts (literature review and consultation – local knowledge).
- Interviews with local specialists.
- A qualitative survey of vegetation, habitats and fauna (vertebrate spp only).
- An assessment of the conservation significance of the study area.
- An assessment of the potential negative and positive effects of the proposal
- An assessment of possible measures to avoid, remedy, or mitigate potential adverse effects of the proposal.

Information on landforms, soils and erosion was derived from the New Zealand Land Use Resource Inventory (NZLRI). Vegetation was mapped based on field observation and the use of stereo-photography (NZ Aerial Mapping Limited Flight Run TL 116 / 062-064). Other information on the site was derived from 1:50,000 scale topographical maps (NZMS T24 and T23).

A species list of birds found in the Manawatu and their national status was derived from the Department of Conservation (DoC) national database (Doc 2001). Their regional status was derived from the Conservation Management Strategy for the Wanganui Conservancy (DoC 1995).

Details on the scale of works, quantities of fill and areas of works were provided by OPUS International Consulting.

The site was visited on 18 March and 29 April. All turbine sites and all proposed deposit sites were visited or viewed during these visits. Habitat, topography, vegetation and birdlife were observed.

The site visits were not intended to be quantitative surveys but were used to verify reference information and personal communications obtained from local specialists, and to gain an understanding of the habitat and topography of the site and of habitats immediately adjacent to it. From this work, all key habitats were identified and a list of bird species known to be present was compiled, together with a list of species likely to occur as vagrants. The use of the site by these species was determined, and the potential risks assessed.

The site visits were also used to understand better the scope of the project, discuss issues between the various disciplines (ecology, landscape, engineering, property), and where possible identify issues early in the design process so that potential effects could be avoided.

PROJECT TE ĀPITI

Location Map and Sub-Regional Context

BOFFA
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planning design ecology

Reference:
W02020-2 Report Figures v1.pmd

Meridian Energy

FIGURE 1

3 CONSULTATION

Consultation was conducted with a range of people with specialist knowledge of the area under consideration.

Initially a few key organisations were contacted (Department of Conservation, Horizons, Fish and Game, QEII, Massey University) for information on protected natural areas, wildlife and vegetation in and around the wind farm site.

Once the site had been visited, a draft ecological assessment was produced and its preliminary findings were presented to a wider audience including conservation NGO's, and interested individuals. This was done at a workshop held on 22 May 2003.

Feedback was received from this workshop and the report amended to address issues raised or include new information that had been volunteered.

The following table lists those agencies that assisted with the initial assessment and/or attended the workshop.

Table 3.1. Organisations Involved in Consultation

- Department of Conservation
- Horizons Manawatu
- Palmerston North City Council
- QEII national Trust
- Manawatu & Hawkes Bay Branch of the Ornithological Society of NZ
- Manawatu Branch of the Royal Forest & Bird Protection Society
- New Zealand Fish & Game Council
- Local Landowners
- Environment Network Manawatu
- EarthPlan Consultants
- Rangitaane O Manawatu

4 RELEVANT PLANNING & POLICY

4.1 CONSERVATION MANAGEMENT STRATEGY (CMS)

The wind farm site lies across two Department of Conservation conservancies (Hawkes Bay - *Hill Country/Ruahine Ranges* & Wanganui - *Manawatu Gorge/Pohangina River*). The conservancy boundary closely follows Saddle Road, effectively splitting the wind farm site into two. The Palmerston North Area Manager noted that the Wanganui Office would handle the application for both Conservancies.

Due to this conservancy boundary the windfarm site falls under two separate Conservation Management Strategies, the Wanganui Conservancy CMS 1997-2007, and the Hawke's Bay Conservancy CMS 1994-2004.

The Wanganui CMS contains the following policy (page 324 Power Generation).

> *24.9.3 Implementation*
>
> *(i) The Department will advocate through statutory and non-statutory processes, the protection of land and water with high natural, historic or recreation value from power generation developments by ensuring that any adverse effects on those values are avoided, remedied or mitigated.*
>
> *(ii) The Department will seek conditions on any power generation proposal to protect natural, historic and recreation values or alternatively may consider the potential for achieving conservation benefits through compensation or other means as agreed between the parties.*

4.2 PROTECTED NATURAL AREA PROGRAMME (PNAP)

The PNAP aims to establish a network of reserves and other protected natural areas, which are representative of the full range of New Zealand’s natural diversity. Ecological districts are surveyed and areas identified which best represent the diversity of their natural features. These are termed Recommended Areas for Protection (RAP’s).

A PNAP survey has only been conducted for the Wairarapa Plains Ecological District. The Ruahine Ranges and Manawatu Gorge area have not been surveyed and contain no areas recommended for protection.

4.3 MANAGEMENT PLANS

A draft management plan was prepare for the Manawatu Gorge Scenic Reserve in 1985 but was never formally approved. Its role was largely taken over by the Wanganui Conservancy CMS.

5 PHYSICAL ENVIRONMENT

5.1 GENERAL DESCRIPTION

This proposed wind farm site is on a landform known as the Manawatu Saddle. It is a moderately rolling landform ranging from 250 metres to 400 metres above sea level. The saddle lies between the Ruahine Ranges to the North and Tararua Ranges to the south.

5.2 TOPOGRAPHY

The wind farm site is generally contained in a triangular shaped terrace of rolling to moderately steep land, which is surrounded by steep to very steep slopes descending to the river plains to the west, south and east. To the north, the land rises to Wharite Peak and onward to the Ruahine Ranges.

The site is underlain by sedimentary "soft rock" units (sandstones, siltstones and conglomerates), which are easily eroded forming deeply incised gullies and gorges. They lie over stronger greywacke. The following description of topography and landform is derived from the New Zealand Land Resource Inventory (Fletcher 1987).

To the south, the site drops steeply into the Manawatu gorge (Unit 8e5, 8e4 and 7e10). To the northwest are moderately steep to strongly rolling hills of sandstone and mudstone (units 6e12, 6e3 & 6e2) that are deeply incised to the north by heavily eroded river valleys (7e3). To the east and northeast, the pattern is repeated with rolling hills (6e3 & 6e2) deeply incised by eroded river valleys (7e10 and 7e2).

Table 5.1. Land Form Descriptions

UNIT	Unit Description
8e5	Long, very steep greywacke mountain slopes with a thin mantle of Tephra. Slight to very severe wind and sheet and slight to moderate soil slip, debris avalanche and scree creep erosion (*North slope of Manawatu Gorge with forest cleared).*
8e4	Long very steep forested mountain slopes with slight to moderate debris avalanche, soil slip and scree creep erosion *(North slopes of Manawatu Gorge still in forest)*
7e10	Steep and very steep slopes with shallow, strongly leached soils developed on greywacke in the Ruahine Ranges. There is potential for severe soil slip, debris avalanche, sheet, and scree erosion *(Shoulder slopes immediately above Manawatu Gorge, and valley systems to the northeast).*
7e3	Steep to very steep hills of moderately consolidated sandstone. There is potential for severe soil slip and moderate sheet erosion *(Deeply incised gullies to the northwest).*
7e1 & 7e2	Steep to very steep hills with fertile soils developed on massive and jointed mudstone. Potential for severe soil slip and moderate earth flow, gully and sheet erosion *(Deeply incised gullies to the east).*
6e12	Moderately steep, to steep hills on unconsolidated and moderately consolidated sandstone mantled with loess in some areas. Potential for moderate soil slip, sheet and tunnel gully erosion *(Hill country to the north and northwest descending toward Ashhurst and the Pohangina River).*
6e3	Strongly rolling to moderately steep hills with soils developed on mudstone or andesitic Tephra on mudstone. There is potential for moderate earthflow and soil slip erosion (Hill country through the centre of the site).

6e2	Strongly rolling to moderately steep short hill slopes and terrace scarps with yellow brown earths developed on loess. Potential for slight sheet and moderate soil slip erosion *(Hill country to the east of the site descending toward Woodville).*
3w2	Flat, narrow, alluvial valley floors subject to runoff from adjacent slopes. Alluvial soils *(A narrow section running through the centre of the site).*

5.3 WATERBODIES

The great majority of the proposed site lies within the Manawatu River catchment, some areas drain directly into the Manawatu Gorge, others drain east into smaller unnamed tributaries.

The Pohangina River drains the western Rauhines, including the western margins of the Saddle Road area, before joining the Manawatu River a short distance from the mouth of the Manawatu Gorge. A small number of turbines lie along the ridgeline separating the Pohangina watershed from the Manawatu.

As the proposed windfarm lies on a high terrace there are no significant waterbodies present. Small farm ponds and dams are present throughout the area. A few gullies with impeded drainage have formed small heavily vegetated wetland areas. The majority of water movement across the site is however in small farm streams which appear to be seasonally dry.

5.4 SUMMARY

- The site is located on young sedimentary rocks. Without appropriate control measures there is potential for erosion and sediment movement from the site.
- There are no large waterbodies, lakes, streams or rivers within the site, although the site drains into two large rivers - the Pohangina to the west, and the Manawatu to the east and south.

6 ECOLOGICAL ENVIRONMENT

6.1 *PROTECTED NATURAL AREAS*

The proposed windfarm lies between several significant protected natural areas.

Reserves

The only scenic reserve in near proximity to the wind farm site is the Manawatu Gorge Scenic Reserve. Most of this reserve lies on the south side of the Manawatu River. A small triangular portion lies on the northwest side of the gorge. At its closest point, it is some 200 metres from turbine A13.

The Manawatu Gorge Management Plan identifies a few notable species that contribute to the scientific value of the area. They include the rare fern *Adiantum formosum,* large totara, and the unusual combination of lowland forest species and montane forest species, e.g. *Rytidosperma buchananii* combined with ngaio and nikau.

The only notable fauna listed in this plan was a rare species of ground beetle.

Railway Land

The majority of the large forest remnant on the northern slopes of the Manawatu Gorge and immediately to the south of the windfarm is land owned by TranzRail. It is, however, managed by the Department of Conservation for its conservation values.

Forest Parks

The wind farm site lies between two significant forest parks. The Ruahine Forest Park is 1.6 kilometres to the north of the northern most turbines. The Tararua Forest Park lies approximately 13 kilometres to the south of the southern most turbines

Covenants

A single QEII Covenant lies in the southern portion of the wind farm site at grid reference NZMS 260 T24 483-965. The closest turbine to it is A04, which lies on the ridge immediately above it to the North metres to the southeast.

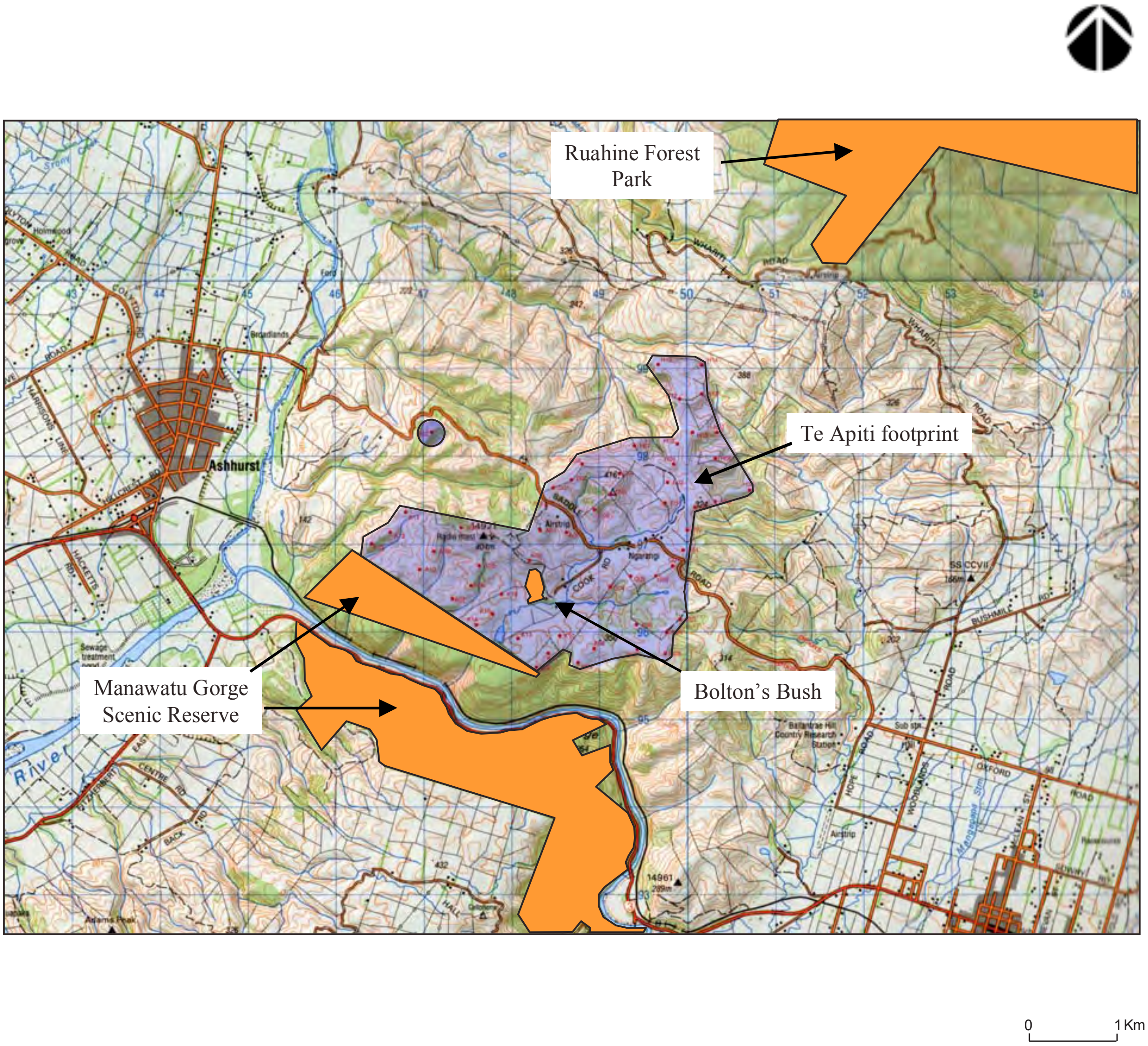
This site is commonly referred to as Bolton Bush. It is 7.3 ha in size and has a rating of 2, which suggests that it has regionally representative forest that is well looked after and in good condition.

The covenanted land contains vegetation similar to that of Manawatu Gorge Scenic reserve.

6.2 *VEGETATION*

The vegetation of the site is shown in Figure 3 on the following pages. It is dominated by improved pasture with a number of native forest remnants in deep gullies, particularly in moister soils to the west of the site.

These forest remnants have a similar composition to the Manawatu Gorge Scenic reserve, forests dominated by tawa and rewarewa up to 30 metres tall with occasional



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Reference:
W02020-2 A4 Ecology Report Figs 245.pmd

PROJECT TE ĀPITI
Protected Natural Areas

Meridian Energy

FIGURE 2

tall podocarps such as totara and rimu. They have a sub canopy dominated by mahoe, pigeonwood, lacebark, lemonwood, supplejack and hinau.

These forest remnants are typically unfenced and farm stock has free access to their interiors. Despite this, the high diversity of canopy species provides potential for rapid recovery if stock were removed. The forest remnants, particularly on the western side of the site are also likely to provide important seasonal habitat for birds such as tui, bellbird, and kereru.

In addition to these forest remnants, many farm gullies contain small patches of young regenerating native treeland typically dominated by mahoe, kanuka, putaputaweta, and cabbage tree over toetoe, Carex and Juncus species, and rank pasture grasses.

On the drier eastern side of the range, almost no forest remnants occur but there is abundant regeneration of kanuka, gorse and broom on dry slopes, and mahoe and mamaku in gullies. Kanuka is, however, typically viewed as a weed by farmers and is usually controlled to maintain pasture. In the time between site-visits in mid March and late April large areas of this kanuka-dominated scrub had been killed by aerial spraying.

Pine is common on site, both as numerous shelterbelts and as small plantations.

There are a number of small farm ponds and some small wetland areas in the southeast of the site where the rolling topography and loess derived soils lend themselves to impeded drainage and wetland formation. They contain small artificial lakes including areas of rush and reed beds. These will provide important habitat for pukeko and other marsh and wetland species. Maemae's are present at most of these ponds.

6.3 WILDLIFE

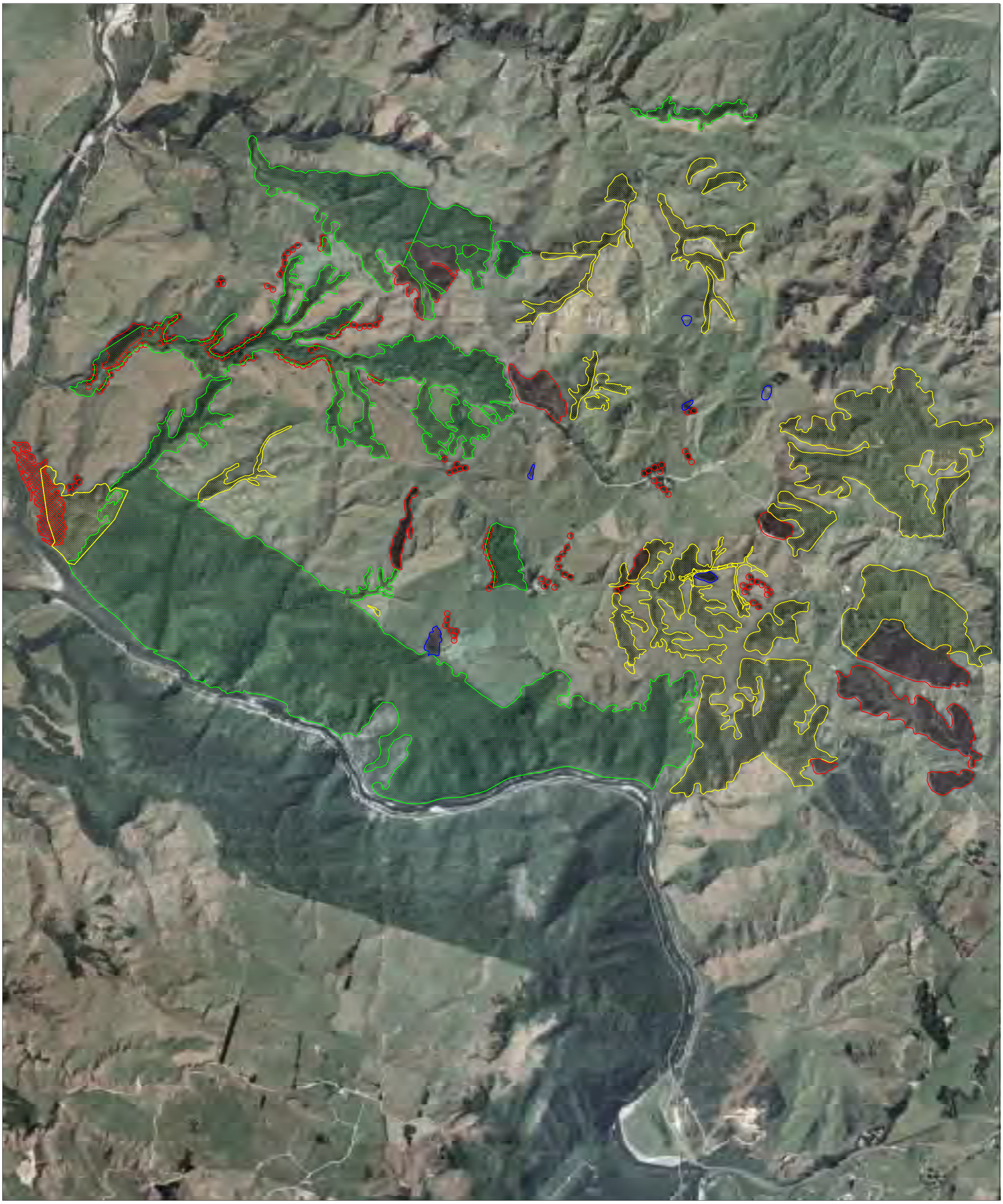
The types of birds found on site are consistent with a largely pastoral environment with bush fragments and pine windbreaks. In line with similar assessments conducted for windfarm development, the birds present or likely to occur at the site can be grouped into three categories – resident, vagrant and migratory.

Resident Birds

Resident birds essentially live in one area throughout the year, although they often move between food sources within the location.

Thirty bird species have been identified as residents of the site or are almost certainly present. Twelve are introduced species and two are recent colonisers (spur winged plover and welcome swallow). The remaining sixteen species of bird are native or indigenous birds. Most are passerines or songbirds such as the tui, bellbird, silvereye and grey warbler.

In terms of abundance, exotic species predominate; especially seed feeding finches, starlings and hedge sparrows. Most native and indigenous species are confined to the bush fragments and pine forests. The exceptions to this are the harrier hawk, New Zealand pipit, pukeko, paradise shelduck, and the recent New Zealand colonisers, spur winged plover and welcome swallow. None of these species are threatened and two, the pukeko and paradise shelduck, are game birds. The paradise shelduck is the single most common waterfowl in the area, expanding its population up to as many as 300 birds each summer before duck hunting season each May culls the population.



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PROJECT TE APITI
Ecological Map

▨	PINE
▨	KANUKA - GORSE SHRUBLAND
▨	NATIVE FOREST REMNANTS
▨	FARM PONDS
●	Turbine locations

FIGURE 3

Table 6.1. Known Resident Bird Species

English Name	Origin	National Threat classification	Regional Threat classification	Source
New Zealand pigeon, kereru	E	5 Gradual decline	Not threatened	SF / DoC
Australasian harrier	N	Not threatened	Not threatened	SF / DoC
Bellbird	E	Not threatened	Not threatened	DoC
Grey warbler	E	Not threatened	Not threatened	SF/ DoC
Morepork	E	Not threatened	Not threatened	Blaschke
New Zealand kingfisher	E	Not threatened	Not threatened	-
New Zealand pipit	E	Not threatened	Not threatened	SF
North Island fantail	E	Not threatened	Not threatened	SF/ DoC
Paradise shelduck	E	Not threatened	Not threatened	SF
Pied tit	E	Not threatened	Not threatened	DoC
Pukeko	N	Not threatened	Not threatened	SF
Shining cuckoo	E	Not threatened	Not threatened	Blaschke
Silvereye	N	Not threatened	Not threatened	SF
Southern black backed gull	N	Not threatened	Not threatened	SF
Tui	E	Not threatened	Not threatened	SF / DoC
White faced heron	N	Not threatened	Not threatened	SF
Spur-winged plover	N	Coloniser	Not threatened	SF
Welcome swallow	N	Coloniser	Not threatened	SF
Black bird	I	Introduced	-	SF
Canada goose	I	Introduced	-	SF
Chaffinch	I	Introduced	-	SF / DoC
Dunnock	I	Introduced	-	SF
Goldfinch	I	Introduced	-	SF
Greenfinch	I	Introduced	-	SF
Magpie	I	Introduced	-	SF / DoC
Mallard	I	Introduced	-	SF
Rook	I	Introduced	-	SF
Skylark	I	Introduced	-	SF
Starling	I	Introduced	-	SF / DoC
Yellow hammer	I	Introduced	-	SF

E = endemic, N = native, I = Introduced

(SF = observed in the course of this field survey, DoC = Manawatu Scenic Reserve Management Plan, Blaschke = Blaschke 2002)

Vagrant Birds

Vagrant birds are species that are uncommonly or rarely found in an area but do occur from time to time.

A few birds have been recorded historically as vagrants at the Manawatu Scenic Reserve, suggesting their movement to the area from either the Tararua Ranges or Ruahine Ranges. They include the New Zealand bush falcon, the North Island kaka and the North Island rifleman. Of these the kaka and falcon are identified as nationally threatened or vulnerable. None of these have been seen in recent years (D. Smith pers.com).

In addition, a number of waterfowl are highly mobile seasonally, are present in the Manawatu Gorge area, and while they have not been recorded on site they are likely to utilise the small farm ponds and wetland areas of the site from time to time. These include shags, grey teal, shoveler, and scaup.

Petrels &/or shearwaters have been heard flying over Palmerston North in the direction of the Ruahines but the species and their destination is not known (D. Smith pers.com). Several species may be involved. The five species listed as present in the Wanganui Conservancy (DoC 2001) are Flesh-footed and sooty shearwaters both listed as ”gradual decline”, and the Grey-faced petrel, Fluttering shearwater, NZ white-faced storm petrel, and Northern diving petrel, all listed as “not threatened”. It is likely they are nesting in scrub and open ground around Wharite Peak.

Table 6.2. Likely Vagrants

English Name	Origin	National Threat classification	Regional Threat classification	Source
North Island kaka	E	2 Nationally endangered	Endangered	DoC/Blaschke
Bush falcon	E	3 Nationally vulnerable	Endangered	DoC
Little black shag	N	6 Sparse	Not threatened	Blaschke
North Island Rifleman	E	Not threatened	Not threatened	DoC
Grey teal	N	Not threatened	Not threatened	Blaschke
Australasian shoveler	E	Not threatened	Not threatened	Blaschke
NZ scaup	E	Not threatened	Not threatened	Blaschke
NZ Pied oystercatcher	E	Not threatened	Not threatened	Blaschke
Little shag	E	Not threatened	Not threatened	Blaschke
Petrels / shearwaters	E / N	Various	Not threatened	DoC

Migratory Birds

Migratory birds are birds that move large distances on a seasonal basis, either between sources of food, or between nesting areas often travelling thousands of kilometres between spring breeding sites and winter-feeding areas.

A large number of migrant birds have been recorded in the Manawatu District many of which breed in the Northern Hemisphere and over winter in New Zealand. Most however are confined to coastlines, estuaries and large river and wetland systems and are unlikely to use the saddle road area as a stop over point.

Similarly, there are some wetland birds such as marsh crake, bittern, and NZ dabchick, which are known to occur in the Manawatu area and which may pass through the saddle road site as they move seasonally between wetlands on either side of the ranges. It is perhaps more likely that migratory birds would use the Manawatu Gorge and river terraces as a route when travelling between the two coastlines.

Native Bats

Bats are New Zealand’s only terrestrial native mammals and are declining nationally. Therefore, these species are a high priority for conservation.

Bats still occur widely, from Northland south to Stewart Island, but their distribution is patchy, and their numbers very low in many areas. Two species of bat are recorded from the district and are probably present in the Ruahines ranges to the north. They are the short tailed bat, which is regionally endangered and has the national status of range restricted, and the long tailed bat, which is considered regionally endangered and nationally vulnerable.

New Zealand bats typically live within areas of mature native forest, selecting the largest and oldest trees for roosting and breeding. The short tailed bat is known for its habit of foraging on a forest floor. The long tailed bat prefers to feed aerially choosing forest margins and native scrub to hunt. Individual bats can range over 50 square kilometres when feeding at night and so may occur as vagrants at the study site travelling south from the Ruahine ranges.

The Department of Conservation is in the process of conducting a bat survey within the Wanganui conservancy and new information may come to hand.

A more detailed list of all native bird species found with in the Manawatu Conservancy, including potential vagrant and migratory species, is been provided in Table 13.1 pg 32. National threat classification is derived from Hitchmough 2001. Regional threat classification is derived from DoC 1995.

6.4 FRESHWATER HABITAT

The site drains to the east and south into the Manawatu River and to the west into the Pohangina River. These rivers are regionally significant wildlife habitats containing a high diversity of indigenous fish species including banded kokapu, short and long finned eel, and four species of bully. There is also an informal record of the brown mudfish being present in the Pohangina River near the Ashhurst Domain.

These rivers also provide habitat for many species of waterfowl and are recognised as significant trout fisheries with high value for recreational fishing. Both have the potential to be affected by this proposal.

Within the windfarm site are a number of small streams, which are heavily modified by stock access. There are no records of native fish in the streams within the windfarm area.

6.5 CORRIDORS

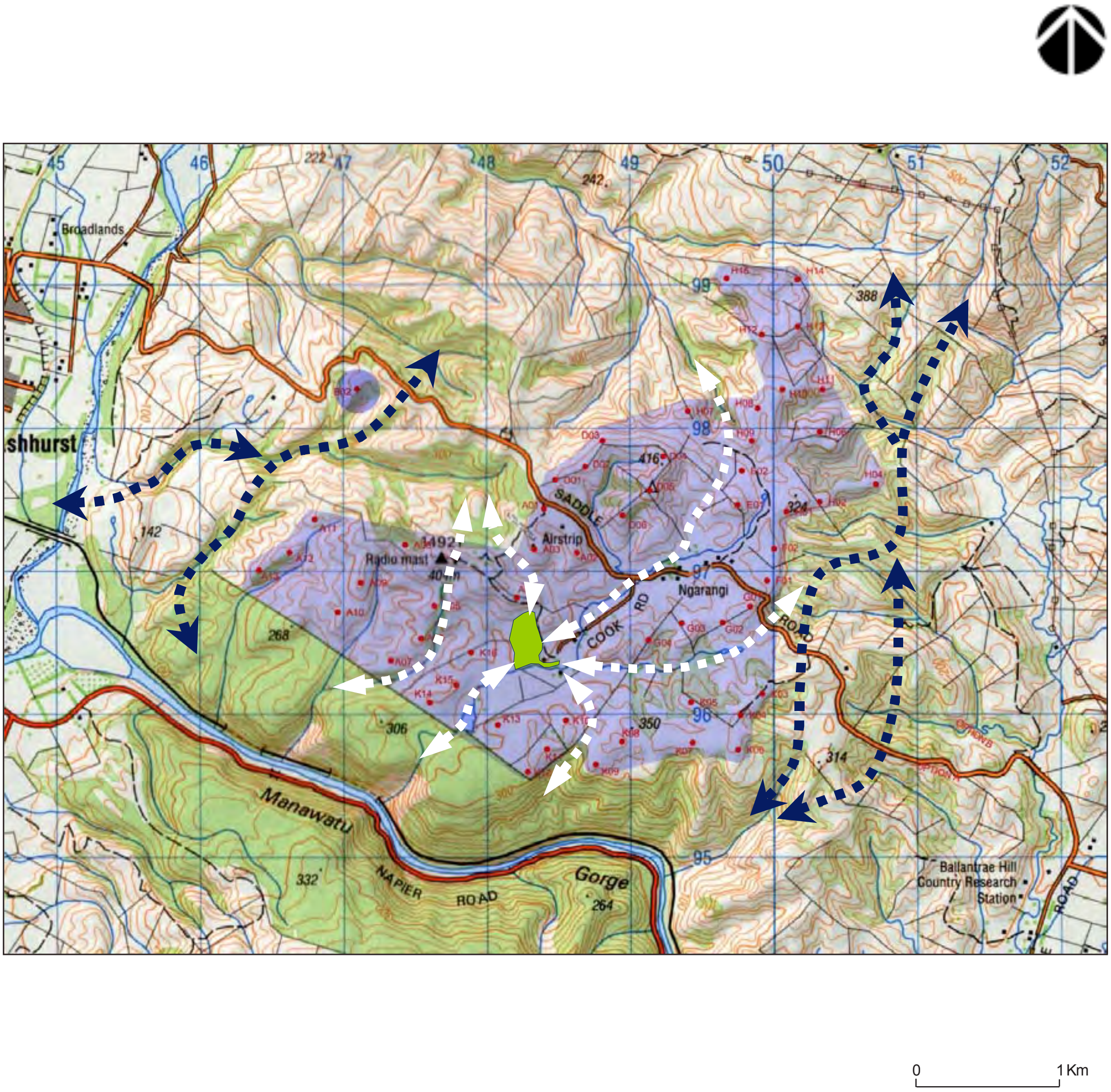
In 2001, Boffa Miskell was commissioned by the Palmerston North City Council to undertake an assessment of ecological processes for the City. This report highlighted the severe loss and fragmentation of forest within the area and the threat this fragmentation posed to the ecological sustainability of many sites. It identified the importance of movement of “keystone” native birds such as bellbird, tui and kereru, which are essential for the distribution of seed and the pollination of key forest tree species, thereby ensuring their long term viability (Blaschke 2002). It also highlighted the importance of access to these fragments to ensure year round access to food species for the birds.

A subsequent issues and options paper prepared by Horizons Manawatu has identified several key wildlife corridors in the area, which are a priority for protection and enhancement. The site of the Te Apiti Wind Farm sits in the middle of the proposed “Ruahine – Gorge” corridor which links the Manawatu Gorge Scenic Reserve and Ruahine forest park with Manawatu floodplain remnants (Janssen 2002). The total width of this corridor zone is approximately 7 kilometres, however, in reality only very narrow passages of vegetation, gullies and saddles, within this largely pastoral zone will provide for effective movement of small forest species.

Assuming that movement of key forest bird species is occurring through this corridor, it is suggested that the most likely routes are within forest remnants in deep gullies to the west of the wind farm site. To the east of the wind farm sites areas of regenerating kanuka may be used but this will be limited by ongoing clearance and farm improvement. Within the site, there is only one small forest remnant, the QEII Covenant which lies near the southern margin. Generally, however, within the windfarm site and wildlife movement will be either over open pasture or via pine shelterbelts.

6.6 SUMMARY

- The site on which the wind farm will be located is predominantly improved farmland with vegetation and wildlife typical of this type of environment. A number of small bush fragments and swampy gullies occur in this area, which are locally important as wildlife habitat.
- Two protected natural areas are located adjacent to the site and one forest remnant (Bolton Bush) lies within the proposed wind farm. These sites are regionally significant wildlife habitats.
- The site supports a moderate diversity of bird species, both native and introduced, that are adapted for open grassland, forest margin, shrubland and scrub, and to a lesser extent freshwater streams and wetlands.
- None of the resident bird life found in the area is nationally or regionally threatened, however, two nationally endangered species have historically been observed in the Manawatu Gorge Scenic Reserve adjacent to the wind farm site.
- The site contains tributaries of two rivers, the Manawatu and Pohangina which are regionally significant freshwater habitats and important for recreational fishing.
- The site lies in the centre of a recognised bird corridor, native forest species utilising the small bush fragments to travel between the Ruahine Ranges, Manawatu Gorge Scenic Reserve, and Tararua Ranges.



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PROJECT TE ĀPITI
Possible Wildlife Corridors

Meridian Energy

Reference:
W02020-2 A4 Ecology Report Figs 245.pmd

FIGURE 4

7 SCOPE OF WORKS

The nature of the proposal and ancillary works are described in detail in the application for consent and the construction reports prepared by Opus Consulting. In summary the scope of the works, which this assessment has considered, are as follows.

Turbines

The turbines will be placed on 70 metres tall tubular towers with a base width of 4.2 metres. The rotor diameter will be 72 metres and it will travel at between 10 and 25 revolutions per minute depending on the final design chosen and whether it will be variable speed or fixed speed. The full height of each turbine, when the blade is standing vertically, will be 106 metres.

Each turbine will be placed on a foundation up to fifteen metres square.

Layout

The turbines will be located over an area of approximately 1,150 ha. The turbines will not be laid out in a geometric grid but each turbine micro-sited to best utilise the wind capacity within the overall site, often following short parallel spurs. The minimum spacing for turbines in a row will be approximately 210 metres and the minimum spacing between rows will be will be approximately 405 metres apart.

Actual spacings between turbines in some areas are closer to 300 metres and some rows are up to 500 metres apart, depending on terrain.

Earthworks

The turbines will be connected by approximately 21 kilometres of access track will need to be formed or upgraded to an average of 10 metres in width to accommodate the construction and transport vehicles necessary to carry the pre-fabricated turbine components, and surfaced in crushed rock. At the location of each turbine, a flat platform will be formed approximately 50 metres by 20 metres.

The total area of excavated works including the turbine pads and road footprints will be approximately 35 hectares will be exposed and approximately 640,000 – 880,000m^3 of material will be excavated. This fill will need to be deposited in a number of disposal sites around the wind farm.

Ancillary Works

Some other works will be associated with the project. Five wind monitoring towers will be installed ranging from 30 metres to 69 metres in height.

A lay-down and assembly area of approximately 4 ha will need to be prepared and this will involve the levelling of the site and culverting of just over 200 metres of stream.

The turbines will need to be connected to the national grid. It is proposed each turbine will be connected to a new substation located at the summit of Saddle Road by underground cabling. From the sub-station, approximately 4.2 km of aerial cables will descend to the existing Woodville substation. These aerial cables are a permitted activity.

8 POTENTIAL IMPACTS ON WILDLIFE

8.1 INTERNATIONAL EXPERIENCE

Internationally wind farms have been implicated in bird deaths at a number of sites. As a result, a large body of research has been conducted to determine the causes of bird mortality and design wind farms better to avoid these effects. Based on this international research the following general conclusions have been reached.

- Where effects occur they result from either habitat loss, disturbance leading to displacement, or collision mortality.
- Actual collisions are rare. There are only a few windfarms implicated in significant avian mortality due to their poor siting and design. These windfarms have been placed either within dense populations of susceptible species (estuaries, wetlands) or on migratory flight paths where many hundred to several thousand bird-movements can be experienced each hour.
- Displacement from habitat as a result of wind farm operation is also rare, most species adapting to the wind farm presence over time. However, for a few species displacement does occur and can be ecologically significant, particularly if they are displaced from their breeding territory.
- Over time, most avian species resident near a windfarm learn to avoid the turbines or adjust their flight to pass under the rotor sweep or between the turbines. The most at risk species are those that migrate through the area or have behaviour that over-rides the avoidance response (hunting raptors).
- A number of research projects have shown that some migratory birds will alter their routes after one or two years of exposure to windfarms.
- Most migration of both waterfowl and passerines occurs well above the height of turbines. The period of greatest risk is during take off and descent at a stop-over point or destination.

