NZ TRANSPORT AGENCY
WAKA KOTAHI

Roads of national significance

Ara Tūhono – Pūhoi to Wellsford

FURTHER NORTH

Pūhoi to Warkworth

Terrestrial Ecology Assessment Report

August 2013

Pūhoi to Warkworth

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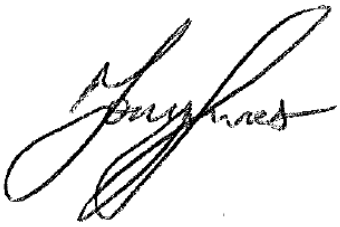

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Glossary of abbreviations

Abbreviation	Definition
ABM	Acoustic Bat Monitoring device
AR	Artificial Lizard Retreat
ARDS	Amphibian and Reptile Distribution Scheme
DOC	Department of Conservation
d.b.h	Diameter at Breast Height (a standardised tree trunk measurement)
ED	Ecological District
GPS	Global Positioning System
Kph	Kilometres per hour
NIWA	National Institute of Water and Atmospheric research
OPW	Outline Plan of Works
NOR	Notice of Requirement
OSNZ	Ornithological Society of New Zealand
RoNS	Road of National Significance
VES	Visual Encounter Survey

Glossary of defined terms

Term	Definition
Arboreal	Living in trees
Bioclimatic	Of or concerned with the relations of climate (e.g. rainfall, temperature, humidity) and living organisms.
Broadleaved	Trees that produce flowers
Canopy	Tallest layer of the forest
Chytridiomycosis	An emerging, infectious disease of amphibians
Crake	A type of wetland bird
Cryptic	Flora or fauna that are difficult to detect, observe, or survey for. Reasons for crypsis may include factors such as excellent camouflage (e.g. lizards, frogs), nocturnality (e.g. lizards, bats, frogs), non-flowering (e.g. small plants), unresponsiveness to recorded call playbacks (e.g. birds), periodic reduced activity levels (e.g. lizards, bats).
Flora	Refers to naturally occurring or native plant life including the species composition
Interstitial	Small spaces in between substrates
Keystone species	A species that has a disproportionately large effect on the communities in which it occurs
Nocturnal	Active at night
Podocarp	Trees that produce cones: e.g. rimu, kahikatea, totara, tanekaha
Pole kauri	Kauri trees in the adolescent stage with straight pole trunks and a distinctive narrow conical crown
Project	Pūhoi to Warkworth section of the Pūhoi to Wellsford Road of National Significance Project.
Project area	From the Johnstone's Hill tunnels portals in the south to Kaipara Flats Road in the north.
Relict	Trees that were part of the original forest of the area
Rhytid	A type of land snail of the genus *Rhytida*
Terrestrial	Land-based
Taxa	Types / groups of animals (e.g. species)
Understorey	The layer of shrubs and other vegetation that grow under the forest canopy
Secondary forest	Not the original forest of the area; forest that has developed after clearance of the original forest
Vegetation	General term for the plant life of an area, both native and exotic

Contents

1. Introduction

This report assesses the terrestrial ecology effects of the NZ Transport Agency's (NZTA's) Ara Tūhono Pūhoi to Wellsford Road of National Significance (RoNS) Pūhoi to Warkworth Section (the Project).

The purpose of this report is to:

- Identify the terrestrial ecology values of the Project area;
- Assess the potential effects of the Project on those values; and
- Recommend measures to avoid, remedy or mitigate those effects.

Terrestrial ecology values include vegetation and flora (including wetlands) and terrestrial fauna. We assessed wetlands on their vegetation and habitat values for terrestrial fauna.

1.1 Purpose of report

This report forms part of a suite of technical reports prepared for the Project. Its purpose is to inform the Assessment of Environmental Effects (AEE) and to support the resource consent applications and Notices of Requirement for the Project.

The purpose of this report is to:

- identify the ecological values of the Project area;
- assess the potential effects of the Project on those ecological values; and
- recommend management options to avoid, remedy or mitigate those effects.

We consider the Project area to include all areas inside the NOR (proposed designation) boundaries. We further draw attention to any terrestrial ecological value that is potentially affected by the indicative alignment (including cut and fill zones).

The indicative alignment shown on the Project drawings has been developed through a series of multi-disciplinary specialist studies and refinement. A NZTA scheme assessment phase was completed in 2011, and further design changes have been adopted throughout the AEE assessment process for the Project in response to a range of construction and environmental considerations.

It is anticipated that the final alignment will be refined and confirmed at the detailed design stage through conditions and outline plans of works (OPW). For that reason, this assessment has addressed the actual and potential effects arising from the indicative alignment, and covers the proposed designation boundary area.

Except as noted in this report:

- We consider that the sites we have selected for surveys and testing are generally representative of all areas within the proposed designation boundary; and

The recommendations we propose to mitigate adverse effects are likely to be applicable to other similar areas within the proposed designation boundary, subject to confirmation of their suitability at the detailed design stage.

This report was written by Chris Wedding and Jennifer Shanks, with the invaluable assistance of Dylan van Winkel, Jay Ruffell, Rhys Gardner and Graham Don.

1.2 Project description

This Project description provides the context for this assessment. Sections 5 and 6 of the Assessment of Environment Effects (Volume 2) further describe the construction and operational aspects of the Project and should be relied upon as a full description of the Project.

The Project realigns the existing SH1 between the Northern Gateway Toll Road (NGTR) at the Johnstone's Hill tunnels and just north of Warkworth. The alignment will bypass Warkworth on the western side and tie into the existing SH1 north of Warkworth. It will be a total of 18.5 km in length. The upgrade will be a new four-lane dual carriageway road, designed and constructed to motorway standards and the NZTA RoNS standards.

1.3 Project features

Subject to further refinements at the detailed design stage, key features of the Project are:

- A four lane dual carriageway (two lanes in each direction with a median and barrier dividing oncoming lanes);
- A connection with the existing NGTR at the Project's southern extent;
- A half diamond interchange providing a northbound off-ramp at Pūhoi Road and a southbound on-ramp from existing SH1 just south of Pūhoi;
- A western bypass of Warkworth;
- A roundabout at the Project's northern extent, just south of Kaipara Flats Road to tie-in to the existing SH1 north of Warkworth and provide connections north to Wellsford and Whangarei;
- Construction of seven large viaducts, five bridges (largely underpasses or overpasses and one flood bridge), and 40 culverts in two drainage catchments: the Pūhoi River catchment and the Mahurangi River catchment; and
- A predicted volume of earthworks being approximately 8M m^3 cut and 6.2M m^3 fill within a proposed designation area of approximately 189 ha earthworks.

The existing single northbound lane from Waiwera Viaduct and through the tunnel at Johnstone's Hill will be remarked to be two lanes. This design fully realises the design potential of the Johnstone's Hill tunnels.

The current southbound tie in from the existing SH1 to the Hibiscus Coast Highway will be remarked to provide two way traffic (northbound and southbound), maintaining an alternative

route to the NGTR. The existing northbound tie in will be closed to public traffic as it will no longer be necessary.

1.4 Interchanges and tie-in points

The Project includes one main interchange and two tie-in points to the existing SH1, namely:

- The Pūhoi Interchange;
- Southern tie-in where the alignment will connect with the existing NGTR; and
- Northern tie-in where the alignment will terminate at a roundabout providing a connection with the existing SH1, just south of Kaipara Flats Road north of Warkworth.

1.5 Route description by Sector

For assessment and communication purposes, the Project has been split into six sectors, as shown in Figure 1. Section 5.3 of the AEE describes these sectors.

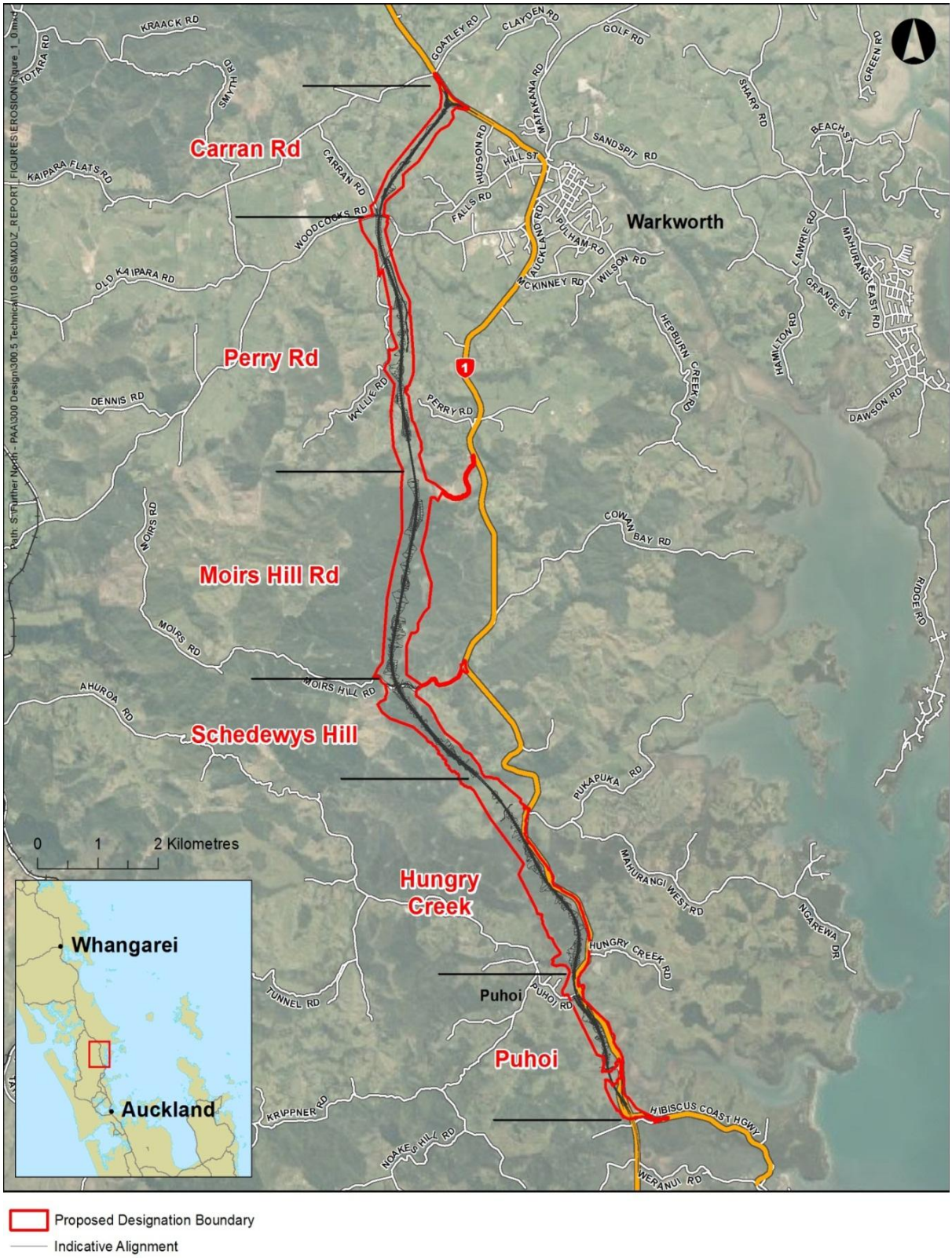

Figure 1: Project sectors

2. Statutory context

The Resource Management Act (RMA), Auckland Regional Policy Statement (ARPS) and Wildlife Act provide the statutory framework for our assessment of effects. We also considered Auckland Council's Indigenous Biodiversity Strategy (2012) and the standards and objectives of the NZTA Environmental Plan (2008).

2.1 Resource Management Act 1991

By reference to s5(2)(b) of the (RMA), this report:

- Assesses the nature of the life-supporting capacity of existing terrestrial ecosystems; and
- Assesses the extent to which the Project would safeguard the life-supporting capacity of existing terrestrial ecosystems.

By reference to section 6(c) of the RMA, this report:

- Assesses the nature of existing indigenous vegetation and habitats of existing indigenous fauna and relative significance; and
- Considers mitigation and concludes whether any identified significant indigenous vegetation and habitats of indigenous fauna affected by the Project will be protected.

By reference to section 7(d) of the RMA, this report:

- Identifies relevant ecosystems and intrinsic values; and
- Assesses how the Project affects these values.

2.2 Auckland Council Regional Policy Statement 1999: Chapter 6: Heritage

Ecological values are under particular pressure in the Auckland Region because it is New Zealand's largest and fastest growing urban area. Consequently, there has been extensive loss, modification and fragmentation of natural environments and fauna habitats. With respect to the policies of the ACRPS (1999) Section 6.4.7, this Report values natural heritage resources according to the following characteristics:

1. the Project area provides a characteristic example of ecology of the local area;
2. the Project area is of good quality (e.g., for natural areas it has an intact understorey and is characterised by a low level of invasion from pest species); and
3. the Project area contributes to the ecological viability of surrounding areas and biological communities;
4. the Project area contains a regionally threatened species or a unique or special feature;

5. the Project area contains an unprotected ecosystem type, or an ecosystem type under-represented within the protected area network or an ecological district;

6. the Project area is a component of, adjoins or provides a buffer to, a significant natural resource, or a watercourse or coastal margin;

7. the Project area has habitat values, or provides or contributes to a habitat corridor or connection facilitating the movement of fish or wildlife species in the local area;

8. the Project area is in a landscape which is depleted of indigenous vegetation; or

9. Protection of the Project area adds significantly to the spatial characteristics of the protected area network (e.g., by improving connectivity or reducing distance to the next protected area).

2.3 Wildlife Act 1953

The WA declares that all native wildlife, except in the case of wildlife for the time being specified in Schedules 1-5, be absolutely protected throughout New Zealand. In particular s63 of the Act states that:

No person may, without lawful authority,

- (a) hunt or kill any absolutely protected or partially protected wildlife or any game:
- (c) rob, disturb, or destroy, or have in his or her possession the nest of any absolutely protected or partially protected wildlife or of any game.

An authority under the Wildlife Act may be required with respect to disturbing any protected wildlife species that might be directly affected by the Project.