Many different factors combine in different ways to create conditions where windfarms are either safe, or hazardous, to wildlife. These factors operate both temporally and spatially; involve terrain, climate, turbine design, spatial patterns of turbine distribution, the particular species of bird present at the site, and factors that affect their breeding, feeding, roosting behaviour and movement patterns. Each site must be considered in its own right based on the unique set of factors known to occur there. This section considers the Te Apiti site in relation to international experience and looks specifically at:

- The design and layout of the windfarm
- The susceptibility of wildlife known to occur at the site.

The following table identifies specific features of windfarms and wind turbines that are implicated in bird strike and displacement internationally, and compares these features with the proposed Te Apiti Windfarm.

Table 8.1. Risk Factors for Collision & Displacement

Known risk factors	Te Apiti comparison
Large concentrations of turbines (1,000+)	55
Closely spaced turbines (<30 m)	Minimum spacing of 210 m between turbines Up to 500 m between rows
Towers in uniform rows across the landscape (barrier)	Micro-sited – random
Lattice Towers – (encourages perching)	Solid tubes
Fast rotating blades 50-72 RPM	10.5 to 24.4 RPM (depending on machine chosen)
Turbines in steep valleys, across saddles	All located on ridges and hill tops
Transmission Lines perpendicular to prevailing winds and without flagging	Turbines connected by underground cables. Connection to national grid follows existing lines.
Transmission lines crossing water	No
Frequent fog & low cloud common (esp. during migration season)	Fog and mist occur year round but most common autumn and spring.
Turbines lie across migratory route	No known migratory routes (See Part 6).
High use of area by susceptible species	Not significant (See Part 6)
Large Prey Base (attracting raptors)	Not significant (See Part 6)
Other	Bottom of blade at lowest point 35 metres from ground

In summary early windfarms often had very large numbers of small turbines with fast rotors, distributed in long chains, with close spacings. Some were located across major migratory routes. These windfarms posed significant risks to birdlife. By comparison the Te Apiti site has a few, large, widely spaced turbines, with slow blades, which are sited on ridge crests and summits, in an area with little or no use by migratory species.

8.2 NEW ZEALAND SITUATION

There has been no research done in New Zealand on the incidence or cause of bird strike on structures of any kind, be they transmission cables, radio masts, or house windows. In particular, there is no body of information relating to wind turbines and their effects on indigenous wildlife, either mortality due to collision, loss of habitat due to site avoidance, or their possible effect as a barrier to migration.

There have been no reported bird strikes at any of the three existing turbine sites in New Zealand although there is anecdotal evidence of mortality of black-backed gulls at the Tararua wind farm. Gulls are recognised as a high-risk group internationally and so this is not unexpected. There is no information to say whether these bird strikes are rare or common.

At the single Brooklyn wind turbine, which is located immediately adjacent to the Karori Wildlife Sanctuary in Wellington, there have not been any reported bird deaths. The Karori Wildlife Sanctuary contains some significant species including two that may be occasional visitors to the Saddle Road site, the bush falcon, and North Island kaka. This area is monitored regularly by staff of the Sanctuary and is a popular tourist spot.

8.3 TE APITI WIND FARM

In determining the risk profile of a site a range of factors need to be considered such as the presence or absence of sensitive bird species, their feeding, roosting and nesting behaviour; the presence or absence of migratory routes, and the specifics of the turbine layout and construction.

The following table identifies bird groups that feature in bird strike statistics internationally, together with an indication of native species found at the Te Apiti Site, which fit within these groups.

Table 8.2. At Risk Bird Groups

Order or Family recognised internationally as "at risk".	**NZ Native Equivalents found at Te Apiti Site**		**Disturbance displacement**	**Barrier to movement**	**Collision**	**Direct habitat loss damage**
	Resident	**Vagrant**				
Mergini (*seaducks*)	-	-	**X**	**X**	**X**	**X**
Gaviidae, (*divers, loons*)	-	-	**X**	**X**	**X**	
Alcidae (*alcids, auks, puffins*)	-	-	**X**		**X**	**X**
Otididae (*bustards*)	-	-	**X**		**X**	**X**
Tetraonidae (*black grouse*)	-	-	**X**		**X**	**X**
Sternidae (*terns*)	-	-			**X**	
Sulidae (*gannets & boobies*)	-	-			**X**	
Podicipedidae (*grebes, dabchicks*)	-	-	**X**			
Ciconiiformes (*herons & storks*)	White faced heron	-			**X**	
Accipitridae (*raptors*) **Strigiformes** (*Owls*)	Harrier hawk Morepork	Falcon	**X**		**X**	
Charadriiformes (*waders & gulls*)	Spur wing plover Black backed gull	Oystercatchers	**X**	**X**	**X**	
Anatidae (*swans & geese*)	Paradise shelduck	Black Swan Grey Teal NZ Shoveler	**X**		**X**	
Gruiformes, (*cranes*)	Pukeko				**X**	
Phalacrocoracidae (*shags*)		Little Black Shag Little Shag				**X**
Bats	-	-			**X**	

Other indigenous NZ species potentially at risk.	Kereru	Kaka	**?**		**?**	

8.3.1 Resident Birds

Table 8.2 shows that seven native species that are resident on site are identified with a high-risk group based on international experience. Of these seven species the hunting birds raptors (morepork and Australasian harrier) are considered most at risk from collision due to their feeding and flight behaviour. Displacement due to wind farm avoidance is also possible depending on the species. The larger waterfowl which are identified here (paradise shelduck, pukeko, heron and gull) utilise farm ponds and open pasture within the wind farm site. They are potentially at risk from both collision, and displacement because of turbine avoidance.

It is not known whether Kereru is at risk but a cautionary approach may suggest that its slow and cumbersome flight as it moves between bush fragments could put it at risk from collision. Alternatively, it may avoid the turbines limiting its movement through the site and reducing its range.

None of the species likely to interact with the wind farm are nationally or regionally significant. Occasional deaths associated with the wind farm would not affect local populations, however, if seed carrying birds such as kereru are displaced from the wider area the farm may affect sustainability of some bush fragments on the site. Avoidance leading to displacement is therefore seen as the most significant potential effect. (See Section 9.6 pg. 22, Corridors).

8.3.2 Vagrant Birds

Of the eight species of vagrants that have been recorded on or around the site, two, the bush falcon and North Island kaka, are considered significant. The nationally vulnerable falcon is identified with raptors as an at risk bird group and could be affected either by collision or displacement. International research suggests, however, that the initial reaction of small raptors such as falcons to the construction of wind farms is avoidance. Over time as they become accustomed to the operation of the turbines, they begin to utilise the habitat again and then are at risk of collision. Given that the falcon are only rare visitors it is assumed their initial reaction will be avoidance and that long term familiarity is unlikely to occur.

There are no records of parrots being affected by wind farms internationally but this may relate more to a lack of wind farms in areas where large parrots are common. There is a possibility that kaka, which is nationally endangered, could interact with the wind farm as they move between forest remnants. Alternatively, kaka may choose to avoid the site utilising forest corridors to the west. Given the intelligence of these birds this may be the more likely scenario.

The other known vagrants are common to the area and are classified as not threatened nationally.

8.3.3 Migratory Birds

There are no known species of migratory birds that utilise the proposed wind farm site.

8.4 SUMMARY

- The wind farm design and turbine type has a range of characteristics that make it a low risk for bird strike and displacement when compared to international indicators.
- International research has shown that resident species of bird adjust their behaviour over time to avoid wind turbines.
- International experiences shows that the groups of birds most at risk are migratory species, particularly during takeoff and landing. No migratory species are known to utilise the site during their travels.
- The range of species present in the Saddle Road area, and which belong to groups recognised as being at-risk, are common to abundant at the site and are not rare or threatened.

9 ASSESSMENT OF ECOLOGICAL EFFECTS

9.1 INTRODUCTION

Potential adverse effects are discussed below. Potential effects considered cover both the construction phase of the wind farm and its ongoing operation. This report considers direct effects such as habitat loss, and indirect effects such as avoidance and displacement of wildlife from the site. Each section concludes with recommendations for mitigation of identified effects.

9.2 PROTECTED NATURAL AREAS

9.2.1 Discussion

All works are on private land. None of the proposed works will affect protected natural areas.

9.2.2 Measures to Avoid, Remedy, Mitigate

Significant sites have been avoided.

9.2.3 Monitoring

No monitoring is required.

9.3 EFFECTS ON INDIGENOUS VEGETATION

9.3.1 Discussion

Bush Remnants

The installation of the turbines, formation of access roads, and the siting of disposal areas will not result in the removal or disturbance of any forest remnants.

Wetland areas

All proposed disposal sites and quarry sites were visited with the project engineer and the natural values of each discussed. A number of potential disposal sites were subsequently removed from the list due to the likely loss of habitat. Several sites were also modified to avoid bush remnants. To compensate for those sites that were removed, several new sites were added. None of the quarry sites were in areas with indigenous vegetation and the installation of turbines, formation of access roads and the siting of disposal areas will not result in the removal or disturbance of any significant wetland areas.

9.3.2 Measures to Avoid, Remedy, Mitigate

Significant sites have been avoided.

9.3.3 Monitoring

No monitoring is required.

9.4 EFFECTS ON AVI-FAUNA

9.4.1 Discussion

Habitat Loss

No wildlife habitat will be lost as a result of this proposal.

Collision

There is a high degree of confidence that the wind farm will not result in mortality of significant species of wildlife. The layout of the windfarm and the design of the turbines are consistent with international recommendations for minimising bird strike.

Birdstrike cannot be ruled out for some species. However, the species most at risk are resident birds of the open country, which are abundant on site and not under threat nationally.

International research would suggest that the two significant vagrant species, the kaka and bush falcon, are most likely to avoid the turbines.

Displacement

The wide spacing of turbines and their micro-sited layout is unlikely to result in displacement of wildlife from feeding or breeding areas. If displacement does occur in some parts of the site, it will only affect species that inhabit the open farmland upon which the windfarm is located. None of these species are threatened nationally or regionally and their displacement would not affect the local ecology.

9.4.2 Measures to Avoid, Remedy, Mitigate

1) The layout of the windfarm, and the design of the turbines, is consistent with international best practice for reduction of the risk of bird strike. No additional mitigation is considered necessary.

9.4.3 Monitoring

1) It is recommended that the applicant record and report all bird strike. If any bird species listed in Appendix 2 pg. 32 as Nationally Critical, Nationally Endangered, Nationally Vulnerable, or in Serious Decline is found injured or killed at the site they will notify the Department of Conservation and provide the bird for autopsy or rehabilitation.
2) If significant bird deaths occur, consideration can be given to establishing a more intensive monitoring programme. At this point additional measures can be investigated for improving tower visibility or enhancement of bird corridors.

9.5 FRESHWATER HABITAT

9.5.1 Discussion

Habitat Loss

It is proposed that a large area near Cook Road be set aside for laydown and storage of materials and for the assembly of various components. This will require levelling of up to 4 ha of the site and the culverting of up to 200 metres of stream. This watercourse is a typical farm stream incised into a basin of grazed pasture. It has low natural value but will provide habitat for some species of birds and invertebrates. The length of culverting is kept to the least extent practicable.

Downstream effects

Given the quantities of material involved with the excavation of the turbine foundations and access roads, and disposal sites, the most significant potential adverse effect of this proposal is movement of sediment into local watercourses and eventually into the Manawatu and Pohangina /Rivers.

Avoidance of this effect is aided by the location of almost all access roads and turbines on ridges or spurs, and the location of deposit sites in upper reaches of gullies. This provides opportunities for capture and management of sediment before it can reach water bodies.

However, close attention will still need to be given to the design, implementation and monitoring of appropriate sediment management techniques. An Erosion and Sedimentation Control Plan will be prepared to address this risk as detailed in the Opus Consultants construction report.

Contaminants

In addition to the movement of sediment, there is the issue of potential discharges of petrochemicals from storage facilities, concrete waste from truck wash down areas, and during construction and maintenance of Turbines. Like the issue of sedimentation, this will require careful site management and is addressed as part of construction planning and monitoring.

9.5.2 Measures to Avoid, Remedy, Mitigate

1) Significant sites have been avoided.
2) The laydown area should be kept as small as practicable to avoid excessive culverting of the farm stream at Cook road.
3) It is recommended that works be conducted outside the winter months, preferably between October and May.
4) A stormwater runoff, erosion and sedimentation control plan will be prepared prior to commencement of construction setting out appropriate measures to ensure the effects of stormwater runoff are minimised. Control to be based firstly on protection of the soil surface, or minimising the extent of disturbance from rain and run off, and secondly on capturing eroded soil particles on site. Measures to include but not limited to:
    - Run off diversion channels
    - Contour drains
    - Earth bunds
    - Sediment retention ponds
    - Silt fences (filter fabric)
    - Check dams
    - Top-soiling and revegetation (including hydro-seeding)
    - Appropriate cut batters where large cuts are required.
5) The plan should include appropriate measures for the use and control of contaminants, and the management of accidental spills. Measures to include but not be limited to:
    - Separate bunded storage area on-site for diesel fuel and lubricants.
    - Minimise the amount of diesel held on site.
    - Separate concrete batching and wash out areas to be bunded.
    - Contingency plan for spillage outside storage and refilling areas.

9.5.3 Monitoring

1) A standard monitoring regime be established to be defined by the sedimentation management plan.

9.6 CORRIDORS

9.6.1 Discussion

International research suggests that the wind farm layout as proposed will not create a significant hazard to wildlife and any bird movement that currently occurs will continue unchanged once the farm is operational.

If however, some species of bird do avoid the wind farm site, passage will still be possible around the site, to the east using a series of small bush remnants, pine forest and regenerating kanuka forest, to the west via a series of vegetated gullies that connect the two largest forest fragments to the Manawatu Gorge Scenic reserve.

9.6.2 Measures to Avoid, Remedy, Mitigate

Adverse effects are considered unlikely. It is not believed that measures to avoid remedy or mitigate effects are required.

9.6.3 Monitoring

See recommendations in section 8.4.

9.7 SUMMARY

Vegetation and habitats

- No protected natural areas or significant habitats will be affected by construction of the proposed wind farm.

Avi-Fauna

- Some bird strike is likely but the species most likely to be involved are not rare and occasional losses will not have a significant adverse effect on the ecology of the area or the populations of these species.

Freshwater Habits

- There is potential for downstream effects, given the large areas of excavation and the nature of the soil and substrate. The planning, implementation and monitoring of sediment control measures as detailed in the Opus Consultants construction report will address this risk.

Corridors

- The design and layout of the windfarm suggest that it will not have a significant affect on bird movement through the site. The best forest corridors connecting the Ruahine Ranges to Manawatu Gorge lie outside the footprint of the windfarm to the west.

10 CONCLUSIONS

In summary:

Physical environment

1) Land ownership on the project site is private. Land use would continue relatively unchanged (pastoral farming) by the construction of wind turbines.

2) Parts of the site are located on young and erodable sedimentary rocks. There is potential for erosion and sediment movement from the site if the soil mantle is disturbed.

3) There are no large waterbodies, lakes, streams or rivers within the site, although the site drains into two large rivers the Pohangina to the west and the Manawatu to the east and south.

Natural Environment

1) The site is predominantly improved farmland with vegetation and wildlife typical of this type of environment. A number of small bush fragments and swampy gullies occur in this area, which are locally important as wildlife habitat.

2) A number of protected natural areas can be found surrounding the site and one covenant site lies within the proposed wind farm. These sites are regionally significant wildlife habitats.

3) The site supports a moderate diversity of bird species, both native and introduced, that are typically birds of open grassland, forest margin, shrubland and scrub, and to a lesser extent freshwater streams and wetlands.

4) None of the resident bird life found in the area are nationally or regionally threatened, however, two nationally endangered species are rare visitors.

5) The site contains tributaries of two rivers, the Manawatu and Pohangina which are regionally significant freshwater habitats and important for recreational fishing.

6) The site lies in the centre of a recognised bird corridor, with forest birds utilising the small bush fragments to travel between the Ruahine Ranges, Manawatu Gorge Scenic Reserve, and Tararua Ranges.

Potential Impacts on Wildlife

1) The wind farm design and turbine type has a range of characteristics that make it a low risk for bird strike and displacement when compared to international indicators.

2) International research has shown that resident species of bird adjust their behaviour over time to avoid wind turbines.

3) International experiences shows that the groups of birds most at risk are migratory species, particularly during takeoff and landing. Current information suggests that migratory birds do not use the site.

4) The range of species present in the Saddle Road area, and which belong to groups recognised as being at-risk, are common at the site, and are not classified as rare or threatened nationally.

Project Description

1) The proposed Te Apiti wind farm, comprising 55 turbines, is small by international standards (often 500 to several thousand turbines).

2) The proposal will involve significant amounts of earthworks including disposal sites for fill and lay down areas during construction. A number of ancillary structures will also be built.

Assessment of Effects

1) No protected natural areas or significant habitats will be affected by construction of the proposed wind farm.

2) Some bird strike is likely but the species most likely to be involved are not rare and occasional losses will not have a significant adverse effect on the ecology of the area or the populations of these species.

3) There is potential for downstream effects, given the large areas of excavation and the nature of the soil and substrate. The design, implementation and monitoring of sediment control measures as outlined in the engineers report, will be appropriate to address this risk.

4) The design and layout of the windfarm suggest that it will not have a significant affect on bird movement through the site. The best forest corridors connecting the Ruahine Ranges to Manawatu Gorge lie outside the footprint of the windfarm to the west.

In conclusion, the results show that the study area is ideally suited to the development of a wind farm and to the avoidance or reduction of potential effects associated with its construction and operation.

Construction will not remove significant indigenous vegetation or habitats of significant indigenous fauna. The specifics of the site ensure that critical wildlife are unlikely to interact with the wind turbines. In addition, the proposed layout and design of the wind farm complies with international guidelines for minimising effects on wildlife generally.

With proper sediment control and management of discharges there should be little or no impact downstream of the works.

The adverse ecological effects of the proposed wind farm on the local ecology are therefore likely to be minor. A number of recommendations are made which will assist to avoid, remedy or mitigate potential effects.

11 RECOMMENDATIONS

Based on what is known about avian risk factors at wind power plants in North America and Europe, the species (type and numbers of individuals) that frequent the project site, and what was learned from the literature search, site visits, and interviews, the following recommendations are made to assist in the avoidance, remedy or mitigation of potential effects.

WILDLIFE MONITORING

It is recommended that the applicant record and report all bird strike. If any bird species listed in Table 13.1 pg. 32 as Nationally Critical, Nationally Endangered, Nationally Vulnerable, or in Serious Decline is found injured or killed at the site they will notify the Department of Conservation and provide the bird for autopsy or rehabilitation.

If bird deaths occur, consideration can be given to establishing a more intensive monitoring programme. At this point additional measures can be investigated for improving tower visibility or further enhancing bird corridors.

TIMING OF WORKS

It is recommended that given the unstable nature of the soil and substrate works be conducted outside the winter months, preferably between October and May.

SEDIMENT MANAGEMENT

A stormwater runoff, erosion, sedimentation control, and monitoring plan be prepared prior to commencement of construction setting out detailed measures to ensure the effects of stormwater runoff are minimised.

CONTAMINANTS

Include in the standard specifications of contract of appropriate measures for the use and control of contaminants, and the management of accidental spills.

12 REFERENCES

Boffa Miskell: 2002: Ecological Processes in Palmerston North City. Report for Palmerston North City Council. 68 pp.

Connell Wagner Ltd Scanpower Ltd. 1998: "Scanpower: Saddle Road wind farm: resource consent application."

Department of Conservation 1994: Conservation management strategy: Hawke's Bay Conservancy 1994-2004.

Department of Conservation 1997: Conservation management strategy: Wanganui Conservancy: 1997-2007.

Department of Lands & Survey 1986: Manawatu Scenic Reserve Management Plan (draft). Management Plan Series SR 222. Unpublished Internal Report, Palmerston North.

Esler, A.E. 1978 Botany of the Manawatu District, New Zealand. Botany Division, DSIR Information series No 127, Government Printer, Wellington, pp. 206.

Fletcher, J.R. 1987: Land use capability classification of the Taranaki-Manawatu region. Water & Soil Miscellaneous Publication no. 110.

Hitchmough, R. (comp.) 2002: New Zealand Threat Classification System lists—2002. Threatened species occasional publication 23. Biodiversity Recovery Unit, Department of Conservation. Wellington. 210 p.

Janssen, H; 2002: Ecological Assessment of a Forest Remnant within the kahikatea floodplain ecosystem, Whiskey Creek / Cloverlea Palmerston North. Prepared for Horizons.mw. Pp. 35.

Janssen, H; 2002: Native Biodiversity Information, Issues and Options for Manawatu District. Prepared for Manawatu District's State of the Environment report. Published by Horizons.mw. Regional Council. Pp. 24.

Kessels, G. 1995: "Tararua Wind Power Limited, Ecological Assessment Report". Consultancy report, Works Consultancy Services Ltd. Pp. 33

Meridian Energy Limited. 2002: "New Zealand wind development: information package."

Montgomery Watson Electricity Corporation of NZ (ECNZ) 1998: "Proposed Makara wind farm: description and assessment of environmental effects."

Montgomery Watson Windcorp Ltd. 2001: "Mill Creek wind farm: planning assessment."

National Wind Coordinating Committee 2001: Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States. Prepared by Western EcoSystems Technology Inc. for NWCC, August 2001 67 pp.

NZ Energy Efficiency and Conservation Authority. 1995: "Guidelines for renewable energy developments: wind energy. " EECA. 9.626 GUI

Page, M.J. 1995: Land use capability classification of the Wellington Region. Landcare Research Science Series No. 6.

Ravine, D.A. 1995: Manawatu Plains Ecological District. Survey Report for the Protected Natural Areas Programme. NZ PNA Programme No. 33. Department of Conservation, Wanganui.

Windfarms and Birds: An Analysis of the effects of windfarms on birds, and guidance on environmental assessment criteria and site selection issues. Report prepared by Birdlife on behalf of the Bern Convention Sept 2002. 37 pp.

12.1 WEB SITES

Watchdogs / Ngo's

Bird Strike

The International Bird Strike Committee - www.int-birdstrike.com/

The Fatal Light Awareness Program (FLAP) - www.flap.org/new/nestegg2.htm

TowerKill.com - www.towerkill.com/

Swedish Ornithological Society - www.sofnet.org/index.asp?DocID=932

U. S. Fish and Wildlife Service - www.fws.gov/

Migratory Birds

The Convention on the Conservation of Migratory Species - www.wcmc.org.uk/cms

The Council of Europe for the Bern Convention - www.coe.int/portalT.asp

Migratory Birds Div U. S. Fish and Wildlife - www.migratorybirds.fws.gov/issues/towers/abcs.html

Sustainable Energy

International Institute for Sustainable Development - www.iisd.org/default.asp/

Green Energy Ohio - www.greenenergyohio.org/

Industry / Government

The World Energy Council - www.worldenergy.org/wec-geis/

The National Wind Coordinating Committee - www.nationalwind.org/

The California Energy Commission - www.energy.ca.gov

The British Wind Energy Association - www.bwea.com/

The Canadian Wind Energy Association - www.canwea.ca/

The European Wind Energy Association - www.ewea.org/index.html

The Danish Wind Industry Association - www.windpower.org/core.htm/

Wind service Holland - home.wxs.nl/~windsh/english.html

NZ Energy Efficiency and Conservation Authority - www.eeca.govt.nz/

NZ Wind Energy Association - www.windenergy.org.nz/

NZ Wind Farm Development - www.windfarmdevelopments.co.nz/

Wind Prospect Australia - www.windprospect.com.au/

The Australian Wind Energy Assn - www.auswea.com.au/

The British Dept of Trade and Industry - www.dti.gov.uk/renewable/pdf.html

Research & Technology

U.S. National Wind Technology Centre - www.nrel.gov/wind/

Includes avian literature database - www.nrel.gov/wind/avian

U.S. Laboratory for renewable energy -- www.nrel.gov/research/wind/wind.html

U.S. Office of Energy Efficiency and Renewable Energy - www.eere.energy.gov/
U.S. Office of Scientific and Technical Information - www.osti.gov
Energy research Centre of the Netherlands - www.ecn.nl/index.html
Danish National Environmental Research Institute - www.dmu.dk/forside_en.asp

AEE

AEE Prince Edward Island Dec-01 - www.bsc-eoc.org
AEE Toronto Feb-2000 - www.torontohydro.com
Risk Assessment May-2002 - www.marylandwind.com
Planning Guidelines South Australia - www.planning.sa.gov.au/windfarms/index.html
Renewable Energy Systems – Drummuir wind farm - www.res-ltd.com/drummuir/landv.htm
Tennessee Valley Authority - www.tva.gov/environment/reports/windfarm/
Nai Kun Wind Farm – Uniterre Resources Ltd. - www.uniterre.ca/Nai_Kun_Wind_Farm_rep.pdf
Pacific Hydro – Portland wind farm - www.pacifichydro.com.au/

Wind Farm Opponents

Country Guardian - www.countryguardian.net/
Wind farm forum - www.windfarmforum.org/
A.L.A.R.M - www.darrylmueller.com/alarm.html
Campaign for the Protection of Rural Wales - www.cprw.org.uk/wind/windindc.htm
Makara Guardians - makara.freeyellow.com/MGfrontpage.htm
Alliance to protect Nantucket Sound - www.saveoursound.org/index.html
Fight To Save Barningham High Moor. - www.wind-farm.co.uk/

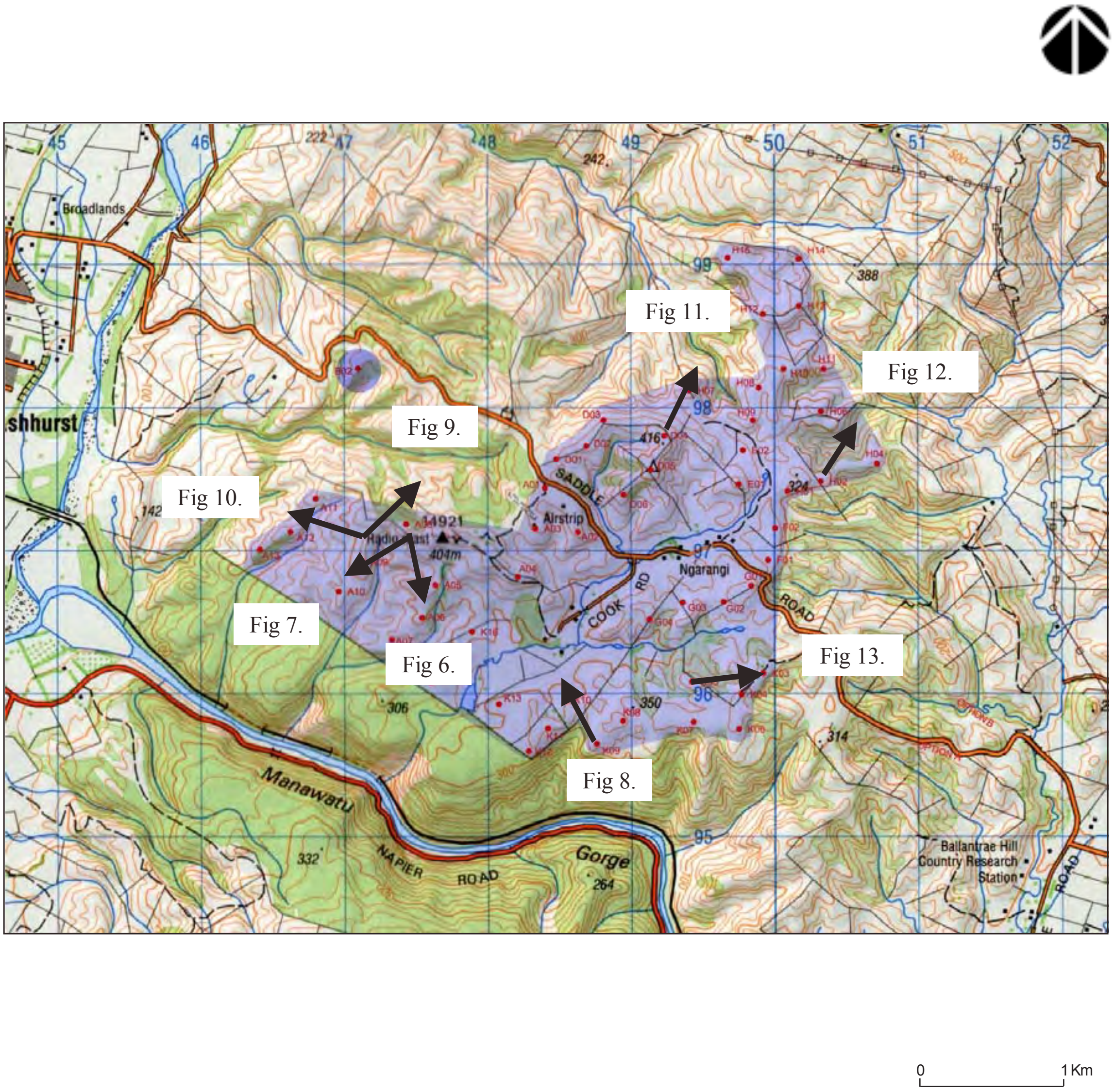
Journals

WIND Directions -official magazine of the EWEA - www.ewea.org/src/directions.htm
Wind Power Monthly - www.wpm.co.nz/
Wind Energy Monthly – Wiley Science - www3.interscience.wiley.com/cgi-bin/jtoc?ID=6276

13 Plants Species Names used in Text and their Latin Equivalents.

Broom *	*Cytisus scoparius*	
cabbage tree	*Cordyline australis*	
fivefinger	*Pseudopanax arboreus*	
gorse *	*Ulex europaeus*	
hinau	*Elaeocarpus dentatus*	
kanuka	*Kunzea ericoides*	
kanuka	*Cunzya ericoides*	
kohekohe	*Dysoxylum spectabile*	
lacebark	*Hoheria populnea*	
lemonwood	*Pittosporum ericoides*	
macrocarpa *	*Cupressus macrocarpa*	
mahoe	*Melicytus ramiflorus*	
manuka	*Leptospermum scoparium*	
ngaio	*Myoporum laetum*	
nikau	*Rhopalostylis sapida*	
pasture grasses*	Typically	*Dactylis glomeratus* (Cocksfoot) *Trifolium spp. (Clover)* *Anthoxanthum odoratum (Sweet vernal)* *Lolium perenne (Perrenial ryegrass)*
pigeonwood	*Hedycarya arborea*	
pine *	Typically	*P. radiata*
putaputaweta	*Carpodetus serratus*	
rewarewa	*Knightia excelsa*	
rimu	*Dacrydium cupressinum*	
supplejack	*Ripogonum scandens*	
tawa	*Beilschmiedia tawa*	
toetoe	*Cortaderia* spp.	
totara	*Podocarpus totara*	
treefern	Typically *Cyathea medullaris* (mamaku)	

* = introduced species



BOFFA
MISKELL
planning design ecology

Reference:
W02020-2 A4 Ecology Report Figs 245.pmd

PROJECT TE ĀPITI
Location of Photographs

Meridian Energy

FIGURE 5

Figure 6 : *Rolling farmland descending to the hard forest edge of the Manawatu Gorge Scenic Reserve*

Figure 7 : *Another view of forest margin, Manawatu Gorge Scenic Reserve*

Figure 8 : *"Bolton Bush" the QEII Covenant, middle right, in relation to the edge of the Manawatu Gorge Scenic Reserve bottom centre.*

Figure 9 : *The largest unprotected forest fragment on the slopes to the west of the windfarm proposal, Saddle Road crosses the hillside middle distance.*

Figure10 : *Forested gully which forms one of the important wildlife corridors to the west of the site.*

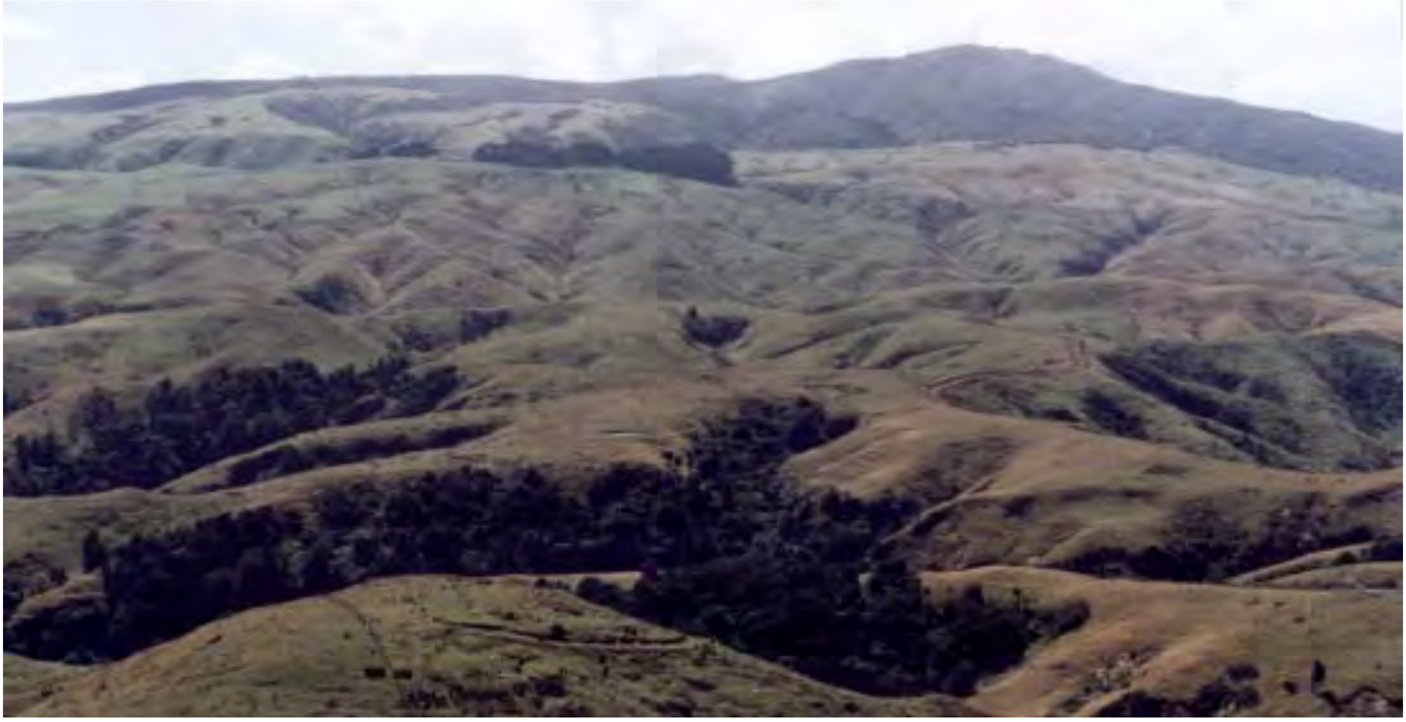


Figure 11 : *Another small forest fragment on the western side of the site. Wharite Peak in the distance.*

Figure 12 : Mixed kanuka and gorse typical of gullies to the east of the windfarm site. This area has recently been sprayed.

Figure 13 : A wet gully of Carex and Cyperus. Kanuka shrubland fringing. This gully was one of several ruled out as deposit areas following field survey. Alternative sites without wetland vegetation were found.

Table 13.1. Listing of bird species likely to be present or liable to occur seasonally at the site.
Sorted by national status (threat classification) and by likely occurrence at site.

English Name	Scientific Name	Threat classification	Origin	Resident	Vagrant	Possible migrant	Highly unlikely
New Zealand pigeon, kereru	*Hemiphaga novaeseelandiae*	5 Gradual decline	**E**	✓			
Australasian harrier	*Circus approximans*	Not threatened	**N**	✓			
Bellbird	*Anthornis melanura melanura*	Not threatened	**E**	✓			
Grey warbler	*Gerygone igata*	Not threatened	**E**	✓			
Morepork	*Ninox novaeseelandiae novaeseelandiae*	Not threatened	**E**	?			
New Zealand kingfisher	*Todiramphus sanctus*	Not threatened	**E**	✓			
New Zealand pipit	*Anthus novaeseelandiae novaeseelandiae*	Not threatened	**E**	✓			
North Island fantail	*Rhipidura fuliginosa placabilis*	Not threatened	**E**	✓			
Paradise shelduck	*Tadorna variegata*	Not threatened	**E**	✓			
Pied tit	*Petroica macrocephala toitoi*	Not threatened	**E**	✓			
Pukeko	*Porphyrio melanotus*	Not threatened	**N**	✓			
Shining cuckoo	*Chrysococcyx lucidus lucidus*	Not threatened	**E**	?			
Silvereye	*Zosterops lateralis*	Not threatened	**N**	✓			
Southern black-backed gull	Larus dominicanus dominicanus	Not threatened	**N**	✓			
Tui	*Prosthemadera novaeseelandiae novaeseelandiae*	Not threatened	**E**	✓			
White-faced heron	*Ardea novaehollandiae*	Not threatened	**N**	✓			
Spur-winged plover	*Vanellus miles*	Coloniser	**N**	✓			
Welcome swallow	*Hirundo tahitica neoxena*	Coloniser	**N**	✓			
Black bird	*Turdus merula*	Introduced	**I**	✓			
Canada goose	*Branta canadensis*	Introduced	**I**	✓			
Chaffinch	*Fringilla coelebs gengleri*	Introduced	**I**	✓			
Dunnock	*Prunella modularis occidentalis*	Introduced	**I**	✓			
Goldfinch	*Carduelis carduelis britannica*	Introduced	**I**	✓			
Greenfinch	*Carduelis chloris*	Introduced	**I**	✓			
Magpie	*Gymnorhina tibicen*	Introduced	**I**	✓			
Mallard	*Anas platyrhynchos*	Introduced	**I**	✓			
Rook	*Corvus frugileus*	Introduced	**I**	✓			
Skylark	*Alauda arvensis*	Introduced	**I**	✓			
Starling	*Sturnus vulgaris*	Introduced	**I**	✓			
Yellow hammer	*Emberiza citrinella caliginosa*	Introduced	**I**	✓			

Table cont …Vagrants & Possible Migrants

English Name	Scientific Name	Threat classification	Origin	Resident	Vagrant	Possible migrant	Highly unlikely
North Island kaka	*Nestor meridionalis septentrionalis*	2 Nationally endangered	E		✓		
Bush falcon	*Falco novaeseelandiae* "bush"	3 Nationally vulnerable	E		✓		
Long-tailed cuckoo	*Eudynamys taitensis*	5 Gradual decline	E		?		
Yellow-crowned kakariki	*Cyanorhamphus auriceps*	5 Gradual decline	E		?		
Black swan	*Cygnus atratus*	Not threatened	N		?		
North Island Rifleman	*Acanthisitta chloris granti*	Not threatened	E		✓		
Red-billed gull	*Larus novaehollandiae scopulinus*	Not threatened	E		?		
Red-crowned kakariki	*Cyanorhamhus novaezelandiae novaezelandiae*	Not threatened	E		?		
Whitehead	*Mohoua albicilla*	Not threatened	E		?		
White heron	*Egretta alba modesta*	1 Nationally critical	N			?	
Australasian bittern	*Botaurus poiciloptilus*	2 Nationally endangered	N			?	
Grey duck	*Anas superciliosa superciliosa*	4 Serious decline	E			✓	
Black shag	*Phalacrocorax carbo novaehollandiae*	6 Sparse	E			?	
Little black shag	*Phalacrocorax sulcirostris*	6 Sparse	N			✓	
Pied shag	*Phalacrocorax varius varius*	6 Sparse	E			?	
New Zealand dabchick, weweia	*Poliocephalus rufopectus*	6 Sparse	E			?	
Marsh crake	*Porzana pusilla affinis*	6 Sparse	E			?	
Spotless crake	*Porzana tabuensis plumbea*	6 Sparse	N			?	
Grey teal	*Anas gracilis*	Not threatened	N			✓	
Australasian shoveler	*Anas rhynchotis*	Not threatened	E			✓	
New Zealand scaup	*Aythya novaeseelandiae*	Not threatened	E			✓	
New Zealand Pied oystercatcher	*Haematopus finschi*	Not threatened	E			✓	-
Pied stilt	*Himantopus himantopus leucocephalus*	Not threatened	N			✓	
Little shag	*Phalacrocorax melanoleucos brevirostris*	Not threatened	E			✓	

Table cont, Species listed in Manawatu but unlikely to be found at the Te Apiti Site

English Name	**Scientific Name**	**Threat classification**	**Origin**	**Resident**	**Vagrant**	**Rare migrant**	**Highly unlikely**
Black stilt	*Himantopus novaezelandiae*	1 Nationally critical	**E**				-
Blue duck, whio	*Hymenolaimus malachorhynchos*	2 Nationally endangered	**E**				-
Wrybill, ngutu-parore	*Anarhynchus frontalis*	3 Nationally vulnerable	**E**				-
North Island brown kiwi	*Apteryx mantelli*	4 Serious decline	**E**				-
Banded dotterel	*Charadrius bicinctus bicinctus*	5 Gradual decline	**E**				-
North Island fernbird, Matata	*Bowdleria punctata vealeae*	6 Sparse	**E**				-
Northern New Zealand dotterel	*Charadrius obscurus aquilonius*	6 Sparse	**E**				-
North Island Robin	*Petroica australis longipes*	Not threatened	**E**				-
Variable oystercatcher	*Haematopus unicolor*	Not threatened	**E**				-
Nankeen night heron	*Nycticorax caledonicus*	Coloniser	**C**				
Bar-tailed godwit	*Limosa lapponica*	Migrant	**M**				-
Cattle egret	*Bubulcus ibis*	Migrant	**M**				-
Curlew sandpiper	*Calidris ferruginea*	Migrant	**M**				-
Grey plover	*Pluvialis squatarola*	Migrant	**M**				-
Large sand dotterel	*Charadrius leschenaultii*	Migrant	**M**				-
Lesser knot	*Calidris canutus*	Migrant	**M**				-
Mongolian dotterel	*Charadrius mongolus*	Migrant	**M**				-
Pacific golden plover	*Pluvialis fulva*	Migrant	**M**				-
Red-necked stint	*Calidris ruficollis*	Migrant	**M**				-
Turnstone	*Arenaria interpres*	Migrant	**M**				-
Central short-tailed bat	*Mystacina tuberculata rhyacobia*	7 Range restricted	**E**				-
Long-tailed bat (North Island)	*Chalinolobus tuberculata* (North Island)	3 Nationally vulnerable	**E**				-

Threat classification derived from DoC 2002.

6.B.5

REPORT ON AVIAN MORTALITY AT TE ĀPITI WIND FARM - BOFFA MISKELL LTD & GOLDER ASSOCIATES 2009

Appendix 6.B.5: Report on Avian Mortality at Te Āpiti Wind Farm – Boffa Miskell Limited & Golder Associates 2009

Report on Avian Mortality at Te Apiti Wind Farm

Te Apiti Windfarm, Palmerston Nth, North Island

Submitted to

Meridian Energy Limited

Report Number W08040-005
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Golder Associates

Boffa Miskell

CONTENTS

1 INTRODUCTION 5
2 STUDY AREA....5
3 METHODS....8
  3.1 Search Effort 8
  3.2 Turbine Selection 8
  3.3 Carcass Search Technique 11
  3.4 Carcass Removal and Decay Trials 11
  3.5 Detection Success....12
  3.6 Bird Activity....12
  3.7 Weather Conditions 12
4 RESULTS 13
  4.1 General Bird Activity 13
  4.2 Weather Conditions....14
  4.3 Detection Success....15
  4.4 Collision Mortality 15
5 CARCASS REMOVAL RATES 19
  5.1 Domestic Chicken 19
  5.2 Wild Carcasses 20
  5.3 Annual Collision Mortality Rates....20
6 DISCUSSION 21
  6.1 Monitoring success....21
  6.2 Recommendations for future monitoring....22
  6.3 Implications for collision mortality of New Zealand birds 24
7 REFERENCES 25
8 APPENDICES 27
  8.1 Weather conditions - autumn monitoring period (detail) 27
  8.2 Weather conditions - spring monitoring period (detail) 28
  8.3 Bird Abundance - autumn monitoring period (detail) 29
  8.4 Bird Abundance - spring monitoring period (detail) 30
  8.5 Scavenging Rates (Detail)....31
  8.6 Field Data Sheets....32

TABLES

Table 1: Distance of sample turbines to the Manawatu Scenic Reserve, other bush fragments within the wind farm footprint and to the nearest wetland areas. 10
Table 2: The species of bird present within the wind farm footprint during spring and autumn carcass monitoring periods, their threat class, and the proportion of days each species was observed....13
Table 3: Summary of weather conditions during autumn and spring monitoring periods combined (see Appendix 8.1 & 8.2 for more detailed daily weather descriptions). 14
Table 4: Details of carcasses located beneath turbines during autumn and spring monitoring periods. 16
Table 5: Annual predicted collision mortalities calculated from the results of intensive searches, per turbine and for Te Apiti wind farm as a whole. Results are shown per season, taking account of different number of turbines monitored between seasons, with an average for the two seasons. 21

FIGURES

Figure 1: Map illustrating the location of Te Apiti wind farm....6
Figure 2: Te Apiti Windfarm layout. Bolton's Bush QEII covenant in red. Manawatu Gorge Scenic Reserve highlighted in Brown. 7
Figure 3: Te Apiti wind farm sample turbines and habitat type. Blue turbines monitored in spring, Pink turbines added to the autumn study. Yellow turbines not included. 9
Figure 4: Typical 1.65 MW wind turbines at Te Apiti wind farm (70 m high supporting column with 35 m blades). Also note the edge of Manawatu Scenic Reserve behind the turbines. 10
Figure 5: Photos of bird carcasses the day they were discovered. 17
Figure 6: Location and distance of bird carcasses relative to turbines....18
Figure 7: Graph of scavenging/ removal rates of day olds chicks (n=11) in autumn....19
Figure 8: Graph of scavenging/ removal rates of half grown chickens (n=8) in autumn. 19

1 INTRODUCTION

Since the construction of the first large scale wind turbine in New Zealand in 1993 the number of wind farms being proposed and constructed has increased exponentially. Currently (2009) the combined capacity of wind farms in New Zealand is 404 megawatts which generates about 3% of New Zealand's electricity (1,040 gigawatt hours in the year to March 2008). One projection is that by 2025 New Zealand could have 2,500 to 3,000 megawatts of installed wind energy capacity supplying 15 to 20 percent of our electricity (NZWEA Website).

However, to date, no investigation into the effects of an operational wind farm on New Zealand's birds has been completed (Powlesland 2009). This situation will change with most windfarm consents now requiring post construction monitoring but until these studies are undertaken we remain reliant on overseas studies for the assessment of potential effects. Overseas literature indicates that in some circumstances birds are prone to collision mortality with wind turbines (Birdlife International 2003, NWCC 2001, Erickson 2001) but the conclusions that can be drawn from these overseas studies remain limited due to variation in location and behaviour between species (Powlesland 2009).

Since the completion of Te Apiti wind farm in August 2004 by Meridian Energy Limited (Meridian) a number of collision mortalities have been recorded at this site. These include, one sacred kingfisher (*Halcyon sancta*), 11 Australian magpies (*Gymnorhina tibicen*) and two harrier hawks (*Circus approximans*). However, these observations have relied on passive monitoring by operational staff that record carcasses whenever they are encountered during routine work. Due to the low intensity of this monitoring it is highly likely that this underestimates the frequency of collision mortality and we suggest that this approach is also biased towards larger, more visible species.

As a result, Meridian sought to address the lack of information on collision mortality by undertaking an assessment of bird strike at Te Apiti wind farm using more rigorous survey techniques. This additional study was not required by consent, but was seen as an opportunity to identify the species likely to be affected, reduce uncertainty in the consenting process, and establish survey protocols for windfarms where post construction surveys were now required.

This report details the results of two months of intensive collision mortality monitoring at Te Apiti wind farm in 2008, and outlines recommendations for future collision mortality monitoring at New Zealand's wind farms. The aims of this study were to:

- Determine the limitations of passive monitoring vs. focussed searching,
- Develop a robust methodology to provide guidance for use at other New Zealand wind farms, and
- To more accurately describe the frequency of collision mortality and the species affected at Te Apiti wind farm.

2 STUDY AREA

Te Apiti wind farm is situated to the north of the Manawatu gorge, in the lower Central North Island of New Zealand, approximately 20 km east of Palmerston North City (figure 1). It consists of 55, 1.65 MW turbines, with 35 m blades mounted on 70 m high tubular towers (figure 2). The turbines are typically located in pasture on ridgelines with fingers of native bush extending up gullies between them. The bush varies from kanuka scrub to remnant podocarp broadleaved forests. There are also areas of plantation pine, and abundant farm ponds of varying size within the wind farm footprint. The turbines are located at varying distances from bush margins, with the closest turbines being located 75 m from Manawatu Gorge Scenic Reserve. Farming of sheep and beef continues in the pasture beneath each turbine maintaining a relatively short sward.

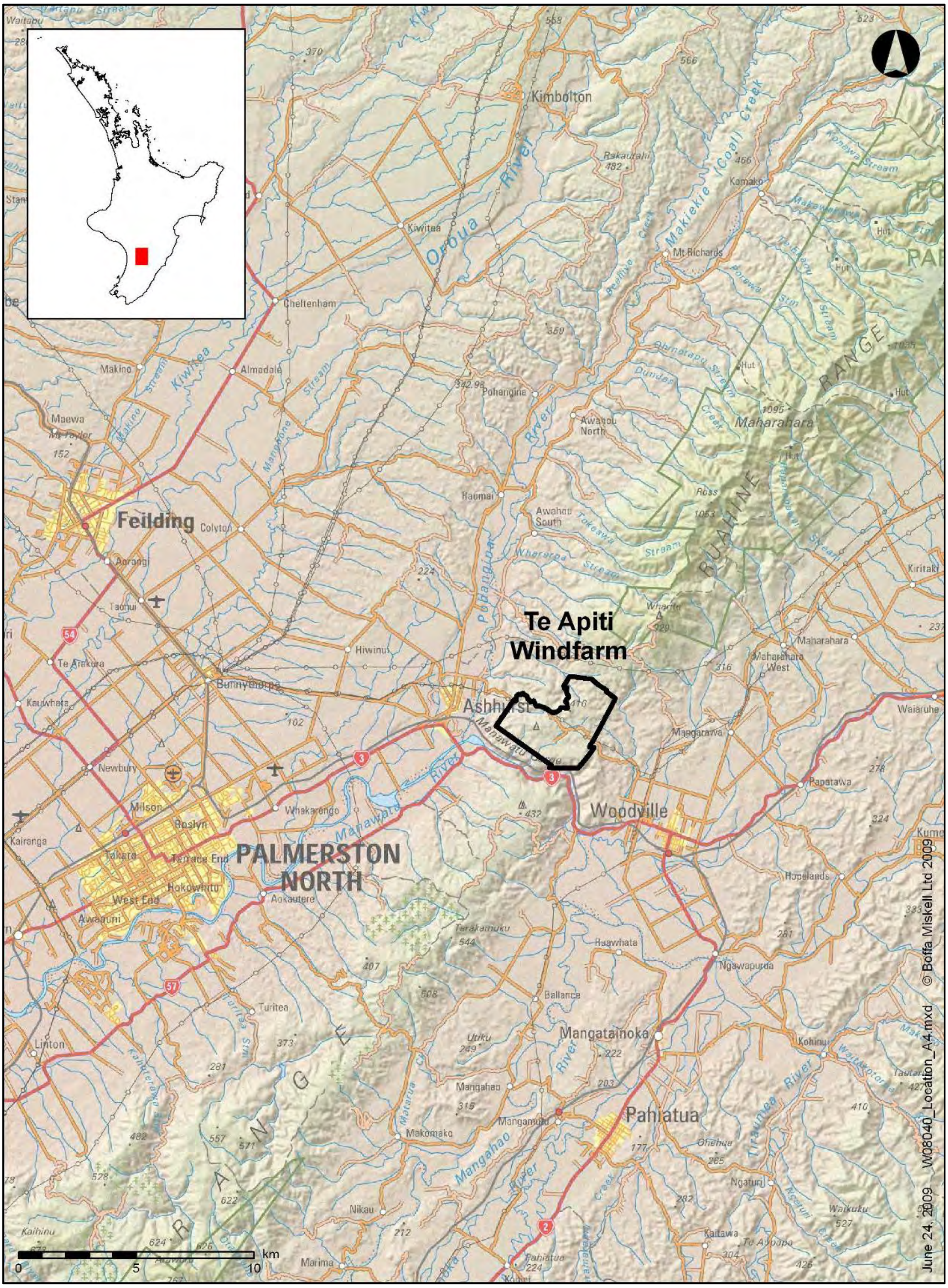

Figure 1: Map illustrating the location of Te Apiti wind farm.

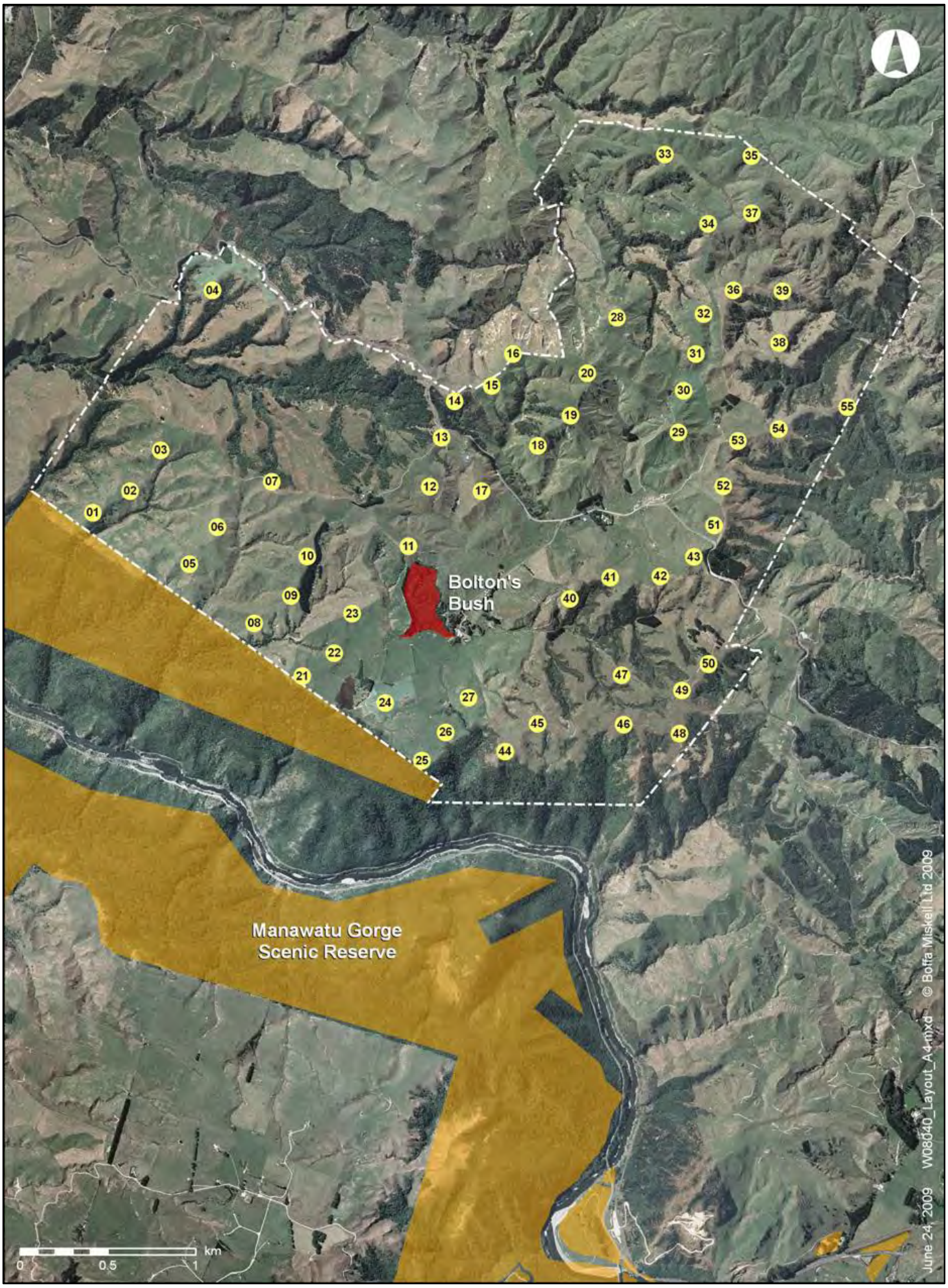

Figure 2: Te Apiti Windfarm layout. Bolton's Bush QEII covenant in red. Manawatu Gorge Scenic Reserve highlighted in Brown.

3 METHODS

At the commencement of this study a range of international methodologies were reviewed and key issues for carcass searches identified, including scavenging\decomposition rates, searcher efficiency, terrain, vegetation, and effort. These methodologies included guidance notes such as Morrison 2002, Anderson 1999, AUSWEA 2005, Canadian Wildlife Service 2006, and NWCC 2005; and a range of mortality studies and papers such as Erickson 2004 and Johnson et al 2002.

There is considerable variation between these methodologies in the areas of search frequency, timing, and extent. There is also considerable variation with regard to the scale of scavenger and searcher efficiency trials. The methodology developed below was set up not only to describe the occurrence of bird collision mortality at Te Apiti but also to assess the suitability of international methodologies to the New Zealand situation.

3.1 Search Effort

The greatest variation in international methodology related to search effort. Recommendations ranged from searches of all turbines every 2 weeks, to searches of a subset of turbines every two to three days. Some methodologies recommended different search efforts depending on season, with greatest effort during spring and autumn, usually with a focus of migration events and breeding.

For this trial our approach was to search a subset of turbines six days a week for one month in April 2008 (autumn), and one month in November 2008 (spring). By combining this intensity of search effort with scavenger trials we sought to determine the most efficient interval of search effort for future projects.

We also sought to limit the effects of day time scavenger losses by searching turbines in the morning. Searches commenced soon after sunrise until around midday. This gave a total of 60 days searching, or 560 hours of search effort (80 minutes per turbine).

3.2 Turbine Selection

Initial field trials indicated that it takes two people approximately 40 minutes to search the base of a turbine (Section 3,3). Due to limited resources it was therefore not possible to monitor all 55 turbines every day. This is a logistical and resourcing problem likely to occur at many wind farms in New Zealand. Daily monitoring of a sample of turbines was therefore employed to assess how frequently it was necessary to search a turbine in order to accurately assess the occurrence of collision mortality.

For the first monitoring period six turbines were selected (Turbine numbers 21, 22, 23, 24, 25, & 44) (Figure 3). Given the high diversity and abundance of native birds in the Manawatu Gorge Scenic Reserve the key ecological concern during consenting was the proximity of the turbines to this reserve (Boffa Miskell 2003). Those turbines selected therefore included several of the turbines closest to the edge of the Manawatu Gorge Scenic Reserve (figure 3 & table 1). Four turbines also lay in relatively close proximity to a large farm pond noted for its sizeable resident population of waterfowl. These turbines were also chosen to sample expected flyways through the site between Manawatu Gorge Scenic Reserve and other bush fragments including the QEII covenant, Bolton's Bush (figure 3).

In the second monitoring period the number of turbines monitored was increased to eight, including the original six turbines and a further two (Turbine numbers 12 & 17) (Figure 3). The additional two turbines were located at a greater distance from forest margins in order to test whether turbines located further from forest margins pose less of a collision risk to birds (Table 1).

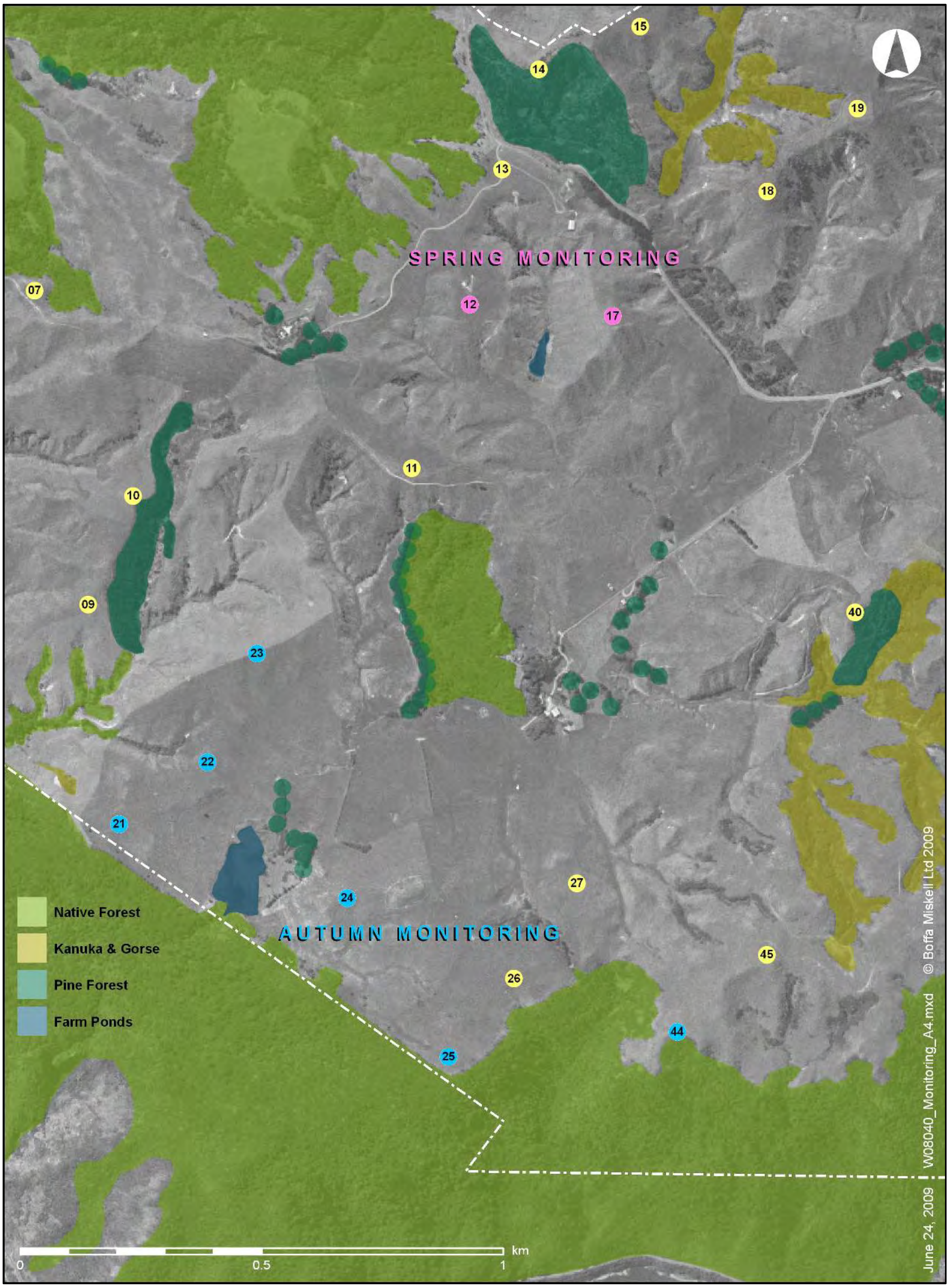

Figure 3: Te Apiti wind farm sample turbines and habitat type. Blue turbines monitored in spring, Pink turbines added to the autumn study. Yellow turbines not included.

The turbines selected also generally had a minimum of 100 m of easily searchable terrain surrounding them with the exception of turbine 44 which was slightly more constrained. In all cases the search area was in pasture and was grazed to a low turf by sheep and cattle. Figure 4 shows part of the study area, the type of terrain and vegetation encountered.

Table 1: Distance of sample turbines to the Manawatu Scenic Reserve, other bush fragments within the wind farm footprint and to the nearest wetland areas.

Turbine Number	Distance to Manawatu Gorge Scenic Reserve (m)	Distance to nearest native bush margin (m)	Distance to nearest Stock Pond (m)
21	65	65	230
22	262	262	140
23	511	325	350
24	158	158	175
25	75	75	455
44	20	20	925
12	1,350	190	150
17	1,520	410	130

Figure 4: Typical 1.65 MW wind turbines at Te Apiti wind farm (70 m high supporting column with 35 m blades). Also note the edge of Manawatu Scenic Reserve behind the turbines.

3.3 Carcass Search Technique

Following a review of a number of overseas studies (e.g. Anderson et al. 1999; Johnson et.al 2002, Erickson 2004) a search radius was settled on that was equivalent to 1.5 to 2 times the length of a turbine blade. 100 x 100 m search grids were set up centred on each turbine providing for a search area which was a minimum of 50m and up to 68m from the turbine base (see Figure 6). As per international guidelines we used square plots rather than circular plots to facilitate marking search boundaries, and conducted the search using parallel transects.

It is acknowledged that some birds may be thrown further than the outskirts of the 100 m grid (e.g. Erickson 2004) but wind farm studies from the USA and Europe indicate that most birds struck by turbines fall within 40m of the tower, and the great majority fall within 65m (Young et al 2003, Orloff & Flannery 1992). Blade length is an important consideration and these studies typically defined a search grid ranging from 1.5 to 3 times the blade length. At Te Apiti, with turbine blade length of 35m, a 100m search grid was seen as a workable compromise between search efficacy and effort.

The grids were searched by two observers walking parallel transects approximately two metres apart until the whole of the 100 x 100 m grid area had been visually scanned. Observers walked slowly to reduce the chances of any carcasses being missed. The time that each search took was recorded to ensure search effort was standardised between turbines and over time (each grid took approximately 40 minutes to search).

Data recorded on bird carcasses included, time and date located, species, sex, age, turbine number, turbine activity at the time, distance from turbine, condition of carcass (intact, scavenged, dismembered, feather spot) weather and comments regarding suspected cause of death. Feather spot was defined as ten or more feathers of the same species in the same location (Erickson 2004). This definition was necessary in order to avoid single random feathers not associated with collision mortality being recorded as potential fatalities. Surveys were carried out regardless of the weather conditions (unless there was risk of lighting strike) in order to test the effect that weather conditions, in particular poor visibility, had on turbine strike. Weather conditions recorded, included wind direction, speed, temperature, precipitation and cloud cover.

Because cause of death is not always able to be determined due to scavenging or decomposition, international studies provide two alternative approaches (AUSWEA 2005). The first is to establish reference plots and determine natural baseline mortality rates for the site. This significantly increases search effort. The second approach is to assume all birds found within the search grid were turbine mortalities even though some may be natural deaths. This approach will therefore over-estimate the number of turbine mortalities but is more cost effective. We have adopted the later method.

In order to assess whether there was any relationship between the relative abundance of bird species in the area and collision risk the species present within the wind farm footprint were noted along with a score of relative abundance.

3.4 Carcass Removal and Decay Trials

We have relied on international studies for developing a methodology for carcass removal and decay, summarised in Morrison (2002). Removal rates will strongly influence the frequency of searching and must be factored into the final analysis of mortalities.

The various studies described by Morrison showed scavenging varied from almost immediate removal of a carcass, to in-situ scavenging over a long period and where the carcass remained identifiable for weeks, or in some cases, months.

These studies suggested a mean length of stay for carcasses ranged from three days to two weeks. Several studies noted that the rates of removal changed seasonally with carcasses remaining longer in autumn and winter. This seasonal variation will relate to changes in the seasonal populations sizes of predator and scavenger species.

Several studies also noted that the scavenger and removal rates differed depending on the size of the bird with smaller birds tending to be removed over a relatively short period and larger birds tending to be scavenged on site over a longer period.

Rates of scavenging, decomposition, and removal of carcasses were measured using both wild carcasses found on site and through the placement of domestic chicken carcasses. Eleven day old chicks and eight half grown pullets were randomly placed under the study turbines the night before searches took place. These were broadly intended to represent small passerines and waterfowl respectively. Searchers were not aware of the location of the carcasses or when this element of the study would take place.

All carcasses were left in situ to allow the assessment of how quickly they degraded and/ or were scavenged. The wild carcasses were mapped in relation to the turbine tower to determine how far from the turbine tower carcasses were likely to be located.

Wild carcasses were monitored for the full duration of observation after they were located. Chicken carcasses were monitored for two weeks.

3.5 Detection Success

The same domestic chicken carcasses were also used to determine the detection success of observers.

Searcher efficiency has been variously reported between 35% and 100% with terrain and vegetation playing a significant role, with efficiency rates varying from 70% to 100% in grassland and reducing in taller vegetation. The size of the bird has also been found to affect searcher efficiency with one study reporting searcher efficiency of 50% for small birds and 87.5% for large birds (Morrison 2002).

Detection success was measured by placing 11 day old and 8 half grown chickens within the turbine search areas the evening before a search. The location maps drawn by the searchers were then compared with the maps of carcass placements.

3.6 Bird Activity

To provide some context to any mortality that was encountered an assessment of bird diversity and activity within the study area was also recorded.

Rather than use the standard 5-minute (10m) bird counts, we undertook a more subjective study that recorded all visible activity over pasture within the windfarm footprint. During each site visit bird activity within the wind farm footprint was recorded onto standardised field sheets. Abundance was broadly measured as; Single, Few (2-5), Many (5-20), Abundant (20+).

3.7 Weather Conditions

On each day of study a range of weather conditions were recorded including visibility, precipitation, temperature, wind strength, and wind direction.

4 RESULTS

4.1 General Bird Activity

Thirty-one species of bird, including three threatened species were recorded within the wind farm footprint during autumn and spring carcass monitoring periods (Table 2). There was some variation in bird assemblage and abundances between seasons, but the species most active within the site were species common to this type of rural environment and included Australian magpie (*Gymnorhina tibicen*), Paradise shelduck (*Tadorna variegata*), Spur-winged plover (*Vanellus miles*), Australasian harrier (*Circus approximans*), starling (*Sturnus vulgaris*), goldfinch (*Carduelis carduelis*), welcome swallow (*Hirundo tahitica*), grey warbler (*Gerygone igata*), and tui (*Prosthemadera novaeseelandiae*), which were seen on 60% of visits or more.

Table 2: The species of bird present within the wind farm footprint during spring and autumn carcass monitoring periods, their threat class, and the proportion of days each species was observed.

			Autumn		**Spring**		**Combined**	
Common	**Latin**	**Status**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Australian magpie	*Gymnorhina tibicen*	Introduced	30	100%	30	100%	60	100%
Paradise shelduck	*Tadorna variegata*	Not threatened	28	93%	29	97%	57	95%
Spur-winged plover	*Vanellus miles*	Not threatened (SO)	27	90%	27	90%	54	90%
Australasian harrier	*Circus approximans*	Not threatened (SO)	23	77%	26	87%	49	82%
Starling	*Sturnus vulgaris*	Introduced	13	43%	27	90%	40	67%
Goldfinch	*Carduelis carduelis*	Introduced	30	100%	8	27%	38	63%
Welcome swallow	*Hirundo tahitica*	Not threatened (Inc SO)	18	60%	20	67%	38	63%
Grey warbler	*Gerygone igata*	Not threatened	12	40%	25	83%	37	62%
Tui	*Prosthemadera novaeseelandiae*	Not threatened (OL St)	13	43%	23	77%	36	60%
Yellowhammer	*Emberiza citrinella*	Introduced	3	10%	30	100%	33	55%
New Zealand pigeon	*Hemiphaga novaeseelandiae*	Not threatened (CD Inc)	16	53%	14	47%	30	50%
New Zealand pipit	*Anthus novaeseelandiae*	Declining	23	77%	7	23%	30	50%
Chaffinch	*Fringella coelebs*	Introduced	7	23%	22	73%	29	48%
Mallard	*Anas platyrhynchos*	Introduced	8	27%	19	63%	27	45%
Eastern rosella	*Platycercus eximius*	Introduced	10	33%	16	53%	26	43%
Black-backed gull	*Larus bulleri*	Not threatened (SO)	3	10%	22	73%	25	42%
House sparrow	*Passer domesticus*	Introduced	0	0%	21	70%	21	35%
Shining cuckoo	*Chrysoccyx lucidus*	Not threatened (DP)	0	0%	21	70%	21	35%
Fantail	*Rhipidura fulginosa*	Not threatened	11	37%	7	23%	18	30%
Blackbird	*Terdus merula*	Introduced	2	7%	15	50%	17	28%
Greenfinch	*Carduelis chloris*	Introduced	6	20%	11	37%	17	28%
Sacred kingfisher	*Halycon sancta*	Not threatened	4	13%	13	43%	17	28%
White-faced heron	*Ardea novaeseelandiae*	Not threatened (SO)	5	17%	5	17%	10	17%
Song thrush	*Turdus philomelos*	Introduced	0	0%	9	30%	9	15%
Rook	*Corvus frugilegus*	Introduced	5	17%	0	0%	5	8%
Silvereye	*Zosterops lateralis*	Not threatened (SO)	5	17%	0	0%	5	8%
Redpoll	*Carduelis flammea*	Introduced	1	3%	3	10%	4	7%
Bellbird	*Anthornis melanura*	Not threatened	2	7%	1	3%	3	5%
Black shag	*Phalacrocorax carbo*	Naturally uncommon (SO, sp)	0	0%	2	7%	2	3%
New Zealand falcon	*Falco novaeseelandiae*	Nationally vulnerable	0	0%	1	3%	1	2%
Skylark	*Alauda arvensis*	Introduced	0	0%	1	3%	1	2%

Status: New Zealand threat classification (Miskelly et al 2008)

Qualifiers: **CD**, Conservation Dependent; **DP**, Data Poor; **Inc**, Increasing; **OL**, One Location; **SO**, Secure Overseas; **St**, Stable;

Native species commonly observed flying over within the wind farm envelope included Tui (*Prosthemadera novaeseelandiae*), grey warbler (*Gerygone igata*), New Zealand pigeon (*Hemiphaga novaeseelandiae*), Australasian harrier (*Circus approximans*), New Zealand pipit (*Anthus novaeseelandiae*) and black backed gull (*Larus bulleri*). A pair of New Zealand falcon (*Falco novaeseelandiae*) were observed on one occasion flying through the centre of the site, which is the first time they have been recorded at Te Apiti. A more detailed table providing data on daily abundances can be found in Appendix 8.3 and 8.4.

4.2 Weather Conditions

Turbine searches were carried out in a wide variety of weather conditions summarised in the following table.

Table 3: Summary of weather conditions during autumn and spring monitoring periods combined (see Appendix 8.1 & 8.2 for more detailed daily weather descriptions).

		COUNT	%
Visibility	Fine/ Sunny	15	16%
	Partly cloudy	22	23%
	Overcast	18	19%
	Heavy cloud	10	11%
	Mist/fog	14	15%
	Rain	16	17%
Precipitation	None	42	49%
	Dripping foliage	7	8%
	Drizzle	12	14%
	Light	6	7%
	Moderate	10	12%
	Heavy	9	10%
Temperature	Freezing (<0)	2	3%
	Cold (0-5)	5	7%
	Cool (5-11)	32	42%
	Mild (11-16)	30	39%
	Warm (16-22)	6	8%
	Hot (>22)	1	1%
Wind strength	Calm	10	11%
	Light breeze	15	16%
	Mod. Breeze	23	24%
	Fresh wind	14	15%
	Strong wind	21	22%
	Near gale	12	13%
Wind direction	Northerly	17	24%
	Southerly	3	4%
	Westerly	13	18%
	Easterly	10	14%
	North Easterly	4	6%
	South Easterly	6	8%
	North Westerly	19	26%

Visibility varied from clear skies to heavy cloud and mist or fog was experienced on 15% of visits. There were 13 days of rain, mist, and fog in autumn and 15 days in spring.