3. Methodology

We undertook literature reviews, database searches and visual site assessments during the initial scoping phase, to identify constraints and potential issues within the proposed designation boundary. Additional adjustments to the alignment occurred during this assessment process. These adjustments have further reduced the Project's ecological impact, by avoiding ecologically valuable sites (including Pohuehue Scenic Reserve) and all or parts of sites that were considered to be of high ecological value.

We undertook field surveys for significant vegetation, flora, wetlands and protected wildlife using a range of methodologies.

We identified native forest and wetland sites within the Project area from aerial imagery, using GIS. We visited all of these areas and assessed potentially significant sites using a walked transect method. We recorded characteristics of the vegetation and flora, including key canopy and understorey species at forested sites and key wetland species in wetland sites.

This section provides an overview of our desktop investigations and describes how we identified areas that we targeted for surveys.

We collated information on important ecological sites in the Rodney Ecological District, (Rodney ED) from Mitchell et al (1992) and Julian et al (2000 a, b, c). The Rodney ED is an area of similar bioclimatic characteristics that spans the Northland and Auckland territorial boundaries. The Project area lies entirely within it.

Mitchell et al (1992) surveyed c. 900 sites of native vegetation within the Rodney ED and identified areas of high value based on vegetation type and physical landform. Julian et al (2000 a, b, c) rated natural sites in the Rodney ED and identified those that should be considered as significant vegetation or significant wildlife habitats ("Significant Natural Areas" or SNAs) under section 6(c) of the RMA.

We reviewed records for all native fauna that were classed as protected wildlife under the Wildlife Act and which could occur within the Rodney ED. Those fauna included native bats, birds, lizards, frogs and Kauri snails (schedule 7, WA 1953).

We undertook desktop investigations, using shape files of the indicative alignment and proposed designation, in conjunction with aerial imagery from Google Maps, to identify and review areas of native and exotic (non-pasture) vegetation within the Project area. We visited all identified areas to visually assess their potential habitat values for flora and fauna, and to determine appropriate survey methodology.

We employed a variety of methodologies to target different groups of organisms. Generally, we undertook transect (line), point and opportunistic counts as well as targeted searches for flora, land snails, frogs, skinks, geckos (by night) and birds. We also used playback-call recordings to survey wetland birds and installed specialised equipment to detect long-tailed bats and lizards (skinks and geckos).

Our field survey locations were within the proposed designation and are identified in Figure 2. Brief descriptions are provided in **Appendix A**. Wetland locations are identified in Figure 3.

Some areas that we assessed as having high ecological values have been subsequently avoided by the Project through adjustments to the indicative alignment or proposed designation. Those areas include all or parts of Sites 5, 13, 14 and 15 and two small areas in Sites 10 and 12 that contain threatened plants. Assessments of those sites are included in this report.

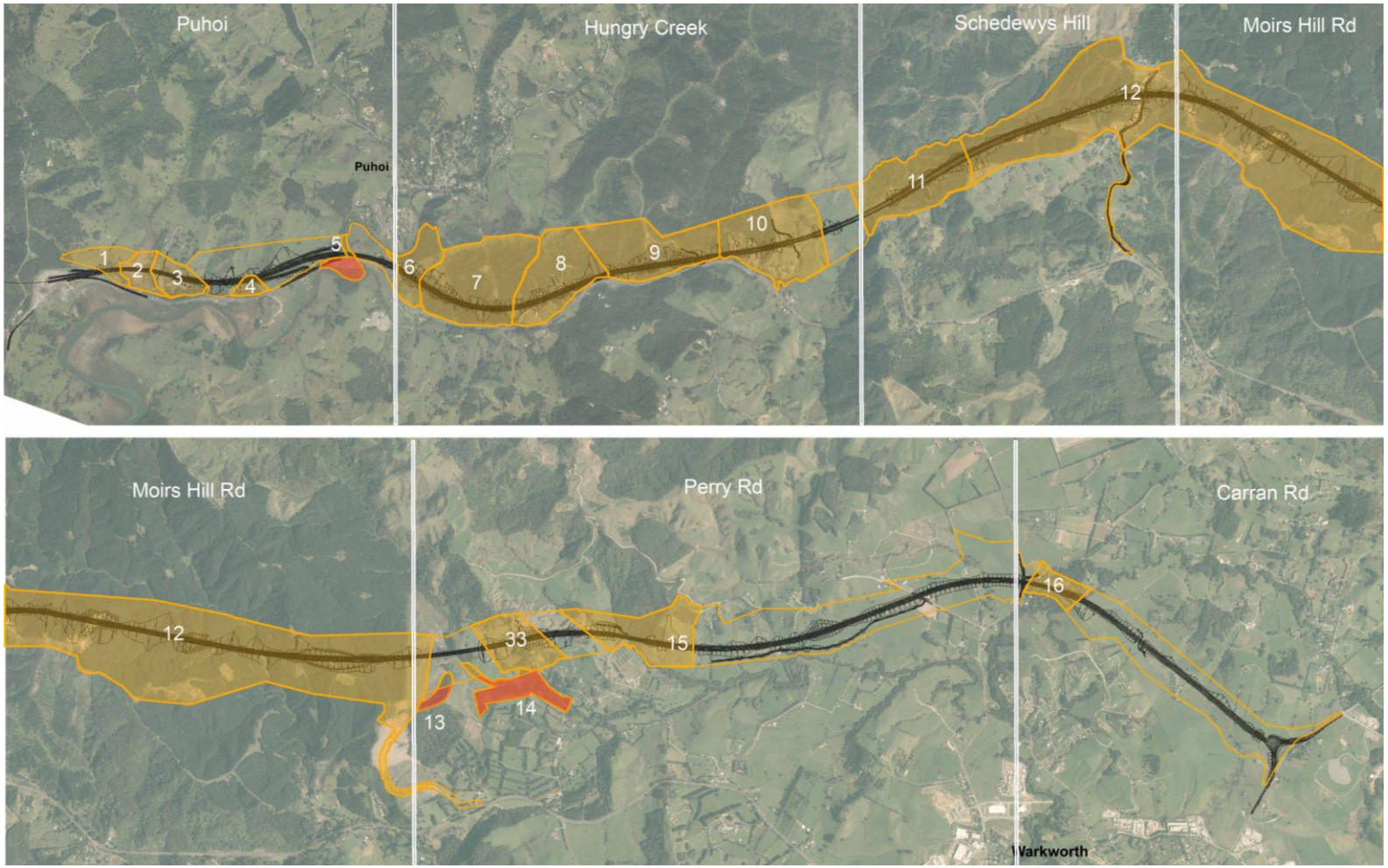

Figure 2: Terrestrial sites assessed within the Project area. Note areas coloured red are outside the proposed designation

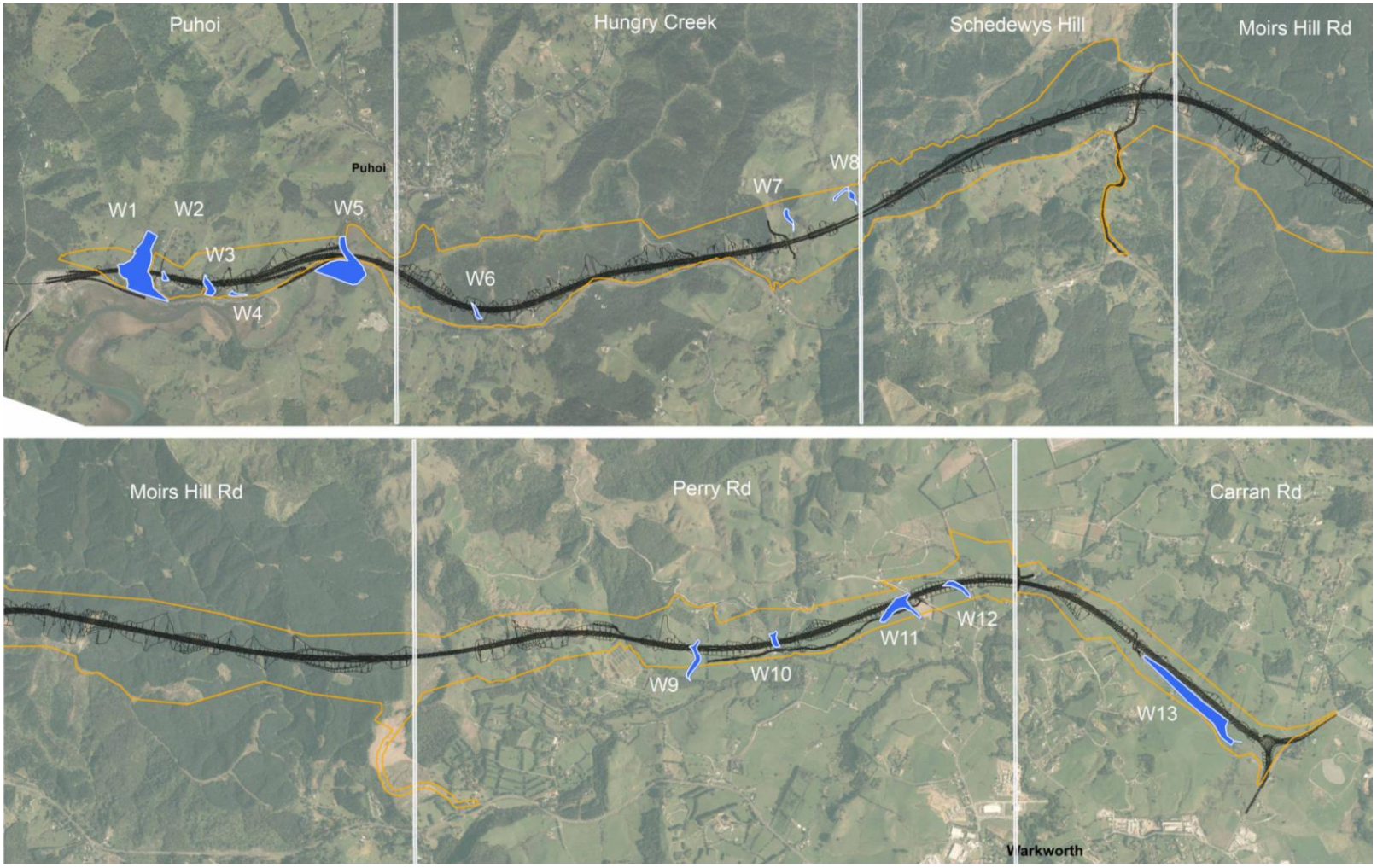

Figure 3: Wetland sites assessed within the Project area

3.1 Vegetation and flora survey methodology

We identified all areas within the proposed designation containing indigenous vegetation and carried out detailed surveys where we considered vegetation with potentially significant values was present. We determined 'significant values' according to the ARPS and the Auckland Council District Plan Operative Rodney Section 2011 (ACDP) criteria.

The RMA defines a "wetland" as "permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of native plants and animals that are adapted to wet conditions". This is a broad definition that may include areas that are grazed by livestock, if they contain predominantly native wetland plants, or provide habitat for wetland fauna. Wetlands within the Rodney ED are generally small and are usually modified by stock, farm run-off and exotic plants. Some of these remnant wetlands do provide habitat for native fauna and uncommon plants (Mitchell et al 1992). Wetlands may be freshwater, brackish or saline and include stream, lake and river margins, swamps, and saltmarsh. Only 3% of the original area of native wetlands remains within Rodney ED, and they are a priority for protection both regionally and locally (NHF, ARPS, ACDP). Therefore we assessed wetlands that we identified within the proposed designation for their botanical values, in particular whether native plant species were dominant and whether the system retained natural hydrological function (Auckland Council District Plan 2011 (Rodney Section)).

Kauri dieback disease is of particular concern where kauri forms a component of the forest, and we searched for signs of this serious disease when we assessed forest where kauri was present.

Plants are referred to by their common names throughout this report. A list of all plants found throughout the surveyed areas and their scientific names is given in in **Appendix E.**

The forested and wetland sites referred to in this report are mapped in Sections 4.1.2 and 4.1.3. In terms of each site:

- Site 1 was not accessible at the time of writing this report. It is in any case a small site with mostly exotic pines and a domestic dwelling;
- Site 2 is mostly saline wetland in the Okahu Creek estuary and the terrestrial vegetation that is adjacent to dwellings consists mainly of exotic pines and open-grown totara trees of no great size. The understorey contains mostly exotic species with a few common native species such as cutty grass. The wetland vegetation is described as W2 in Section 4.1.3 along with other wetland areas.
- We did not consider Sites 7 and 9-12 because we considered the botanical values over the bulk these sites within the proposed designation area to be low (e.g. pine plantations or pasture). We did identify threatened plants in highly localised areas of Sites 10 and 12. Although pine plantations often have an understorey that includes native plants, these plant communities are generally composed of common species and the nature of plantation forestry means that the understorey is regularly cleared during the harvesting cycle. These sites however are considered in other sections (e.g. reptiles and bats).
- Site 10 was of some interest because of the presence of several totara trees carrying green mistletoes inside the proposed designation near the intersection of SH1 with Mahurangi West Road. We investigated these trees and verified the presence of mistletoes. The green mistletoe, (*Ileostylus micranthus*) is listed as a threatened plant in the Auckland Region

(Stanley et al 2005). The species is a hemiparasite and totara is one of its host plants. The rest of Site 10 is similar to Sites 7,9,11 and 12 and was not assessed.

- Site 12 contains a small area of secondary native forest where the taraire orchid (*Danhatchia australis*) has been recorded. This plant has a national threat status of "Naturally Uncommon".
- We assessed Sites 3-4, 6, 8, 16 and 33 by walking through as much of the site as possible in a systematic way to assess the characteristics of the vegetation and flora present.
- We conducted detailed measurements of kauri tree size and density at Site 15A to determine the quality of the kauri forest found at this site.

We recorded key canopy and understorey species at each site. We also noted diameter at breast height (dbh) (1.4m above the ground) of any particularly large trees that were present, that could potentially be affected by the Project, and recorded GPS positions for these.