Temperatures ranged from 0 to 22 degrees Celsius but were typically cool to mild in both seasons. Winds varied from calm to near gale, and blew predominantly from the north, northwest and west.

4.3 Detection Success

Out of the 11 day-old chicks placed in pasture nine were successfully located the next morning; one was overlooked, but located the next day, the other had been removed and was presumably scavenged. Of the ½ grown chickens all eight individuals were successfully located the next day.

This gives a 100% detection rate for large sized birds and a 90% detection success rate for small birds. However, it needs to be highlighted that the sites were all in closely cropped pasture and that these high detection rates are unlikely to be applicable to other types of vegetation, where it is likely to be considerably more difficult to visually locate carcasses.

Not including birds removed by scavenging, this indicates that the search technique was efficient and is likely to identify a high proportion of collision mortalities occurring at these turbines during the study period.

4.4 Collision Mortality

Four bird carcasses were already present beneath the study turbines before the monitoring commenced, two in autumn and two in spring; a mallard (*Anas platyrhynchos*) and a goldfinch (*Carduelis carduelis*) in autumn, and an Australian magpie and a silvereye (*Zostrops lateralis*) in spring (Table 4 - Figure 5). It was not possible to confirm whether the mortalities of the goldfinch and silvereye were caused by collision with the turbines or how long they had been dead due to the stage of decomposition. However, we have assumed based on their locations that they were turbine strikes. The mallard was also highly decomposed not allowing an assessment of the time of death, but had an obvious fracture at the back of the skull indicating a high likelihood of turbine strike. The magpie was present at the start of the spring monitoring period but based on scavenging rates discussed below, we conclude it had been killed no more than two days previous and possibly the night before the start of the monitoring period.

During the two month monitoring period three further carcasses were located beneath the study turbines, a mallard, a silvereye, and a chaffinch (*Fringella coelebs*) (table 4 - figure 5). Additionally, during the spring study period the carcasses of an Australasian harrier and an Australian magpie were located by operational staff at turbine sites not part of this monitoring programme (Table 4 - Figure 5). Of particular note is the silvereye mortality in spring, where the moment of collision was actually observed by the field team carrying out a search at the base of a turbine (Figure 5.d.).

All carcasses located were assumed to have died as a result of collision with turning turbine blades. In some cases this is indicated by fractured bones (table 4). However, other carcasses were too heavily scavenged or decomposed to confirm cause of death. We have assumed they died as a result of collision due to their location beneath the turbines (table 4). This may therefore represent a bias in the data.

Figure 6 shows the compass bearing of each carcass and their distance from the turbine base. Too few carcasses were found to provide any meaningful analysis of this distribution.

Table 4: Details of carcasses located beneath turbines during autumn and spring monitoring periods.

	Autumn				Spring				
Collision no.	1	2	3	4	5	6	7	8	9
Species	Goldfinch	Mallard	Mallard	Silvereye	Australian magpie	Silvereye	Australian magpie	Chaffinch	Australasian harrier
Figure	5.a.	5.b.	5.c.	5.d.	5.e.	5.f.	5.g.	5.h.	5.i.
Date located	31/03/08	31/03/08	11/04/08	12/04/08	20/10/08	20/10/08	23/10/08	28/10/08	04/11/08
Age	-	Adult	Adult	Adult	Adult	Adult	Adult	-	Adult
Likely time of death	Unknown	Unknown	10/04/08	12/04/08	18-19/10/08	Unknown	Unknown	27/10/08	Unknown
Turbine number	23	24	22	23	22	23	11	22	10
Wind conditions*	-	-	Calm	normal	-	-	-	Near gale	-
Wind direction**	-	-	-	Easterly	-	-	-	North	-
Distance from turbine (m)	11.5	45.7	51.4	27.2	17.5	27.4	-	60	28.7
Direction to turbine (º)	60	134	282	150	270	290	-	256	20
Remains	Wings	Almost whole	Feathers & bones	Two parts	Almost whole	Body	-	Wing	Wing missing
Condition	-	Decomposed	Fresh	Fresh	Fresh	Decomposed	Decomposed	-	Decomposed
Scavenged?	Yes	No	Yes	No	Yes	No	?	Yes	Possibly
Evidence	Location	Fractured skull	Fractured wing	Observed	Fractured wing	Location	Location	Location	Fractured wing
How long detectable for (days)	34 +	34 +	23 +	22 +	34 +	34 +	-	25	-

* Classes: Calm; light breeze; moderate breeze; fresh wind; strong wind; near gale Details given for date when the collision is suspected to have occurred.

** Details given for date when the collision is suspected to have occurred.

5.a. Goldfinch

5.b. Mallard

5.c. Mallard

5.d. Silvereye

5.e. Australian magpie

5.f. Silvereye

5.g. Australian magpie

5.h. Chaffinch

5.i. Australasian harrier

Figure 5: Photos of bird carcasses the day they were discovered.

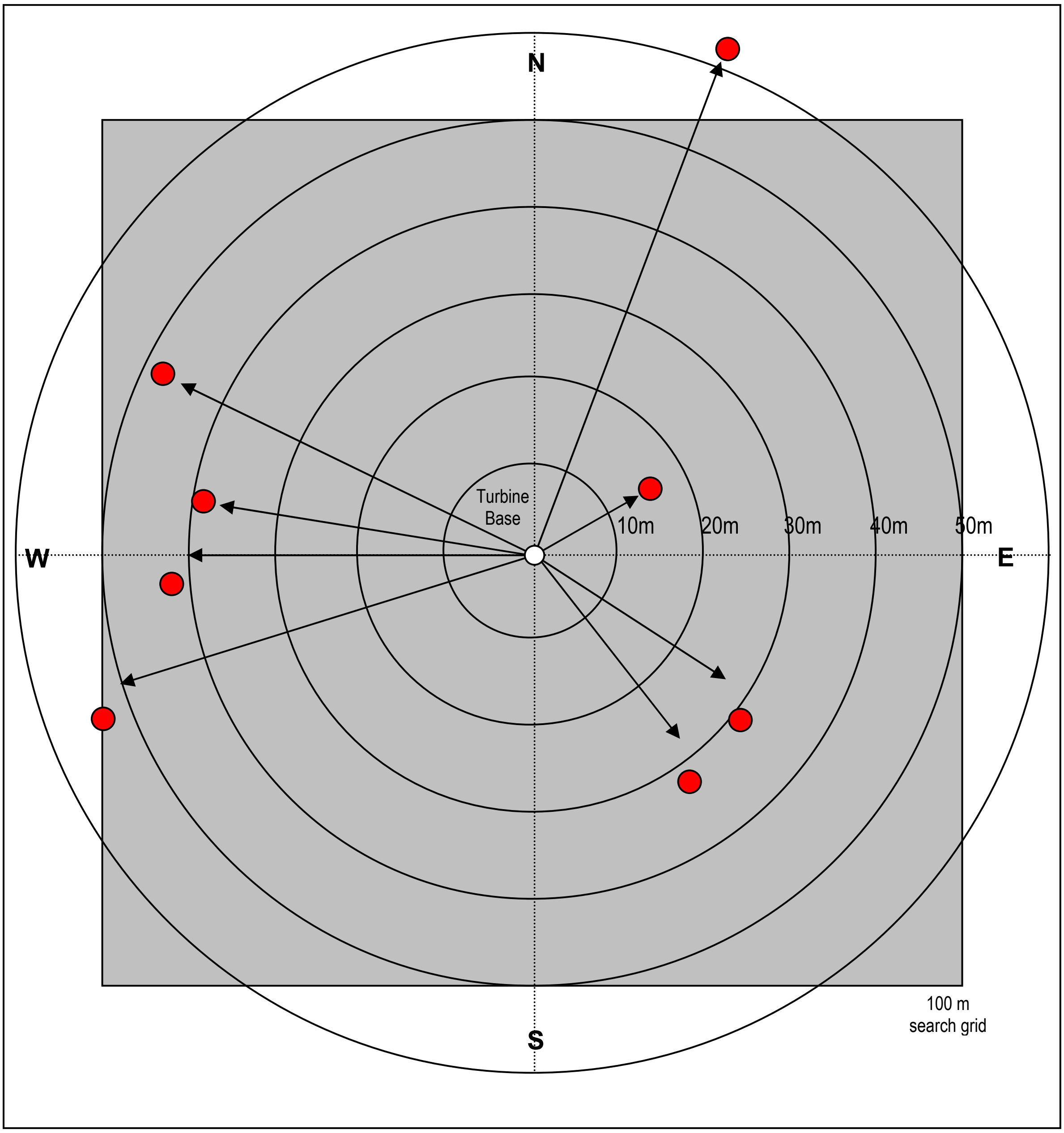

Figure 6: Location and distance of bird carcasses relative to turbines.

5 CARCASS REMOVAL RATES

5.1 Domestic Chicken

One day old chick was removed on the first night; six were removed after seven days (Figure 7). After two weeks nearly all sign of the day old chicks had gone, with the remains of only two chicks remaining as feather spots after 11 days. Day old chicks tended to be removed from the site without any remains being left, indicating they are eaten whole insitu or are removed offsite before feeding.

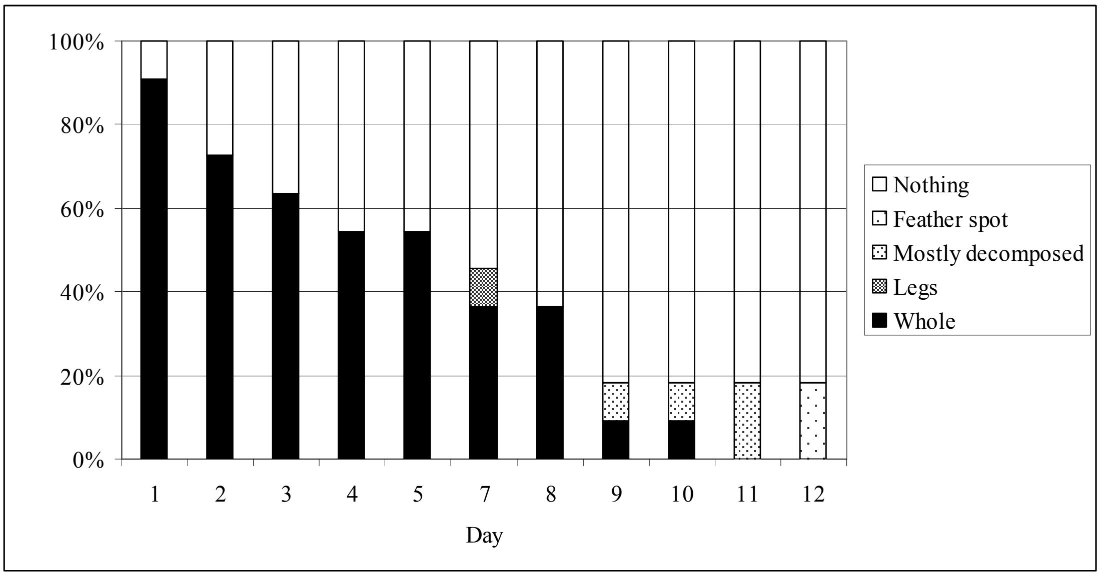

Figure 7: Graph of scavenging/ removal rates of day olds chicks (n=11) in autumn.

Larger carcasses were more obviously scavenged and within a week were largely reduced to feather spots (Figure 8). However, after two weeks all carcasses were still detectable as feather spots. Overall, neither day old chicks or half grown chickens were moved very far from the place they were originally placed, indicating that the place in which wild carcasses are located beneath turbines is close to where they landed after turbine collision.

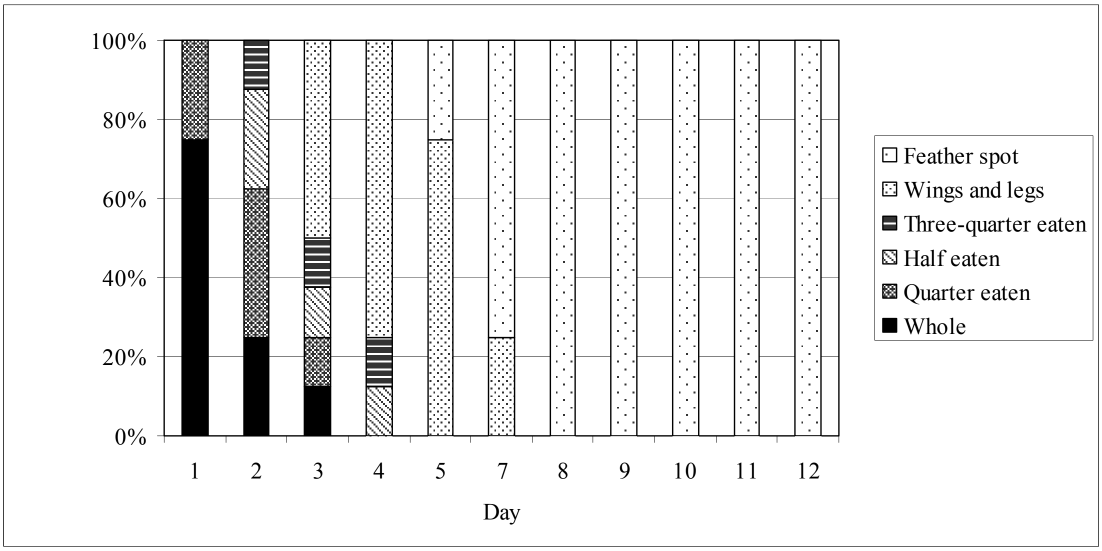

Figure 8: Graph of scavenging/ removal rates of half grown chickens (n=8) in autumn.

5.2 Wild Carcasses

Of the seven wild carcasses located under turbines during the study period, all seven were still detectable and identifiable more than 20 days after discovery (table 4).

During the autumn, the goldfinch remained present as a feather spot for the whole of the monitoring period. The first mallard was mostly decomposed and semi-desiccated when discovered and changed little during the monitoring period. The second mallard however was scavenged the first day but remained as a feather spot. The silvereye was not scavenged, remaining for the whole period as a feather spot after decomposing. During spring the magpie was scavenged but left largely intact during the whole monitoring period. The silvereye also remained largely intact, but the feather spot of the chaffinch disappeared after 25 days, presumably having been blown away.

Overall this indicates that signs of wild carcasses may remain onsite longer than the day old and half grown chickens used to experimentally describe carcass removal rates.

5.3 Annual Collision Mortality Rates

Below we examine the potential total number of birds that may suffer collision mortality per turbine per annum, and for Te Apiti wind farm as a whole, based on the results from the subset of turbines monitored over the two month study and correcting for scavenging and detection rates.

Overall, nine wild carcasses were located within the study period (table 4), however only four are included in this analysis. Three carcasses died at an undefined time prior to the study commencing so in order to avoid bias they are not included in this scaling analysis. One harrier and one magpie were located during the study period but at turbines outside the study area, and at an undefined time, so are also not included. One magpie was present on the first day of the spring monitoring period, but we believe that it had been killed that night or the day before and for this reason we have included it with the other three mortalities that were observed during the two month study.

5.3.1 CORRECTING FOR DETECTION SUCCESS

The detection success was 100% for large bird carcasses and 90% for small bird carcasses, therefore no correction factor was required to account for detection of large birds but a correction factor of 10% was required to account for small birds being overlooked.

5.3.2 CORRECTING FOR REMOVAL OR SCAVENGE

Nine percent of day old chicks were removed the day after they were placed out beneath turbines. However, because they were put out just before dark and the searches began at first light the next day, a correction factor of 27% (see figure 7) was used for small birds (i.e. chaffinch & silvereye) in order to account for the fact that some birds could have collided shortly after a turbine was searched in the morning and then had a daylight scavenging period as well as a night time scavenging period within which to have been scavenged. No correction was required for large birds (i.e. magpie & mallard).

5.3.3 CALCULATION OF ANNUAL COLLISION RATES PER TURBINE AND PER ANNUM

Overall, a mean of four birds are predicted to be killed through collision with turbine blades per year at each turbine, or 224 birds per year over the whole wind farm (Table 5).

Table 5: Annual predicted collision mortalities calculated from the results of intensive searches, per turbine and for Te Apiti wind farm as a whole. Results are shown per season, taking account of different number of turbines monitored between seasons, with an average for the two seasons.

	Autumn	**Spring**
Large carcasses found	1	1
Small carcasses found	1	1
Correction factor for detection success for large birds	0.00	0.00
Correction factor for detection success for small birds	0.10	0.10
Correction factor for large bird removal	0.00	0.00
Correction factor for small bird removal	0.20	0.20
Total mortalities during study period after correction factor applied	2.30	2.30
Days of study	30	30
Number of sample turbines	6	8
Mortalities per turbine during study period	0.38	0.29
Mortalities per turbine per day	0.01	0.01
Mortalities per turbine annually	4.66	3.50
Total mortalities over wind farm per annum	256.51	192.39
MEAN NUMBER OF COLLISONS PER TURBINE PER YEAR	**4**	
MEAN NUMBER OF COLLISONS AT TE APITI PER YEAR	**224**	

6 DISCUSSION

6.1 Monitoring success

6.1.1 Passive versus Active Searching

As expected, the numbers of birds and the species recorded colliding with turbine blades differs between passive and intensive monitoring techniques. Using passive monitoring techniques not only results in fewer individuals being recorded, but fewer species, and a bias towards relatively large species. In contrast a broad size range of birds, from 13g silvereye's to 1,300g mallards, were recorded by the intensive monitoring employed during this study. This included three species not previously recorded as colliding with turbines at Te Apiti (silvereye, goldfinch, and chaffinch). Overall, intensively monitoring the bases of a sample of turbines daily allowed the number and type of collision mortalities to be determined with a high degree of confidence.

6.1.2 Detection Success

Detection success was relatively high, although this may be largely due to the relative ease in which it was possible to search the area below the turbines and detection rates are likely to be far lower in even slightly longer grass, and especially in different habitat types such as tussock and scrub. Therefore, should collision studies be required at future wind farms, it is important that consideration is given to the surrounding vegetation. For example, if revegetation of the turbine platform is proposed as part of consent, this should possibly be delayed until after any collision studies are completed.

6.1.3 Search Area and Effort

Carcasses were located between 11 and 60 m from turbine bases with an average distance of 33m. The upper 95% confidence interval gives a distance of 45m, and a more conservative two standard deviations gives an upper limit of 67m. Both of these values are very similar to the values obtained from overseas studies as discussed above, however, we have a very small sample size (n = 8) which to some degree limits confidence in this distribution.

This study gives no indication of the likely distance a bird may be thrown on collision with a turbine blade, although it is noted that the silvereye that was observed colliding with the turbine blade fell directly to the ground after collision, rather than being thrown any distance. It is plausible to imagine a bird being thrown a greater distance than the 100 x 100 m area searched in this study but as the search area is expanded effort increases geometrically with distance from the turbine ultimately reaching a point of diminishing returns. A search area needs to be selected which can be covered efficiently and where the highest concentration of carcasses might be expected.

International guidance suggests that in making this decision it is generally preferable to search a larger number of turbines, but with a smaller search area at the base of each turbine, than to search intensively at only a few turbines. This is because it is possible that only a few turbines may cause problems for birds (Canadian Wildlife Service 2006).

6.1.4 Climatic Influence

Weather conditions, in particular poor visibility, may influence collision strike risk although the link has not been confirmed and may be more of an issue for migratory species (NWCC 2005). However, given the high rates of fog and cloud on many potential windfarm sites, it is an issue that needs further consideration. The sample size collected during this study was not sufficient to investigate the effects of weather. However, although the study was carried out over a relatively short period, a wide variety of weather conditions occurred and it can be assumed that any effects due to weather are broadly representative.

6.2 Recommendations for future monitoring

Although monitoring the bases of a sample of turbines daily allowed the number and type of collision mortalities to be determined with a high degree of confidence, in doing so the number of turbines that could be searched was reduced. However, results of removal rates indicate if turbines are not searched daily then much more reliance is placed on the accuracy of correction factors. It is essential therefore that the rate at which bird carcasses are removed and the length of time that evidence of bird strike remains is accurately determined before designing the study and making a decision on the frequency that searches are to take place.

Two different approaches can be taken to this. The first is to search frequently, as was done for this study, to limit the effect of scavenging on the final results. The second approach is to search less frequently, assume that a significant proportion of carcasses will be removed by scavengers without being recorded, and to place much greater reliance on extensive scavenger trials to account for these removal rates. Both approaches are used internationally.

6.2.1 Removal Rates

Observations of wild carcasses indicated that small carcasses were possible to find as feather spots more than 20 days after first being located. However, the day old chicks used in investigations of removal rates were generally removed far earlier. The lack of hard penned feathers and the soft bones of day old chicks may well explain this. It is also conceivable that domestic chickens are more visible to scavengers and so scavenger rates are higher. It is therefore recommended that in future studies carcasses of birds more closely representing the types and sizes of species likely to be encountered should be used. We also recommend that due to the large differences in removal rates between small and large birds, a third medium sized category of bird should be used for future trials.

A number of factors including weather and scavenger density will vary between different areas of New Zealand. It is therefore essential that removal studies are carried out at each site to investigate the situation in each area. Further, the time of year may also influence removal and decomposition rates and the more times investigations of removal can be repeated through the year the more accurate the correction factors will be. Carcasses should be placed beneath turbines early in the day, the day before any searches take place, to ensure one day and one night of scavenging occurs before searches. Consideration must also be given to the fact that a large number of carcasses could encourage increased scavenger numbers, although it is acknowledged that at what point this may occur, and how to account for this, is difficult to determine.

6.2.2 Search Effort

Considering the results above, the optimum search effort for Te Apiti windfarm would be to undertake turbine searches on a weekly rotation. In doing so it would be possible to survey nearly all of the turbines at Te Apiti weekly with the same effort, while still locating a high proportion of collision mortalities. Ideally the study would cover all four seasons and would extend for a minimum of two years to cover annual variation in avian activity.

However, further trials that more accurately establish the removal rates of small birds need to be completed to confirm the appropriateness of this search frequency and the necessary correction factor.

6.2.3 Searcher efficiency

Searcher efficiency in this trial was very high when compared to some international studies. We believe that this is largely due to the generally flat to rolling terrain and closely cropped grass pasture that all turbines were located within.

However, even with the grass beneath the turbines being kept to a short sward by grazing stock it was still very difficult to locate small birds such as finches. It is therefore recommended that the 80 minute searches' using transects spaced approximately 2 m apart employed in this study, is an appropriate search intensity. The use of at least two team members to reduce the levels of monotony in searching is further recommended.

We anticipate that other sites which are steeper or which have a greater proportion of scrub and shrubland will pose greater problems for searchers and the efficiency rates will fall accordingly.

6.2.4 Cause of death

Ideally, carcasses should be checked for signs of collision by a qualified vet. Nevertheless, in this study when signs of the cause of mortality were not obvious (e.g.

large broken bones or missing wings) it is unlikely that a vet would have added any further interpretation. Some international studies have suggested the most efficient approach is to assume that all carcasses located in the search area have died as a result of collision mortality even if this occasionally will result in natural deaths being included in the sample. Nevertheless, due to difficulties in feather identification it is strongly recommended that somebody familiar with bird identification using bird feathers (e.g. a museum curator) confirms the species of all collisions.

6.3 Implications for collision mortality of New Zealand birds

- This study calculates 4 mortalities per turbine per annum for the Te Apiti wind farm. This number is consistent with overseas studies (NWCC 2001, Birdlife International 2003).
- This study recorded considerable activity of a wide range of bird species, raptors, passerines (native and exotic) and waterfowl within the windfarm footprint over two seasons. Of the 31 species observed in the site, mortalities were recorded of 7 species (chaffinch, goldfinch, mallard, magpie, silvereye, harrier, and kingfisher). This number includes the results of this study combined with the previous 4 years of passive observation.
- All affected species are common species of open country and dissected farmland. No mortalities were recorded of species of the surrounding forests and shrublands such as tui, bellbird, kereru, grey warbler, and shinning cuckoo, all of which were recorded passing through the windfarm footprint.
- Three of the species killed, were amongst the most abundant recorded on site (magpie, harrier hawk, goldfinch). However, two species that were recorded colliding twice (mallard and silvereye) were observed in relatively low numbers and a number of other species that were recorded as abundant (e.g. paradise shelduck, spur winged plover, starling, and welcome swallow) were not recorded as collision fatalities. This suggests that the risk of collision mortality varies between species, possibly due to differences in behaviour. For example, mallards will fly at night between roosting and feeding grounds, harriers use the wind to slowly quarter the ground for prey, and chaffinch, goldfinch, and silvereyes exhibit flocking behaviour, all of which could potentially make these species more prone to collision with turbine blades.
- This was a trial study and future wind farm monitoring should be carried out over a greater time period and include more turbines. However, while this study is unlikely to have picked up every species that was killed, especially where mortality rates are very low (1 per annum), it is likely to be representative of the relative level of impact for common and abundant species.
- In conclusion the level of mortality calculated by this study is highly unlikely to affect local populations of the species killed. All affected species are abundant at this site regionally and nationally.

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7 REFERENCES

Anderson, R., Morrison, M., Sinclair, K. & Strickland, D. (1999) Studying wind energy/bird interactions: a guidance document. Metrics and methods for determining or monitoring potential impacts on birds at existing and proposed wind energy sites. National Wind Coordinating Committee (NWCC) December 1999.

Australian Wind Energy Association (AUSWEA) 2005: Wind Farms and Birds: Interim Standards For Risk Assessment. Prepared for the Australian Wind Energy Association by Brett Lane & Associates Pty Ltd In Association with Aria Professional Services Pty Ltd.

Bird Studies Canada 2003: Wind Turbines and Birds Phase III Report, A guidance document for Environmental Assessment.

Birdlife International 2003: Windfarms and Birds: An analysis of the effects of windfarms on birds, and guidance on environmental assessment criteria and site selection issues Report written by BirdLife International on behalf of the Bern Convention on the Conservation Of European Wildlife And Natural Habitats, Standing Committee. RHW Langston & JD Pullan, RSPB/BirdLife in the UK. September 2003

Canadian Wildlife Service 2006: Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds. Prepared by Canadian Wildlife Service for Environment Canada, July 2006.

Erickson, W. 2003: Synthesis and Comparison of Baseline Avian and Bat Use, Raptor Nesting and Mortality Information from Proposed and Existing Wind Developments. Prepared for Bonneville Power Administration. Prepared by WEST, Inc December 2002.

Erickson, W. 2004: Bird and Bat Fatality Monitoring Methods. In Proceedings of the Wind Energy and Birds/Bats Workshop: Understanding and Resolving Bird and Bat Impacts Washington, DC May 18- 19, 2004.

Erickson, W. P., Johnson, G. D., Strickland, M. D., Young Jr., D.P., Sernka, K.J. & Good, R.E. (2001) Avian Collisions with Wind Turbines: A summary of existing studies and comparisons to other sources of avian collision mortality in the United States. Western EcoSystems Technology Inc. National Wind Coordinating Committee (NWCC) Resource Document. http://www.nationalwind.org/pubs/avian_collisions.pdf.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002: Collision mortality of local and migrant birds at a large-scale wind power development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30:879-887.

Morrison M. 2002: Searcher Bias and Scavenging Rates in Bird/Wind Energy Studies National Renewable Energy Laboratory. June 2002 • NREL/SR-500-30876.TO DO

National Wind Coordinating Committee (NWCC) 2001: Resource Document: Avian collisions with wind turbines: A summary of existing studies and comparisons to other sources of avian collision mortality in the United States.

National Wind Coordinating Committee (NWCC) 2005: Proceedings of the Onshore Wildlife Interactions with Wind Developments: Research Meeting V. Lansdowne, VA November 3-4, 2004. Prepared for the Wildlife Subcommittee of the National Wind Coordinating Committee by RESOLVE, Inc., Washington, DC, Susan Savitt Schwartz, ed. 120 pp.

Orloff, S. and A. Flannery. 1992. Wind turbine effects on avian activity, habitat use, and mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1991. Final Report to Alameda, Costra Costa and Solano Counties and the California Energy Commission by Biosystems Analysis, Inc., Tiburon, CA.

Powlesland, R.G. 2009: Impacts of wind farms on birds: a review. Science for Conservation 289. Department of Conservation, Wellington. 51 p.

Young, D.P., Erickson, W.P. and Good, R.E. 2003. Avian and bat mortality associated with the initial phase of the Foote Creek Rim Wind Power Project, Carbon County, Wyoming. Report prepared for: Pacificorp, Inc., Portland, Oregon; SeaWest Windpower Inc., San Diego, California; and Bureau of Land Management, Rawlins District Office, Rawlins, Wyoming.

8 APPENDICES

8.1 Weather conditions - autumn monitoring period (detail)

	Visibility							Precipitation							Temperature							Wind strength							Wind direction						
	Fine/ Sunny	Partly cloudy	Overcast	Heavy cloud	Mist/fog	Rain		None	Dripping foliage	Drizzle	Light	Moderate	Heavy		Freezing (<0)	Cold (0-5)	Cool (5-11)	Mild (11-16)	Warm (16-22)	Hot (>22)		Calm	Light breeze	Mod. Breeze	Fresh wind	Strong wind	Near gale		Northerly	Southerly	Westerly	Easterly	North Easterly	South Easterly	North Westerly
31 Mar 08					X						X							X					X												
1 Apr 08					X				X	X								X								X					X				
2 Apr 08		X						X									X									X						X			
3 Apr 08	X							X									X									X						X			
4 Apr 08			X					X										X						X											X
5 Apr 08			X					X										X						X											
6 Apr 08																																			
7 Apr 08						X		X		X								X								X						X			
8 Apr 08		X						X									X									X						X			
9 Apr 08			X					X									X							X											
10 Apr 08	X							X										X				X													
11 Apr 08	X							X																X							X				
12 Apr 08		X						X										X							X							X			
13 Apr 08																																			
14 Apr 08		X						X										X						X									X		
15 Apr 08				X					X										X					X					X						
16 Apr 08					X					X								X						X											
17 Apr 08					X	X						X	X					X							X					X					
18 Apr 08				X		X					X							X									X								X
19 Apr 08		X						X									X						X											X	X
20 Apr 08																																			
21 Apr 08	X							X									X							X					X						
22 Apr 08				X		X					X		X					X								X					X				
23 Apr 08		X						X		X							X										X		X						
24 Apr 08			X					X										X					X						X			X			
25 Apr 08	X				X			X										X				X													
26 Apr 08					X			X									X							X								X			
27 Apr 08																																			
28 Apr 08			X						X			X							X				X						X						
29 Apr 08				X		X					X							X						X									X		
30 Apr 08		X						X										X								X			X						
1 May 08			X			X		X					X			X		X						X			X			X					X
2 May 08		X	X			X		X		X		X	X				X									X	X								X
3 May 08	X							X								X									X										X
COUNT	6	8	7	4	6	7		21	3	5	4	3	4		0	2	9	17	2	0		2	4	11	3	8	4		6	2	3	7	2	1	6
%	16%	21%	18%	11%	16%	18%		53%	8%	13%	10%	8%	10%		0%	7%	30%	57%	7%	0%		6%	13%	34%	9%	25%	13%		22%	7%	11%	26%	7%	4%	22%

8.2 Weather conditions - spring monitoring period (detail)

	Visibility						Precipitation						Temperature						Wind strength						Wind direction						
	Fine/ Sunny	Partly cloudy	Overcast	Heavy cloud	Mist/fog	Rain	None	Dripping foliage	Drizzle	Light	Moderate	Heavy	Freezing (<0)	Cold (0-5)	Cool (5-11)	Mild (11-16)	Warm (16-22)	Hot (>22)	Calm	Light breeze	Mod. Breeze	Fresh wind	Strong wind	Near gale	Northerly	Southerly	Westerly	Easterly	North Easterly	South Easterly	North Westerly
23 Oct 08						X					X				X							X								X	
24 Oct 08						X			X						X					X											X
25 Oct 08					X				X							X			X				X		X		X	X			
26 Oct 08																															
27 Oct 08		X					X							X										X	X						
28 Oct 08		X	X				X								X							X	X								X
29 Oct 08				X	X		X				X				X								X	X							X
30 Oct 08	X	X					X								X	X				X	X						X			X	
31 Oct 08		X					X								X							X	X	X							X
1 Nov 08			X			X	X		X						X							X	X	X							X
2 Nov 08																															
3 Nov 08		X					X		X						X						X				X		X				
4 Nov 08			X				X		X						X	X				X	X	X									X
5 Nov 08				X	X	X					X	X		X									X	X			X				
6 Nov 08			X	X		X					X	X			X								X	X							X
7 Nov 08	X			X		X					X	X			X						X	X	X		X		X				
8 Nov 08	X	X					X								X	X	X			X								X			
9 Nov 08																															
10 Nov 08			X				X									X			X						X		X				
11 Nov 08		X	X				X									X				X	X										X
12 Nov 08		X			X		X								X						X									X	
13 Nov 08	X	X			X		X	X							X					X	X										X
14 Nov 08		X					X								X	X					X	X	X						X		
15 Nov 08			X		X			X							X	X			X	X	X						X				
16 Nov 08																															
17 Nov 08			X	X	X	X			X		X	X			X	X			X	X			X		X		X				
18 Nov 08		X				X	X			X					X						X	X	X				X				X
19 Nov 08			X				X								X							X	X	X	X						
20 Nov 08	X	X	X				X	X							X	X	X		X	X					X					X	
21 Nov 08	X						X								X	X			X												X
22 Nov 08	X	X					X								X	X	X			X	X	X			X						X
COUNT	9	14	11	6	8	9	21	4	7	2	7	5	2	3	23	13	4	1	8	11	12	11	13	8	11	1	10	3	2	5	13
%	16%	25%	19%	11%	14%	16%	46%	9%	15%	4%	15%	11%	4%	7%	50%	28%	9%	2%	13%	17%	19%	17%	21%	13%	24%	2%	22%	7%	4%	11%	29%

	Visibility						Precipitation						Temperature						Wind strength						Wind direction						
	Fine/ Sunny	Partly cloudy	Overcast	Heavy cloud	Mist/fog	Rain	None	Dripping foliage	Drizzle	Light	Moderate	Heavy	Freezing (<0)	Cold (0-5)	Cool (5-11)	Mild (11-16)	Warm (16-22)	Hot (>22)	Calm	Light breeze	Mod. Breeze	Fresh wind	Strong wind	Near gale	Northerly	Southerly	Westerly	Easterly	North Easterly	South Easterly	North Westerly
BOTH SEASONS	15	22	18	10	14	16	42	7	12	6	10	9	2	5	32	30	6	1	10	15	23	14	21	12	17	3	13	10	4	6	19
%	16%	23%	19%	11%	15%	17%	49%	8%	14%	7%	12%	10%	3%	7%	42%	39%	8%	1%	11%	16%	24%	15%	22%	13%	24%	4%	18%	14%	6%	8%	26%

8.3 Bird Abundance - autumn monitoring period (detail)

Date	Australian magpie	Goldfinch	Paradise shelduck	Spur-winged plover	Australasian harrier	New Zealand pipit	Welcome swallow	New Zealand pigeor	Starling	Tui	Grey warbler	Fantail	Eastern rosella	Mallard	Chaffinch	Greenfinch	Rook	Silvereye	White-faced heron	Sacred kingfisher	Black-backed gull	Yellowhammer	Bellbird	Blackbird	Redpol	Black shag	House sparrow	New Zealand falcon	Shining cuckoo	Skylark	Song thrush
31 Mar 08	A	A	M	F	F	F	F	A			F		F	M	F		S	A	S	S	S			F	M						
1 Apr 08	A	M	M	M	F	F			M	S	S						S														
2 Apr 08	M	A	M	F		S			M	S			S																		
3 Apr 08	M	A	M	F		S			F		F	S					S														
4 Apr 08	A	A	M	F	F		M		F				M						S												
5 Apr 08	A	A	F	F	F	F		F		S	S	S	F		S	F	F	A			S	S									
6 Apr 08																															
7 Apr 08	M	M	F	F	F	S	F																								
8 Apr 08	M	A	M	F		S			F																						
9 Apr 08	M	A	M	M	F			M	F	F		S		F	F																
10 Apr 08	A	A	A	F	F	S	M	M	F	F		F	F		S	M															
11 Apr 08	M	A	M	F			F	F	S	S			F							S											
12 Apr 08	M	A		F	S	S	F	S		F		F				M		S													
13 Apr 08																															
14 Apr 08	M	A	M	F	S		S		M	F				M				F													
15 Apr 08	A	A	M	F	S	S		S	M	F	F			F	S	M					S										
16 Apr 08	M	A		F		S				S																					
17 Apr 08	A	A	F			S				S									S												
18 Apr 08	M	A	M	F			F												S												
19 Apr 08	M	A	M	F	S	S	M	M	M	F	S	F	F		S	F															
20 Apr 08																															
21 Apr 08	A	A	M		S		M	F	F						S	F						S									
22 Apr 08	M	A	M		S	S	S	M				S																			
23 Apr 08	M	A	M	F	S	F		F				S																			
24 Apr 08	M	A	M	M	M	F	M	A	F		F	F	M																		
25 Apr 08	M	A	M	F	S	F	S	S					S																		
26 Apr 08	M	A	M	M	M	F	F	M			F	S						M	S	S		F	F	S							
27 Apr 08																															
28 Apr 08	M	M	M	F	M	F		F				S		M																	
29 Apr 08	A	A	M	F	M	F	F	A						F									S								
30 Apr 08	M	A	M	F	M	S	F				S			F																	
1 May 08	M	A	A	F	F	F					S									S											
2 May 08	M	A	M	F	F	F	F				S		F				F														
3 May 08	M	A	M	F	F		F			S	F			M																	
COUNT	30	30	28	27	23	23	18	16	13	13	12	11	10	8	7	6	5	5	5	4	3	3	2	2	1	0	0	0	0	0	0
%	100%	100%	93%	90%	77%	77%	60%	53%	43%	43%	40%	37%	33%	27%	23%	20%	17%	17%	17%	13%	10%	10%	7%	7%	3%	0%	0%	0%	0%	0%	0%

S - Single | F - Few (2-5) | M - Many (5-20) | A - Abundant (20+)

8.4 Bird Abundance - spring monitoring period (detail)

	Australian magpie	Yellowhammer	Paradise shelduck	Spur-winged plover	Starling	Australasian harrier	Grey warbler	Tui	Black-backed gull	Chaffinch	House sparrow	Shining cuckoo	Welcome swallow	Mallard	Eastern rosella	Blackbird	New Zealand pigeon	Sacred kingfisher	Greenfinch	Song thrush	Goldfinch	Fantail	New Zealand pipit	White-faced heron	Redpol	Black shag	Bellbird	New Zealand falcon	Skylark	Rook	Silvereye
20 Oct 08	M	M	M		F				S				F		F		S														
21 Oct 08	M	M	M	F	M	S	F	F				F				S						F									
22 Oct 08	M	M	M	F	M	F	F	S					S		F			S													
23 Oct 08	M	M	M	F			F	F	M	S				S		S		F						S							
24 Oct 08	M	M	M	M	A	F	F	F	M	F			F	F			S	S			F			S							
25 Oct 08	M	M	M	M	A	F	M	S				M		F	F																
26 Oct 08																															
27 Oct 08	M	M	M	F	A	S			S	S	M			M	F																
28 Oct 08	M	A	M	M	M	F					M									S									S		
29 Oct 08	M	A	M		A		S							M	M		F														
30 Oct 08	M	A	M	M		M	M	F		M	M			M		F	F	S	M	S			F				F				
31 Oct 08	M	M	M	F	M	S	F		S	F	F	S	F	F	F			S			F					S					
1 Nov 08	M	A	M	F	M	S	F		S	S	F	S	F		F	S						S	S								
2 Nov 08																															
3 Nov 08	M	A	M	M	M	F	M	F	S	M	M	F	F							S			S								
4 Nov 08	M	A	M	M	F	F	M	S	F	M	F	F	M	F	S	F	F						S								
5 Nov 08	M	M	M	F	M				S	M	F			M	F			S													
6 Nov 08	M	A	M	F	A	S		S	F	F		S	F		F	S	F			S			S								
7 Nov 08	M	M	M	M	A	F	F	F	S	M	F	F	S	M	S	F				S						S					
8 Nov 08	M	A	M	M	M	S	F	F		F	M	F	F	M		F	F		M	F		F	F								
9 Nov 08																															
10 Nov 08	M	M	M	M	M	F	M	F	F	M	M	F	M		S		F	F		S	S	F		F	F			F			
11 Nov 08	M	M	M	F	M	M	M	F	M	F	M	F	M	F	F	F	F		F	S		F	S		F						
12 Nov 08	M	M	M	F	F	F	M	M	F	M	M	F	F	F		F		F	M		F				F						
13 Nov 08	M	M	M	F	M	F	F	F	F	F	M	F	F		F	F	F	F	M		F			S							
14 Nov 08	M	M	M	F	M	F	F	F	F	F	M	F	F	M		F	S	S			F										
15 Nov 08	M	M	M	F	M	F	F	F	F	F	F	F	F			F		S	F			S									
16 Nov 08																															
17 Nov 08	M	M		F	M	F	F	F	F			F	F	M		S			S					F							
18 Nov 08	M	A	M		F	F	F	F	F	F	M	F	S				S		F												
19 Nov 08	M	M	M	F	F	F	F	F	S	F	M	F		F	S		S														
20 Nov 08	M	A	F	F	M	F	F	M	S	F	F	F	F	F	F			F	F		F	F									
21 Nov 08	M	M	M	F		F	F	M			M	F	F	F			F	F	F	F	F										
22 Nov 08	M	M	M	F	M	F	F	F	F	F	F	F		F		S			F												
COUNT	30	30	29	27	27	26	25	23	22	22	21	21	20	19	16	15	14	13	11	9	8	7	7	5	3	2	1	1	1	0	0
%	100%	100%	97%	90%	90%	87%	83%	77%	73%	73%	70%	70%	67%	63%	53%	50%	47%	43%	37%	30%	27%	23%	23%	17%	10%	7%	3%	3%	3%	0%	0%

S - Single | F - Few (2-5) | M - Many (5-20) | A - Abundant (20+)

8.5 Scavenging Rates (Detail)

Day old chickens					
Date	**21**	**22**	**24**	**25**	**44**
21/04/08	*2*	*2*	*2*	*3*	*2*
22/04/08	2 whole	2 whole	1 whole + 1 overlooked	3 whole	1 whole, 1 missing
23/04/08	1 whole, 1 missing	2 whole	1 whole	3 whole	1 whole
24/04/08	1 whole, 1 missing	2 whole	1 whole	3 whole	0
25/04/08	1 whole	2 whole	1 whole	2 whole, 1 missing	0
26/04/08	1 whole	2 whole	1 whole	2 whole	0
27/04/08					
28/04/08	1 whole	2 whole	1 foot remaining	1 whole	0
29/04/08	1 whole	2 whole	0	1 whole	0
30/04/08	0	1 whole, 1 half rotten	0	0	0
1/5/2008	0	1 whole, 1 half rotten	0	0	0
2/5/2008	0	Both mostly decomposed	0	0	0
3/5/2008	0	2 x feather spot	0	0	0
1/2 Grown Chickens					
Date	**21**	**22**	**24**	**25**	**44**
21/04/08	*2*	*1*	*2*	*2*	*1*
22/04/08	2 whole	1 whole	1 whole + 1 1/4 eaten	1 whole + 1 head missing	1 whole
23/04/08	1 whole, 1 1/2 eaten	1 whole	1 1/4 eaten + 1 1/2 eaten	1 1/4 eaten + 1 head missing	3/4 eaten
24/04/08	1 1/2 eaten, 1 only feet and wing	1 whole	1 3/4 eaten + bones & feathers	1 wings, legs & vertebrae + 1/4 eaten	only major bones and wings
25/04/08	2 x bones and wings	1 1/2 eaten	1 feather spot, 1 winds and legs	1 wing and feathers, 1 3/4 eaten	only major bones and wings
26/04/08	1 bones & wings, 1 just legs	feather spot	1 feather spot, 1 winds and legs	1 just legs, 1 legs, wings & ribcage	bones and wings
27/04/08					
28/04/08	2 x feaher spot	feather spot	2 x feather spot	1 just legs, 1 legs, winds & rib cage	feather spot
29/04/08	2 x feaher spot	feather spot	2 x feather spot	2 x feather spot	feather spot
30/04/08	2 x feaher spot	feather spot	2 x feather spot	2 x feather spot	feather spot
1/5/2008	2 x feaher spot	feather spot	2 x feather spot	2 x feather spot	feather spot
2/5/2008	2 x feaher spot	feather spot	2 x feather spot	2 x feather spot	feather spot
3/5/2008	2 x feaher spot	feather spot	2 x feather spot	2 x feather spot	feather spot

8.6 Field Data Sheets

Te Apiti Windfarm

Tower Number:..

Page Number..

Tower Search Datasheet (All carcasses, avian and terrestrial)

Find Number			
New / Repeat			
Species			
Body (Yes / No)			
Feather spot (Yes / No)			
Age (juv / adult)			
Sex			
Estimated time of death			
Distance to tower			
Bearing to tower			
Scavenged (Yes / No)			
Detailed description of carcass			
Notes (number of photos)			

Age: U = unknown, I = Immature, A = Adult, Sex: U = unknown, F = Female, M = Male

Estimated time of death: 1 = Unknown (write description of flesh and feather in description), **2** = Fresh Kill (Several days old, describe “freshness” in description), **3** = Actual time estimate (based on blood, other rationale, give in description), **4** = Not applicable (i.e. Feather spots)

TURBINE NO.	**Date**	**Start Time**	**End Time**	**Carcass located?**	**Turbine Activity**
MONDAY					
21					
22					
23					
24					
44					
TUESDAY					
21					
22					
23					
24					
44					
WEDNESDAY					
21					
22					
23					
24					
44					
THURSDAY					
21					
22					
23					
24					
44					
FRIDAY					
21					
22					
23					
24					
44					
SATURDAY					
21					
22					
23					
24					
44					

Turbine activity: 0, none. 1, Slowly turning. 2, Normal/ fast moving

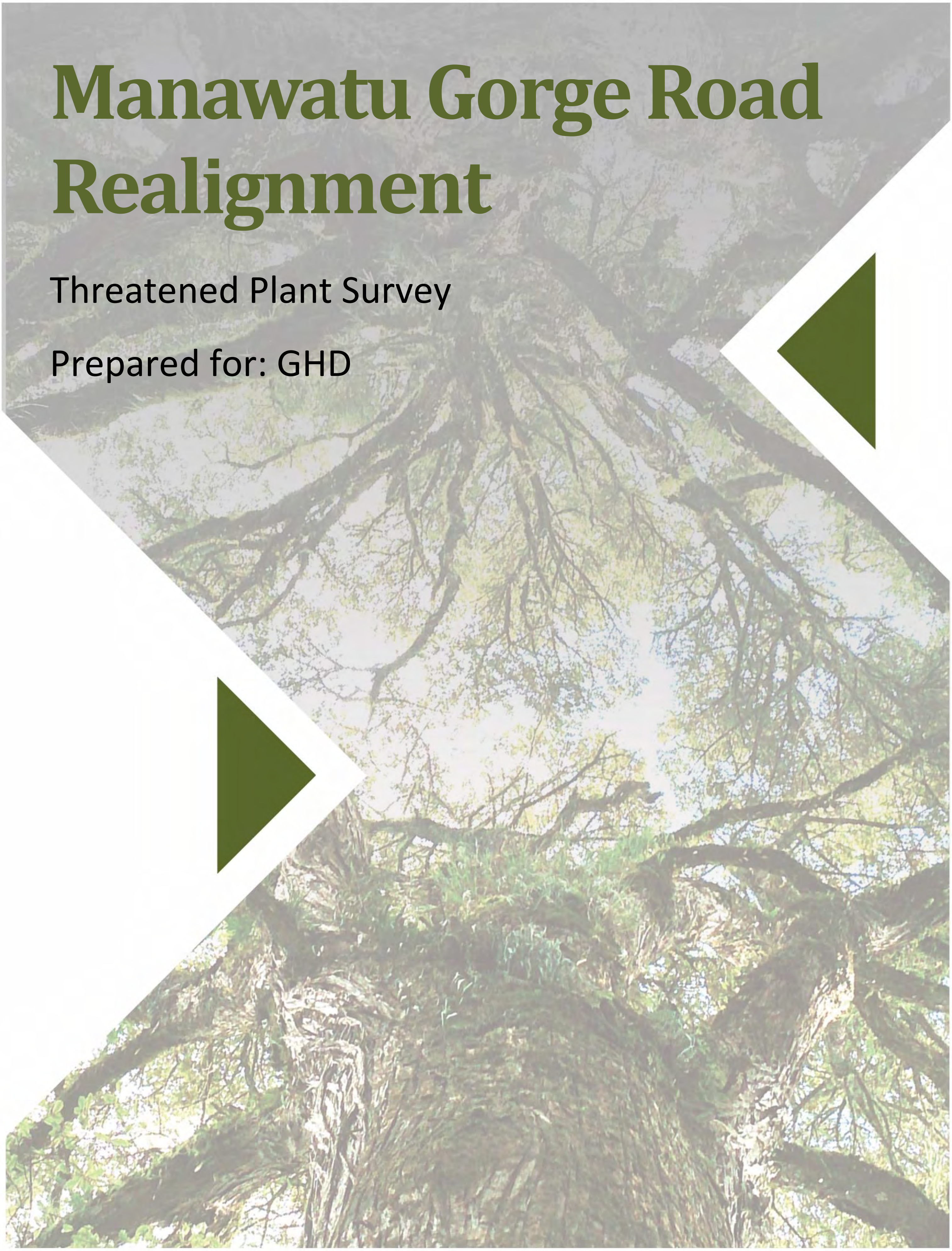
6.A.G

THREATENED PLANT SURVEY

Manawatu Gorge Road Realignment

Threatened Plant Survey

Prepared for: GHD



Nicholas Singers
Ecological Solutions
Innovation in conservation

NSES Ltd report :2017/18

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Date: March 2018

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Contents

1. Introduction 4
2. Office-based review 5
3. Field survey 8
    Area A........ 8
    Area B........ 11
    Area C........ 15
    Area D 15
4. Discussion and recommendations 16
5. Conclusion........ 17
6. References 17

1. Introduction

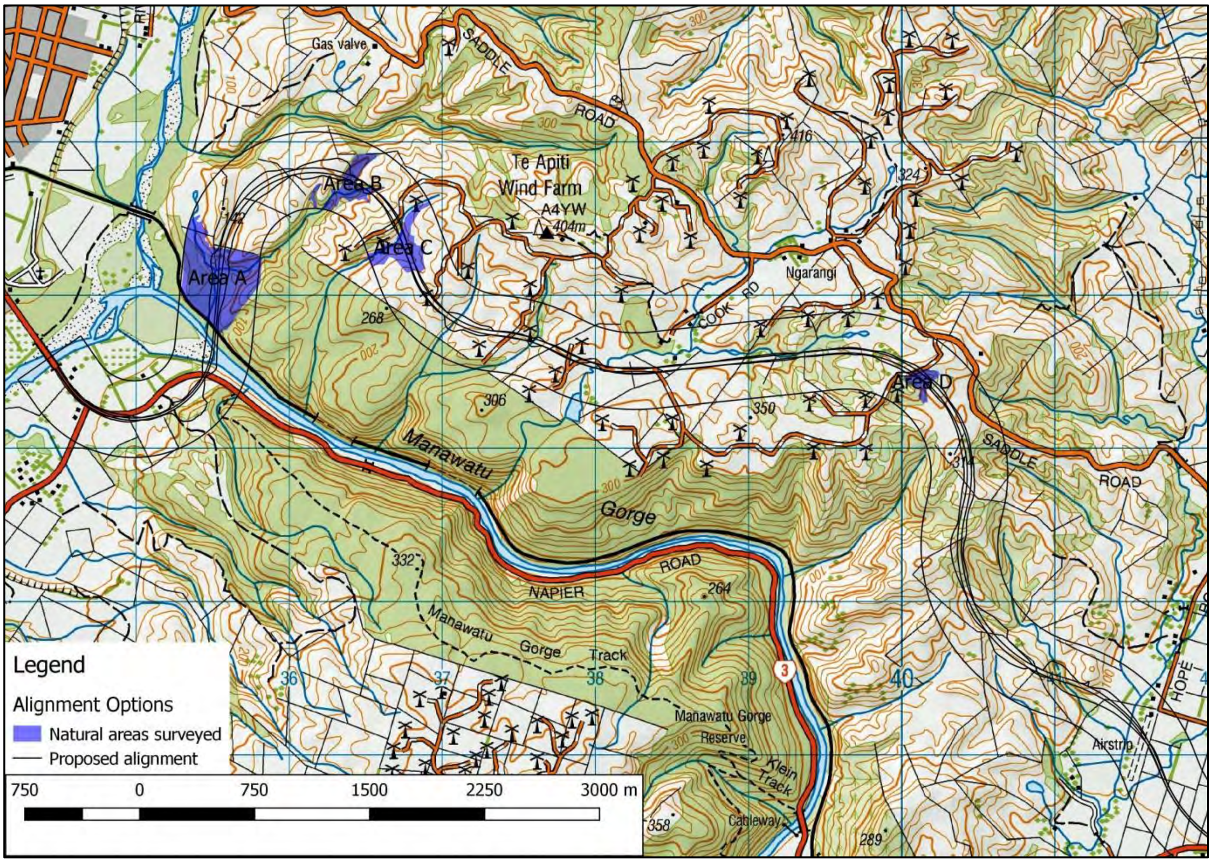
As part of the Manawatu Gorge project, the NZ Transport Agency has engaged suitably qualified ecologists to undertake initial species and habitat surveys for the 2017/2018 summer season. This survey focuses on rare or threatened flora that would only be present or detectable within the project area during the summer period.

The purpose of this survey was to establish potential presence, absence and distribution of rare or threatened flora within the preferred corridor and areas affected by this (e.g. stormwater receiving environments) to inform the future Assessment of Ecological Effects for the project. Four areas were identified as potential habitat of threatened plants based on advice from Dr Adam Holdsworth and a review of spatial data.

The proposed alignment is located on the north side of the gorge and rises from approximately 80 m a.s.l near the Manawatu River at Ashhurst to a height of 300m on the summit. The original vegetation would have been almost entirely tawa dominant forest with occasional to common podocarp and northern rata emergent trees — somewhat similar to the most intact areas within the Manawatu Gorge Reserves. At lower altitude titoki was likely co-dominant with tawa. Nikau palm is also a notable feature in this area and is locally abundant in gullies. On the windswept summit kamahi is also present and was common within the canopy and sub-canopy. The gorge environment also includes; smaller areas cliff and steep slopes with shrubland and wharariki flaxland, riparian areas dominated by species tolerant to periodic flooding. Remnant, mostly modified, examples of these habitats occur on the proposed alignment.

To focus surveying to likely threatened plant habitat and improve the probability of finding any species present, an office-based review was conducted.

Figure 1: Natural Areas surveyed for threatened plants (highlighted in blue)



2. Office-based review

An initial office-based review of the habitats present and associated rare and threatened plants known to have been recorded or that potentially could be present within the habitats was undertaken. This utilised the following resources to develop a potential candidate list of rare and threatened plant species, previously recorded within the Manawatu Gorge area and other species which could potentially be present.

Information sources included the following information:

- Plant Species Lists by A.P. Druce for the Manawatu Gorge and Envions and the Totara Reserve (Pohangina Valley).
- Review of threatened plants from de Lange *et al.* (2010) and the de Lange *et al.* (2013)
- Review of species distribution information from herbarium records from the Australasian Virtual Herbarium data and species list information from the New Zealand Plant Conservation Network website, for selected species identified from de Lange *et al.* (2010) and de Lange *et al.* (2013).
- Knowledge and previous experience of species that potentially could be present considering the known habitats within the preferred alignment.

Tables 1 – 3 identify the candidate list of nationally threatened and regionally rare plants. The Horizons Region does not have a published list of regionally rare plants though some plants known to be uncommon or at a distribution limit were additionally considered for survey (Table 3). These are not nationally threatened but also need to be considered due to their regional rarity or importance.

Table 1: Threatened Plants listed by de Lange *et al.* (2013) recorded at the Manawatu Gorge and nearby

Species Name	**Common Name**	**Threat class**	**Site recorded**
Adiantum formosum	Giant maidenhair, Plumed maidenhair	At Risk - Relict	Manawatu Gorge in a stronghold for this Australasian species. First collected by William Colensoi (WELT.P002459). Still locally abundant within reserves.
Epilobium hirtigerum	hairy willowherb	Threatened - Nationally Critical	Collected by Alan Esler in 1960 (AK219328) and also recorded by Druce.
Epilobium insulare	willowherb	Data Deficient	Recorded on APD 'Manawatu Gorge and environs' plant species list.
Libertia peregrinans	New Zealand iris, mikoikoi	Threatened - Nationally Vulnerable	Collected by on a dry cliff within the gorge in 1937 by Lucy Moore (CHR33682).
Solanum aviculare var. aviculare	poroporo	At Risk - Declining	Recorded on APD 'Manawatu Gorge and environs' plant species list.
Teucridium parvifolium	Teucridium	At Risk - Declining	Recorded by A.P.Druce within 'shrub-grassland habitat' (CHR471574)
Urtica perconfusa (syn. *U.linearifolia*)	swamp nettle	At Risk - Declining	Recorded on APD 'Manawatu Gorge and environs' plant species list.

Table 2: Threatened Plants listed by de Lange *et al.* (2013) that occur in the lower North Island and potentially suitable habitat maybe present in the Manawatu Gorge

Species Name	**Common Name**	**Threat class**	**Closest location**
Anogramma leptophylla	Annual fern	Nationally vulnerable	Eastern Wairarapa to central Hawkes Bay growing on exposed, dry cliffs (WELTU 6559). Similar habitat present in gorge.
Brachyglottis kirkii	kohurangi	At Risk - declining	Epiphytic shrub formerly common on large emergent trees throughout lowland to montane areas. Recorded from northern Tararua Range (AK35326).
Bulbophyllum tuberculatum		At risk - Naturally uncommon	Known from near Wanganui (CHR400997). Suitable habitat and host species present.

Daucus glochidiatus	native carrot	Nationally vulnerable	Potentially present on open cliffs. Occurs on exposed greywacke cliffs at Eastern Wairarapa Taipo's and also recorded in Ruahine Range Phillips Turner (AK105136).
Drymoanthus flavus	little spotted moa (orchid)	At Risk - Naturally Uncommon	Described in 1994, limited information known about distribution. Known from near Ohau River, Horowhenua, often grows on titoki & rewarewa, both trees present.
Korthalsella salicornioides	dwarf mistletoe	At Risk - Naturally Uncommon	Historically known from near Fielding & Halcombe (CHR107898). Closest extant location near Marton. Hemi-parasitic on kanuka and manuka.
Spiranthes novae-zelandiae	laddies tresses (orchid)	Nationally vulnerable	Wetland plant known from Whitiau & Whangaehu. Needs disturbance in wetlands.

Table 3: Regionally uncommon species with distributions including the Manawatu Gorge

Threatened Plants within lower North Island and potential habitat exists			
Species Name	**Common Name**	**Threat class**	**Closest location and habitat information. Herbarium voucher in brackets.**
Ileostylis micranthus	Green mistletoe	Regionally uncommon	Formerly common and prior to the 1960's widespread in Manawatu including Pohangina Valley (Totara Reserve). Threatened by possum browse and recovery now occurring nationally with sustained possum management.
Pittosporum cornifolium	Hanging kohuhu	Regionally uncommon	Epiphytic shrub formerly common on large emergent trees. Collected near Palmerston North by Petrei in 1894 (WELT.SP035592).
Scandia geniculata	Native aniseed	Regionally uncommon and northern limit in Manawatu Gorge	Recorded by A.P. Druce in 1971. Regionally important as this location is the northern limit for this species.
Syzygium maire	Swamp maire, maire tawake	Regionally uncommon	Principally would have occurred on the margins of wetlands and on poorly drained river terraces. Known from Pohangina and Manawatu River.

The office-based review also mapped habitats targeted for survey using QGIS. Vegetation communities were mapped into broad classes which were visible from aerial imagery to help assist surveying of suitable habitats of the known or potential threatened plant species present.

3. Field survey

The proposed alignment has been located to avoid (as best as possible) areas of significant indigenous vegetation. The alignment does traverse through several small natural areas, including three which contain mature tawa forest, of which two are legally protected by an open space covenant. Other areas of indigenous vegetation affected are dominated by early successional tress including mahoe, kaikomako, pate, houhere, kanuka and manuka. Small wetland areas occur in several locations. A targeted threatened plant survey concentrated within and immediately adjoining the proposed alignment in four specific areas (Figures 1 & 2). Information was also gathered for specific areas, such as wetlands outside of the proposed alignment including summarising community vegetation composition.

Area A

On the western side of the gorge, the proposed alignment dissects through an area which is a mosaic of vegetation communities including; native forest, wetland, secondary scrub and rough pasture, and mixed exotic/native scrub (Figure 2).

The area of indigenous forest vegetation is dominated by tawa (*Beilschmiedia tawa*), titoki (*Alectryon excelsus* subsp. *excelsus*) forest. Also present within this remnant are rewarewa (*Knightia excelsa*), matai (*Prumnopitys taxifolia*), occasional hinau (*Elaeocarpus dentatus* var. *dentatus*), ribbonwood (*Plagianthus regius* subsp. *regius*), white maire (*Nestegis lanceolata*) and several large mature pukatea (*Laurelia novae-zelandiae*) and a large kahikatea (*Dacrycarpus dacrydioides*) on a stream terrace. Common understorey trees include kaikomako (*Pennantia corymbosa*), mahoe (*Melicytus ramiflorus*) and houhere (*Hoheria sexstylosa*). The remnant is grazed by sheep and cattle, however due to the steepness of some slopes several areas are relatively unaffected by stock. On the steep terrace riser two divaricating shrubs are particularly common; *Coprosma areolata* and taurepo (*Rhabdothamnus solandri*) along with several ground ferns including common maidenhair fern (*Adiantum cunninghamii*), Hooker's spleenwort (*Asplenium hookerianum* var. *hookerianum*) and *Polystichum wawranum*.

No threatened plants were located within this remnant. Suitable habitat exists for several species including;

- *Adiantumn formosum* and *Teucridium parvifolium* especially on the terrace riser amongst taurepo and *C. aerolata*.
- *Brachyglottis kirkii*, *Bulbophyllum tuberculatum*, *Drymoanthus flavus* as well as the regionally rare species *Pittosporum cornifolium* and *Ileostylus micranthus* as epiphytes or parasites on some of the larger host trees.

Of additional significance is that effective possum control is occurring, and canopy condition was observed to be high with no obvious browse on palatable species.

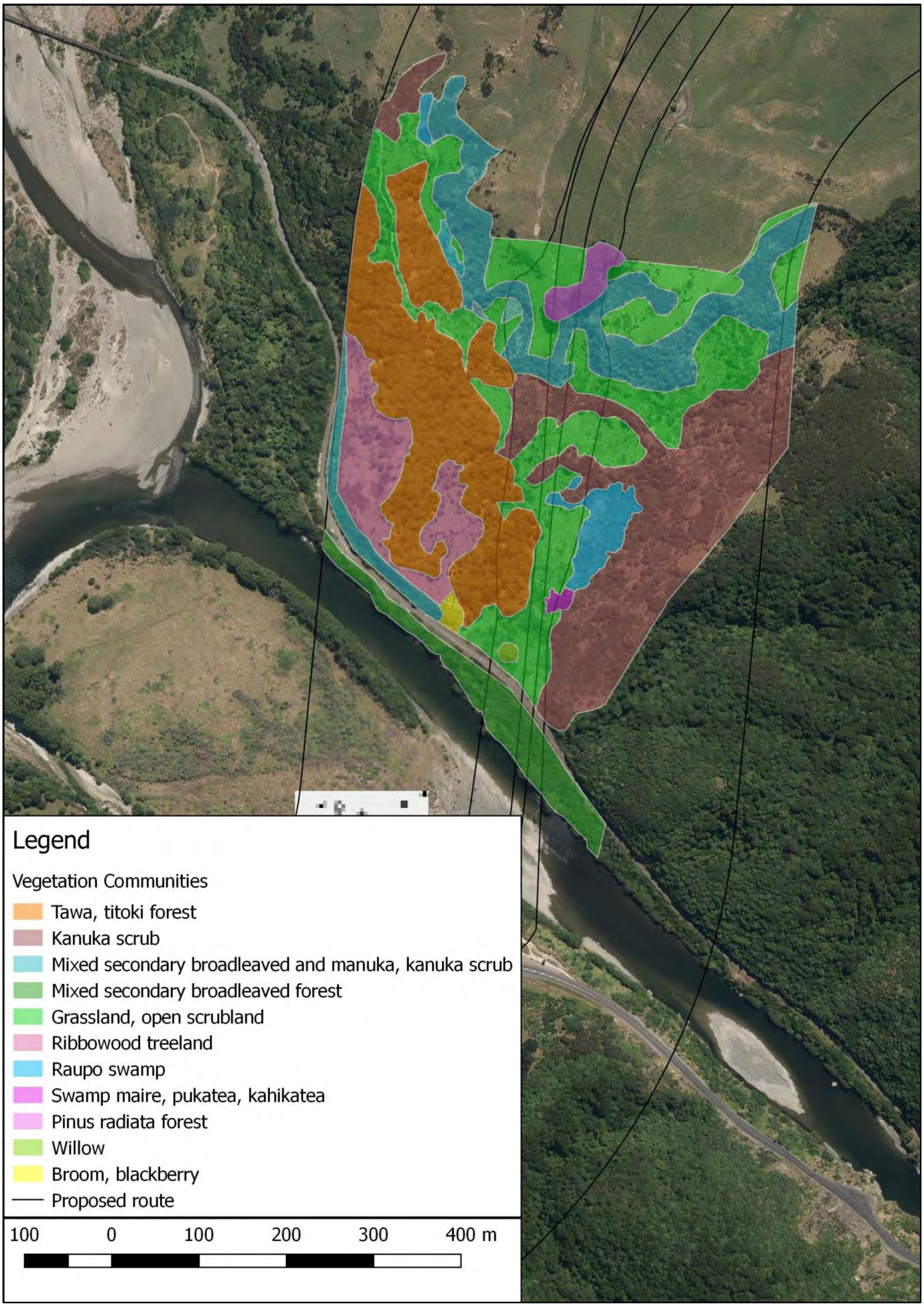


Figure 2: Vegetation communities present within Area A

Figure 3: Raupo reedland on the eastern side of the proposed alignment (looking south)

Several discrete areas of wetland vegetation are also present within area A. The largest area, which is approximately 0.6 ha occurs on what appears to be a landslip at the base of a very steep slope (Figure 3). Raupo is the dominant species and has a cover of approximately 75%, while scattered manuka and occasional karamu occur. The water table of this wetland was, in most areas, below the surface and the understorey vegetation was dominated by exotic species of which goat's rue (*Galega officinalis*), lotus (*Lotus pedunculatus*), tall fescue (*Lolium arundinaceum* subsp. *arundinaceum*) and water pepper (*Persicaria hydropiper*) were abundant. These species are often found in damp pasture as well as dryland vegetation types. Apart from raupo, native herbaceous species were relatively uncommon, though *Carex secta* and *C. maorica* were present in areas of high water table. The penny wort (*Hydrocotyle pterocarpa*) was found in one location. Near the lower edge of the wetland, vegetation was grazed to a short turf by sheep and in this area three small native species occurred; dwarf bog rush (*Schoenus maschalinus*), *Hydrocotyle moschata* and *Dichondra brevifolia*.

The low water table is unusual for raupo reedland vegetation, which typically occurs in permanently saturated wetlands, often with 10-30cm of standing water. The low water table is likely to be a cause for the dominance of exotic species beneath raupo. Consequently, the low water table and the dominance of exotic plants are probably make this habitat unsuitable for swamp nettle (*Urtica perconfusa*) and other threatened wetland plant species to be present.

Of most significance in Area A was a small remnant of fourteen swamp maire (*Syzygium maire*) trees in association with several pukatea and a single kahikatea tree. Swamp maire is now rare in the Manawatu with two other small populations known, one in the Pohangina Valley and the other north of Palmerston North. These trees were particularly healthy and were flowering heavily, an indicator of low possum browse (Figure 4).

Figure 3: Flowering swamp maire

Area B

The proposed alignment crosses two tributaries of Area B which are protected through QEII open space covenant (Figure 5). This area encompasses two steeply incised streams, which have eroded through deep layers of gravels to create near vertical canyons of 5–10 m high. In some areas the fence line is located very close to the canyon edge, while elsewhere it is buffered by forest on steep hillslopes. Vegetation is relatively sparse on the canyon walls and composition is variable dependent on light and moisture availability. Where seepages occur kiokio (*Parablechnum novae-zelandiae*), parataniwha (*Elatostema rugosum*), gully fern (*Pneumatopteris pennigera*) and locally kiekie (*Freycinetia banksii*) are common. Vegetation is sparser on most of the canyon walls and includes meadow grass (*Poa anceps*), taurepo (*Rhabdothamnus solandri*), tank lily (*Astelia hastata*), shining karamu (*Coprosma lucida*), puka (*Griselinia lucida*), climbing rata (*Metrosideros perforata*), Easter orchid (*Earina autumnalis*) and nini (*Austroblechnum chambersii*) in shaded locations.

On the western side of the largest tributary, tawa is the dominant canopy tree above the canyon with approximately 70% cover while rewarewa occupies 10% (Figure 6 & 7). Several miro are also present. On the eastern side of the main tributary and on both sides of the southern tributary, forest vegetation is dominated by secondary broadleaved forest, which lancewood (*Pseudopanax crassifolius*) and rewarewa are dominant with approximately 45% and 35% cover respectively. Also present are tarata (*Pittosporum eugenioides*), puka, houhere, locally mamaku (*Cyathea medullaris*) and kanuka (*Kunzea robusta*). South of the alignment is a stand of nikau palm (*Rhopalostylis sapida*), which kereru were feeding in during the site visit. Understorey vegetation is relatively sparse beneath this community and changes with respect to the proximity to the canyon. Close to the fence line, hangehange (*Geniostoma ligustrifolium* var. *ligustrifolium*) is most common with hen and chicken fern (*Asplenium gracillimum*) and shining spleenwort (*A. oblongifolium*) the most common ferns present. Deeper into the canyon mahoe is also present in the canopy with kawakawa (*Piper excelsum* subsp. *excelsum*) and occasional nikau palm the most common understorey species.

Kanuka forest occurs on a narrow ridge that separates the two tributaries. Beneath this vegetation community understorey is dominated by *Coprosma rhamnoides*, tall mingimingi (*Leucopogon fasciculatus*) and occasional turutu (*Dianella nigra*) and *Asplenium* ferns.

No threatened plants were recorded in this area, though habitat is suitable for several species including the green mistletoe (*Ileostylis micranthus*) and the dwarf mistletoe (*Korthalsella salicornioides*). Tall canopy trees present had relatively small epiphytes communities, which are not particularly suitable for kohurangi or *Pittosporum cornifolium*. While not included in the candidate list, the areas of secondary lancewood forest would also be ideal habitat for *Dactylanthus taylorii*, which the nearest populations of are Mangaweka and Mt Bruce.

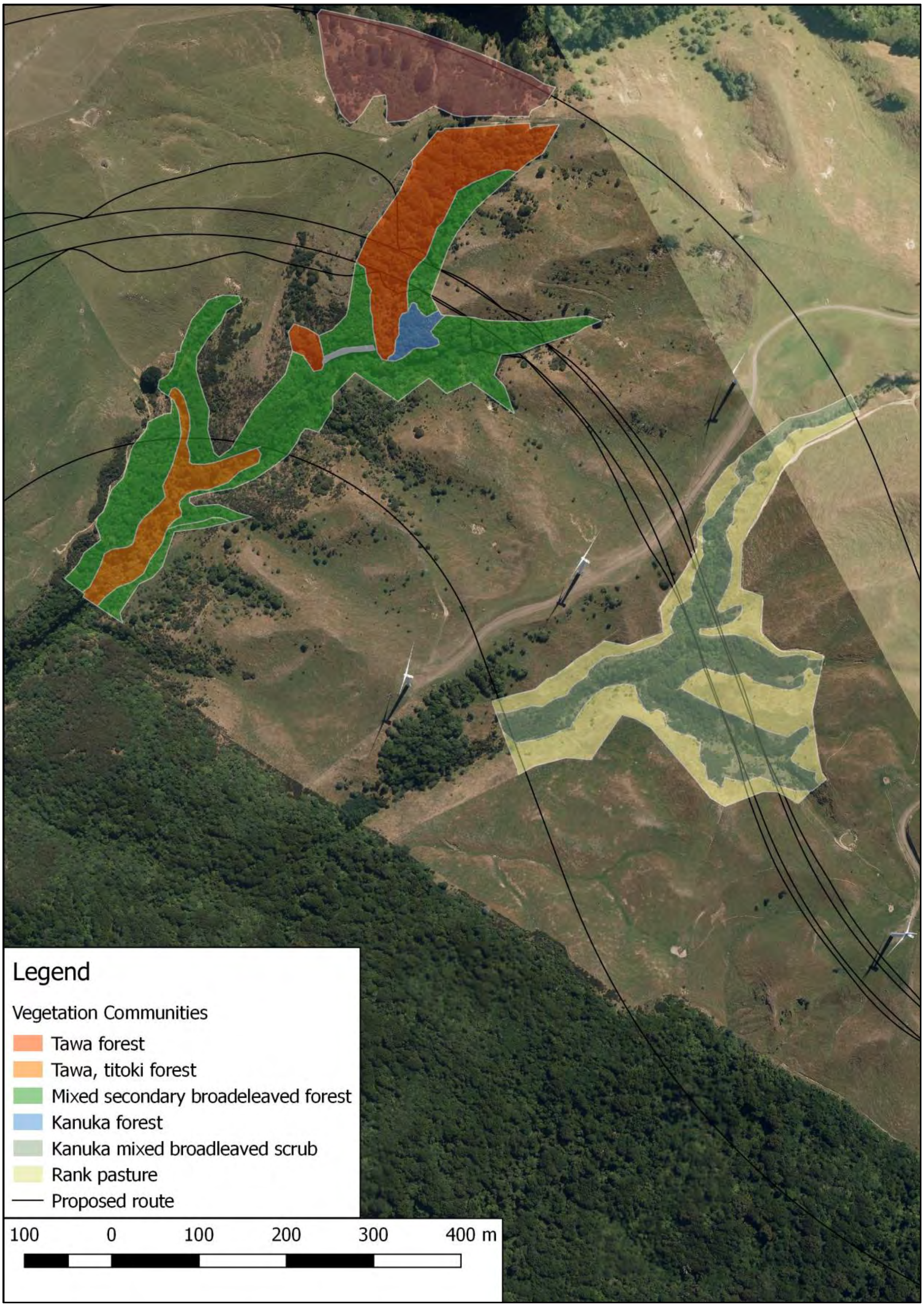


Figure 5: Vegetation communities of Areas B & C

Figure 6: Overview of area B.