Forested sites are described in Section 4.1.2. We identified a number of small wetlands within the proposed designation boundary. We investigated these wetlands and those that we considered to be potentially affected by the Project are described in Section 4.1.3. The forested and wetland sites described in this report are representative of the range of indigenous terrestrial vegetation types present within the proposed designation boundary We thoroughly investigated sites of the highest botanical value and documented their values. We consulted threatened plant publications for the Auckland Region and New Zealand (de Lange et al 2009, Stanley et al 2005) and specifically searched for threatened plants at all sites. Common names for plant species have been used in this report.

3.2 Land snail survey methodology

We searched all potentially suitable habitats for the large kauri snail, *Paryphanta busbyi busbyi*, and the smaller Rhytid snail *Amborhytida dunniae*. Both species are listed as "At Risk – Declining" by the Department of Conservation (Mahlfeld et al 2012). The former species is also listed as protected wildlife under the Wildlife Act.

Both species of land snail prefer cool, moist areas of leaf litter in native forest and scrub. The kauri snail is also known to occur in pine plantations and areas dominated by introduced vegetation (McGuiness 2001).

Kauri snails have been introduced to areas outside their natural range in the Auckland Region, including at Little Huia, Waitakere Ranges, Waiuku and Awhitu Peninsula (B. Hayward pers.comm. in Parrish et al (1995), cited in McGuiness 2001). However, their natural southern limit is considered to be around Warkworth (Chris Green pers. comm., cited in McGuiness 2001), and therefore some snail populations south of this may not be naturally occurring.

We undertook targeted snail surveys at [redacted] (refer Figure 2), where their preferred habitats occurred. We also undertook opportunistic searches at all other terrestrial sites that we accessed [redacted] including pine plantations (Site 12 occurs around the natural southern limit of *P. b. busbyi*). We also considered [redacted] contained potential habitat, but we did not search that site because the indicative alignment was adjusted to avoid that area.

Our targeted surveys involved both dedicated searches where moist, native forest leaf litter was present, and the use of 10 to 15 1m by 1m search plots across the forest floor. We searched the

leaf litter in each plot to record the presence of live snails or empty shells. We considered empty shells, as well as live snails, to indicate presence. Our dedicated searches targeted particular areas of greater habitat quality, such as where dense leaf litter had accumulated alongside and under rotting logs and under fallen nikau palm fronds.

3.3 Hochstetter's frog survey methodology

Hochstetter's frog (*Leiopelma hochstetteri*) is a small, cryptic endemic frog that occurs in small isolated populations throughout the northern half of the North Island and on Great Barrier Island (Green and Tessier, 1990). They are listed as "At Risk - Declining" by the Department of Conservation (Newman et al 2010) and are regarded as "Vulnerable" on the IUCN Red List 2009 (Bell et al 2009). Frog populations in the Auckland Region form three genetically distinct groups, of which populations in the Waipu-Brynderwyn-Warkworth areas are considered most at risk by the Auckland Council (Boffa Miskell 2012).

The frog is most commonly associated with shaded streambeds or seepages under mature native forest. However, it is capable of tolerating modified habitats, such as exotic forest (Douglas 1999, Bell et al 2004, Stephenson and Stephenson 1957). Hochstetter's frogs are sensitive and vulnerable to environmental disturbances, such as floods and sedimentation (Najera-Hillman 2009) and because they tend to occur in small and localised populations (Newman, 1996).

We surveyed areas of potential Hochstetter's frog habitat within the Project area for the presence of frogs. We considered streams where Hochstetter's frogs occurred to have high ecological significance.

3.3.1 Desktop investigations

We undertook desktop assessments to identify valleys that could potentially contain both permanent and intermittent streams. While typically associated with stream edges, Hochstetter's frogs do not necessarily require permanently flowing water. They are also capable of tolerating modified habitats such as exotic forest (Douglas 1999, Bell et al 2004, Stephenson and Stephenson 1957).

We also reviewed the Department of Conservation's *Amphibian and Reptile Distribution Scheme* (ARDS) database (accessed April 2013) to gain a summary of native frog observations through both the Project area and wider North Auckland region.

3.3.2 Stream searches

We carried out frog surveys within identified streams during spring 2010, 2011 and summer 2013 to determine the presence of frogs. We conducted all searches during the day, between 0900 and 1630 hours. Our surveys aimed to determine presence only and we did not attempt to provide information on frog abundance, other than to note spatial distribution of frogs and the habitat in which they were identified.

We used a protected frog reserve within [redacted] as a reference (control) site for determining the presence of frogs during the survey period. Frogs are known to occur within the control site, which was within pine forest and outside the Project area.

3.4 Reptile survey methodology

New Zealand has two major groups of terrestrial reptiles: lizards (Order Squamata) and tuatara (Order Rhynchocephalia). Tuatara have been reintroduced to some predator-fenced wildlife sanctuaries in New Zealand and are also known to occur on a few pest-free islands in the Hauraki Gulf. They are not considered to occur on the Auckland mainland and we do not consider them further.

Nine species of native lizards could occur within potential habitats in the Project area. Two of those species (common gecko and striped skink) have not previously been recorded in the Rodney ED although we considered that they could potentially be present because the Rodney ED occurs within their natural geographic range and because those species are known to occur on the mainland in nearby areas including the Waikato, Auckland or Northland Regions.

Six of these species (Table 1) are recognised as "At Risk" and three are considered "Not Threatened" under the Department of Conservation's New Zealand Threat Classification System (Hitchmough et al 2013).

One introduced species, the rainbow skink (*Lampropholis delicata*), is classified as an "Unwanted Organism" by the Ministry for Primary Industries (MPI) Biosecurity New Zealand (7 July 2010), under the Biosecurity Act 1993. Rainbow skinks are therefore not considered in this report.

Table 1: Threat classification[1] of native lizards recorded and potentially occurring within the Rodney ED

Species	Threat category	Threat status
Copper skink (*Oligosoma aeneum*)	Not Threatened	
Ornate skink (*Oligosoma ornatum*)	At Risk	Declining
Moko skink (*Oligosoma moco*)	At Risk	Relict
Shore skink (*Oligosoma smithi*)	Not Threatened	
Striped skink (*Oligosoma striatum*)*	At Risk	Declining
Common gecko (*Woodworthia maculata*)*	Not Threatened	
Forest gecko (*Mokopirirakau granulatus*)	At Risk	Declining
Pacific gecko (*Dactylocnemis pacificus*)	At Risk	Relict
Auckland green gecko (*Naultinus elegans*)	At Risk	Declining

*Not previously recorded on mainland in the Rodney ED

[1] Hitchmough et al. (2013).

We employed specific survey methodologies to target native lizard species within different habitat types. Those methodologies included the use of artificial lizard retreats (ARs), nocturnal visual encounter searches (VES) and manual habitat searches. Those methodologies are described below.

3.4.1 Desktop investigation

We reviewed high resolution aerial imagery of the Project area to provide indications of the likely nature and extent of reptile habitats, and to guide the selection of appropriate field survey methods. We considered both native and exotic (non-pasture) vegetation to be potential lizard habitat. We accessed the Department of Conservation's *Amphibian and Reptile Distribution Scheme* (ARDS) database (accessed April 2013) to gain historic records of all native reptiles recorded in the Project area as well as the wider region.

3.4.2 Visual habitat assessment

We visited all areas identified in our desktop investigation to visually assess their potential to support native lizards.

We considered that fragments of native forest, mixed native and exotic scrub (e.g. manuka, *Leptospermum scoparium*; kanuka, *Kunzea ericoides*), some exotic vegetation (e.g. pampas, *Cortaderia* spp., non-pasture rank grass), and their edges and interfaces had greatest potential for lizard habitat. We surveyed these areas with greater effort than areas considered less likely to support lizard populations (e.g. pine plantations).

Pine plantations were considered to be of lower value than native vegetation, mixed scrub or non-pasture grass for lizards. Our survey methodology in pine plantation therefore largely involved manual habitat searches along plantation edges and clearings where logs and debris were abundant and could be easily searched.

3.4.3 Artificial lizard retreats (ARs)

We used artificial lizard retreats (ARs) to survey for terrestrial (ground dwelling) lizards. Lizard retreats are corrugated sheets of Onduline© (500mm x 500mm). Onduline is an organic, bitumen-saturated material used in reptile surveys throughout New Zealand due to its lightweight and suitable thermal properties (Lettink and Cree 2007, Wilson et al 2007).

We installed 208 ARs and inspected them over the summer months (October – March) to correspond with typically increased activity of lizards. Our ARs were installed in clusters of four ('sampling stations') throughout areas [redacted]. We considered these areas to have potential habitat for lizards at ground level. Sites where ARs were placed were typically within and alongside dense clusters of vegetation, logs, fallen trees and piles of debris where potential lizard encounters were considered most likely.

We left the ARs to settle within the environment for at least three weeks before we checked them on four separate occasions for the presence of lizards. Repeated checks are necessary as native lizards may use multiple retreat sites within their home ranges. We conducted lizard retreat checks on separate, non-consecutive days during calm, settled weather.

3.4.4 Nocturnal visual encounter surveys (VES)

We undertook nocturnal visual encounter surveys (VES) where we identified potential habitat for arboreal, nocturnal geckos. We used powerful headlamps (LED Lenser™ H7) and hand-held spotlights (e.g. *Powa-Beam* 12v 100W) aided by Nikon Monarch™ 8 x 42 binoculars to search for geckos on the ground and in vegetation above the ground (tree trunks, branches and foliage). We searched after dusk during calm, rain-free nights. Lizard locations were recorded with a hand-held GPS unit (Garmin 60CSx).

Where we encountered lizards, an "encounter rate" was calculated as: $n / (h \times s)$, where:

n = number of geckos encountered at a site

h = number of hours spent searching (per surveyor)

s = number of surveyors searching

Low encounter rates (e.g. less than 0.1 lizards/ hour) are typical of many mainland forest sites in New Zealand (Whitaker et al 1999) and therefore non-detection of geckos cannot be interpreted as absence. However encounter rates greater than 0 (i.e. confirmation of presence) provide important information for ecological assessment and subsequent management.

3.4.5 Manual habitat searches

We undertook manual habitat searches in areas where refuges and/ or loose debris (e.g. logs, loose vegetation, and inorganic debris) were available and could be lifted. We recorded active lizards (i.e. observed sun-basking or moving through vegetation) and lizard sign (i.e. faeces and sloughed skin) where we observed them. We completed habitat searches at all accessed sites that we identified as having potential lizard habitat, with the exception of [redacted] where no liftable habitat was identified. We recorded lizard locations with a hand-held GPS unit (Garmin 60CSx).

All reptile species located throughout the survey were identified and released at the point of capture.

3.5 Bird survey methodology

All birds are protected under the Wildlife Act except those listed in Schedule 5 of that Act. We considered the presence of "Threatened" and "At Risk" and keystone species to be significant, where we identified them within the Project area. A keystone species, such as kereru, is one that plays a crucial role in maintaining ecosystem functions.

We conducted literature searches to identify all bird species that could potentially be present within the proposed designation boundaries. This included a summary of all birds recorded in the 10km^2 grid squares applying to the wider surrounding area from Robertson et al (2007).

We recorded all bird species (native and exotic) that were observed using habitats, including native forest, shrubland, pine plantation and pasture grass and wetlands within the Project area during all terrestrial site visits (including both diurnal and nocturnal visits).

We also used playback lure tapes (in November 2010 and April-May 2013) for fernbird, spotless crake and marsh crake around wetland areas W1 to W6, as these areas were considered to provide enough vegetation to provide potential habitat for those bird species. We undertook dedicated searches for banded rail sign (e.g. footprints) at the two estuarine crossings near Pūhoi (W1 and W5). Refer to Figure 3 for the locations of wetland areas.

3.6 Bat survey methodology

Long-tailed bats are classified as 'Nationally Vulnerable' in the North Island (O'Donnell et al 2010) – they are thought to have a large population but a high ongoing or predicted decline. This classification is given the qualifier "Data Poor", indicating that there is low confidence in the rating (O'Donnell et al 2010). Therefore we consider those areas that provide important resources to long-tailed bats to be significant wildlife habitats under the Resource Management Act (1991) and Auckland Regional Policy Statement (1999). Long-tailed bats are protected under the Wildlife Act.

Long-tailed bats require large trees (including standing dead trees) with cavities (e.g. deep knot holes), epiphytes or loose bark for roosting; and typically use linear landscape features such as bush edges, gullies, water courses and roadways to transit between roosting and feeding sites (Borkin and Parsons 2009; Griffiths 1996). In addition to roosting communally in large trees, long-tailed bats also roost solitarily in smaller trees. All areas containing trees large enough to develop cavities (perhaps > 15cm d.b.h.) could potentially contain roosting habitat for solitary bats.

Long-tailed bats tend to forage in open areas, including clearings (Borkin and Parsons 2009; Griffiths 1996), along forest edges (Alexander 2001; O'Donnell and Sedgeley 1994), over wetlands, open water and along rivers and roadways (Borkin and Parsons 2009; Griffiths 1996). Long-tailed bats are highly mobile, they regularly change roost sites (Griffiths 1996) and can fly at 60kph over very large home ranges (up to 100km^2). Median range spans for long-tailed bats in plantation forest have been recorded at approximately 2-8 km (Borkin and Parsons 2011) Long-tailed bat activity is significantly reduced in winter, though usually does not cease completely.

New Zealand's other bat species, the short-tailed bat (*Mystacina tuberculata*), is associated with extensive areas of old-growth native forest (Lloyd 2001). Because of the absence of this habitat and the lack of short-tailed bat records within hundreds of kilometres of the Project area (with the exception of a population on Little Barrier Island (Lloyd 2001) we consider this species is very unlikely to occur in the Project area. We also note that our surveys would have detected short-tailed bats if they passed our Acoustic Bat Monitors (ABMs), as the equipment was set to record the call frequencies of both species (see below).