Figure 7: Tawa forest on the western side of Area B and mixed secondary broadleaved forest in the foreground.

Area C

A rapid survey was undertaken to assess this habitat which is protected through QEII open space covenant (Figure 5). Upon observation of this area it was determined to be not suitable habitat for threatened plants within the canopy except potentially for mistletoes; dwarf mistletoe and green mistletoe. Vegetation present is dominated by young kanuka and manuka (*Leptospermum scoparium* var. *scoparium*) with small broadleaved trees including rewarewa and tree ferns restricted mainly to the steep gully (Figure 8). Vegetation was surveyed for the presence of mistletoes with none being found.

Figure 8: Overview of area C

Area D

A rapid survey was undertaken to assess whether the habitat present was suitable for threatened plants, especially the valley floor for wetland plants. Upon observation this area was confirmed to be wet pasture with small areas of cutty grass (*Carex geminata*) were not suitable for threatened wetland plants such as swamp nettle. The surrounding hillslopes were dominated largely by mahoe and locally mamaku, which likely had regenerated from gorse and broom (Figure 9). Recent aerial herbicide application had also impacted some of this vegetation.

Figure 9: Overview of area D

4. Discussion and recommendations

One plant of significance was found — fourteen swamp maire trees on the margin of the small raupo wetland. Swamp maire is a regionally rare tree in the Manawatu with very few populations remaining. This species is however soon to be classified as critically threatened (Data poor) in the next threatened plant list (de Lange *pers.com.*). The proposed change in threat rank is because swamp maire is expected to be severely impacted by myrtle rust (*Austropuccinia psidii*) which has the local extinction of some plant species in Australia, and heavily impacted some related *Syzygium* species in Australia, such as *S. hodgkinsoniae* and *S. corynanthum*, have been (Pegg *et al.* 2017). While this recommendation may be overly cautious, it does highlight how significant the Department of Conservation views the threat of myrtle rust on swamp maire, given that containing spread of the disease and managing population impacts will be extremely difficult, if not impossible. Further, whether natural resistance is present in populations or whether the climate suitability across the variable climatic areas of New Zealand is not known. The following recommendations have been made on the assumption that myrtle rust will not deleteriously affect this population of swamp maire and these may need to be reviewed in future.

The location of the proposed road alignment will directly impact the swamp maire population and will require the clearance of most trees for a probable roadside embankment (Figure 2). Remaining trees not cleared could also be impacted by adjoining construction activities, such as root damage and post construction changes in site hydrology.

While it would be prudent to investigate design options to avoid removing these trees, there is limited space to move the road westward. Shifting the road westward could result in more tawa-titoki forest also being impacted, so this would also need to be considered. Measures taken such as constructing a steep wall (instead of a fill) should however be investigated. Given the proximity of the road to the trees, and potential changes in hydrology, this option may not be successful to effectively protect these trees.

For these reasons it is strongly recommended that species specific mitigation measures be undertaken in addition to any potential design improvements. Of highest priority is to collect seed from these trees this season in order to ensure the genetic contribution of this population is not lost. As these trees were flowering heavily during field work in February, this action should occur soon ensuring that seed is collected from every tree.

Ideally the progeny cultivated should be planted in one or more ecologically appropriate locations which are expected to be permanent. Appropriate locations would firstly need to be environmentally suitable to ensure survival of any planted seedlings and also long-term be suitable for natural regeneration. Swamp maire typically grows next to and in wetlands, such as on poor draining (seasonally flooded) soils on alluvial terraces. Conservation management would need to be undertaken to ensure their ongoing survival including exclusion of stock, and possum and weed control to ensure trees remain healthy. At least one translocation site should be in close proximity to the Manawatu Gorge. Other options could include using this species in riparian restoration projects to enhance water quality and potentially establishing an ex-situ population in an appropriate municipal reserve, which could be used in future for seed collection. Suitable habitat for this species may be available within the broader Project footprint, such as adjoining the raupo wetland or along streams where riparian or landscape planting may be required. Sites chosen would need to be hydrologically appropriate.

5. Conclusion

Surveying targeted likely habitat for a range of threatened plant species within the candidate list, which are either known from the Manawatu Gorge or for which suitable habitat potentially exists. No plants categorised as threatened within de Lange *et al.* (2013) were detected in this survey, though a small population of swamp maire was located within the Project's footprint which has been recommended to be classified as Nationally Critical in the next threatened plant list. It is my opinion, given the vegetation communities present, their management history and current state, the proposed route is unlikely to contain any nationally threatened plant species.

6. References

The Australasian Virtual Herbarium. https://avh.chah.org.au/

De Lange, P.J.; Heenan, P.B.; Norton, D.A.; Rolfe, J.R.; & Sawyer, J. (2010). Threatened plants of New Zealand. Canterbury University Press, Christchurch.

De Lange, P.J.; Rolfe, J.R.; Champion, P.D.; Courtney, S.P.; Heenan, P.B.; Barkla, J.W.; Cameron, E.K.; Norton, D.A.; Hitchmough, R.A. (2013). Conservation status of New Zealand indigenous vascular plants, 2012. *New Zealand Threat Classification Series 3*. Department of Conservation, Wellington.

Druce, A.P. Manawatu Gorge and Environs Plant Species List. APD List 084. Sourced from the NZPCN website. http://www.nzpcn.org.nz/observation_site_details.asp?sid=2832

Druce, A.P. Totara Reserve, Pohangina Valley Plant Species List. APD List 130. Sourced from the NZPCN website. http://www.nzpcn.org.nz/observation_site_details.asp?sid=2886

Pegg, G., Taylor, T., Entwistle, P., Guymer, G., Giblin, F., & Carnegie, A. (2017). Impact of Austropuccinia psidii (myrtle rust) on Myrtaceae-rich wet sclerophyll forests in south east Queensland. *PloS one*, *12*(11), e0188058. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5697815/

6.C

FRESHWATER - ECOLOGICAL IMPACT ASSESSMENT

Boffa Miskell

Te Ahu a Turanga; Manawatū Tararua Highway Project

Freshwater – Ecological Impact Assessment
Prepared for New Zealand Transport Agency

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Cover photograph: Manawatu and Pohangina River confluence, © BML, 2018.

CONTENTS

1.0 Introduction 1

1.1 Background 1

1.2 Scope of this report 1

2.0 Methods 2

2.1 Desktop analysis 2

2.2 Site visit 2

2.3 Stream classification 3

2.4 Assessment of ecological value and effects 4

3.0 Freshwater ecological description, condition and values 5

3.1 Watercourse network one 5

3.2 Watercourse network two 7

3.3 Watercourse network three 11

3.4 Watercourse network four 13

3.5 Watercourse network five 16

3.6 Watercourse network six 17

3.7 Watercourse network seven 19

3.8 Watercourse network eight 22

3.9 Manawatu River 23

3.10 Ponds 24

3.11 Sediment quality 24

3.12 Macroinvertebrate assemblage 25

3.13 Stream Ecological Valuation 26

3.14 Fish and koura survey 29

3.15 Ecological significance 32

3.16 Freshwater ecological values 32

4.0 Assessment of potential effects 1

4.1 Description of potential adverse effects 2

4.2 Level of Project effects 5

5.0 Conclusion 8

6.0 References 9

Appendices

No table of contents entries found.

1.0 Introduction

1.1 Background

The existing State Highway 3 ("**SH3**") through the Manawatū Gorge has been permanently closed due to repeated landslips and instability constraints. New Zealand Transport Agency ("**NZ Transport Agency**") has identified a preferred option to construct and operate a new State Highway route, to be known as Te Ahu a Turanga; Manawatū Tararua Highway Project ("**the Project**"). The proposed route is located further north of the existing State Highway, between Saddle Road and the Manawatū Gorge Scenic Reserve. An overview of the proposed designation corridor, within which the Project is to be constructed, is presented in Figures 1 to 3 (Appendix 6.C.1).[1]

The proposed corridor crosses several different catchments varying in size, as well as crossing the Manawatū River. Freshwater ecological values have been described and assessed across the Project as part of the Notices of Requirement ("**NoR**") process. This report provides an assessment of the sensitivity of the receiving environment and the potential level of adverse freshwater ecological impacts the project might have. It has informed the design parameters of the Project, including its location and the proposed designation boundaries.

The assessment also forms part of a wider assessment, undertaken in conjunction with other technical specialists, of the Project's effects on the natural character of watercourses and their margins.

The NZ Transport Agency will seek resource consents at a later stage, once detailed design of the Project has been carried out, including for any in-stream works. An updated report and assessment will be required for that phase of the Project.

1.2 Scope of this report

As such, the purpose of this freshwater ecological report is to assist with understanding the sensitivity of the freshwater ecology within the Project area and feed into the natural character assessment, and inform the location of the designation by:

- Describing and assessing existing freshwater ecological values present under the corridor;
- Discussing the likely and potential effects on the ecological values present from the Project (operation); and
- Provide preliminary recommendations for appropriate avoidance, remediation and/or mitigation of adverse effects from the Project on the freshwater ecological values present.

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[1] Note that these figures depict a previous iteration of the proposed designation area; three relatively small areas relating to unformed access tracks, unrelated to water courses, have since been added.

2.0 Methods

2.1 Desktop analysis

All available literature and aerial imagery was reviewed to assist in identifying freshwater ecological values present over the designation corridor. The Manawatū-Wanganui Regional Council's ("**Horizons**") One Plan was reviewed to identify and assess if any recognised freshwater ecological areas were present across the Project.

The desktop analysis was also used to determine appropriate sampling locations that would best characterise the aquatic biodiversity and habitat condition. The area is extensive and not all waterways in all locations could be surveyed within the time constraints of the current phase of the Project. Habitat grouping, to best sample representative habitats and stream reaches, was used to identify sampling locations and included parameters such as natural flow path, River Environment Classification ("**REC**"), stream order, riparian cover, location and likely gradient. Sampling site locations are provided in Figures 1 to 3 (**Appendix 6.C.1**).

A freshwater fish survey was completed in early 2018 to assess fish values within a selection of waterways across (and adjacent to) the proposed designation corridor. The fish survey was conducted during summer to align with best practice protocols (with regard to seasonal timing), to assess fish values. The fish report is in **Appendix 6.C.2** and has been used to assist in the assessment of stream values described in this report.

2.2 Site visit

Fieldwork was conducted on 17th to 20th of July 2018. Weather conditions varied between mostly clear to cloudy and generally high winds. Approximately 9.5mm of rain had fallen in the preceding 48 hours of the site visit[2], while a further 8mm fell over the four days during the fieldwork period.

Aquatic ecological values were assessed across the waterways present within the designation corridor through representative sampling (conducted at eight locations) as well as a site walkover of non-sampled waterways, carried out in part to ensure the representativeness of the chosen sampling locations. The walkover was also used to map waterway pathways and provide qualitative habitat information.

Sampling conducted at each of the eight sampling sites included:

- An instream and riparian habitat assessment following protocol P1 methods outlined in Harding *et al*. 2009.
- A composite sediment sample collected from between five to ten pool/sediment deposition sites along the assessed reach. Samples were refrigerated before being sent to Hill Laboratories for analysis of heavy metals (lead, copper and zinc), total phosphorus and total nitrogen in the total sediment and <63 m sediment fraction.
- Collection of a single macroinvertebrate kick-net sample (from an array of instream habitats), following protocols C1 (hard-bottomed) and C2 (soft-bottomed) outlined in Ministry for the Environment 2001. Samples were preserved in ethanol and sent to a

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[2] Rainfall data collected from an automatic weather station in Palmerston North and data downloaded from https://cliflo.niwa.co.nz/.

taxonomist to be analysed according to Protocol P1: coded abundance. Macroinvertebrate indices (MCI and SQMCI) were calculated for all samples (Stark & Maxted 2007) as well as species richness and number of EPT taxa.

- Collection of stream ecological valuation ("**SEV**") data following methods outlined in Neale *et al.* 2011. The data was entered into the SEV spreadsheet designed for use in the Auckland region. Spreadsheets V_{surf} and $V_{physhab}$ were modified to suit the Horizons region based on reference site data provided by Horizons. The system uses a set of reference site data to establish what an expected high SEV outcome is. There are currently limited Regional reference SEV data, but a value can be established using only physical parameters. Thus macroinvertebrate data was excluded from the SEV spreadsheet as data for the reference systems is limited.

In addition, a fish survey was completed at the downstream reach of site 7A (upstream of the Manawatū confluence) as this site was not surveyed earlier in the year due to access constraints. The fish survey was completed using an electric fishing machine and following methods outlined in Joy *et al*. 2013. All native fish caught were identified, measured, and released. It is acknowledged that the season in which the current survey was undertaken is less productive than spring or summer, however we consider the data to be adequate to reflect the fish species present.

2.3 Stream classification

For the purposes of this freshwater ecological assessment, we do not use the Horizons One Plan definitions as they do not differentiate between stream types (i.e. intermittent, permanent (otherwise termed perennial) or ephemeral). We instead have defined ephemeral, intermittent and perennial streams using definitions from the Auckland Unitary Plan (Auckland Council 2016), as per below (noting that ephemeral streams have not been mapped across the designation corridor):

Ephemeral stream: Stream reaches with a bed above the water table at all times, with water only flowing during and after rain events. This category is defined as those stream reaches that do not meet the definition of permanent river or stream or intermittent stream.

Intermittent stream: Stream reaches that cease to flow for periods of the year because the bed is periodically above the water table. This category is defined by those stream reaches that do not meet the definition of permanent river or stream and meet at least three of the following criteria:

(a) It has natural pools;

(b) It has a well-defined channel, such that the bed and banks can be distinguished;

(c) It contains surface water more than 48 hours after a rain event which results in stream flow;

(d) Rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel;

(e) Organic debris resulting from flood can be seen on the floodplain; or

(f) There is evidence of substrate sorting process, including scour and deposition.

Permanent river or stream (Perennial): The continually flowing reaches of any river or stream.

2.4 Assessment of ecological value and effects

This assessment of ecological effects follows the methods documented in the revised Ecological Impact Assessment Guidelines (EIANZ 2018). The method involves assessing the magnitude of the Project's adverse effects on the site's ecological values, before using a matrix to assess the level of ecological effects. **Table 6.C.1** describes the categories for the possible effect magnitudes, while **Table 6.C.2** provides a matrix in which to determine the level of the effect on the ecological values.

Ecological features were assigned values based on the attributes outlined in the Ecological Impact Assessment Guidelines ecological integrity of freshwater ecosystems including nativeness, pristineness, diversity and resilience. Results from the assessment were used to assist in assigning values.

Table 6.C.1: Magnitude of effects

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

Table 6.C.2: Level of ecological effects

Level of ecological effects		Ecological value				
		Very high	High	Moderate	Low	Negligible
Magnitude	Very high	Very high	Very high	High	Moderate	Low
	High	Very high	Very high	Moderate	Low	Very low
	Moderate	High	High	Moderate	Low	Very low
	Low	Moderate	Low	Low	Very low	Very low
	Negligible	Low	Very low	Very low	Very low	Very low
	Positive	Net gain	Net gain	Net gain	Net gain	Net gain

3.0 Freshwater ecological description, condition and values

There are eight catchments (excluding Manawatū River) across the designation corridor that are affected (directly or indirectly) by the Project. **Figures 1 to 3** of **Appendix 6.C.1** provide an overview of the waterways within the designation corridor, including the intermittent and perennial reaches. Watercourses have been numbered on the figures for ease of reference. Generally, all relevant watercourse networks flow in a southerly direction and eventually discharge into the Manawatū River. In some instances, particularly for headwaters, a conservative approach has been taken and the waterways have been classified as perennial, but this may not be reflective of summer conditions.

3.1 Watercourse network one

Watercourse one is located towards the eastern end of the survey extent and includes two stream reaches that are bisected by the Project. The main stem (1A) flows in a southerly direction adjacent to Woodlands Road before flowing beneath Napier Road (SH3). The main stem begins further north within the rural catchment. A tributary (1B) to the main stem is located approximately 100m to the west of the confluence with the main stem immediately south of Napier Road.

Within the designation corridor, the perennial main stem has been straightened and follows a defined channel. The channel is approximately 0.5m wide for the most part, although it is near 2m wide immediately upstream from Napier Road. During the fieldwork period, water depth varied between 0.15 and 0.5m. The waterway network consists of marginal instream habitat values with mostly uniform hydrologic conditions. Habitat is limited to macrophytes and some overhanging rank grass vegetation, although cobble habitat does exist further downstream towards Napier Road. The substrate was dominated by fine sediment.

Tall riparian vegetation is absent, with vegetation consisting of pasture grasses to the stream edge. Aquatic vegetation is common along the stream edge and includes monkey musk (*Erythranthe guttata*), watercress (*Nasturtium officinale*), and duckweed (*Lemna* sp.), and covered approximately 25% of the wetted width. A culvert is present within the waterway to provide for stock access. Stock were excluded from the waterway. **Images 6.C.1 and 6.C.2** show the main stem.

The tributary has poor instream ecology values with low habitat abundance and diversity, and slow flowing uniform hydrologic conditions over a silt substrate. The tributary consists of a thick cover of macrophytes and pasture species across the channel/depression area. Riparian vegetation consists of pasture grasses, and stock are not excluded from the tributary. Multiple culverts are present along the tributary. The tributary is likely to be intermittent as grass covers the entire channel in places. **Images 6.C.3 and 6.C.4** show the tributary.

Image 6.C.1: Straightened channel of the main stem (1A).

Image 6.C.2: Downstream extent of the main stem (1A) before flowing beneath SH3.

Image 6.C.3: Tributary (1B) with dense macrophyte and grass cover.

Image 6.C.4: Upstream reach of tributary (1B) with dense macrophyte and grass cover.

3.2 Watercourse network two

Watercourse two is located towards the eastern end of the Project and includes a main stem (2A) and three tributaries (2B, 2C and 2D) that flow into the main stem at various points near the designation corridor. Other tributaries also flow into the main stem, but these are unlikely to be affected by the Project, and are therefore not discussed further. The main stem (2A) flows in a southerly direction at the base of the hill, and slopes towards the west before eventually flowing beneath Napier Road and into the Mangapapa Stream.

Within the corridor, the perennial main stem follows a mostly sinuous channel that varies in width from 3.4m to over 6m in places. Water depth is also variable, ranging from less than 0.1m to over 0.6m. The main stem is assessed as having sub-optimal to optimal instream ecology values with a mixture of hydrologic conditions. Habitat consists of riffles, pools, undercut banks and cobbles, but there is a noticeable lack of wood debris and overhanging vegetation. The substrate is dominated by a mix of silt/sand, and varying sized gravels and cobbles.

Riparian vegetation is mostly absent, consisting of pasture grasses to the stream edge and occasional large exotic conifers further back from the stream edge. Pampas (*Cortaderia* sp.) is also present in the true left bank in places. No macrophytes were observed within the assessed reach, but periphyton (mats) is common in places. Stock are not excluded from the waterway, and there is evidence of bank slumping and erosion. **Images 6.C.5 and 6.C.6** show the main stem.

Image 6.C.5: Upstream end where the designation corridor bisects the main stem (2A).

Image 6.C.6: Main stem (2A). Note the steep banks in places and the lack of fencing to prevent stock access.

The perennial tributary flowing in from the eastern side of the main stem (2B) consists of a straightened farm drain where it bisects the designation corridor, although the waterway is more sinuous further upstream and downstream. The tributary consists of a thick cover of macrophytes (watercress and to a lesser extent duckweed) covering a large proportion of the channel. Stock can access the waterway and there is evidence of erosion and bank slumping in places. The tributary's instream ecology values are assessed as poor, with limited habitat diversity and slow flowing uniform hydrologic conditions. **Images 6.C.7 and 6.C.8** show the tributary.

Image 6.C.7: Straightened channel of tributary (2B). Note the dense macrophyte cover.

Image 6.C.8: Tributary (2B) upstream of designation corridor.

The southernmost tributary flowing in from the western side of the main stem (2C) is located at the base of a steep gully with several different smaller side branches, some of which are likely to be intermittent and ephemeral. For the purposes of this assessment, only the likely affected waterway reaches have been described. The tributary, including the upper headwater branch, follows a sinuous flow path. Instream habitat varies along the waterway and is influenced by stock access, bank gradients and riparian cover. Incised reaches with some canopy cover are generally not able to be accessed by stock and provide sub-optimal habitat with a mix of hydrological conditions. Substrate within these reaches consist of a mix of silt/sand, gravel and cobbles, whereas less steep reaches that stock can access consist of reduced habitat diversity and often lack riparian cover. These reaches are also typically dominated by a silt/sand substrate, as well as macrophyte cover (watercress and duckweed). In heavily pugged areas the waterway channel is less defined, and bank slumping is common. The tributary's instream ecology values are assessed as sub-optimal marginal. **Images 6.C.9 and 6.C.10** show the tributary.

Image 6.C.9: Tributary (2C) with minimal riparian cover and stock access. Note the less defined channel.

Image 6.C.10: Tributary (2C) with partial riparian cover and reduced stock access.

The northernmost tributary flowing in from the western side of the main stem (2D) is located at the base of a steep gully and consists of several small branches making up the headwaters. Only the headwaters have been described in this report, although downstream reaches are likely to have similar characteristics to the southernmost tributary described previously (2C). The headwater tributaries follow a sinuous flow path and are incised with steep banks on both sides. Instream habitat diversity and hydrologic values are assessed as optimal while substrate consists of a mix of silt/sand, gravel and cobbles. The riparian margin consists of mostly native vegetation providing optimal shade over the waterway. **Images 6.C.11 and 6.C.12** show the tributary.

Image 6.C.11: Tributary (2D) flowing over bedrock.

Image 6.C.12: Tributary (2D) flowing at the base of a steep sided gully with riparian cover.

3.3 Watercourse network three

Watercourse three is located towards the eastern end of the Project and includes a main stem (3A) and tributary (3B). There are likely to be other tributaries that flow into the main stem, but these are unlikely to be affected by the proposed corridor and are not discussed further in this report. The main stem flows in a southerly direction at the base of a steep gully on the north-eastern edge of the Manawatū Gorge Scenic Reserve and discharges into the Manawatū River.

The headwaters of the main stem consist of three intermittent branches that are located within the designation corridor. Constructed ponds are located at the upstream extent of two headwater branches. Water was flowing within all three branches at the time of the fieldwork, however grass was dominant across some flow path extents (as well as *Glyceria* sp.). A channel was not evident for large segments of the pathways, with habitat mostly resembling boggy areas. Stock are not excluded from these sites with pugging and grazing evident. Vegetation consists mostly of grazed pasture as well as gorse (*Ulex europaeus*), rushes (*Carex* and *Juncus* spp.), and pampas.

The waterway appears to become perennial at the confluence of the three intermittent waterways, with a more defined channel. Approximately 50m downstream from the confluence, the riparian cover becomes more prominent. At this point, the stem follows a natural flow path, with the channel becoming more incised as the banks and gradient become steeper. The main stem within the forested reach was assessed as providing optimal fish and macroinvertebrate habitat with a mixture of hydrologic conditions. Instream habitat consists of riffles, pools, undercut banks, woody debris and cobbles. The substrate is comprised of a mix of silt/sand, and varying sized gravels and cobbles. Riparian vegetation consists of mostly native vegetation and no macrophytes were found where the stream reach was observed. Vegetation and the steep topography prevent stock from accessing the majority of the reach. Instream habitat is assessed as optimal in the forested reaches and poor within the upstream agricultural areas. **Images 6.C.13 and 6.C.14** show the main stem.

Image 6.C.13: Main stem (3A) within the forested reach. Note the waterfall likely reducing fish passage.

Image 6.C.14: One of the three intermittent streams in the headwaters of the main stem (3A).

The tributary flows into the main stem on the eastern side and has similar characteristics to the headwaters described in the main stem. There are two branches, both of which begin as intermittent waterways that follow pathways consisting of both defined channel and boggy reaches. Grass is present across the width of the silt/sand channel and boggy areas in many sites with pugging and grazing evident. Riparian vegetation consists mainly of grazed pasture as well as gorse and rushes, although more shade is provided on the eastern branch with low stature vegetation present (i.e. blackberry (*Rubus fruticosus*) and tree ferns (*Cyathea* and *Dicksonia* spp.) as well as pines (*Pinus* sp.). A more contiguous channel is present once the waterways flow into the forested areas downstream and the stream appears to become permanent. Habitat diversity improves downstream and gravel and cobbles are found within the channel. Instream habitat is assessed as optimal in the forested reaches and poor within the upstream agricultural areas. **Images 6.C.15 and 6.C.16** show the headwaters of the tributary.

Image 6.C.15: Western branch of the eastern tributary (3B).

Image 6.C.16: Eastern branch of the eastern tributary (3B).

3.4 Watercourse network four

Watercourse four is located towards the central part of the corridor and includes a main stem (4A) and six tributaries (4B, 4C, 4D, 4E, 4F and 4G) that flow within or partially within the corridor and join the main stem at various points. There are other tributaries that flow into the main stem, but these are unlikely to be affected by the proposed corridor and are not discussed further in this report. The main stem begins at the downstream end of two created ponds. The stream flows west for over a kilometre before flowing in a southerly direction and into a second created pond before eventually flowing into the Manawatū Gorge Scenic Reserve.

Within the corridor, the perennial main stem consists of straightened reaches and natural flow paths. The width of the assessed reach varies between 1.3m to nearly 3m while water depths as observed ranged from less than 0.1m to nearly 0.7m. Further upstream, channel widths are less and water depths are lower. The instream values at the surveyed reach are assessed as optimal. Habitat consists of a mix of hydrologic conditions including riffles and pools as well as other instream habitat such as undercut banks, wood and cobbles. The substrate is dominated by a mix of silt/sand, and varying sized gravels and cobbles.

Tall riparian vegetation is mostly absent, consisting of pasture grasses to the stream edge. There are pockets of mixed native and exotic riparian vegetation providing some cover over the stream. Macrophytes were observed in certain reaches but were not dominant over the waterway. Species consist of duckweed, watercress, starwort (*Callitriche stagnalis*), Canadian pondweed (*Elodea canadensis*) and *Glyceria* sp. Periphyton (mostly mats) is common in places. Stock are excluded from small sections of the main stem but grazing and erosion, as well as bank slumping, was observed over most of the reach. **Images 6.C.17 and 6.C.18** show the main stem.

Image 6.C.17: Typical view of the upper reach of the main stem (4A).

Image 6.C.18: Downstream reach of the main stem (4A). Note the erosion and lack of riparian cover and fencing.

The six tributaries all share similar characteristics with waterways found in the base of small gullies that drain into the main stem or the upstream ponds. None of the waterways are fenced off from stock with grazing and pugging evident across all tributaries. The majority of the waterways are intermittent although there appear to be perennial reaches within tributaries 4C and 4D, with a defined contiguous flow path and small pools present. Flow paths over the remaining reaches are either not well defined, particularly where pugging is extensive, or consist of a combination of saturated soils and small reaches of defined flow paths. The tributaries are assessed as having poor instream ecology values with limited habitat diversity and slow flowing (in some cases stagnant) uniform hydrologic conditions. Silt/sand is the dominant bed substrate and riparian vegetation is generally limited to grazed pasture grasses. Pasture is present across the channel and boggy areas over large proportions of the tributaries, while rushes are also present in areas. Some macrophytes are present including *Glyceria* sp. **Images 6.C.19, 6.C.20, 6.C.21 and 6.C.22** show typical characteristics of the tributaries.

Image 6.C.19: Tributary (4B) flowing through a created depression before connecting to the main stem.

Image 6.C.20: Tributary (4C) flowing through more of a wetland /boggy area at the base of a gully.

Image 6.C.21: High level of pugging affecting the stream channel of the tributary (4E).

Image 6.C.22: Less defined channel of tributary (4F).

3.5 Watercourse network five

Watercourse five is located towards the central part of the corridor and includes two main stems (5A and 5B) that are bisected by the corridor. The confluence of the two stems is located downstream within the Manawatū Gorge Scenic Reserve. Each main stem branches out further upstream of the designation corridor crossing, into smaller headwater gullies which are unlikely to be affected and are not discussed further in this report. Both main stems flow in a southerly direction, before coming together and eventually flowing into the Manawatū River.

An assessment was conducted within the eastern main stem (5A), however the two perennial stems share similar characteristics consisting of sinuous flow paths within an incised gully. The width of the assessed reach varies between 0.5m to nearly 2m, while water depths ranged from less than 0.05m to nearly 0.3m. The waterway at the surveyed reach is assessed as having sub-optimal instream habitat values and optimal hydrologic conditions. Habitat consists of riffles, pools, undercut banks and cobbles with a noticeable absence of wood debris. The substrate is dominated by a mix of silt/sand, varying sized gravels and cobbles and bedrock.

Riparian vegetation is variable across the assessed reach, consisting of grazed pasture grasses to the stream edge as well as more contiguous patches of trees and shrubs providing cover. There is far less riparian cover over the adjacent main stem (5B). Macrophytes were not observed within the waterway and periphyton (mats) were sparse. Stock are excluded from small sections of the eastern stem where steep banks prevent access. Grazing and pugging, as well as bank slumping, was observed over large proportions of both reaches. **Images 6.C.23, 6.C.24, 6.C.25 and 6.C.26** show the two main stems.

Image 6.C.23: Eastern main stem (5A) flowing at the base of the gully.

Image 6.C.24: Eastern main stem (5A). Note the steep sided true right bank and pugging on the true left bank.

Image 6.C.25: Gravel and cobble substrate within the western main stem (5B).

Image 6.C.26: Bank slumping along the western main stem (5B).

3.6 Watercourse network six

Watercourse six is located towards the western end of the corridor and includes a main stem (6A) and two smaller side tributaries (6B and 6C) that are bisected by the corridor. The two tributaries share similar characteristics with the main stem. The perennial waterway is similar to the main stems of watercourse five, consisting of sinuous flow path within an incised gully. The main difference is that watercourse six has more contiguous riparian vegetation, and stock have been excluded. The main stem flows in a southerly direction, into the Manawatū Gorge Scenic Reserve before discharging into the Manawatū River. An assessment of the stream was conducted at the upstream extent of the waterway within the Manawatū Gorge Scenic Reserve.

The width of the assessed reach varies between 0.6m to 2.3m, while water depths ranged from less than 0.05m to nearly 0.2m. The waterway at the surveyed reach was assessed as containing optimal instream habitat values and optimal hydrologic conditions. Habitat consists of riffles, pools, undercut banks, cobbles and wood debris. The substrate is dominated by varying sized gravels and cobbles with some silt/sand and bedrock.

Riparian vegetation was intact over the assessed reach, consisting of mature native bush. Upstream, outside of the Scenic Reserve, vegetation is mostly contiguous and comprised of regenerative native forest species. Pasture is present in some places near the stream edge, however it did not appear to be grazed. Macrophytes were absent from the waterway while periphyton (mats) were sparse outside of the Scenic Reserve (absent within the reserve). Pugging was absent along the stream bank, although there was occasional bank slumping where stock had previous access to the stream edge. **Images 6.C.27, 6.C.28, 6.C.29 and 6.C.30** show the watercourse and two tributaries.

Image 6.C.27: Main stem (6A) flowing through the DOC reserve.

Image 6.C.28: Main stem (6A) close to where the designation corridor bisects the waterway.

Image 6.C.29: Tributary (6B) flowing through a mix of pasture and early succession vegetation.

Image 6.C.30: A reach of tributary (6C) with a more intact understory.

3.7 Watercourse network seven

Watercourse seven is located towards the western extent of the corridor and includes a main stem (7A) and two tributaries (7B and 7C) that flow within or partially within the corridor and join the main stem. There are other tributaries that flow into the main stem, but these are unlikely to be affected by the proposed corridor and are not discussed further in this report. The main stem flows in a southerly direction, adjacent to the Manawatū Gorge Scenic Reserve, before discharging into the Manawatū River. Assessments of the stream were conducted at the upstream and downstream extents of the waterway.

The upstream reach of the perennial main stem shares characteristics with watercourse five and six, consisting of a sinuous flow path within an incised gully. The width of the upstream assessed reach varied between 0.35m to 1m with water depths ranging from less than 0.05m to 0.08m. The waterway was assessed as containing optimal instream habitat and hydrologic conditions, consisting of riffles, pools, undercut banks, wood and cobbles. The substrate was dominated by varying sized gravels and cobbles.

Riparian vegetation is intact over the assessed reach, consisting of a mix of mature and regenerating native bush. Macrophytes are absent from the waterway, while periphyton (mats) is sparse. Stock are excluded from the waterway, although a deceased cow was found within a particularly incised reach. Pugging and bank slumping were not observed.

The assessed downstream reach of the main stem is less incised, and there is a greater connection to the floodplain. The stem follows a natural flow path, with channel widths varying between 0.8m to 4.8m and water depths ranging from less than 0.05m to 0.15m. The waterway is assessed as containing optimal instream habitat and hydrologic conditions, consisting of riffles, pools, undercut banks, wood and cobbles. The substrate includes varying sized gravels and cobbles as well as silt/sand.

Riparian vegetation is sporadic over the assessed reach, consisting of patches of regenerating native bush and grazed pasture. Macrophytes are absent from the waterway while periphyton (mats) is sparse. Stock was not excluded from the waterway with pugging and grazing evident to the stream edge as well as numerous sites where stock cross the stream. Bank slumping was also evident within the downstream reach. Partial fish passage barriers are present near the confluence with the Manawatū River. There are two barriers associated with the railway that bisect the stream (perched culvert and additional structure upstream) as well as a natural barrier which appears to be as a result of root mats from riparian vegetation. **Images 6.C.31, 6.C.32, 6.C.33 and 6.C.34** show the upstream and downstream reaches of watercourse seven.

Image C.6.31: Upstream reach of the main stem (7A). Note the incised stream bed.

Image C.6.32: Upstream reach of the main stem (7A). Note the steep true left bank.

Image 6.C.33: Downstream reach of the main stem (7A). Note the differences from the upstream reaches.

Image 6.C.34: Downstream reach of the main stem (7A). Note the stream flowing over a retaining wall structure reducing fish passage.

The downstream reach of tributary 7B shares similar characteristics to the downstream reach of the main stem including in terms of bed substrate, instream habitat, hydrologic conditions, riparian vegetation, stock access and subsequent pugging and erosion. A barrier to fish passage is present near the pine trees with an approximately 5m waterfall. The pine trees also mark a change in upstream habitat quality. The upstream extent of the tributary includes poor instream habitat values with reaches where the channel is not always defined and appears to be intermittent in places. There is a high proportion of silt/sand covering the streambed, and grazed pasture is present to the stream edge with pugging and bank slumping also observed. Macrophytes are more common and include mostly watercress and duckweed. **Images 6.C.35 and 6.C.36** show the tributary.

Image 6.C.35: Downstream reach where stock frequently cross tributary (7B).

Image 6.C.36: Upstream reach of tributary (7B) within area used for grazing.

Tributary 7C is predominantly wetland with a flow path through the centre. The waterway is slow flowing and instream habitat values were assessed as marginal to poor. Silt/sand is the dominant bed substrate, and riparian vegetation is mostly wetland species (i.e. rushes and sedges) with some shrubs and trees present. Grazed pasture is present to the stream edge in places, more so in the upper reaches, with pugging also observed. **Images 6.C.37 and 6.C.38** show the tributary.

Image 6.C.37: Pugging within and adjacent to tributary (7C). Note the lack of channel.

Image 6.C.38: Slow flowing reach of tributary (7C).

3.8 Watercourse network eight

Watercourse eight is located towards the western end of the survey extent on the southern side of the Manawatū River and includes an intermittent reach that is bisected by the corridor. The intermittent stream (8A) flows in a northerly direction from within mostly pine forest before flowing west parallel along the southern edge of Napier Road. The waterway then flows south via a culvert into adjacent farmland, where the stream channel turns into what appears to be saturated/boggy farm paddock.

The intermittent stream within and adjacent to the corridor follows a straightened channel. The channel is approximately 0.5m for the most part and water depth varied between approximately 0.1m to 0.3m. The waterway network was assessed as containing poor instream habitat with mostly uniform hydrologic conditions. Habitat is limited to occasional macrophytes including watercress, duckweed and *Glyceria* sp., although there is evidence that macrophytes are regularly sprayed. Grass was present within sections of the channel and the substrate consisted of fine sediment.

Riparian vegetation was absent where the waterway flows adjacent to the road and in the agricultural area, although mixed native and exotic trees and shrubs provide some shading towards the upstream end of the observed reach. Stock are not excluded from the boggy area within the farmland. **Images 6.C.39 and 6.C.40** show the main stem.

Image 6.C.39: Tributary (8A) flowing through a garden area before eventually turning into a roadside drain.

Image 6.C.40: Tributary reach (8A) that flows into a paddock and the channel becomes less defined.

3.9 Manawatu River

The Manawatū River flows in a westerly direction to the south of the designation corridor. The river flows through the Manawatū Gorge, which runs almost parallel with the Project before the proposed alignment bridge crossing at the southern end of the Gorge. The river varies in width through the Gorge, from approximately 20m to almost 100m at the widest point. Depth is likely to be variable from shallow river margins and riffle areas to pools, which are likely to be over several meters deep.

Observations of the Manawatū River through the Gorge and adjacent upstream and downstream reaches show the waterway consists of optimal instream habitat and hydrologic conditions. Habitat consisted of riffles, pools, undercut banks, cobbles, woody debris and overhanging vegetation. The substrate appeared to be dominated by varying sized gravels and cobbles, although sand/silt is likely to be present in slower flowing reaches.

Riparian vegetation consisted of regenerating and more mature native forest present within the Manawatū Gorge Scenic Reserve, although exotic species are also likely to be present. The railway corridor and closed road (SH3) have caused a reduction in riparian vegetation along both banks of the river. No macrophytes were observed, although they might be present in slower flowing reaches.

Macroinvertebrate data from 2017 was provided by Horizons for three state of the environment monitoring sites, including Manawatū River at the upper Gorge and Teachers' College, and Pohangina River at Mais Reach. Data can be found in **Appendix 6.C.3**.

Macroinvertebrate populations from the three samples were dominated by *Deleatidum* sp., Elmidae (beetles) and *Hydropsyche* sp. (caddisflies from Aoteapsyche group). *Deleatidum* sp.

are sensitive taxa commonly found in waterways with high water quality, while *Hydropsyche* sp. (and to a lesser extent Elmidae) are more tolerant of lower water quality.

Caution should be used when interpreting macroinvertebrate indices for large rivers as they are intended for wadeable streams. However, MCI and QMCI scores indicate good water quality in the upper Gorge and excellent water quality in the Pohangina River. Manawatū River at Teachers' College was indicative of good (MCI) and excellent (QMCI) water quality.

3.10 Ponds

Various sized ponds are present within and adjacent to gullies across the designation corridor. The ponds are often small and located in the headwaters of gullies. They are man-made, generally for the purpose of supplying water for agricultural use (i.e. stock water), with a bund created at the downstream extent. Most ponds have some connectivity to the downstream watercourse, however in some cases there are partial or complete barriers to fish passage. There are two ponds across the designation corridor that are noticeably larger in size relative to the other ponds. These are located along watercourse four, towards the upstream extent and immediately upstream of where the watercourse flows into the Manawatū Gorge Scenic Reserve.

Other than likely supporting populations of eel and potentially bully species, the ponds provide poor habitat and are of limited aquatic ecological value.

3.11 Sediment quality

A summary of the sediment quality data is provided below in **Table 6.C.3**. All analysed heavy metal concentrations, for both total sediment and the less than 63 µm fraction, were below the ANZECC low interim sediment quality guidelines indicating a low potential for biological harm to instream fauna.

Total nitrogen and phosphorus measures were variable across the sampled sites, with no obvious trend relating to concentrations of nutrients in the sediment and predominant land cover. There are no guidelines for which to compare nitrogen or phosphorus concentrations within sediment.

Table 6.C.3: Sediment quality results

Site	**TS / <63 µm**	**Total (recoverable)**				
		Copper	Lead	Zinc	Total Phosphorus	Total Nitrogen
		mg/kg dry wt				g/100g dry wt
1	TS	5.1	8.8	50	290[3]	0.09
	<63 µm	9.8	15.7	85	630	0.25
2A	TS	3.7	7.1	32	280	<0.05

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[3] While there are no national guidelines or indicators of problematic levels, these values are low by comparison with other sediment phosphorus studies (e.g. Ostrofsky 2012 measures of lake sediment total phosphorus were greater than 750 µg/g sed. dry wt.).

Site	**TS / <63 m**	**Total (recoverable)**				
		Copper	Lead	Zinc	Total Phosphorus	Total Nitrogen
		mg/kg dry wt				g/100g dry wt
	<63 m	6.0	11.0	44	500	0.07
2D	TS	3.3	5.9	31	280	<0.05
	<63 m	7.1	11.9	46	470	0.13
4	TS	3.6	5.7	33	230	<0.05
	<63 m	6.8	10.8	48	530	0.19
5	TS	3.0	5.7	26	184	0.08
	<63 m	5.2	8.1	36	290	0.12
6	TS	4.0	5.8	25	138	<0.05
	<63 m	8.5	15.1	43	420	0.16
7A US	TS	5.5	7.4	30	210	<0.05
	<63 m	8.0	11.0	40	370	0.12
7A DS	TS	3.9	5.2	26	230	<0.05
	<63 m	5.7	6.9	39	410	0.07
ANZECC guidelines						
ISQG - Low		65	50	200	-	-
ISQG - High		270	220	410	-	-

3.12 Macroinvertebrate assemblage

A summary of the macroinvertebrate data is provided in **Table 6.C.4** below. Full macroinvertebrate results are provided in **Appendix 6.C.4**. Sampling sites are displayed on **Figures 1 to 3, Appendix 6.C.1**.

Mayfly larvae *Deleatidum* sp. and *Zephlebia* sp. were the most dominant taxa across sites 2A, 2D, 5, 6, 7A (upstream) and 7A (downstream), featuring a high proportion of one or both taxa. These species are relatively sensitive to degraded water quality and habitat modification (especially loss or reduction in periphyton supporting hard substrate). Samples from sites 1 and 4 contained a high proportion of *Potamopyrgus antipodarum*, Oligochaete worms, *Paracalliope* sp. and *Austrosimulium* sp. These species are more tolerant of poor water quality and habitat modification (preferring/requiring substantive macrophyte cover common to soft substrates and higher nutrient waters).

Sites 2A, 6 and 7A (upstream) contained the highest number of EPT taxa, as well as the highest percent EPT abundance. It should be noted that EPT taxa recorded from the Site 2A sample were generally more sensitive species, compared to those recorded at sites 6 and 7A (upstream). Site 7A (upstream) is somewhat of an anomaly, with high value indicator macroinvertebrates, but a low species richness suggesting a small area of simple, but good quality habitat. Site 1 contained the least amount of EPT taxa with just one and the lowest percent EPT abundance. Macroinvertebrate indices were variable across the eight samples. MCI results showed site 1 was indicative of poor water quality, sites 2A, 4 and 5 were indicative of fair water quality, sites 2D, 6 and 7B were indicative of good water quality and site 7A (upstream) was indicative of excellent water quality. SQMCI results showed differences with sites 2A, 5, 6, 7A (upstream) and 7A (downstream) indicative of excellent water quality, site 2D was indicative of good water quality, and sites 1 and 4 were indicative of poor water quality.

The SQMCI score considers the relative abundance of each taxa in the sample, and is calculated using the proportional abundance of each scoring taxa. It is thus a better index of a community's composition, whereas the MCI is strongly influenced by rare taxa, which contribute to the MCI score disproportionally to their abundance.

Table 6.C.4: Macroinvertebrate results

Sampling site	**Macroinvertebrate parameter**				
	Taxonomic richness	**No. of EPT taxa**	**Percent EPT abundance**	**MCI**	**SQMCI**
1A	13	1	7.7	63	2.58
2A	19	8	42.1	92	6.29
2D	9	2	22.2	110	5.52
4A	21	5	23.8	81	3.54
5A	17	5	29.4	94	6.63
6A	17	7	41.2	115	7.55
7A US	9	4	44.4	120	7.06
7A DS	20	6	30.0	111	7.38

3.13 Stream Ecological Valuation

A summary of the SEV data is provided in **Table 6.C.5** below, with sampling sites displayed on Figures 1 to 3, **Appendix 6.C.1**.

SEV values (function values can vary between 0 (poor) and 1 (optimal)) varied across the assessment sites ranging from 0.36 within watercourse 1A to 0.86 within watercourse 6A (located within the Manawatū Gorge Scenic Reserve). Generally, assessment sites over the designation corridor scored better with some degree of canopy cover. Some SEV scores, particularly the reaches north of the Manawatū Gorge Scenic Reserve, were affected by the naturally incised gullies and associated steep banks. This caused a disconnect from the floodplain and riparian zone and had effects on fish spawning habitat. Site 6A had a noticeably low score with regard to fish fauna intact. No fish species were recorded within the assessed reach, which may be due to a natural barrier preventing fish passage further downstream or potentially a perched culvert preventing fish passage where the railway corridor bisects the stream, as observed at the downstream extent of Site 7.

Table 6.C.5: Overview of Stream Ecological Valuation data and results

SEV function	Site							
	1A	**2A**	**2D**	**4A**	**5A**	**6A**	**7A US**	**7A DS**
Natural flow regime	0.23	0.71	0.79	0.75	0.76	0.93	0.83	0.96
Floodplain effectiveness	0.03	0.08	0.52	0.17	0.26	0.84	0.60	0.44
Connectivity for natural species migrations	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Natural connectivity to groundwater	0.62	0.81	0.91	0.79	0.82	0.97	0.93	0.97
Hydraulic function mean score	0.47	0.65	0.81	0.68	0.71	0.94	0.84	0.84
Water temperature control	0.32	0.24	0.80	0.24	0.42	0.80	0.80	0.68
Dissolved oxygen levels maintained	0.68	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Organic matter input	0.00	0.10	1.00	0.10	0.40	1.00	1.00	0.70
In-stream particle retention	0.20	0.74	0.88	0.70	0.70	0.96	0.90	0.98
Decontamination of pollutants	0.77	0.49	1.00	0.61	0.64	1.00	1.00	0.90
Biogeochemical function mean score	0.39	0.51	0.94	0.53	0.63	0.95	0.94	0.85

SEV function	Site							
	1A	**2A**	**2D**	**4A**	**5A**	**6A**	**7A US**	**7A DS**
Fish spawning habitat	0.05	0.50	0.68	0.50	0.49	0.90	0.43	0.43
Habitat for aquatic fauna	0.39	0.56	0.97	0.56	0.69	0.98	0.95	0.82
Habitat provision function mean score	0.22	0.53	0.83	0.53	0.59	0.94	0.69	0.63
Fish fauna intact	0.40	1.00	0.87	0.40	0.80	0.00	0.87	0.87
Riparian vegetation intact	0.05	0.03	0.32	0.07	0.21	0.80	0.27	0.32
Biodiversity function mean score	0.23	0.52	0.60	0.24	0.51	0.40	0.57	0.60
Overall mean SEV score	**0.36**	**0.56**	**0.83**	**0.53**	**0.63**	**0.86**	**0.81**	**0.77**

3.14 Fish and koura survey

A summary of the fish survey data is provided in **Table 6.C.6** below. The fish survey report, conducted at the beginning of 2018, is provided in **Appendix 6.C.2**. Fish surveys were conducted within representative waterways across the proposed designation corridor. Fish surveys were targeted using similar parameters used to guide the survey data collected as part of this assessment (i.e. natural flow path, **REC**, stream order, riparian cover, location and likely gradient) as well as trying to conduct a survey within each of the affected sub-catchments. A fish survey location figure (Figure 4) is provided on the following page.

A total of four fish species were recorded from the survey across the eight sampling sites, including one *At Risk (declining)* species, longfin eel (Dunn *et al.*, 2018). No site had numerous fish abundances, and given the extent of the survey, fish presence must be considered uncommon. Site two was the only surveyed reach which contained all the species. All other sites recorded either one or two species with site six the only site to record no fish species. In addition, koura were found across six of the eight survey sites.

There are more than 40 freshwater fish database records for the Manawatū River, Pohangina River and connecting gully systems, within an approximate 10km radius from the designation corridor. The records included five additional native fish species not recorded during the fish survey including upland bully, torrentfish, brown mudfish, common smelt and dwarf galaxias. In addition, other native species such as shortjaw kokopu, giant kokopu, banded kokopu, koaro, lamprey, crans bully and giant bully have been recorded within the Manawatū River and connecting gullies near Palmerston North. There appears to be only two records within or adjacent to the designation corridor. Fish species recorded included shortfin and longfin eel and koura.

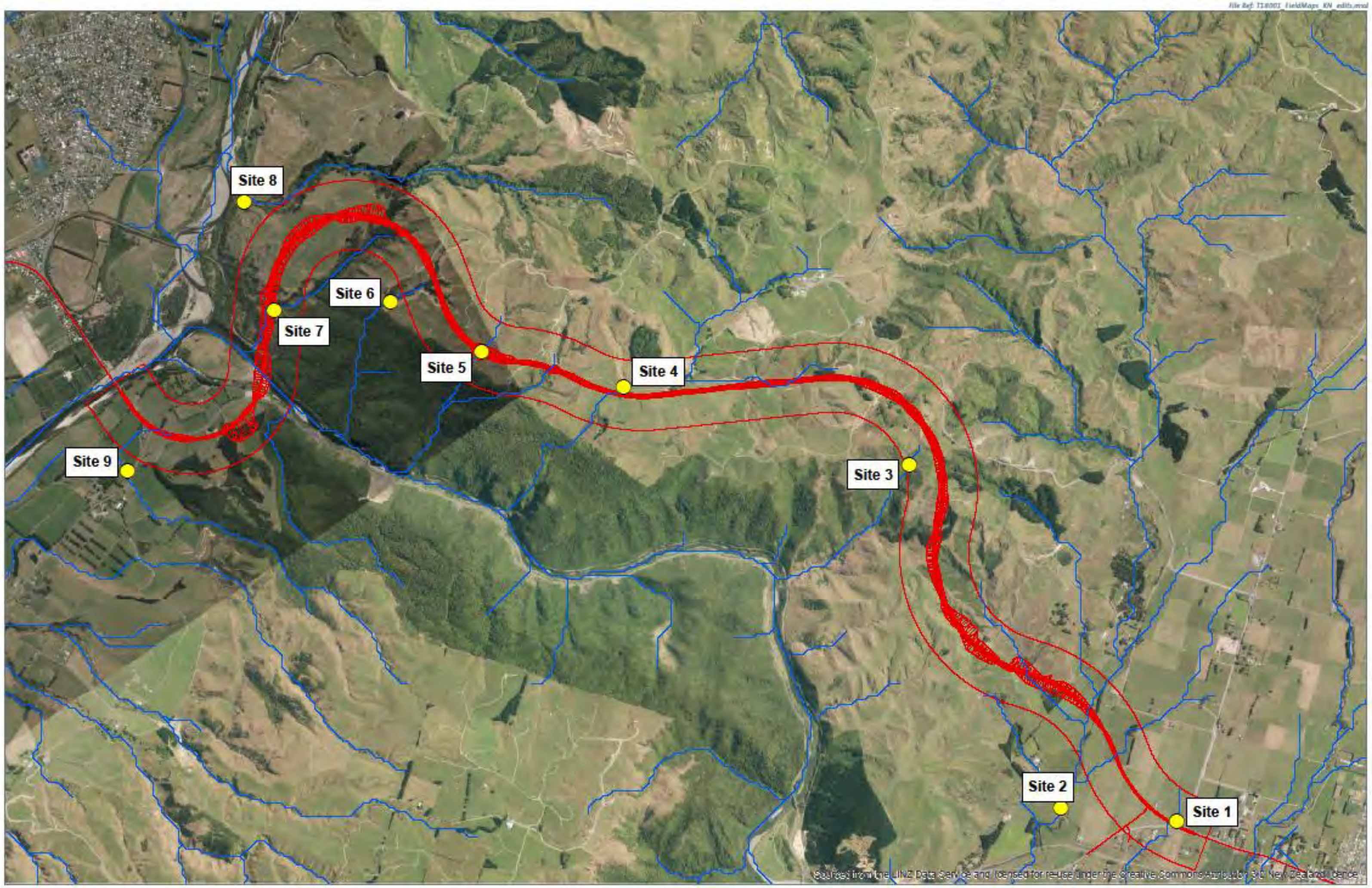
The results from the fish survey across the designation corridor showed reduced diversity, compared to species recorded from the freshwater fish database in the main river and connecting tributaries. This is likely due to several factors including reduced habitat quality and quantity in low-lying streams and barriers (natural and man-made) preventing, or partially preventing, fish passage from the Manawatū River.

Table 6.C.6: Summary of fish survey results (number in parenthesis indicates the size range in mm)

Species	Site							
	1	2	3	4	5	6	7	8 (9)
Redfin bully		1 (50)						
Longfin eel		3 (250-400)	1 (250)		2 (400-450)		2 (400-500)	
Shortfin eel	21 (180-400)	2 (200-250)		3 (400-800)			2 (120)	12 (250-800)
Common bully		4 (40-60)						27 (30-70)
Koura		2 (40-50)	2 (30-40)	13 (30-50)	20 (10-50)	6 (10-50)	3 (10-40)	

Species	Site							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8 (9)**
Eel sp		6 (80-100)					9 (80-120)	8 (200-400)
Bully sp								6 (20-30)

File Ref: T18001_FieldMaps_KN_edits.mxd



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Data Sources: Land Information New Zealand, Crown Copyright Reserved

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend

MANAWATU GORGE SUMMER ECOLOGY

Figure 1: Freshwater Survey Locations

Date: 19 March 2018 | Revision: 0

Plan prepared for NZ Transport Agency by Boffa Miskell Limited

Project Manager: Sharon.DeLuca@boffamiskell.co.nz | *Drawn:* KN | *Checked:* KMi

3.15 Ecological significance

None of the waterways across the designation corridor have been identified as “Natural State” or “Sites of Significance – Aquatic” under the Horizons One Plan. However, the definition of Natural State includes “sections of rivers and their beds that have sources in, and flow within, Public Conservation Land (land held under the Conservation Act 1987 or administered by the Department of Conservation)”. This is not a proxy for condition, but assumes protection and reduced use will reflect a better biodiversity. Many of the waterways crossed by the Project have reaches downstream of the Project that fall under this criterion as they flow through the Manawatū Gorge Scenic Reserve. However, as further discussed under the assessment of potential effects, the downstream reaches are unlikely to be directly affected by the Project (i.e. the activity is unlikely to directly diminish the natural state values of the waterways). There may be indirect effects on natural state values, such as sedimentation, which is also addressed further in the document. The Manawatū River also meets the “Natural State” definition within the Gorge.

If considering the fauna present, the functional role and conservation values, it is unlikely any of the waterways, individually or collectively, can be considered “significant habitat for indigenous fauna”.

That said, the Horizons One Plan also provides reference to maintaining and enhancing (where degraded) the existing life supporting capacity of rivers and their beds with regards to surface water quantity and quality, and provides water quality targets for specific water management zones.

3.16 Freshwater ecological values

The waterways across the designation corridor vary in size, morphology, instream fauna, function and riparian characteristics, which all affect the overall value of that respective waterway.

Table 6.C.7 provides a summary of the characteristics from each of the waterways that may potentially be directly or indirectly affected by the Project. Ecological values vary across the Project from negligible/low to high value.

The Manawatū River, specifically the Gorge area where the designation corridor crosses over it, is considered to have very high ecological value. This is due to the optimal instream habitat and hydrologic conditions, sinuous flow path, general high macroinvertebrate indices and high diversity of native fish species.

Table 6.C.7: Waterway characteristics and associated ecological values

Site	Waterway type	Ecological integrity components										Ecological value
		Nativeness		Pristineness				Diversity		Resilience		
		Native fish species	Presence of invasive macrophytes	SQMCI	Fish IBI	Sediment quality	Riparian cover	Macroinvertebrate taxonomic richness	Instream habitat	SEV score	Percent EPT taxa	
1A	Perennial	Shortfin eel	Monkey musk, Watercress, Duckweed	2.58 (Poor)	24 (very poor)	Good	Absent	13	Marginal	0.36	8	Low
1B	Intermittent	Comparable to 1A	Watercress	Comparable to 1A	Comparable to 1A	Comparable to 1A	Absent	Comparable to 1A	Poor	Comparable to 1A	Comparable to 1A	Low - Negligible
2A	Perennial	Shortfin eel Longfin eel Common bully Redfin bully	-	6.29 (Excellent)	70 (excellent)	Good	Minimal	19	Sub-optimal	0.56	42	High
2B	Perennial	Comparable to 1A	Watercress, Duckweed	Comparable to 1A	Comparable to 1A	Comparable to 1A	Absent	Comparable to 1A	Poor	Comparable to 1A	Comparable to 1A	Low
2C	Perennial	Comparable to 3A	Watercress, Duckweed	Comparable to 2D	Comparable to 3A	Comparable to 2A / 2D	Partial	Comparable to 2D	Sub-optimal / marginal	Comparable to 2A / 2D	Comparable to 2D	Moderate
2D	Perennial		-	5.52 (Good)		Good	Well	9	Optimal	0.83	22	High
3A	Intermittent	Natural barrier downstream	Glyceria Watercress	-	-	-	Minimal	-	Poor	-	-	Low - Negligible
	Perennial	Longfin eel	-	Comparable to 2D	48 (moderate)	Comparable to 2D	Well	Comparable to 2D	Optimal	Comparable to 2D	Comparable to 2D	High
3B	Intermittent	-	Glyceria, Duckweed, Watercress	-	-	-	Minimal	-	Poor	-	-	Low - Negligible
	Perennial	Comparable to 3A (perennial)	-	Comparable to 2D	Comparable to 3A (perennial)	Comparable to 2D	Well	Comparable to 2D	Optimal	Comparable to 2D	Comparable to 2D	High
4A	Perennial	Shortfin eel	Duckweed, Watercress, Starwort, Canadian pondweed, Glyceria	3.54 (Poor)	24 (very poor)	Good	Minimal	21	Optimal	0.53	24	Moderate
4B	Intermittent	Comparable to 4A	Glyceria, Duckweed, Watercress	-	Comparable to 4A	-	Absent	-	Poor	-	-	Low - Negligible
4C	Perennial / Intermittent			Comparable to 1A		Comparable to 1A	Absent	Comparable to 1A	Poor	Comparable to 1A	Comparable to 1A	Low

4D	Perennial / Intermittent					Comparable to 1A	Absent		Poor			Low
4E	Intermittent			-		-	Absent	-	Poor	-	-	Low - Negligible
4F	Intermittent			-		-	Absent	-	Poor	-	-	Low - Negligible
4G	Intermittent			-		-	Absent	-	Poor	-	-	Low - Negligible
5A	Perennial	Comparable to 5B	-	6.63 (Excellent)	Comparable to 5B	Good	Partial	17	Sub-optimal	0.63	29	High
5B	Perennial	Longfin eel	-	Comparable to 5A	48 (moderate)	Comparable to 5A	Minimal	Comparable to 5A	Sub-optimal	Comparable to 5A	Comparable to 5A	High
6A	Perennial	None recorded	-	7.55 (Excellent)	0 (no native fish)	Good	Well	17	Optimal	0.86	41	High
6B	Perennial	Comparable to 6A	-	Comparable to 6A	Comparable to 6A	Comparable to 6A	Partial	Comparable to 6A	Optimal	Comparable to 6A	Comparable to 6A	High
6C	Perennial		-				Partial		Optimal			High
7A	Perennial	Longfin eel Shortfin eel	-	7.06 / 7.38 Excellent	52 (moderate)	Good	Well	9 / 20	Optimal	0.77 / 0.81	44 / 30	High
7B	Perennial / Intermittent (upstream)	Natural barrier downstream	Duckweed, Watercress, Glyceria	Comparable to 1A	-	Comparable to 1A	Absent	Comparable to 1A	Poor	-	Comparable to 1A	Low
	Perennial (downstream)	Comparable to 7A	-	Comparable to 7A	Comparable to 7A	Comparable to 7A	Partial	Comparable to 7A	Optimal	Comparable to 7A	Comparable to 7A	High
7C	Perennial		-	-			Partial	-	Marginal / Poor	-	-	Low
8A	Intermittent	Shortfin eel Common bully (downstream)	Glyceria, Duckweed, Watercress	Comparable to 1A	-	Comparable to 1A	Partial	Comparable to 1A	Poor	Comparable to 1A	Comparable to 1A	Low - Negligible

4.0 Assessment of potential effects

The Project will involve the construction and operation of a new road and associated infrastructure (e.g. fill disposal sites, stormwater treatment swales, erosion and sediment control ponds, etc). This section provides an initial assessment, based on the information currently available, to inform an overall assessment of the Project's effects on the freshwater ecology (it also contributes to the Natural Character Assessment through provision of biotic components), and to inform the location of the proposed designation. As noted above, the NZ Transport Agency is currently seeking to enable works within the designation corridor, and the detailed design of the Project is yet to be undertaken, or regional consents sought for any in-stream works.

The type (and magnitude) of effects are thus subject to change with refinements and further detail guiding the final design of the alignment and proposed construction methods. In the interim, for the purposes summarised above, we have provided what we consider to be the likely effects on freshwater ecology values based on a realistic 'worst case' assessment of the Project based on the location and extent of the proposed designation, the likely roading layout shown as an indicative alignment within that corridor, and our prior experience with similar roading projects. The indicative alignment within the corridor has continually been refined with both small and large-scale adjustments. A significant change includes the replacement of an embankment, on the true right bank of the Manawatū River and immediately north of the river crossing, with a viaduct as the preferred option based on the potential ecological effects of an embankment option.

Note that our assessment excludes the potential effects of construction activities on watercourses, over and above the permanent effects of stream change and loss and some consideration of long term sedimentation. Conditions can be imposed on the resource consents to avoid and mitigate many of the potential effects identified.

Activities and effects associated with the construction and operation of the alignment and related to freshwater ecology within or adjacent to the site may/are likely to include:

- watercourse modification across numerous streams and tributaries including:
    - stream loss and new stream path creation (waterway diversions);
    - aquatic habitat loss or replacement of aquatic habitat with culverts or armouring;
    - potential modification / barrier to species passage;
- instream works within Manawatū River including permanent and temporary structures;
- earthworks sediment related discharges to water; and
- discharge of stormwater (operational).

Specific construction effects have not been included as part of this assessment (i.e. effects from the construction of a haul road, laydown areas and other associated infrastructure or specific sites), other than to mention that there are likely to be earthworks and sediment related discharges to water.

We have assumed that wherever the designation corridor bisects a waterway, a culvert will be installed, and that there will be a stream diversion where the designation corridor runs parallel and close to a waterway. We have assumed culverts will be to the width of the outer boundaries of the indicative roading alignment, taking into account the proposed batter slopes shown in the drawings. Waterway length modifications are approximate only.

4.1 Description of potential adverse effects

4.1.1 Watercourse modification

The Project will result in the removal and diversion of intermittent and permanent waterways across the alignment. **Figures 1 to 3, Appendix 6.C.1**, show the designation corridor in relation to the waterways present, while **Table 6.C.9** provides an overview of the freshwater values and lengths of waterway modification. These lengths are indicative only and based on the designation corridor and the assumptions described earlier. Actual waterway modification (including specific sites and extents) will need to be reviewed and revised with the development of a more detailed alignment, and regional resource consents will need to be sought for those activities.

Overall, the Project may result in approximately:

- 1190m of high value waterway being culverted,
- 30m of high value waterway being bridged,
- 670m of moderate value waterway being culverted,
- 780m of moderate value waterway being diverted,
- 560m of low value waterway being culverted,
- 630m of negligible to low value waterway being culverted, and
- 130m of negligible to low value waterway being diverted.

Waterway loss will result in the loss of habitat as well as the potential death and/or injury to native fish, including longfin eel, which have a conservation status of *At risk (declining)*.

The magnitude of effects will be variable across the waterways, as different waterway extents and locations will be affected. The magnitude of an effect is judged on the individual stream catchment areas and the effect in terms of linear length of a waterway relative to the total linear length within each sub-catchment. In some instances, wetted area is the measure for describing the quantum of effect, but linear length is the better proxy to assess and manage the quantum of effect, with the caveat that when, and if, it comes to offsite mitigation, the different wetted width dimensions that may exist between affected and mitigation systems are accounted for. The linear length is used to determine the scale of effect, along with how the activity affects the habitat. A description of what constitutes the different magnitude of effects (e.g. negligible, low, moderate, high, very high) is provided in **Table 6.C.1**.

In determining the potential magnitude of effects, a scaled approach has been used to provide more clarity and consistency with regard to the proportion of linear habitat loss/modification from proposed stream diversions and culverted reaches. The site context, regarding the extent of waterway affected relative to the size of the sub-catchment, is different for each sub-catchment. The extent has been guided by the highest order stream affected within the sub-catchment, downstream to the confluence of where the stream order increases. The extent of each sub-catchment has been described below:

- Watercourse networks one and two: All linear waterway upstream of the respective confluences with the Mangaatua Stream.
- Watercourse networks three, four, five, six and seven: All linear waterway upstream of the respective confluences with the Manawatū River.
- Watercourse eight: All linear waterway upstream of the confluence with an unnamed tributary of the Manawatū River (identified on the figure within **Appendix 6.C.1**).

The following approach has been used to determine magnitude:

- From an activity perspective, all culverts and diversions (high impact activities) will have at least a low magnitude effect as the change will be discernible and result in at least a minor shift away from existing baseline conditions.
- Moderate magnitude effect: between 5 to 20% of the linear stream length within the sub-catchment is affected.
- High magnitude effect: between 20 to 50% of the linear stream length within the sub-catchment is affected.
- Very high magnitude effect: more than 50% of the linear stream length within the sub-catchment is affected.

The following table (**Table 6.C.8**) aims to provide more context and clarity as to the quantity of available resource (linear length of stream) within each of the sub-catchments and the percentages that have been used to guide the scale of the magnitude of effect. The approximate linear length of freshwater habitat has been calculated for each of the sub-catchments and includes both perennial and intermittent stream habitat. Length has been calculated based on the fieldwork. However, the REC database has been used to calculate the linear length where sub-catchments are extensive (sub-catchments two and four), as it is impractical to confirm the habitat extents of these sub-catchments without further assessment.

Table 6.C.8: Approximate linear length of existing stream habitats and the correlating percentages associated with the scale of effect.

Sub-catchment	Approximate linear length of existing stream habitat (m)	5% of stream habitat (m)	20% of stream habitat (m)	50% of stream habitat (m)
1	4,000	200	800	2000
2	35,500	1,775	7,100	17,750
3	3,500	175	700	1,750
4	9,700	485	1,940	4,850
5	4,500	225	900	2,250
6	2,300	115	460	1,150
7	3,100	155	620	1,550
8	1,300	65	260	650

4.1.2 Manawatū River crossing

A bridge is proposed over the Manawatū River at the western extent of the designation corridor. The final design of the bridge as well as the proposed construction methods will determine the type, extent and magnitude of effects on the Manawatū River. A worst-case scenario will require buttressing on one or both banks as well as piers within the river. This would result in the permanent loss of instream habitat along the modified banks and where the piers are located, as well as changes to riparian habitat. Loss of instream habitat (and other changes) will be discernible but are likely to be localised and small in magnitude relative to the extent of the Manawatū Gorge.

The construction of the bridge could potentially result in the temporary loss of habitat as temporary staging is set up to construct the permanent bridge. This would also result in the deposition and re-suspension of sediment in the Manawatū River, particularly when temporary and permanent piers are installed.

These effects are speculative only and based on previous projects and experience. Some of these effects may be reduced or may not eventuate depending on the final design and construction methods.

4.1.3 Erosion and sedimentation

Earthworks over the site have the potential to reduce temporarily the water quality of the surrounding waterways (including the Manawatū River) through erosion and sediment runoff. At this stage, erosion and sediment control measures have not been developed, and further detail will be provided as the Project progresses. However, the magnitude of effect on aquatic ecological values from erosion and sedimentation, in our experience from other large-scale roading projects, is likely to be low against the background, even though a substantial amount of sediment may be discharged. This is provided by a robust and enforced erosion and sediment control plan designed and implemented to the permitted standards outlined in section 8 of the “Erosion and Sediment Control Guidelines for the Wellington Region” dated September 2002, as described under the Horizons One Plan. As explained below, the final design of the alignment will impact the freshwater effects from construction and operation of the Project and subsequently, the necessary management of erosion and sedimentation. For example, at the downstream end of Watercourse seven, a longer bridge option will have less effects than an earth embankment option.

4.1.4 Stormwater discharge

Stormwater entering the waterways from the completed development (operational phase effect) has the potential to reduce the water quality of the watercourses across the site through the input of impermeable roading contaminants (e.g. copper, lead, zinc, hydrocarbons, etc). This effect is still speculative, as the surface area delivering potential contaminants is relatively small, and treatment methods that eventually get developed will affect any assessment.

At this stage, stormwater treatment measures have not been developed and further detail will be provided as the Project progresses. However, it is assumed, based on our experience with similar NZ Transport Agency roading projects, stormwater from the alignment will be treated using a combination of bio-retention devices such as treatment wetlands and swales before being discharged into adjacent waterways. There is reasonable evidence that these systems supply a treatment effect of around 70% (Birch *et al*. 2005; Maine *et al*. 2006). In addition, the alignment may reduce the amount of nutrients currently entering waterways across the site.

The magnitude of effect on aquatic ecological values from stormwater discharge is predicted to be negligible, provided the stormwater treatment systems are designed to treat stormwater to the permitted rules and standards outlined in the Horizons One Plan.

It should also be noted that stormwater flowing into the receiving environment will likely have a higher quality, relative to the existing SH3 through the Manawatū Gorge (when it was operational) and the Saddle Road diversion. These two roads do not have any existing stormwater treatment.

4.2 Level of Project effects

This is an initial assessment based on the indicative design detail available including a viaduct option at the western end of the alignment (at the downstream end of Watercourse seven). The type and magnitude of effects (and level of ecological effects) are subject to change depending on the final design of the alignment and proposed construction methods.

The level of the adverse effects on the ecological values present on site from the designation corridor are variable. Adverse effects are variable, ranging from low to high and are dependent on how discernible the change is and the extent of loss and alteration to key features of existing baseline conditions, and how post-development composition and attributes will be fundamentally changed (i.e. loss of instream habitat).

The level of ecological effect is dependent on the ecological values being affected, which is variable, and the magnitude of the effect. The magnitude has two components, scale and type. **Table 6.C.9** provides an envelope of the scale of an effect as it applies to determining the magnitude with a threshold of 20% of the resource affected being a high magnitude of effect. Where the scale can be brought below the 20% scale of effects then the level of effect will likely to be below high. Please note that construction effects are not included as part of this assessment.

As noted above, the refinement of the proposed designation corridor has included different options for crossing the Manawatū River and area over the river which is at the downstream end of catchment seven. This report refers to an earth embankment option (which has been discarded on ecological grounds – see Technical Assessment 6), and an option to extend the bridge crossing part-way up the downstream end of catchment seven. In comparison to the earth embankment option, the option to extend the bridge at the downstream end of catchment seven will likely reduce the construction and operational effects of the Project on the freshwater ecological values within this area relative to large scale infilling to create an embankment.

We recommend that the loss of permanent and intermittent habitat (including stream diversions) along the alignment be mitigated. This is recommended in situations where the level of the effect is moderate or higher. This is recommended with the recognition that an aim should be to ensure that there is no net loss of aquatic habitat, but is tempered by the current quality (functionality) of the waterway and its realistic potential condition given the current landuse.

It is noted that there is an ongoing local, regional and national level drive to reduce the amount of tributary and headwater aquatic habitat reduction due to continued small scale loss. While the process we follow (EIANZ 2018) suggests that effects which are low and very low should not normally be of concern, very low equating to “less than minor” and not requiring mitigation, the emphasis is still on minimising adverse ecological effects and on a target of “no net loss” in the quantum of onsite aquatic habitat.

The assessment in this report will be updated as more detail is provided on the Project. This will allow a more accurate measure of both construction and operational effects on the existing freshwater ecological values to inform the resource consent applications. This will also provide more guidance as to how adverse effects can be appropriately mitigated. Resource consents will be required at a later date and it is during this process that adverse effects on freshwater ecological values and associated mitigation will be addressed.

Stream replacement and enhancement will likely be required as part of the Project to mitigate for the loss/modification of habitat, however there may be other mitigations options or amendments to the design to reduce/avoid adverse impacts on ecological values (i.e. constructing bridges as opposed to culverts). There is potential for mitigation (i.e. stream enhancement) to be conducted within the affected sub-catchments within the designation corridor. However, mitigation will also likely be required outside the designation corridor.

Table 6.C.9: Overview of waterways affected by the Project (based on the viaduct option and as it stands at report writing), the likely magnitude (scale) of effect and level of ecological effect.

Waterway & chainage	Ecological value	Effects	Impacted length (m)	Affected habitat in sub-catchment (%)	Magnitude of effect	Level of ecological effect
1A 13900 - 14000	Low	Culvert	160	5-10	Moderate	Low
1B 13700 - 13800	Low - Negligible	Culvert	50			Very low - Low
2A 12900 - 13000	High	Bridge	30	0-5 (excl. bridge)	Low	Low
2B 13100 - 13200	Low	Culvert	50		Low	Very low - Low
2C 11200 - 13000	Moderate	Diversion	560			Low
		Culvert	530			Low
3A 10100 - 10500	Low - Negligible	Culvert	110	5-10	Moderate	Very low - Low
		Culvert	40			Very low - Low
3B 10900 - 11100	Low - Negligible	Culvert	120			Very low - Low

Waterway & chainage	Ecological value	Effects	Impacted length (m)	Affected habitat in sub-catchment (%)	Magnitude of effect	Level of ecological effect
4A 7800 - 9300	Moderate	Diversion	220	5-10	Moderate	Moderate
		Culvert	140			Moderate
4B 8300 - 8400	Low - Negligible	Culvert	60			Very low – Low
4C 8800 - 8900	Low	Culvert	100			Low
4D 9000 - 9100	Low	Culvert	100			Low
4E 9300 - 9400	Low - Negligible	Culvert	100			Very low – Low
4F 9600 - 9700	Low - Negligible	Culvert	90			Very low – Low
5A 7300 - 7500	High	Culvert	170	5-10	Moderate	High
5B 6800 - 7000	High	Culvert	190			High
6A 6000 - 6300	High	Culvert	160	15-20	Moderate	High
6B 6200 - 6400	High	Culvert	70			High
6C 6300 - 6500	High	Culvert	140			High
7A 3900 - 5900	High	Culvert	140	15-20	Moderate	High
		Culvert	190			High

Waterway & chainage	Ecological value	Effects	Impacted length (m)	Affected habitat in sub-catchment (%)	Magnitude of effect	Level of ecological effect
7B 4700 - 5200	Low	Culvert	80			Low
7B 4200 - 4400	High	Culvert	130			High
7C 4300 - 4400	Low	Culvert	70			Low
8A 2800 - 3300	Low - Negligible	Diversion	130	10-15	Moderate	Very low - Low
		Culvert	60			Very low - Low

As discussed, the overall effects on the Manawatū River from the Project will be dependent on the final design of the bridge and associated structures and the construction methods. **Table 6.C.10** provides an overview of the effects and the magnitude of those effects on the ecological values of the Manawatū River under the worst-case scenario.