We surveyed for long-tailed bats using ABMs. ABMs record ultrasound created by the bats' echolocation calls, whenever a bat travels within 50m of the ABM. Bat calls can be distinguished as individual 'passes' (i.e. a bat using its echolocation to navigate as it flies past) and 'feeding buzzes' (i.e. where echolocations speed up markedly, indicating prey being honed in on). We identified feeding buzzes to determine whether any habitats were being used for foraging for flying invertebrates, such as moths and small dipterans (e.g. flies, mosquitoes). We considered that a higher proportion of feeding buzzes compared to passes would indicate a localised foraging area. We considered a foraging area to be of greater significance.

We set the ABMs to record from sunset to sunrise and installed them throughout the Project area at locations that provided edges and gullies of native and exotic forest, wetlands, estuarine and riparian areas, to maximise the chance of detecting long-tailed bats.

We installed the ABMs at 25 locations throughout the Project area between 8 October and 24 November 2009 and left them to record for 5 - 17 consecutive nights. We considered the data recorded per night to be 'useable' if the temperature remained above 5 °C throughout the night and if more than half the night was rain-free. Bats are less likely to be active or leave their roosts during these weather conditions and are therefore less detectable (O'Donnell 2000b, Griffiths 2007).

We also noted the presence of potential communal roosting areas, such as large trees that contain cavities, where ABMs were installed.

4. Existing environment

The existing environment within the Project area is characterised by large areas of pine plantation (Hungry Creek, Schedewys Hill and Moirs Hill Road Sectors), managed pasture, and several smaller fragments of native secondary forest and scrub. Pine plantations provide habitat for threatened long-tailed bats, "At Risk" North Island fernbird and "At Risk" New Zealand pipit. Smaller fragments of native vegetation provide habitat for other native fauna, particularly land snail and lizard populations. No native frogs were found within the Project Area.

Of the 40 ha of native vegetation within the proposed designation, less than 8.5 ha falls within the indicative alignment. There are few areas of mature forest within the indicative alignment and wetlands are generally small and degraded by grazing.

We consider the botanical values throughout most of the Project area to be low to moderate. An exception is Site 15A. Site 15A is part of a substantial area of mature secondary native forest, containing high plant diversity and some areas of well-developed secondary kauri forest. Approximately one third of this site falls within the proposed designation and 1.6ha is within the indicative alignment. The indicative alignment avoids other areas of high ecological values within the Project area.

4.1 Vegetation and flora

4.1.1 Rodney Ecological District

New Zealand has been divided into some 260 ecological districts. An ecological district is a local part of New Zealand where the topographical, geological, climatic, soil and biological features, including the broad cultural pattern, produce a characteristic landscape and range of biological communities. The Project area lies entirely within the Rodney Ecological District (Rodney ED) which has the following broad bioclimatic characteristics:

- Low altitude dissected hill country which ranges from steep and broken to easy and rolling topography;
- the climate is mild with high sunshine hours and 1200 – 1600 mm of rainfall per annum;
- originally the district was extensively forested but only remnants of that forest cover remain today, due to past logging and clearance for agriculture dating from pre-European times. Prior to human settlement podocarp/ broadleaf/ kauri forest and kauri forest were the dominant forest types.
- extensive areas of regenerating forest and scrub dominated by early successional species such as kanuka, manuka and tree ferns reflect this historic disturbance;
- Although regenerating kauri forest is commonly found in the Rodney ED examples of primary kauri forest are only found within a few small reserves, such as Parry Kauri Park and Thomson Scenic Reserve;
- Totara dominated remnants are common throughout the District, often forming distinctive riparian forests;
- Taraire dominated forest remnants are found in both lowland and coastal hillslope environments and it is likely that there were once extensive areas of this forest type on the central hill country;

- Freshwater wetlands are small and scattered, consisting mainly of raupo reedland; and
- Extensive areas of exotic forests are found throughout the District on infertile broken hill country (Mitchell et al 1992).

The Threatened Environments Classification (Landcare Research 2007) for Rodney ED shows that there is between 20% and 30% of native vegetation land cover across most of the Rodney ED.

4.1.2 Descriptions of native forest

The general characteristics of the vegetation and flora at Sites 3-6, 8, 10, 13-16 and 33 are described below. Refer to Figure 2 for locations. Signs and symptoms of kauri dieback disease were not observed at any of the assessed sites.

Site 3: Surrounding 22B Billing Road, including Okahu Creek Scenic Reserve

This site includes the Okahu Creek Scenic Reserve, a small area of mixed secondary forest containing kauri, podocarps and kanuka. The area that may be affected by the Project is grazed and contains young totara, manuka and mature pine trees. The vegetation in this part of the stand has generally low botanical values.

Site 4: Western side of Pūhoi Road 800m south of Pūhoi Road – SH1 intersection.

This is a small area of kauri/ podocarp forest approximately 0.6ha in area on a ridge spur. The key canopy species are kauri, rimu, totara, tanekaha and kanuka. There is little understorey and kauri roots are exposed on the sides of the spur due to stock damage. Several larger kauri trees on the end of the spur were measured and their GPS locations noted. The botanical values in the part of this stand that may be affected by the Project are generally low – moderate. Further up the ridge spur within the designation to the east is a stand of secondary kauri/ podocarp forest of medium size which is not within the proposed fill area. This forest is under threat at present due to the effects of grazing.

Site 5: Pūhoi Road – SH1 Intersection

This riparian band of forest vegetation owned by the Department of Conservation is found mainly on a steep slope about 30m wide adjacent to the Pūhoi River. The eastern two thirds of it (0.5ha) is within the proposed designation. The forest canopy consists partly of medium-sized podocarps (rimu, totara and kahikatea) and partly of kanuka of lesser size. There are several well-established kauri and a few large kowhai trees scattered throughout. We found native long-hair plume grass and short-hair plume grass on a small open flat area with a discontinuous canopy next to Pūhoi Road near its junction with SH1. Native short hair plume grass has a national threat status of "Naturally Uncommon". The botanical values at this site are moderate.

Site 6: Ridge to the north of the Puhoi River

Site 6 takes in the south eastern edge of an area of mixed regenerating native bush and pines on a steep south-facing slope above the Puhoi River and the ridge crest above it to the north comprising about 1ha. On the ridge to the north are a dozen or so large open-grown totara trees and several old puriri trees surrounded by rank kikuyu grass. The overall botanical values of this site are low to moderate.

Site 8: Western side of SH1 opposite Hungry Creek

The native vegetation at this site is mainly manuka and kanuka up to c. 5m tall on moderately steep east-facing slopes dissected by minor gullies. Associated with this canopy are common plants such as mahoe and mamaku. There are also a few scattered large relict puriri trees, some medium sized totara and tanekaha, and mature exotic trees. Parts of the site near the houses are heavily impacted with a range of weed species. The botanical values at this site are low.

Site 10: Western side of SH1 opposite Mahurangi West Road intersection with SH1

Within the proposed designation on its north eastern boundary is an area of rolling land dissected by a lowland stream where there are several totara trees carrying green mistletoe plants. The most significant of these is a large open-grown tree some 1.5m in diameter that has at least 12 mistletoe plants among its branches. Another much smaller sub-mature tree has two plants and three totara trees on the western side of the stream also have mistletoes. Another five large trees slightly further north that are hosts to a number of mistletoes are just outside the proposed designation boundary. Mistletoe is classed as "Regionally Critical" as there are a limited number of small populations within the Auckland Region. The largest of these populations is the one around the Mahurangi West/SH1 intersection with some 300 plants (Young 1996). Elsewhere in New Zealand the species is widely distributed throughout the North and South Islands and Stewart Island. It is also known from Norfolk Island. It parasitises a wide range of native and exotic host species and is classed as "Non-Threatened" nationally (http://www.nzpcn.org.nz/flora). The botanical values of this area of site 10 are high.

The proposed construction access track in this area avoids the trees containing mistletoes.

Site 12: Eastern edge of the designation

A small area of secondary native forest about a hectare in size contains the native taraire orchid *Danhatchia*. This plant has a national threat status of "Naturally Uncommon". The botanical values of this small area of Site 12 are high. The construction access track proposed for this area avoids this forest.

Sites 13 and 14

These sites contain good quality native forest, and although parts of them are within the proposed designation, the alignment passes to the west of these parts via a viaduct and they will not be directly affected by road construction. The botanical values at these sites are high.

Site 15A: East of Wyllie Road, southern bush block

The designation here takes in the eastern most 10 ha or so of a large (24ha) native forest remnant on a steep south-facing slope between a tributary of the Mahurangi River Right Branch and Wyllie Road. The vegetation is old secondary forest, the bulk of which is taraire/podocarp forest with some smaller areas of kauri forest on the east-facing ridges. Riparian podocarp forest occurs along the Mahurangi River Right Branch to the north and south of the main forest block.

Of highest ecological value is a stand of kauri estimated to be approximately 3ha in area within the proposed designation area (See Figure 6). The trees are in early maturity (c. 20m tall and 25 -

30cm diameter), and are densely aggregated on the lower half of the northernmost ridge in the block. There is another small stand (c 0.1ha) near the top of the ridge outside the designation (see Plate 1 and 2, in **Appendix B**). We estimate the trees to be 75 – 100 years old. Tanekaha of similar age are a common component of the kauri forest. Rimu also has a strong presence in the canopy, but is mostly found separate from the kauri to the south, often in association with very old kanuka trees. We found kauri to be present throughout much of the indicative alignment footprint at this site; sometimes as aggregated stands and sometimes as scattered trees. Broad-leaved podocarp forest occupies most of the rest of the forest area and the densely aggregated kauri is not found to the same extent elsewhere in the forest block although there are some smaller stands on the lower part of the next ridge to the south west. The forest here is of high quality and botanically very diverse.

We measured kauri plots at two locations within the main stand on the ridge close to the indicative alignment. Our measurement of kauri within the proposed designation indicates that kauri trees of the greatest size and density occur to the west of the indicative alignment area on the ridge crest. Kauri forest also occurs within the indicative alignment to the east and this forest is also of good quality although not of as high quality as that to the west of the indicative alignment. There are other stands of kauri outside the designation that contain trees of similar size (Plate 2, Appendix B) and some larger specimens of riparian kauri up to 107cm d.b.h. within the designation. On the colder, southwest-facing side of the ridge there are some stands of smaller pole kauri with podocarps and taraire forest. Down into the valley bottom the forest is less dense with rimu in the canopy and black ponga in the understorey.

There is a mature kawaka tree (58cm d.b.h) and a number of seedlings within the proposed designation and outside the indicative alignment. Kawaka has a threat classification of "Naturally Uncommon" (de Lange et al 2009).

Riparian forest containing rimu, kahikatea, totara and tanekaha with scattered kauri, continues to the north of the main forest block. This forest is partially fenced and there is an intact understorey on the northern side of the river.

To the south of the main forest block described above, a smaller area of partially protected riparian forest is contiguous with the main forest, running for a further 600m southwards along the stream banks. Parts of this forest are within the proposed designation.

This site has high significance in terms of the ARPS criteria set out in Section 2 of this report and its botanical values are high.

Site 15B: East of Wyllie Road, northern block

Site 15B is located adjacent to the northern edge of site 15A on a moderately steep south-east facing slope. This is a small stand (1.5ha) of good quality old-growth broadleaved–podocarp forest with a mature canopy 15-20m tall and a diverse and well-developed understorey. It contains some large old puriri trees and a diverse range of vines and epiphytes. The site has high botanical values and has been avoided by the indicative alignment.

Site 16: East of Carran Road Warkworth

This is an area of riparian podocarp forest on the left branch of the Mahurangi River. Within the proposed designation the band of riparian forest varies between 30 and 80m in width with a canopy of secondary totara and a sparse understorey of thin-leaved coprosma seedlings and saplings on the true left bank. There are infestations of Chinese privet, Wandering Jew and other weeds in a number of places on the right bank. The canopy cover to the east where the viaduct will land is a continuation of the riparian forest described above. Although it is shown as part of a Significant Natural Area on the Auckland Council District Plan 2011 (Rodney section) maps, the area is grazed and shows signs of pugging by livestock (which were present at the time of the assessment). It has a relatively low and discontinuous canopy of totara with seedling coprosma in the ground layer and weeds such as Wandering Jew. The community structure of this area is degraded and botanical values are low to moderate.

Site 33: South of Perry Road

This irregularly shaped site consisting mainly of kanuka forest and scrub is grazed and has little understorey. There are a few medium sized totara trees scattered through it. The botanical values at this site are low.

4.1.3 Wetland vegetation

We identified a number of small wetlands within or partially within the proposed designation boundary. Wetlands 10, 11 and 12 are all to some degree, wetland restoration plantings and are fenced off from livestock. None of these are more than about 7 seven years old according to GIS imagery and they contain a restricted range of common wetland plants and native shrubs. Wetland 6 is an artificially dammed pond which is not grazed but is heavily impacted by weeds. Overall the botanical values of all these sites are low. All of the wetlands and their values are described below. Refer to Figure 3 for locations. Note that Wetland 5 is no longer within the designation and is not discussed. A total of 9 ha of wetlands fall within the proposed designation and 3.5ha of these will be lost under the indicative alignment."

Wetland 1: Okahu Creek Estuary

This is saline wetland dominated by oioi and mangroves. In the upper western part where several small streams enter the estuary there are small areas of raupo, with giant umbrella sedge and rushes (*Juncus* spp.). There are mature pine trees on the margins of the lower part of the estuary.

Wetland 2: 26 Billing Road

This is a small freshwater wetland containing lake club rush, giant umbrella sedge and leafless rush. There are scattered native sedges, wheki ponga, kiokio and young totara and kahikatea in the upper part. Stock has access to most of the wetland and the upper parts are heavily grazed. The lower part is fenced but is impacted by pasture weeds.

Wetland 3: Pūhoi Farms

This grazed wetland covers an area of about 0.6ha in the bottom of a broad gully. Much of its upper part has weedy pasture species with clumps of rushes, while the lower part has mainly

raupo with mangroves, native rushes and oioi around the bottom saline edge which is tidal and connected to the Pūhoi River. Its botanical values are low.

Wetland 4: Pūhoi Farms, Pūhoi Sector

This wetland is heavily grazed and pugged in its upper parts, although a very small area of about 0.3ha adjacent to SH1 is tidal and -this area is currently fenced off. It contains a range of wetland species including rautahi, water buttons, *Triglochin*, oioi, and around the edges, marsh ribbonwood, manuka and a number of other native scrub species. There are also weedy exotics here such as gorse, Himalayan honeysuckle and pampas. The grazed part of the wetland has mainly pasture species with clumps of rushes. The bulk of the wetland is unfenced and has very low botanical values, while the small fenced portion has moderate values.

Wetland 6: West of SH1, 0.5km north of its intersection with Hungry Creek Road

This wetland consists of an artificially dammed pond with raupo on the western and southern edges. At the western end there is a sward of lake club rush and the pond surface is covered with duckweed. The pond is surrounded by pine forest and a range of other exotic species including Tasmanian blackwood, crack willow, and Himalayan honeysuckle. The botanical values of the pond are low.

Wetlands 7 and 8: West of the indicative alignment

Both of these wetlands are in open pasture and are grazed with scattered clumps of rushes in them. They are generally dominated by exotic species and their botanical values are low.

Wetland 9: East of the indicative alignment

This wetland is open and grazed with predominantly exotic wetland and pasture species and some raupo in the bottom part as it joins the Mahurangi River Right Branch. The lower third of it adjoining the Mahurangi River is outside the designation. We consider its botanical values to be low.

Wetland 10: East of Wyllie Road

There are three small wetlands in the general area between Chainage 51000 and 51400. Two of these contain small dammed ponds with wetland restoration planting around them. These works are of recent origin. Wetland species here are common rushes and sedges, toetoe, flax and manuka. The other wetland at about Chainage 51400 is open and grazed. The lowest third of this wetland adjoining the Mahurangi River is outside the designation and this contains some raupo while the upper part contains common rushes and sedges and exotic vegetation. We consider the botanical values of all of these small areas to be low.

Wetland 11: Adjacent to Wyllie Road

This area of wetland was formerly open grazed pasture and it has been fenced very recently. It contains a range of common rushes and sedges with manuka and planted flax. It drains eastward to the Mahurangi River Right Branch and most of it lies outside the designation. We consider the botanical values of the part of the wetland that lies inside the designation to be low.

Wetland 12: West of Wyllie Road

This is a revegetated area surrounding a constructed wetland of recent origin, containing a range of species commonly used for revegetation purposes. The plants are well grown and canopy closure is almost complete. We consider its botanical values to be low.

Wetland 13: East side of the alignment

This area is open pasture with a channelized small stream running through it. It is dominated by exotic species including pasture grasses and weeds, hawthorn, water pepper and gorse. Some of the wetland lies within the proposed designation, although none is within the indicative alignment. We consider its botanical values to be very low.

4.2 Land snails

We identified two Rhytid snails (*Amborhytida dunniae,* shell diameters 19 and 20mm) at Site [redacted] Both snails were located at least 20m inside the existing edge of the larger forest fragment, within leaf litter debris dams alongside rotting logs.

The larger kauri snail, *Paraphanta busbyi busbyi,* is reported to be present at [redacted] (Brian Hall, *pers. comm*. 2010) though we did not undertake a formal search at that site because the indicative alignment was adjusted to avoid it**.**

4.3 Hochstetter's frogs

We identified and visited 31 streams within the Project area (Refer Figure 4) that had the potential to contain Hochstetter's frog habitat. Some of those streams had additional, unmarked tributaries flowing into them, which we also searched.

The Department of Conservation's ARDS database identified records of Hochstetter's frogs from within some areas of pine plantation north of Warkworth, outside the Project area (Bioweb, *accessed 16.04.2013*). The only records of native frogs between Pūhoi and Warkworth were outside the Project area. Those included frogs from two areas of native broadleaf forest at [redacted]

No frogs were found during targeted searches within the Project area. Most of the streams that we identified did not contain suitable habitat for native frogs. Those streams were either completely dry during the assessment, and / or were severely degraded from rooting by feral pigs.

We located one frog within the [redacted] reference site, outside the Project Area.

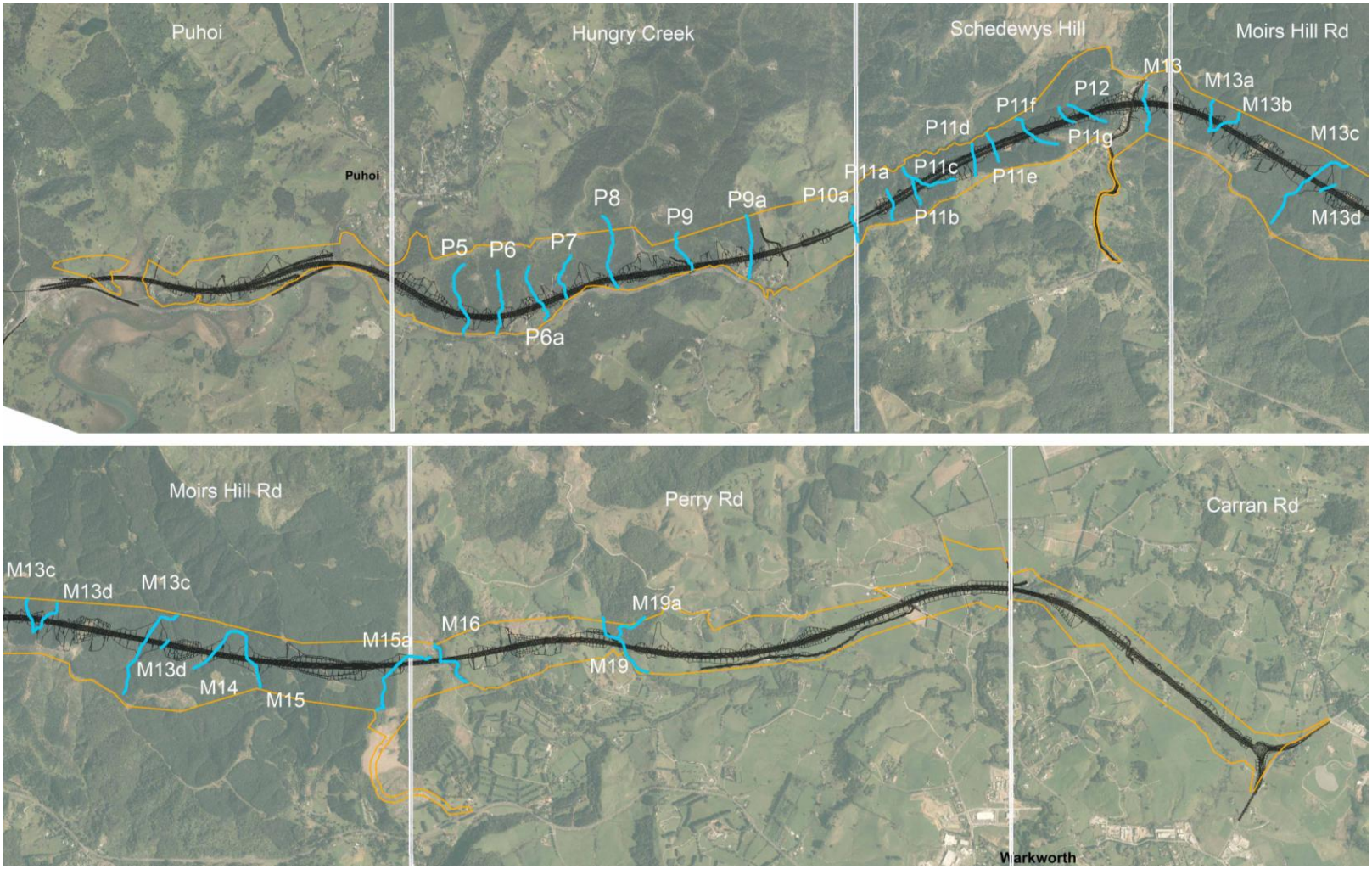

Figure 4: Streams searched for Hochstetter's frog

4.4 Reptiles

Our desktop investigations revealed two large areas of pine plantation and several smaller areas of native forest and scrubland that could be potential reptile habitats. The Department of Conservation's ARDS database contained records of copper skink, ornate skink, forest gecko, Auckland green gecko and pacific gecko within 3km of the proposed Project designation (Bioweb, *accessed 16.04.2013*)

For those sites we could access, we identified copper skinks at [redacted] (n = 4 individuals),[redacted] (n = 5), and [redacted] (n = 9) from inspections of artificial lizard retreats. We considered all Sites where copper skinks were recorded to represent populations.

Our habitat searches identified a single copper skink at [redacted] Most sites that were dominated by native vegetation had few searchable materials, aside from leaf litter. Pine plantations provided ample searchable material and potential habitat, along the edge of the pine and in clearings. No native lizards were identified in the pine plantation areas.

We identified six forest geckos from 32 person search hours of nocturnal VES (visual encounter surveys). We identified forest geckos at [redacted] (n = 3), [redacted] (n = 2), and [redacted] (n = 1).

4.5 Birds

We recorded 20 native bird species within the Project area. These include terrestrial, wetland and aquatic species.

4.5.1 Terrestrial birds

Our literature search indicated 38 terrestrial species have been recorded in the wider area surrounding the Project (Robertson et al 2007). Those species consist of 16 endemic and native species, and 22 introduced species. One of those species is considered threatened (North Island kaka) while two are considered to be "At Risk" (NZ pipit and kakariki). We consider that the presence of kaka, kakariki and NZ pipit is likely to be limited and intermittent, and that the areas of the indicative alignment likely to be used by these species consists of grazed pasture, young pines and cutover pine plantation.

Kaka are known to use pine plantations (e.g. Kaingaroa Forest, Pawson *et al*, 2010) and have been observed feeding on young cones of *Pinus radiata* on Great Barrier Island (G. Don, pers. obs.). Kakariki are also present on Little Barrier Island, Tiritiri Matangi Island, Motuihe Island and Motutapu Island, and have dispersed across the water from the Tiritiri Matangi to Shakespear Regional Park c. 4km away.

NZ pipit is a recent addition to the "At Risk" species list on the basis of changes in land-use, particularly the conversion of sheep farming to dairy farming (Miskelly et. al 2008), however this assertion was not supported by empirical data. Gill et al (2010) report that NZ pipit was originally probably restricted to mountain and lowland tussock grasslands, riverbeds and the coastal zone, but with European settlement its range increased greatly; now avoids pure pasture land, but still fairly common in rougher farmland and open country generally (including alpine). We consider that

Pipit are likely to be more prevalent in more open habitat types along the coastal strip to the east between Pūhoi and Warkworth.

Of the three "At Risk" or "Threatened" terrestrial species recorded from the wider area (i.e. North Island kaka, NZ pipit, red-crowned parakeet), we recorded a single NZ pipit at a clearing in the pine plantation at Site 12.

We did not record any other At Risk or Threatened terrestrial species. The most common species we recorded were grey warbler and fantail. We recorded kereru at six locations (Sites 6, 8, 13-16). See **Appendix D** for a list of the bird species identified at each site.

4.5.2 Wetland birds

Four wetland species have previously been recorded in the wider Project area, three of which - marsh crake, spotless crake and fernbird - are considered to be "At Risk" (Miskelly et al 2008) in New Zealand (both crakes are secure overseas), although the fernbird population is considered to be stable.

During our field surveys, we observed pukeko throughout the areas surveyed. No crakes or fernbirds were identified in November (during the breeding season) using lure tapes at surveyed wetland Sites. However, we observed fernbird at Site 7, at the southern end of the pine plantation, adjacent to the Pūhoi Pioneers Memorial Park and along Cook Road, in regenerating scrub along the ridgeline (also within the plantation).

We note that although we undertook the field inspections in drought conditions during summer 2012/13, the fernbird is not especially mobile, and also uses dry terrestrial habitats (such as where we identified them at Site 7). We consider it unlikely that fernbird would have dispersed from wetland sites where we played lure tapes.

Conversely both spotless crake and marsh crake are more wetland-dependent and are considered quite mobile (Heather and Robertson, 2005). Therefore, we consider that crakes could have conceivably vacated wetland habitat and moved elsewhere, during our survey period. However vegetated areas containing lakes or freshwater ponds are limited within the Project area.

4.5.3 Aquatic birds

A total of 22 aquatic (freshwater and estuarine) species have previously been recorded (Robertson et al 2007) in the wider Project area and of those five are considered threatened (caspian tern, grey duck, NZ dabchick, pied shag and red-billed gull) and six are considered "At Risk" with the remaining considered "Not Threatened".

Our field surveys identified mallard ducks (not native) as the most common aquatic bird. We also identified pied shags roosting on a dead tree upstream of the SH1 bridge at the Pūhoi Intersection (Site 5) and banded rail in the Okahu Creek habitat. We observed one banded rail crossing Billing Road and their footprints were common in the lower half of the Okahu Creek channel east of the indicative alignment. Our literature review indicated that banded rail had not previously been recorded in that area (Robertson et. al 2007). Given the habitat type available, we expect banded rail to be frequent throughout the Pūhoi River estuarine area.

4.6 Bats

Some habitats within the Auckland Region are known to support populations of the threatened long-tailed bat (*Chalinolobus tuberculatus*), including the Hauraki Gulf Islands: Kawau, Great Barrier and Little Barrier. On the mainland, the Waitakere and Hunua Ranges support the best-known populations. Historic records indicate long-tailed bats occur around the southern Kaipara Harbour and there is one 1984 record from a bush patch on Wyllie Road within the Project area (O'Donnell 2000a; Department of Conservation bat records database). Long-tailed bats were recently recorded north of Auckland at Riverhead Forest and near Pūhoi (Bioresearches unpubl. data). Because the species is difficult to observe in the wild, the paucity of records around Auckland may reflect a lack of bat survey effort in the region.

The weather was very warm and dry during our survey period which was favourable. ABMs recorded for an average of 6.6 'useable nights' at each location (range 4 - 17 nights; total useable ABM-nights = 166).