Table 6.C.10: Overview of the likely magnitude of effect and level of ecological effect on the Manawatū River

Waterway	Ecological value	Effects	Magnitude of effect	Level of ecological effect
Manawatū River	Very high	Permanent loss/ modification of instream habitat	Low	Moderate
		Temporary loss/ modification of instream habitat	Low	Moderate
		Erosion and sedimentation in river	Low	Moderate

5.0 Conclusion

There are eight catchments across the designation corridor (excluding Manawatū River) and each of the watercourses varies in morphology, riparian cover, function, macroinvertebrate assemblage and fish diversity. This creates different freshwater ecology values across the designation corridor. Stream incision is common across many of the watercourses, particularly through the central part of the designation corridor, which causes a disconnect from the floodplain and riparian margins. Many waterways have also been subject to grazing pressures, which limits riparian cover and creates erosion and bank slumping issues.

The Manawatū River, specifically the Gorge area where the designation corridor crosses over, is considered to have very high ecological value. This is due to the optimal instream habitat and hydrologic conditions, sinuous flow path, general high macroinvertebrate indices and high diversity of native fish species.

The Project will involve the construction and operation of a road and associated infrastructure. Activities and effects associated with the construction and operation of the alignment are likely to include watercourse modification/diversion, instream works within Manawatū River and stormwater and sediment related discharges to water. The type and magnitude of these effects (and level of ecological effects) are subject to change, depending on the final design of the Project and proposed construction methods.

Stream replacement and enhancement will likely be required as part of the Project to mitigate for the loss/modification of habitat. There may however, be other mitigation options that can be explored. Resource consents will be required at a later date and it is during this process that adverse effects on freshwater ecological values and associated mitigation will be addressed.

6.0 References

ANZECC 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Auckland Council 2016. Auckland unitary plan: operative in part 15 November 2016 – Chapter J Definitions. Document prepared for Auckland Council.

Birch GF, Fazeli MS, Matthai C 2005. Efficiency of an infiltration basin in removing contaminants from urban stormwater. Environmental monitoring and assessment 101, 23-38.

Dunn NR, Allibone RM, Closs GP, Crow SK, David BO, Goodman JM, Griffiths M, Jack DC, Ling N, Waters JM, Rolfe JR 2018. Conservation status of New Zealand freshwater fishes, 2017. Report prepared for Department of Conservation.

Environment Institute of Australia and New Zealand 2018. Ecological Impact Assessment (EcIA) – EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems (2nd edition). EIANZ, Melbourne.

Franklin P, Gee E, Baker C, Bowie S 2018. New Zealand fish passage guidelines for structures up to 4 metres. Report prepared by NIWA and Department of Conservation.

Harding J, Clapcott J, Quinn J, Hayes J, Joy M, Storey R, Greig H, Hay J, James T, Beech M, Ozane R, Meredith A, Boothroyd I 2009. Stream habitat assessment protocols for wadeable rivers and streams of New Zealand. University of Canterbury. Christchurch, New Zealand.

Joy M, David B, Lake M 2013. New Zealand freshwater fish sampling protocols. Massey University. Palmerston North, New Zealand.

Maine MA, Sune N, Hadad H, Sanchez G, Bonetto C 2006. Nutrient and metal removal in a constructed wetland for wastewater treatment from a metallurgic industry. Ecological engineering 26, 341-347.

Ministry for the Environment 2001. Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103.

Neale MW, Storey RG, Rowe DK, Collier KJ, Hatton C, Joy MK, Parkyn SM, Maxted JR, Moore S, Phillips N, Quinn JM 2011. Stream Ecological Valuation (SEV): A user's guide. Report prepared for Auckland Council.

Ostrofsky ML 2012. Determination of total phosphorus in lake sediments. Hydrobiologia 696: 199-203.

Stark JD, Maxted JR 2007. A user guide for the macroinvertebrate community index. Report prepared for the Ministry for the Environment.

6.C.1

FIGURES 1 TO 3

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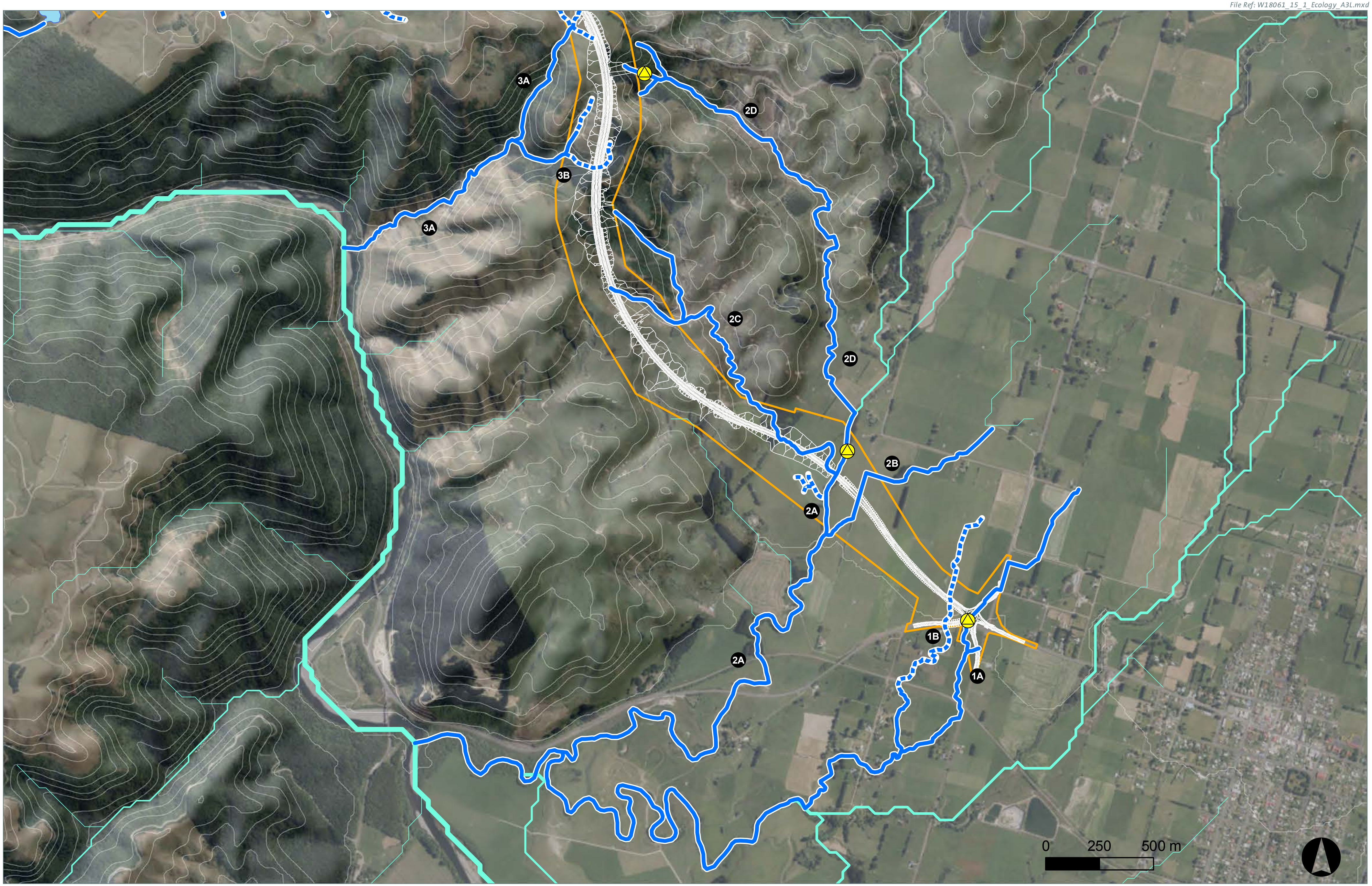

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Data Sources: Horizons RC, MDC, PNCC, TDC, DoC, LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

Waterways

┅	Intermittent
━	Permanent
─	River (REC2)
▲	Sampling Site

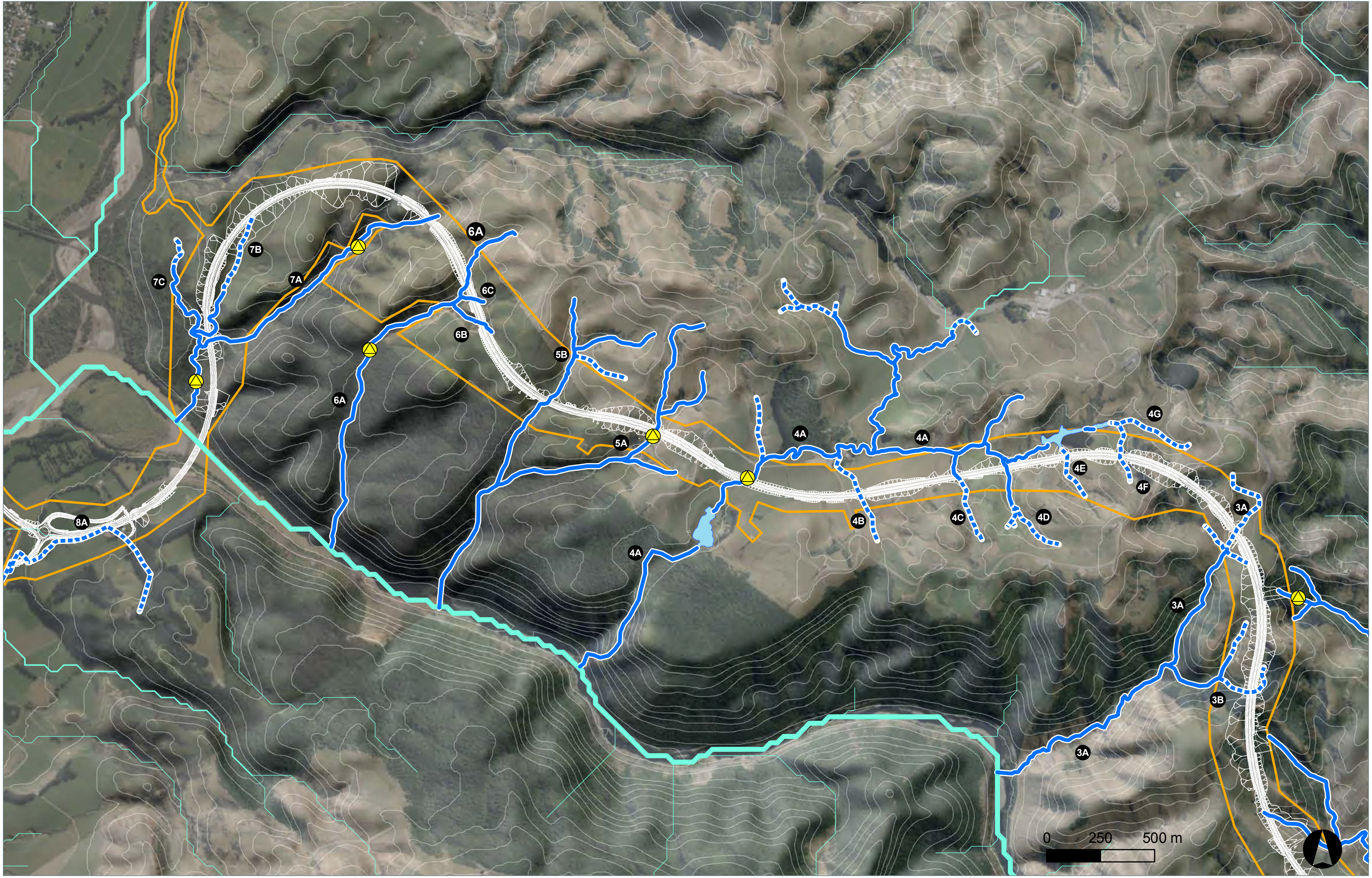
TE AHU A TURANGA PROJECT

Ecological Monitoring - Sheet 1 of 3

Date: 03 October 2018 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: **boyden.evans@boffamiskell.co.nz** | *Drawn:* HHu | *Checked:* BEv



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Data Sources: Horizons RC, MDC, PNCC, TDC, DoC, LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

Waterways

- ▪▪▪ Intermittent
- ━ Permanent
- ━ River (REC2)
- ▲ Sampling Site

TE AHU A TURANGA PROJECT

Ecological Monitoring - Sheet 2 of 3

Date: 03 October 2018 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: **boyden.evans@boffamiskell.co.nz** | *Drawn:* HHu | *Checked:* BEv

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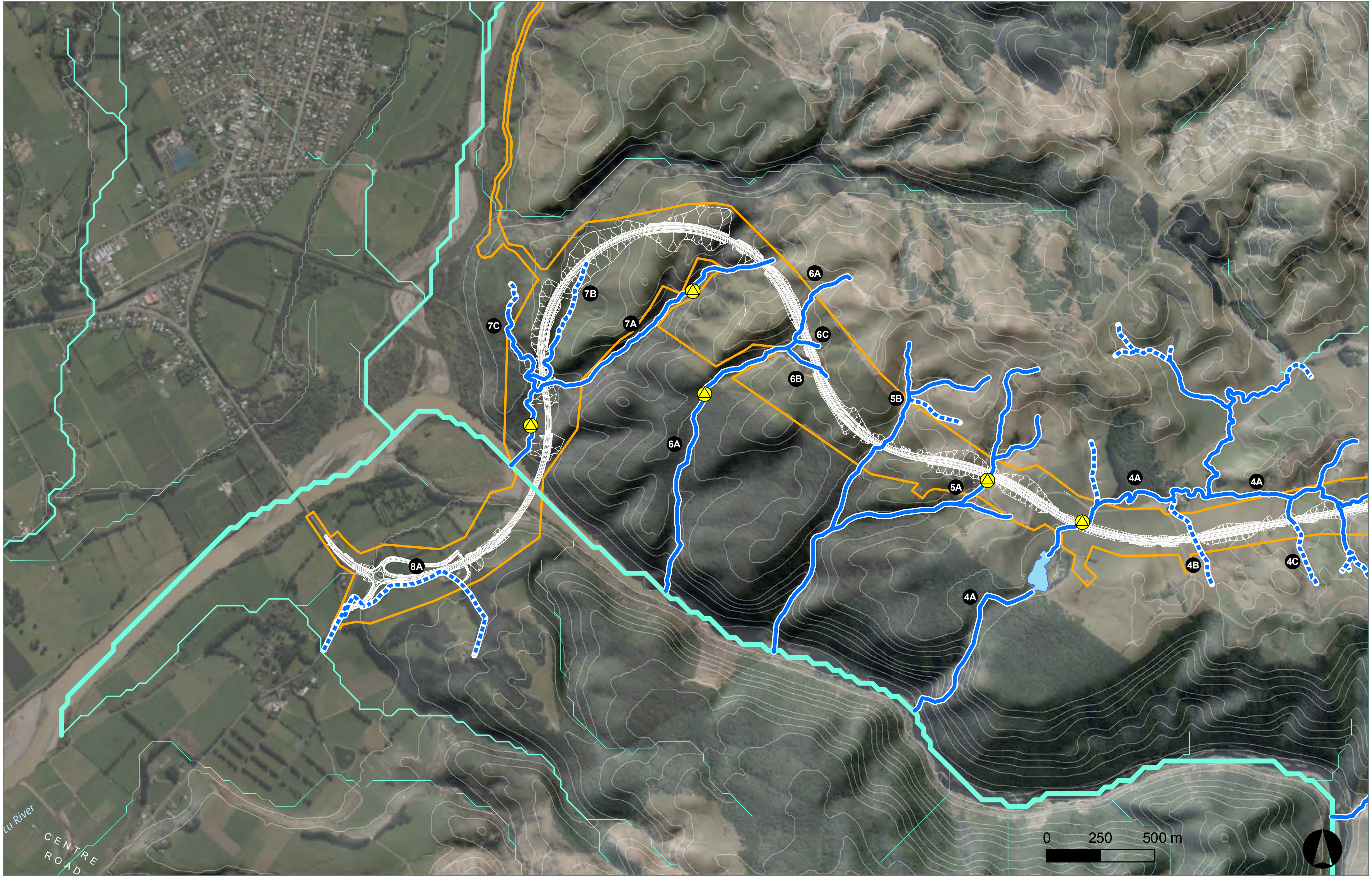

Waterways

▪▪▪	Intermittent
▬	Permanent
▬	River (REC2)
△	Sampling Site

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Data Sources: Horizons RC, MDC, PNCC, TDC, DoC, LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

TE AHU A TURANGA PROJECT

Ecological Monitoring - Sheet 3 of 3

Date: 03 October 2018 | Revision: 0

Plan prepared by Boffa Miskell Limited

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6.C.2

FISH SURVEY REPORT

Manawatu Gorge SH3

Summer Ecology Survey - Freshwater

Prepared for GHD and the New Zealand Transport Authority

21 March 2018

Document Quality Assurance

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Cover photograph: Manawatu River, Boffa Miskell, 2018.

Contents

1.0 Introduction 2

2.0 Methodology 2

3.0 Results 4

- 3.1 Freshwater fish database records 4
- 3.2 Fish survey results 5
- 3.3 Site Locations 5
  - 3.3.1 Site 1 5
  - 3.3.2 Site 2 6
  - 3.3.3 Site 3 7
  - 3.3.4 Site 4 7
  - 3.3.5 Site 5 7
  - 3.3.6 Site 6 7
  - 3.3.7 Site 7 8
  - 3.3.8 Site 8 8
  - 3.3.9 Site 9 9

4.0 Summary 10

5.0 References 11

1.0 Introduction

New Zealand Transport Agency (NZTA) with GHD Ltd commissioned Boffa Miskell Ltd (BML) to undertake summer ecology surveys of the freshwater fish communities for the preferred proposed new alignment of SH3. The purpose of the surveys is to identify fish species present, and their distribution, within representative waterways, across the preferred corridor and proposed associated infrastructure to inform future ecological assessments.

2.0 Methodology

A desktop assessment and review of waterways (River Environment Classification REC) indicated 11 stream/waterways could be directly impacted by the preferred designation, with additional indirect effects on five other waterways (e.g. erosion sediment control and stormwater discharges). The sites selected to be surveyed in the field were considered to be representative of the 16 potentially affected waterways. These sites were categorised into nine stream networks across the preferred option with nine survey sites identified prior to entering the field (Figure 1).

One site (site 7) was not able to be surveyed due to lack of access when assessed in the field.

The NIWA Freshwater Fish database was searched for any previous surveys had been undertaken in the area and in other waterways within the catchment.

The Fish communities were surveyed by BML on 21st and 22nd February 2018 using Joy *et al*. 2013 New Zealand freshwater fish sampling protocols. Methods were modified for each waterway, involving either netting or electric fishing[1].

Site 1 was surveyed using 1 x fyke net and 7 x Gee's minnow traps. The fyke net and traps were set on the evening of the 21st of February and left in situ overnight. Nets were checked the following morning where fish were identified and measured (fork length, mm) before being returned alive to the stream.

The remaining sites were surveyed using a Kainga EFM 300 backpack mounted electric fishing machine (NIWA Instrument Systems, Christchurch). Fish were captured in a downstream push net or in a hand (dip) net and temporarily held in buckets. All fish were then identified, counted and measured (fork length, mm) before being returned alive to the stream.

Photographs for each stream were taken. However, due to equipment failure, photos are not available for sites 4-6.

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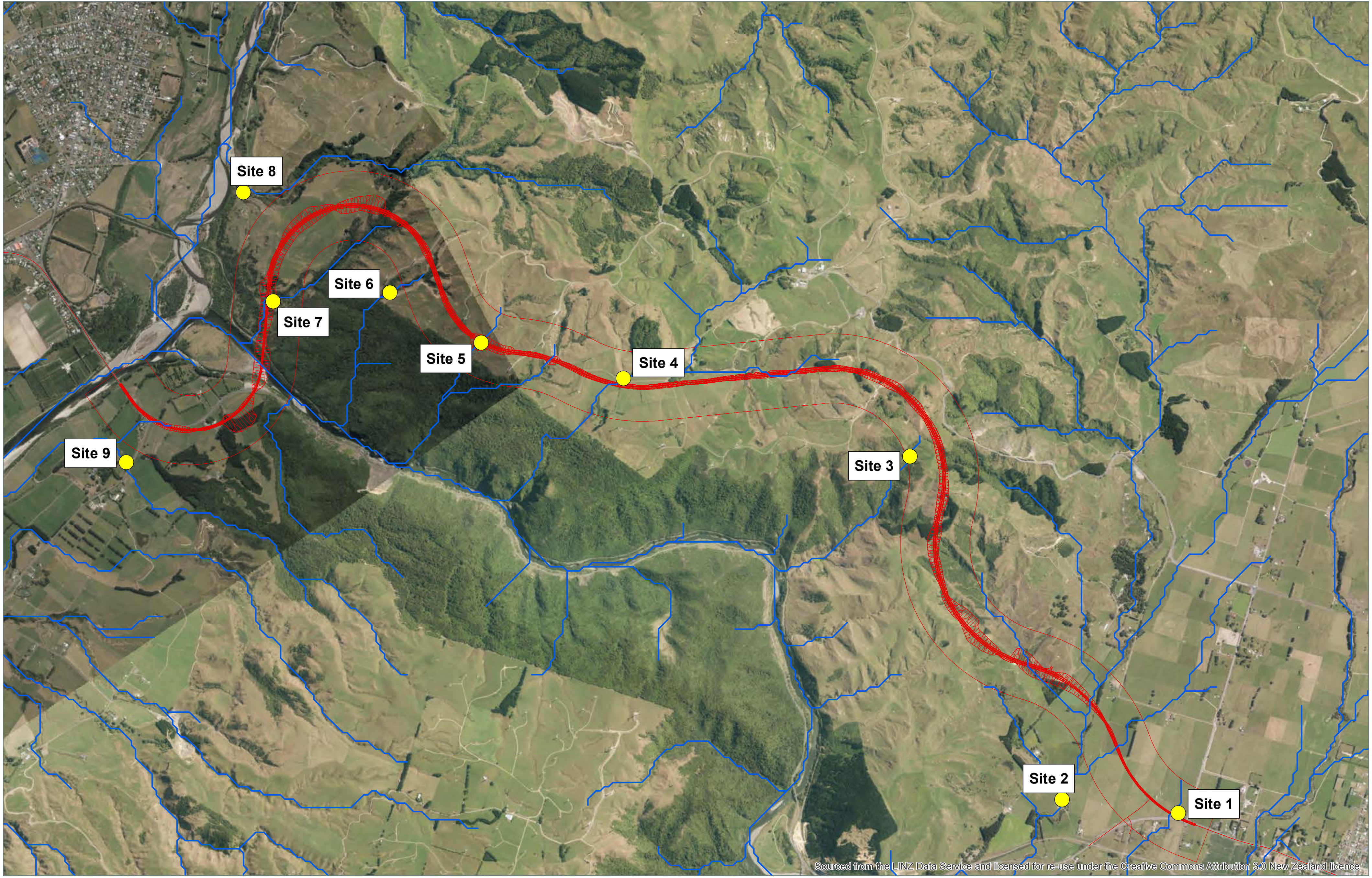
[1] Boffa Miskell has the required authority and permits to conduct fish surveys (including electrofishing) throughout New Zealand.



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Projection: NZGD 2000 New Zealand Transverse Mercator

MANAWATU GORGE SUMMER ECOLOGY

Figure 1: Freshwater Survey Locations

Date: 19 March 2018 | Revision: 0

Plan prepared for NZ Transport Agency by Boffa Miskell Limited
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3.0 Results

3.1 Freshwater fish database records

NIWA's Freshwater fish database indicated previous freshwater fish surveys had been undertaken within the Manawatu River and adjoining waterways but none within the stream networks surveyed and potentially affected by the proposed alignment. Species recorded in previous surveys in the Manawatu River are shown in Table 1 below.

Table 1: NIWA Freshwater Fish Database records for the affected catchment.

Common name	**Scientific name**	**Threat Status** [2]
Upland bully	*Gobiomorphus breviceps*	Not threatened
Common bully	*Gobiomorphus cotidianus*	Not threatened
Koura	*Paranephrops* spp.	*At Risk* - Declining
Longfin eel	*Anguilla dieffenbachia*	*At Risk* - Declining
Torrentfish	*Cheimarrichthys fosteri*	*At Risk* - Declining
Brown trout	*Salmo trutta*	Introduced and Naturalised
Redfin bully	*Gobiomorphus huttoni*	*At Risk* - Declining
Perch	*Perca fluviatilis*	Introduced and Naturalised
Shortfin eel	*Anguilla australis*	Not threatened
Brown mudfish	*Neochanna apoda*	*At Risk* - Declining
Common smelt	*Retropinna retropinna*	Not Threatened
Dwarf galaxias	*Galaxias divergens*	*At Risk* - Declining
Unidentified salmonid	*Salmo* spp.	

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[2] Freshwater fish classification as from Goodman et al., 2014. koura classification from Grainger et al., 2014.

3.2 Fish survey results

Table 2 provides a summary of the freshwater fish species captured during the 2018 summer surveys across the 8 sites. A total of 160 individuals across eight species were captured.

Table 2: Total number of fish caught (or seen) at sites surveyed in February 2018. Size ranges (mm) are shown in parentheses.

Species	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 8**	**Site 9**
Redfin bully		1 (50)						
Longfin eel		3 (250-400)	1 (250)		2 (400-450)			
Shortfin eel	21 (180-400)	2 (200-250)		3 (400-800)			2 (200)	12 (250-800)
Common bully		4 (40-60)					1 (60)	27 (30-70)
Koura		2 (40-50)	2 (30-40)	13 (30-50)	20 (10-50)	6 (10-50)		
Eel sp		6 (80-100)						8 (200-400)
Bully sp							11 (30-40)	6 (20-30)
Brown trout							7 (50-90)	

3.3 Site Locations

3.3.1 Site 1

Site 1 is located in low lying farmland (Photo 1). The waterway is choked with macrophytes, predominantly monkey musk (*Erythranthe gutta*), with minimal areas of open water. There was no visible flow and electric fishing was deemed unsuitable. This was the only site where trapping methods were used. Shortfin eel (Not threatened) were the only species.

Photo 1: Site 1 looking downstream.

3.3.2 Site 2

This waterway has a wide riparian zone (Photo 2), dominated by exotic species such as willow (*Salix sp.*). Cobble substrate, overhanging vegetation and undercut banks provide abundant habitat for native freshwater fish. This site had the highest fish diversity with six species caught, including the *At Risk* (Declining) species (longfin eel and redfin bully). Other species caught at this site included common bully, shortfin eel and koura.

Photo 2: Site 2 looking downstream.

3.3.3 Site 3

Site 3 is located in a steep gully surrounded by native forest (Photo 3). The substrate was comprised primarily of bedrock, with several cascades and steep waterfalls along the reach. Due to lack of safe access only 50m of the stream reach was able to be surveyed. Longfin eel and koura were caught at this site.

Photo 3: Site 3 looking upstream.

3.3.4 Site 4

Site 4 is located within open farmland. The waterway has little riparian cover with margins consisting of pasture grasses. Substrate is a mix of fine sediment/ clay and small cobbles. Downstream of the survey location is a large pond, created by a man-made dam. The dam provides a barrier to fish passage. Two species were found at this site (shortfin eels and koura).

3.3.5 Site 5

Site 5 is located in a gully network within agricultural land. The riparian margin is a mix of pasture grasses and sparse native trees. The substrate is dominated by cobbles and the waterway had little flow relative to other sites. Instream habitat consists mostly of shallow, rocky pools. Longfin eel and koura were recorded at this site.

3.3.6 Site 6

Site 6 is located in the upper reaches of a gully network. The stream is narrow, shallow and is dominated by large cobbles and boulders with small rocky pools (Photo 4). Koura were the only species found at this site.

Photo 4: Site 6 looking upstream

3.3.7 Site 7

Site 7 was not surveyed as the waterway is located in a deep and steep sided gully that could not be safely accessed. Due to the proximity to the Manawatu River, and based on results from similar sites in this survey, this waterway is likely to have fish species present.

3.3.8 Site 8

Site 8 was slightly upstream of the confluence with the Pohangina River, one of the main tributaries of the Manawatu River. This site had a relatively open canopy and cobble substrate. A ford ran through the middle of the survey reach and remnants of a concrete track were scattered throughout in the waterway reach surveyed (Photo 5). A total of four species were found at this site including brown trout, common bully, shortfin eel and juvenile bullies that were too small to be identified to species level.

Photo 5: Site 8 looking downstream.

3.3.9 Site 9

Site 9 was the only site surveyed on the southern side of the Manawatu River. The site is located in low lying farmland with riparian margins consisting of pasture grasses and exotic plants (Photo 6). The substrate was predominantly soft bottomed, predominantly silt. This site had the highest abundance of fish caught including common bully, shortfin eel and juvenile bullies.

Photo 6: Site 9 looking downstream.

4.0 Summary

The fish survey was conducted over nine waterways with varying substrate, size and available habitat. A total of eight species were caught during the survey, including seven native freshwater species and one exotic species. Of these species caught, koura, longfin eel and redfin bully have a threat status of *At Risk*- Declining.

5.0 References

Goodman J.M., Dunn N.R., Ravenscroft P.J., Allibone R.M., Boubee J.A.T., David B.O., Griffiths M., Ling N., Hitchmough R.A., Rolfe J.R. 2013. New Zealand Threat Classification Series 7. Department of Conservation, Wellington. 12 p.

Grainger, N.; Collier, K.; Hitchmough, R.; Harding, J.; Smith, B.; Sutherland, D. 2014: Conservation status of New Zealand freshwater invertebrates, 2013. New Zealand Threat Classification Series 8. Department of Conservation, Wellington. 28 p.

Joy M., David B. and Lake M. (2013). *New Zealand freshwater fish sampling protocols. Part 1: wadeable rivers & streams.* Massey University, Palmerston North, New Zealand.

6.C.3

HORIZONS REGIONAL COUNCIL MACRO-INVERTEBRATE DATA

HRC SoE 2017		Pohangina at Mais Reach	Manawatu at Upper Gorge	Manawatu at Teachers College
Date	MCI	9-Mar-17	9-Mar-17	26-Apr-17
Mayflies				
Austroclima sepia	9	3	-	-
Coloburiscus humeralis	9	7	2	3
Deleatidium sp.	8	180	88	170
Nesameletus sp.	9	7	-	-
Stoneflies				
Austroperla cyrene	9	1	-	-
Zelandoperla decorata	10	2	1	-
Dobsonflies				
Archichauliodes diversus	7	4	1	-
Beetles				
Elmidae	6	49	151	49
Hydraenidae	8	1	-	-
True Flies				
Aphrophila neozelandica	5	1	-	-
Austrosimulium spp.	3	-	6	2
Empididae	3	1	-	-
Eriopterini	9	2	-	-
Orthocladiinae	2	7	3	-
Tanytarsus spp.	3	9	1	-
Caddisflies				
Costachorema xanthopterum	7	-	1	-
Hydrobiosis parumbripennis	5	1	-	-
Hydrobiosis spp.	5	1	6	-
Hydrobiosis umbripennis	5	-	1	-
Hydropsyche - Aoteapsyche grou	4	50	82	11
Olinga spp.	9	2	-	-
unidentified Hydroptilidae	2	-	1	-
Psilochorema leptoharpax	8	1	1	-
Psilochorema spp.	8	1	-	-
Pycnocentria evecta	7	2	-	-
Pycnocentrodes sp.	5	6	-	-
Crustacea				
Paracalliope sp.	5	-	1	-
Oligochaeta	1	1	4	-
Platyhelminthes	3	-	1	1
Snails				
Potamopyrgus antipodarum	4	2	-	-
Number of taxa		24	17	6
Number of individuals		341	351	236
%EPT richness		58.33	47.06	50.00
%EPT abundance		77.42	51.85	77.97
MCI		127	104	110
QMCI		6.79	5.88	7.35

6.C.4

MACRO-INVERTEBRATE RESULTS

General Group	Taxa	Common Name	MCI Score HB	MCI Score SB	Site 1A	Site 2a	Site 2d	Site 4A	Site 5A	Site 6A	Site 7a US	Site 7a DS
Hydrozoa	Hydra sp.		3	1.6	5 (C)			1 (R)				
Platyhelminthes	Platyhelminthes	Flat Worm	3	0.9	1 (R)			1 (R)				1 (R)
Gastropoda	Latia sp.	Freshwater limpet	3	6.1				20 (A)				
Gastropoda	Physa sp.	Freshwater snail	3	0.1	20 (A)							
Gastropoda	Potamopyrgus antipodarum	Estuarine snail	4	2.1	500 (VVA)	5 (C)		100 (VA)	5 (C)	1 (R)	1 (R)	1 (R)
Gastropoda	Pseudosuccinea columella	FW snail (introduced)	5	1.2	5 (C)							
Bivalvia	Sphaeriidae	pea mussel	3	2.9				1 (R)				
Oligochaeta	Oligochaeta	Oligochaete worms	1	3.8	20 (A)	5 (C)		20 (A)	5 (C)	1 (R)		
Collembola	Collembola	Springtails	6	5.3	1 (R)	1 (R)	1 (R)	1 (R)	5 (C)	1 (R)		5 (C)
Isopoda	Oniscoidea	Isopods Terestrial	5	4.5			1 (R)					
Amphipoda	Paracalliope	hoppers	5	5	100 (VA)	5 (C)	5 (C)	20 (A)	1 (R)			5 (C)
Amphipoda	Talitridae	Amphipod (family)	5	5				5 (C)	5 (C)	5 (C)	5 (C)	
Decapoda	Paranephrops planifrons	Freshwater crayfish (Koura)	5	8.4						1 (R)		
Ostracoda	Ostracoda	Ostracods	3	1.9	1 (R)			1 (R)	1 (R)			
Copepoda	Copepoda	Copepods	5	2.4								1 (R)
Insecta	Limonia sp.	Crane fly larvae	6	6.3			5 (C)	1 (R)				
Ephemeroptera	Acanthophlebia	Mayfly larvae	7	9.6								1 (R)
Ephemeroptera	Coloburiscus humeralis	Mayfly larvae	9	8.1						1 (R)		5 (C)
Ephemeroptera	Deleatidium	Mayfly larvae	8	5.6		100 (VA)		1 (R)	100 (VA)	100 (VA)	20 (A)	100 (VA)
Ephemeroptera	Zephlebia sp.	Mayfly larvae	7	8.8			5 (C)		100 (VA)	20 (A)	5 (C)	20 (A)
Plecoptera	Acroperla sp.	Mayfly larvae	5	5.1		1 (R)		5 (C)	1 (R)	1 (R)		1 (R)
Plecoptera	Zelandobius sp.	Stone fly	5	7.4		1 (R)						
Hemiptera	Microvelia macgregori	Waterskaters	5	4.6								5 (C)
Megaloptera	Archichauliodes diversus	Toe biter	7	7.3						1 (R)		1 (R)
Coleoptera	Elmidae	Riffle Beetle	6	7.2		20 (A)						1 (R)
Coleoptera	Hydraenidae Larvae	Beetle larvae	8	6.7			1 (R)					
Diptera	Eriopterini	crane fly	9	7.5		1 (R)			1 (R)	5 (C)		1 (R)
Diptera	Muscidae	Fly larvae	3	1.6			1 (R)					1 (R)
Diptera	Orthocladiinae	midges	2	3.2	5 (C)	5 (C)		20 (A)	20 (A)	1 (R)		1 (R)
Diptera	Sciomyzidae	marsh flies	3	3								1 (R)
Diptera	Aphrophila sp.	Crane fly	5	5.6		1 (R)						
Diptera	Austrosimulium	sandflies	3	3.9	20 (A)	20 (A)		20 (A)	1 (R)			
Diptera	Corynoneura	non-biting midges	2	1.7	1 (R)							
Diptera	Hexatomini sp.	Crane fly larvae	5	6.7							1 (R)	
Diptera	Molophilus sp.	crane fly	5	6.3					1 (R)			
Diptera	Paralimnophila sp.	crane fly	6	7.4				1 (R)				
Diptera	Polypedilum	non-biting midges	3	8		1 (R)		1 (R)	1 (R)	1 (R)	1 (R)	1 (R)
Diptera	Tanytarsini sp.	Midge fly larvae	3	4.5		1 (R)						
Trichoptera	Hudsonema amabilis	Case caddis	6	6.5		1 (R)						
Trichoptera	Hydrobiosella	Free-living caddis	9	7.6						1 (R)		
Trichoptera	Hydrobiosis sp. (juveniles)	Free-living caddis	5	6.7	1 (R)	5 (C)		1 (R)				
Trichoptera	Hydrobiosis umbripennis	Free-living caddis	5	6.7	1 (R)	5 (C)		1 (R)	1 (R)			
Trichoptera	Hydropsyche-Aoteapsyche	net-spinning caddis	4	6		1 (R)	1 (R)	1 (R)	5 (C)	1 (R)		
Trichoptera	Hydropsyche-Orthopsyche	net-spinning caddis	9	7.5						1 (R)	1 (R)	1 (R)
Trichoptera	Oxyethira albiceps	Axe-head caddis	2	1.2		1 (R)		1 (R)				
Trichoptera	Psilochorema nemorale	Free-living caddis	8	7.8							1 (R)	
Trichoptera	Pycnocentrodes	stony cased caddis	5	3.8		5 (C)						
Arachnida	Acarina	Mites	5	5.2			1 (R)	1 (R)	1 (R)	1 (R)	1 (R)	1 (R)
	MCI HB					**92**	**110**	**81**	**94**	**115**	**120**	**111**
	SQMCI HB					**6.29**	**5.52**	**3.54**	**6.63**	**7.55**	**7.06**	**7.38**
	MCI Soft Bottom				**63**							
	QMCI Soft Bottom				**2.58**							