We recorded bats in clearings and edges within plantations of medium-sized (c. 10-20cm d.b.h.) pines, riparian areas, and along the edges of native forest. Locations where long-tailed bats were detected are shown in Figure 5. We detected bats at eight locations from Schedewys Hill to the southern Perry Road sector. Habitat in these sectors comprised a large plantation (several hundred hectares) of medium-sized pine and several smaller remnants of native forest (Perry Road sector). The pine is bordered by two large Significant Natural Areas (SNAs), containing mature native forest, outside the proposed designation (Pohuehue Scenic Reserve and Moirs Hill). The two native forest sites (Sites 13 and 14) where long-tailed bats were found (ABM 13 and ABMs 14a, b, c) have been avoided following amendments to the indicative alignment and these areas are now largely outside the proposed designation.

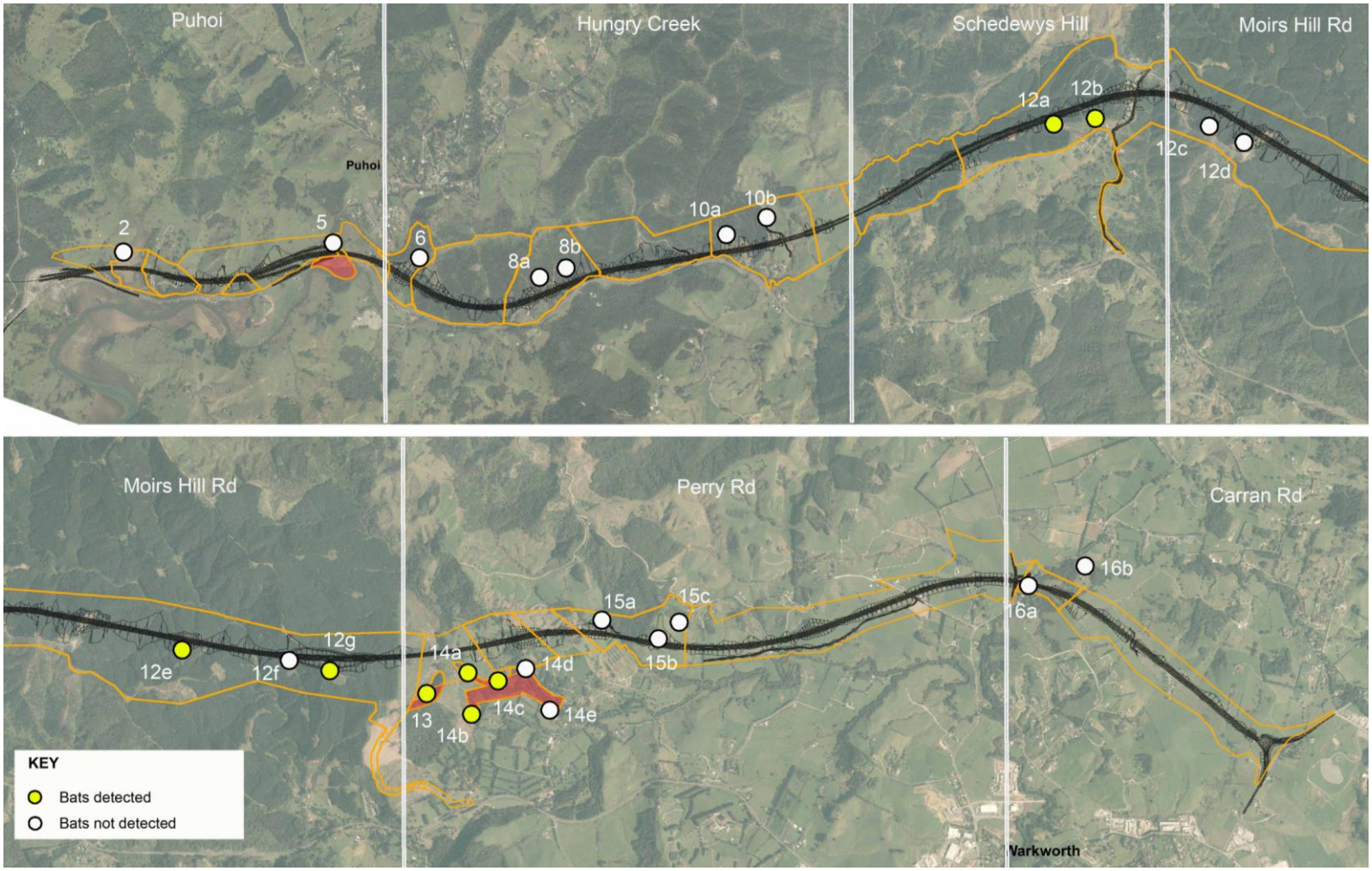

Figure 5: Locations of ABMs that detected and did not detect bats. Numbers correspond to Sites as given in Figure 2

Feeding buzzes were recorded at Sites 12a, 12g, 13, 14a, and 14c. The maximum number of feeding buzzes recorded from any ABM was two and this was low in comparison to the number of passes recorded from those ABMs.

We consider the native forest remnants at Sites 13 and 14 to have high potential to provide for communal roosts, as many large and relict native trees were observed there. Both sites also had large numbers of kauri, the species preferred for roosting in by long-tailed bats in the Waitakere Ranges (Alexander 2007).

In contrast, all of the areas of pine plantation that were within the proposed designation boundary at Site 12, which made up the largest continuous area of habitat where bats were recorded, contained trees that were probably too small to provide suitable communal roosts at the time of the survey (2009). However it is possible that some of those areas were being used for roosting by solitary bats.

Site 15 contained potential communal roost habitat, similar to what we observed at Sites 13 and 14, although we did not detect bats there. However, Site 15 was very close to habitats where bats were detected and therefore may be used by bats intermittently, or in the future.

The landscapes beyond the proposed designation boundaries of the Project area further provide many potential communal roosting areas that would be within the range of the bat populations we recorded. For example, areas of larger, mature pines were observed within the plantation beyond Site 12. Several large SNAs that contain mature native trees (which would provide cavities suitable for communal roosts) occur nearby to the east and west of Site 12 (e.g. Pohuehue Scenic Reserve) and a large area of native forest (c. 12ha) adjacent to Site 13 contained many relict trees.

5. Assessment of effects on terrestrial ecology

The terrestrial ecology effects of the Project arise from the direct and indirect effects of the Project on loss of vegetation and habitat for terrestrial fauna. Affected fauna species include land snails, reptiles, birds and long-tailed bats.

The effects of the Project on vegetation include direct loss, edge effects, shading and rain shadow effects of bridges and viaducts, increased dust deposition and reduction in the height of vegetation under bridges and viaducts. Given that the total area of native forest vegetation of all classes inside the actual alignment is less than 8.5 ha (only 5% of the total Project area), we consider the overall effects of the Project on native vegetation to be minor.

Four wetland sites will be totally lost, as well as generally small areas of a further five sites. However, as these wetlands are generally small with low botanical values, we consider the overall effects on wetlands to be minor. Some wetlands within the proposed designation are suitable for restoration as part of the overall mitigation planting plan.

We consider that the Project may have significant effects on the presence of "At Risk" native land snails (*A. dunniae*), two species of native lizard, "At Risk" fernbirds and "Nationally Vulnerable" long-tailed bats. For most species, these effects are greatest at the vegetation-clearance phase. There will also be longer-term effects for long-tailed bats and common birds, as replanted vegetation will take time to mature to provide feeding and roosting habitat.

Overall, we consider that our species-specific recommendations will adequately minimise and mitigate the construction and operational effects of the Project. The Project affords the opportunity to plant areas of higher quality native vegetation within the proposed designation. This would greatly exceed the area of native vegetation lost. Plantings would also increase habitat connectivity in the long-term, which would benefit all terrestrial fauna.

5.1 Effects on vegetation and flora

5.1.1 Potential effects on native vegetation

Native vegetation within the Project area can be affected by road construction activities both directly and indirectly as follows:

(a) Direct loss of native vegetation, which also provides habitat for a range of native terrestrial fauna such as lizards, bats, frogs, snails and birds.
(b) Creation of new edges where the vegetation is removed from part of a stand of native forest. The vegetation at the new edge will experience altered environmental conditions including an increase in light levels, increased temperatures, greater fluctuations in temperature and decreased humidity at the new forest edge compared to the conditions they formerly experienced in the forest interior. These effects are known to occur over at least 50m from the newly created edge, (Young and Mitchell 1994). The drier, warmer and lighter conditions may result in the death of some native species that require the cooler, moister and shadier conditions of the forest interior. More importantly many species fail to regenerate at the edge resulting in a gradual loss of species diversity. Trees that are situated at the new edge are also susceptible to "wind throw" or being blown over during storm events as they no longer have the shelter and support of neighbouring trees. Small areas of native vegetation under about 9ha in area are generally already influenced to some degree by edge effects depending on their shape and land

contour. Where new edges are created within larger areas of native bush there are likely to be significant edge effects.

(c) Weed invasion along newly created forest edges and where the ground is disturbed during the construction phase. Machinery moving from place to place may spread weed seeds which are then likely to invade any disturbed ground. Invasive weeds may colonise disturbed areas and forest edges where they can smother native plants and suppress natural regeneration of native species. Shade tolerant weeds such as ginger and climbing asparagus are able to invade the forest interior and disrupt the ecological integrity of the native forest.

(d) Changes in soil moisture resulting from changes to the hydrology of the area caused by cut and fill activities. Excavation of topsoil and subsoil associated with "cut" activities during the construction of the road may exert a drainage effect on the moisture content of the soil in the vicinity of such works. If these effects are severe enough there may be adverse effects on the health of surrounding vegetation. Even quite small alterations in soil moisture may predispose some forest species to adverse health effects or death in the event of drought. Wetlands may be adversely affected by losing all or some of their water sources resulting in their drying out and shrinking in size.

(e) Airborne dust may be created in significant amounts during construction where large areas of earthworks are exposed There is a small risk of adverse effects on adjacent native vegetation. If they do occur these effects are expected to be temporary because the high rainfall of the district should ensure dust is generally washed off vegetation within a short time period, except during periods of prolonged dry weather. We have recommended dust suppression measures as set out below to ensure that dust deposition onto native vegetation is minimised.

(f) Deposition of fill alters the soil level for larger plants and trees and may result in adverse health effects such as collar rot which can kill the plant. Fill re-directs ground water flow and overland water runoff which may raise the water table leading to root rot. Wetlands may be filled in and disappear if fill or sediment is deposited within them.

(g) Shading and rain shadow effects due to the carriageway passing over the top of vegetation. The construction of bridges and viaducts over areas of native bush may result in shading and rain shadow effects that deprive them of the sunlight and moisture that all plants need to survive. The scale of these effects is determined by the width and height of these structures: wider and lower structures have greater shading and rain shadow effects than higher and narrower structures which allow greater penetration of light and less interception of rainfall. Plants affected by rain shadow and shading will be subject to dry, shady conditions which are generally poor conditions for plant growth and which may cause adverse effects to their health and potentially death.

(h) Trees that are located under viaducts and bridges may need to have their height reduced, depending on the height of these structures. Smaller trees may survive trimming but large trees that have their height reduced by a substantial amount may not survive.

(i) Kauri dieback is a serious disease of kauri that is present in the Auckland Region. The disease kills kauri trees and is spread from one area to another through the movement of infected soil. Areas containing kauri that are free of kauri dieback disease may become infected if infected soil is brought onto the site on machinery or work boots. The disease is of particular concern given the serious depletion of kauri forest in Rodney ED due to historic logging of the species.

5.1.2 Native forest sites

Native forest sites within the designation are generally small and of low to moderate value with the exception of Site 15A. The indicative alignment avoids Sites 13, 14 and 15B which are of high ecological value and areas containing threatened plants at Sites 10 and 12. The effects of the project on native forest sites are described below.

Site 3

Approximately 0.5ha on the western edge of the area (on the western and northern sides of the house at 22B Billing Road) would be affected by cut and fill for the indicative alignment. The vegetation in this part of the stand has generally low botanical values as it is grazed and contains mainly young totara and manuka with mature pines. The vegetation affected by the indicative alignment is not significant. We expect edge effects to be negligible as cut and fill would occur up to the ridge crest and the remaining vegetation on the eastern side of the ridge would be protected by the landform. Similarly, any minor changes to the surface hydrology would not affect the vegetation on the other side of the ridge. The Okahu Creek Scenic Reserve which lies within the proposed designation will remain unaffected except for the possible loss of up to 150m² in the extreme north western corner where the vegetation is similar to that described above. This reserve is a small, narrow area of secondary forest containing some medium-sized kauri and podocarps lying next to SH1. We consider the effects of the project on this site to be minor.

Site 4

Approximately 0.2ha on the edge of the ridge spur would be lost to fill activities for the indicative alignment. The botanical values in this part of the stand are generally moderate. Several medium sized kauri trees and some smaller trees may be lost. The secondary kauri forest found within this site has moderate significance because it is under-represented in the Rodney ED, however it is a very small area of which the greater part will be preserved. The main kauri stand is further up the ridge and will not be affected either by edge effects or any minor hydrological change brought about by the fill batter required for the indicative alignment. The stand is already very small and lacks an understorey so that edge effects already permeate it to a large degree. Stock damage of kauri tree roots currently threatens the long-term persistence of the forest. We consider the effects of the project to be low to moderate.

Site 5

This area contains colonies of native short hair plume grass (*Dichelachne inaequiglumis*) which is ranked nationally as "Naturally Uncommon" (de Lange et al 2009). In addition there are a number of well-established podocarps and kauri trees of moderate size, a few of which may be lost as a result of the Project. The design provides for a viaduct through this site at a height of 6 – 15m above the ground and the placement of a bridge pylon approximately of 4m x 4m somewhere within it, which will result in some vegetation disturbance. There is a dual carriageway of approximately 12-13m in width northbound and southbound, separated by approximately 4m. Vegetation under the bridges may potentially be trimmed to reduce its height and it will also be subject to a rain shadow effect given the low height of the bridges and their width. Because of the north-south orientation of the carriageway the amount of vegetation underneath that is in total shade will be minimised. Rain shadow effects and the effects of trimming forest vegetation are described in section 5.1.2. Overall the effects on the vegetation at Site 5 will be minor provided our recommendation to conserve the short-hair plume grass is followed.

Site 6

Although some of the totara trees on the ridge in this site are of large size, they are few in number and the overall botanical values of this site are low - moderate. Only about half of these trees will be affected by construction and cut and fill activities. In terms of the criteria set out in Section 2 the site has low significance. Effects on vegetation at this site are considered to be minor.

Site 8

Effects on vegetation at this site are expected to be minor. There are some large puriri trees scattered within the Project area but they are mostly outside the indicative alignment and are unlikely to be directly affected by road construction activities. We identified three large puriri trees at this site, which are outside the indicative alignment and there may be others scattered across the proposed designation. The potential loss of one or two of these trees that may be within the indicative alignment represents a minor effect. It is unlikely that all of these trees would be lost as they are generally quite widely scattered.

Site 10

The totara trees containing mistletoe plants that are within the designation have been avoided by the indicative alignment and construction access track at this site. Assuming they are avoided, there would be no effects of the Project on these plants.

Site 13

The indicative alignment avoids this site, passing to the west of it. An access track is planned to run along the south western side of the site below the ridge spur it occupies. The effects of the project on this site would be negligible provided the site continues to be avoided.

Sites 14A and 14B

Only parts of these sites are inside the Project area and the indicative alignment itself avoids them, passing to the west via viaduct. Provided the sites continue to be avoided, these sites are unlikely to be affected by road construction.

Site 15A

A total of approximately 1.6ha (6.6%) of the forest will be lost to the indicative alignment and associated cut and fill (refer to figure 6), including 0.44ha of kauri forest. Within the Rodney ED kauri-dominant forest is estimated from Auckland Council databases to be 622ha (K Hill pers comm); this represents 55% of this forest type remaining in the Auckland Region. The loss of 0.44ha of kauri forest at Site 15A represents 0.07% of the kauri forest present within the Rodney ED. A section c. 170m long of the riparian forest immediately to the south of the main forest block will be lost due to a stream diversion.

The indicative alignment passes to the eastern edge of the site and avoids most of the main kauri stand, particularly the densest and best quality part. A 220m long viaduct is proposed to pass over most of the affected area at a height of between 6m and 20m approximately. Earthworks associated with the viaduct abutment will occur on the northern eastern edge of the forest and approximately seven of the 14 viaduct support piers may be placed within the forest in the alignment. Riparian forest to the north along the Mahurangi River Right Branch may be affected by the viaduct but generally it will remain contiguous with other riparian vegetation to the north.

Kauri are sensitive to soil moisture, and although they generally occupy ridge crests and other well-drained sites, they are shallow–rooted and may be potentially more susceptible to drought if a cut exerts a drainage effect on the ridge above. The scale of the cut planned in the vicinity of the northern abutment of the viaduct will not result in significant drainage effects however (Pers Comm. Ben Fountain).

The indicative alignment avoids the single mature kawaka tree that we found at this site although seedlings may be within the indicative alignment. Mature kawaka trees are present in the Woodcocks Kawaka Park Scenic Reserve 4km away.

Vegetation located underneath the viaduct will, as a minimum be trimmed to reduce its height and in reality will probably be lost to the construction zone. Kauri and some podocarps such as rimu will not tolerate trimming and will be lost. Understorey vegetation and small trees may well tolerate trimming and survive well, if they are not cleared, given that the viaduct runs north – south and there should be reasonable light penetration underneath much of it. Since the viaduct is located at the base of a long ridge and valley system this vegetation may not be unduly affected by rainshadow effects because surface water will tend to flow under the viaduct from the land above.

There will be some edge effects since new forest edges will be created on each side of the road, along the cut face associated with the viaduct and abutment on the western side and with the stream diversion. Forest plants that are sensitive to humidity and exposure may be lost and there is potential for windthrow to occur. These effects are likely to be moderate as the indicative alignment passes generally no more than 50m into the forest from the existing edge and this area will currently be subject to some edge effects. Associated with the creation of new forest edges is the potential for weed invasion along the newly created edges.

The key effects of the Project on the botanical values of this site are:

- Loss of a total area of 1.6ha of mature secondary forest and riparian forest;
- Loss of an area of c. 0.44ha of kauri forest estimated to be 75 - 100 years old, containing some trees of medium size;
- Moderate edge effects;
- Potential for weed invasion along the newly created forest edges; and
- The potential for kauri dieback disease to be introduced and/ or invade the site.

We consider the effects of the Project to be significant at this site.

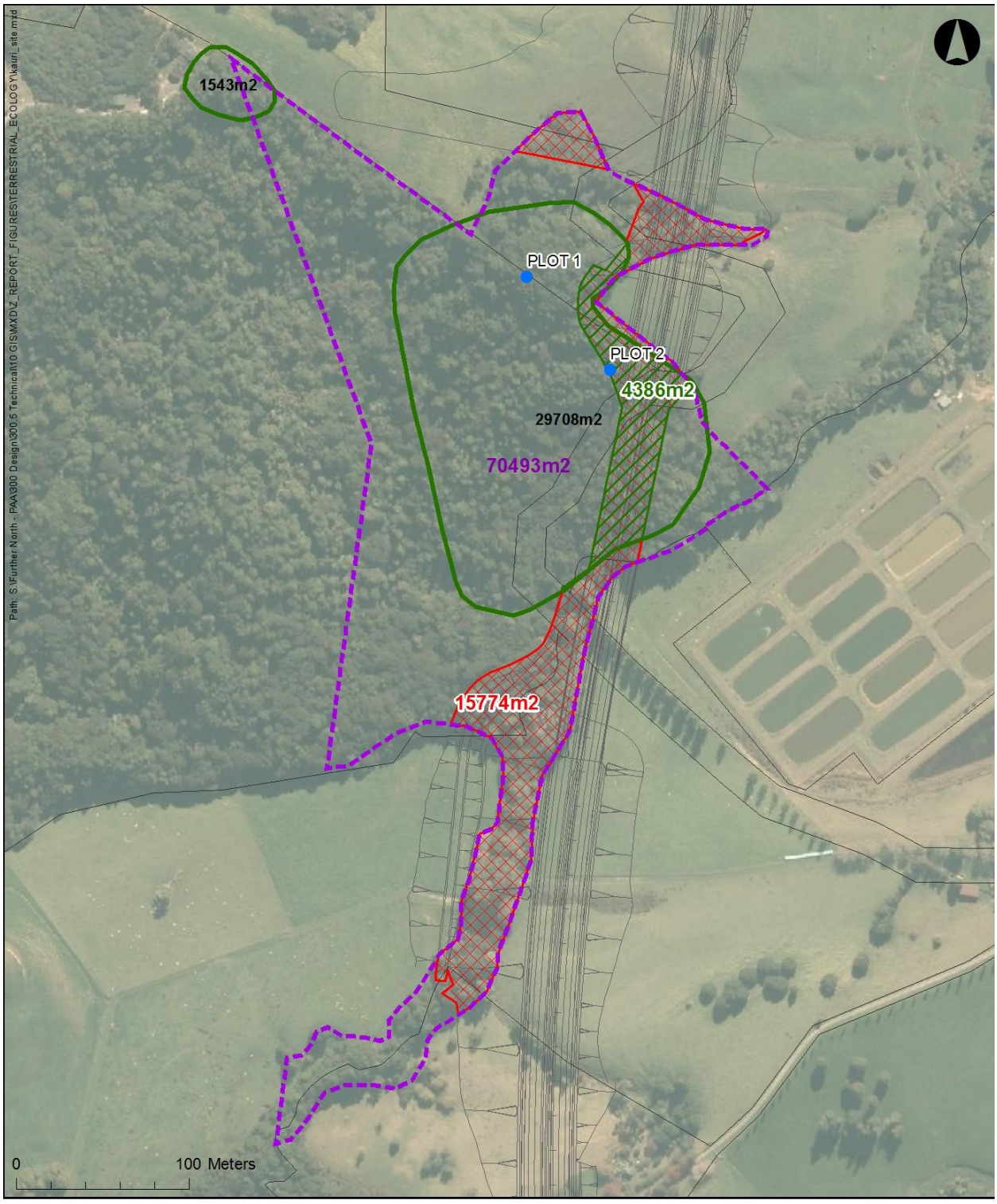

Figure 6: Site 15A showing areas of forest affected by the indicative alignment
The location of the two sample plots (Plot 1 and Plot 2) described in Section 4.1.2 are shown

Site15B

This forest patch is within the proposed designation and although it is quite small it has high botanical values due to the age and maturity of the vegetation. This site is avoided by the indicative alignment and there will be no ecological effects on it.

Site 16

The indicative alignment passes over only a small area of native forest at this site estimated to be no more than 0.3ha. A dual carriageway bridge structure of approximately 12-13m in width northbound and southbound, separated by approximately 4m will span this site at a height of 6m. Trees under the bridge will have their height reduced to less than 6m and rain shadow effects from the bridge above will affect the vegetation underneath. Because of the north-south orientation of the carriageway the amount of vegetation underneath that is in total shade will be minimised. Rain shadow effects and the effects of trimming forest vegetation are described in section 5.1.2. A small area may be required for the construction of a bridge pylon as described for Site 5, although this is more likely to be placed in the adjacent pasture or area of exotic trees The indicative alignment lands just to the north of this site and a small cut on the western side may affect a few trees on the edge of the site. We expect that some medium sized totara trees will be lost here, however the overall effects at this site should be less than minor.

Site 33

This site has low plant diversity and the vegetation type is one of the most common in Rodney ED (Lindsay et al 2009). We consider the loss of 1.5ha of this vegetation to be a negligible effect.

Wetland Sites

With the exception of the Okahu Creek Estuary, all of the wetland sites described in Section 4.2.3 are small. The majority of them are in open grazed pasture and their botanical values are low. The effects on wetlands within the Project area are as follows:

- Wetland 1: Okahu Creek Estuary: Construction activity in this area will be the temporary and structural work required to build the 475m viaduct across the Okahu Creek. These works will include the construction of supporting piers for the viaduct, approximately five of which will be constructed within the estuary itself. Two of these piers (S2 and N2) will be constructed within the saline vegetation fringing the northern shores of the estuary. A narrow tidal channel next to the proposed pier locations will be diverted to allow the works to occur and a temporary access road to the base of the piers will be constructed partially within the intertidal zone (refer to Concept Plan ES071 for indicative locations). The foundation for each pier will be approximately 2.5 x 4m in area when complete; however a temporary coffer dam will be constructed around each pier to provide dry conditions for construction. The dam will provide a 5m buffer area around each pier. The other piers will be constructed either further out in the middle of the estuary or on dry land to the north or south of the estuary. The saline vegetation at the construction site on the north shore of the estuary is sparse because the area is shaded by several large old pine trees. We consider the effects of the project on the saline vegetation will be negligible at this site.
- Wetland 2: will be partially lost and it may lose all or part of its water source as a result of the Project. This wetland is very small and its botanical values are low due to stock grazing and weed impacts. We consider the potential ecological effects at this site to be minor.
- Wetlands 3: All of this wetland will be lost apart from the lowermost edge. The effects of the Project on the bulk of this wetland will be minor as the upper part of it contains mainly exotic species and it

is grazed and pugged. The lower part contains a restricted range of native wetland species and is tidal. Much of this part will also be lost and we consider the effects of this loss to be minor due to the low botanical values here.

- Wetland 4: The upper grazed part of this wetland will be lost. The effects of the Project on this area will be negligible as it contains mostly exotic species and it is impacted by stock. The small lower tidal area is avoided by the current alignment and we expect the effects of the Project on it to be negligible.
- Wetland 6: The pond will be filled in and lost. We consider this effect to be minor as the pond has low botanical values and is very small.
- Wetlands 7 & 8: The indicative alignment passes to the east of both of these and no works are proposed within them other than a culvert in the lower part of Wetland 7 to carry water under the indicative alignment. The effects of the Project on these wetlands will be negligible.
- Wetland 9: The indicative alignment will cross the uppermost part of this wetland and a culvert will carry water under the alignment into the lower part of the wetland. The botanical values in the upper part of this wetland are low and we consider the effects of the Project to be negligible as the most of the wetland is outside the designation and will remain unaffected.
- Wetland 10: One of the ponds at this site will be lost while the other will be avoided except for a small area on the edge of the planted vegetation. The alignment and fill batters will affect about half of the other small wetland in its middle section. These wetlands have low botanical values and we consider the ecological effects of the Project on them to be negligible.
- Wetland 11: The uppermost southern part of this wetland will have some fill placed in it and a property access road will be constructed along the edge of this fill; however most of the wetland lies outside the proposed designation and indicative alignment. We consider the ecological effects of the Project on this wetland to be minor.
- Wetland 12: This wetland will be lost as a result of the Project. As it is a revegetated area of relatively recent origin and not a natural plant community we consider the ecological effects of its loss to be minor.
- Wetland 13: There will be no effects of the Project on this wetland.

Despite their botanical values being low, these wetlands do not have negligible values. Accordingly, we consider the overall effects of the Project on wetlands within the designation to be minor.

5.2 Effects on land snails

The effects of the Project on the Rhytid snail, *Amborhytida dunniae*, identified at [redacted], include both direct and indirect adverse effects, namely reduction in habitat quality and direct mortality. Because this species is classified as "At Risk", we consider that these effects would be significant. However, the Rhytid snail is not listed as a protected species and therefore approvals under the Wildlife Act to mitigate potential effects would not be required. The effects of the Project are detailed below.

5.2.1 Habitat clearance

The clearance of vegetation and habitat features could result in direct adverse effects (i.e. significant injury or mortality) to native land snails at[redacted] Removal of forest floor substrate would cause desiccation and mortality to resident snails and their invertebrate food source. Furthermore, the potential displacement of some snails into remaining areas of the forest fragment may result in failed attempts to re-establish due to competitive exclusion by resident wildlife communities already present in those areas.

5.2.2 Disturbance

Noise, vibrations, and large volumes of dust created by activities associated with works are likely to be short-term stressors only.

The effects of excessive dust can degrade and impact significantly on native land snails in adjacent habitats. Dust particles can fill in important interstitial spaces (small gaps) into which native snails and their invertebrate food source would otherwise retreat, and therefore reduce adjacent habitat quantity and quality for snails as well as their invertebrate food sources. However high levels of dust are not expected to be created through construction and operation of the viaduct [redacted], and therefore we consider that these effects will be minor.

Land snails use chemosensory cues to detect prey; though it is unknown to what extent they may also use vibration. A population of another carnivorous and closely related Rhytid snail, *Rhytida greenwoodi greenwoodi*, is known to occur adjacent to an operating rock Quarry in Drury, South Auckland (G. Don, pers obs), where substantial vibrations (rock blasting) have not had any apparent effect on presence. The effects of vibration on land snail populations at [redacted] is relatively unknown. However, based on the persistence of a population of *R. greenwoodi* adjacent to the South Auckland rock quarry, we anticipate that the effects of vibrations associated with construction and operation of the Project are likely to be minor.

We consider disturbances associated with noise to be minor, as land snails are not considered to have a developed auditory capabilities beyond noise vibrations.

5.2.3 Edge effects

The Rhytid snail, *Amborhytida dunniae*, naturally occurs in moist areas of native forest with a dense leaf litter. We observed these habitat types at least 20m from the existing edge of [redacted], where *A. dunniae* were identified.

We consider that *A. dunniae* is vulnerable to edge effects at [redacted], where some small areas of vegetation clearance could adversely change the microclimates within the forest that the Rhytid snails require. Those edge effects include increased light, wind and temperature levels, and all of these could potentially have a significant, desiccating impact on Rhytid snail habitat.

In addition, invasion of the newly created forest edge by weed plants could significantly alter the forest floor structure and reduce leaf litter accumulation. Forest floor leaf litter is important for providing the particular microhabitats that the snails require as well as providing a food source for the snail's invertebrate prey species. Such alteration of snail habitat along the forest edge at [redacted] could have a significant effect along the newly created edges, particularly where viaduct support structures are proposed.

5.3 Effects on frogs

No frogs were detected within the Project area.

5.4 Effects on reptiles

Many native reptiles are visually and behaviourally cryptic, particularly when they occur at low density. This is often the case for "At Risk" and "Threatened" species, which now account for the majority of the

reptile fauna. Therefore surveys typically require repetitive sampling, as per our methodology, to increase the probability of detecting them where they are present. For this reason, we cannot confirm that any species is absent from Project sites where we did not detect them. Further, "At Risk" green geckos, pacific geckos, and ornate skinks are known to occur in habitats that also support copper skinks and forest geckos.

The effects of the Project on copper skinks and forest geckos, where recorded from our surveys, are discussed below. We also consider that the effects described would apply to other lizard species potentially present at those sites.

5.4.1 Habitat clearance

We recorded native lizards using native forest as well as mixed native and exotic scrub at Sites [redacted] No native lizards were recorded in pine plantation sites. Scrub vegetation (including exotic) often supports populations of native lizards, including those species in Table 1. These vegetation types typically occur around the edges of established forest, are often early seral, and are typically regarded as having low or no ecological value (especially exotic vegetation, such as pampas and kikuyu grass) despite their importance to native lizards where they are present. Consequently, these vegetation types tend to undergo rapid turnover (clearance and re-growth), which has contributed to the decline of many native lizard species in human-modified landscapes.

The clearance of vegetation and habitat features during Project construction would result in significant, direct adverse effects (i.e. significant injury or mortality) to native lizard populations at [redacted] (clearance for viaduct support structures), [redacted] (clearance for indicative alignment and associated earth works). Removal of debris and shelter structures (e.g. logs, rock and wood piles), via dragging or rolling and burying shelter structures under soil, may cause injury or mortality to resident reptile communities at those sites. Furthermore, the consequent displacement of lizards into surrounding areas may result in failed attempts by lizards to establish, due to competitive exclusion by resident wildlife communities already present in adjacent habitat.

Habitat clearance associated with pre-works activities such as installation and establishment of site offices, parking and storage areas would also affect native lizard populations at [redacted] Although not always associated with construction works, these activities would have similar effects to those described above.

5.4.2 Disturbance

Noise and vibrations created by earthworks are likely to be short-term stressors that could adversely impact on lizards in adjacent habitat. Noise and vibration are likely to be short-term, non-lethal stressors to any lizards in adjacent habitats. Native lizards rely on visual and chemosensory cues to detect and capture prey, and to find mates. We do not consider that the potential effects associated with noise and vibration during the Project construction or operation will be significant.

Excessive volumes of dust are not considered to be an issue during construction within the Project area and therefore we consider that these effects will be less than minor.

5.4.3 Edge effects

Forest gecko and copper skink are typically encountered in edge habitats, including scrub vegetation on roadsides. Similarly, these locations could accommodate other lizard species that were not detected, but

may be present nonetheless (e.g. pacific gecko, Auckland green gecko, and ornate skink). Therefore we do not consider that the creation of edge habitat will have any negative effect on native lizards.

An increased proximity to the roadway could create regular noise, vibration and lighting disturbances, however we consider these effects to be minor, as the species detected, and potentially present, are known to occur in roadside habitats, including some main roadways (e.g. geckos along Coatesville-Riverhead Highway and copper skinks alongside SH16).

5.4.4 Summary of effects on reptiles

We consider that the overall effects of the Project on native reptiles are likely to be low-moderate, based on there being mostly small areas of habitat affected and a low diversity of reptile species identified at those sites. However, we also consider that forest geckos are a nationally "At Risk" species, and that other species may be present at those sites but were not detected.

Most sites where native reptiles were identified were found to contain a population of at least one of two species (forest geckos and copper skinks). Those species are characteristic of reptile communities within similar habitats throughout the Auckland Region.

We consider that the potential magnitude of adverse effects will be greatest at [redacted], where the quantity of habitat that would be cleared is greatest (approximately 3ha). We also recorded the highest diversity of lizards at [redacted] and consider that other native lizard species may also occur there.

The following table summarises the key sites and resident reptiles that would potentially be affected by habitat and vegetation clearance associated with construction works.

Table 2: Effects of habitat clearance on reptiles at each site

Site	Issue	Potential Scale of Effect	Explanation
■	copper skink population	Low	Copper skink population- small area affected
■	forest gecko population	Moderate	Forest geckos "At Risk", small area affected
■	copper skink & forest gecko populations	High	Two species present including "At Risk" forest geckos. Large area affected (approximately 3ha).
■	copper skink population	Low	Site avoided by indicative alignment
■	forest gecko	Moderate	Forest geckos "At Risk", small area of habitat affected.

5.5 Effects on birds

The Project will result in a loss of terrestrial and freshwater habitats for birds. Potential adverse effects on avifauna include the clearance of isolated food trees, direct mortality of eggs and chicks (if clearance occurs during the breeding season), habitat reduction and further fragmentation, general disturbance effects such as light and noise, further edge effects together with sediment discharges during the construction phase, and stormwater discharges during the operational phase.

5.5.1 Terrestrial birds

Overall the majority of avifauna that would be affected by the Project consists of common native and introduced species. We consider that the effects of the Project on such species, such as temporary displacement, will be minor. However on a cumulative basis, there will be a significant loss of vegetation that provides feeding and nesting habitat, including some important native food trees, particularly at Sites 8 and 15 where we identified kereru within the proposed designation.

Some birds, including kereru and tui, will commute long distances to exploit productive food trees, therefore the route has the potential to affect birds well beyond the Project area.

Approximately 8.5ha of native vegetation will be cleared as part of the Project, which will have a significant effect on (mostly common) native birds with respect to feeding and nesting habitat.

We consider the loss of habitat of kereru to be significant because kereru is a keystone species (Mander et al 1998) and therefore is of greater importance than other "Not Threatened" bird species. The kereru is a highly mobile bird and capable of dispersing the seeds of large-fruited native tree species, including karaka, taraire, tawa and puriri, which most other birds cannot. Kereru is therefore considered crucial to the health of mixed podocarp-broadleaf native forest (Mander et al 1998). In addition, kereru is slow breeding and has a high level of recruitment failure. Therefore, we consider that vegetation clearance at Sites 8 and 15, where the greatest areas of kereru habitat are affected, would be most significant (see Table 4 for our conclusions on other areas).

Table 3 summarises the areas of affected vegetation that provide habitat for terrestrial birds in general and kereru in particular. A total of approximately 50ha of tree habitat (including pines) will be removed as part of the Project, and of that, we assess about 2.3ha as providing suitable habitat for kereru.

Table 3: Estimated amount of terrestrial bird habitat (native and exotic scrub and trees) and potential kereru habitat in particular (native trees) at each site as a whole, within the proposed designation and indicative alignment

SITE	DESCRIPTION	AREA OF TREE HABITAT WITHIN PROPOSED DESIGNATION BOUNDARY (HA)*		AREA OF TREE HABITAT IN INDICATIVE ALIGNMENT (HA)*		KERERU SEEN?
		ALL TERRESTRIAL BIRDS	KERERU	ALL TERRESTRIAL BIRDS	KERERU	
1**	Pine	1	0	0.2	0	
2	Wetland, native	0.45	0.2	0.1	0.1	
3	Native & pine	1.4	0.4	0.3	0	
4	Native	0.6	0.6	0.1	0.1	
5	Native, riparian	2	0.6	0.1	0.1	
6	Native	8.5	4.1	2.6	0.2	•
7	Pine, few natives	32.5	0.1	8.7	0	
8	Native	24	1	3.3	0.3	•
9	Pine	16	0	3	0	
10	Pine, pasture, native scrub	9	0	2	0	
11	Pine	17	0	6	0	
12	Pine	77	0	20	0	
13	Native	0.6	0.6	0	0	•

14	Native	0	0	0	0	•
15	Native	12	12	1.2	1.2	•
16	Native	1.5	1.5	0.2	0.2	•
33	Native	2	0.5	2	0.1	
		205.55	**21.6**	**49.8**	**2.3**	

*The estimated areas presented in this table are a guide only.

** Site Not Accessed

The following table summarises the key potential effects, and the scale of that effect, on populations of bird species that comprise the characteristic avifauna along the route. All the effects listed are relevant to this Project.

Table 4: Avifaunal issues

Issue	Scale of Effect	Explanation
(i) Clearance of kereru food trees e.g. kahikatea, taraire, puriri.	moderate	High-quality native fruit trees are food resources for kereru, including birds travelling from outside the proposed designation boundaries. However only small areas affected at Sites 2, 4-6, 8, 15, 16 and 33 (approximately 2.3 ha in total).
(ii) Clearance of other native vegetation.	moderate	Approximately 8.5ha of native vegetation throughout the indicative alignment used for feeding, roosting and nesting by native birds. Largest area of native vegetation would be cleared at Site 8 (approximately 3ha).
(iii) Direct mortality of eggs and juveniles.	moderate	Approximately 8.5ha of native vegetation throughout the indicative alignment used for feeding, roosting and nesting by native birds. Largest area of native vegetation would be cleared at Site 8 (approximately 3ha).
(iv) Habitat reduction and fragmentation.	low	Habitats throughout the proposed designation already highly fragmented, terrestrial birds typically highly mobile except potentially fernbird (considered wetland species in this assessment).
(v) Edge effects.	low	Most native vegetation areas throughout the proposed designation already subject to edge effects (ie. adverse changes in microclimate gradients). Also, see above (fragmentation). Tomtit in pine blocks may be more sensitive.
(vi) Disturbance effects – light and noise.	moderate	Most of the terrestrial avifauna occurs in a variety of environments subject to a wide range of noise levels. Some, more localised species may be more sensitive such as fernbird and tomtit, both of which were associated with pine plantation.

5.5.2 Wetland birds

We recorded a low diversity of wetland birds from surveys. Species such as welcome swallow and pukeko, which are known to use wetlands, are widespread. Therefore, we consider Project effects on these species, including some loss of feeding and roosting habitat, to be minor.

5.5.3 Aquatic birds

We recorded aquatic birds generally around estuarine areas. Those areas will be traversed via Project viaducts. Therefore, we consider that Project effects on aquatic birds will be minor. A similar complement of species is common in bridged areas of habitat such as the upper Waitemata Harbour and Mangere Inlet, Manukau Harbour (G. Don, unpubl. data).

The project will result in a considerable reduction in stream habitat (via culverting) that will impact locally upon common birds such as pukeko, mallard and kingfisher. These species are common and nationally widespread, and therefore we consider effects on these species to be minor.

5.6 Effects on bats

We consider that construction and operation of the Project could potentially cause: (1) direct mortality of bats during habitat clearance; (2) loss of bat habitat; and (3) creation of impassable barriers, preventing bats from accessing resources on the other side of the road. In addition, we consider that bat distribution may change by construction year, particularly with respect to roost site selection and availability. Therefore these effects may also change in scale. We address each of these below.

5.6.1 Risk of direct death of bats during construction

Clearance of active bat roosting habitat could potentially lead to mortality of individual and/or colonies of bats by crushing them during tree felling, causing lethal levels of stress, or forcing them out of their roost and exposing them to diurnal predators. Therefore we consider that felling of active roost trees would have significant adverse effects on long-tailed bat populations. This effect would be higher if an active communal roost tree is felled and a large proportion of the colony is killed, than if an active solitary roost tree is felled. The potential for this effect would be greatest between November and mid-February, when females are most likely to be pregnant or when communal roosts contain non-volant (non-flying) juveniles; and during winter (June to August inclusive), when their physiological activity is greatly reduced. The potential for this effect is also greater where larger, more mature trees are present, which have greater a capacity to provide cavity roosts.

5.6.2 Potential loss of habitat

The removal of habitat for construction will result in some loss of some commuting, foraging, and potentially roosting areas. We consider that such habitat loss could have significant adverse effects on the the population if areas of similar size and quality cannot be found elsewhere. However, we consider that this effect is low, as there are large areas of suitable potential roosting and foraging habitat throughout the surrounding landscape, adjacent to and outside the Project area. We

consider that these surrounding areas are also well within the range spans of the bats that we identified in the pine habitats in this study, with respect to median range spans of bats in pine forest in another study (2-8 km, Borkin and Parsons 2011).

Although it is unknown if those surrounding areas are currently being used by bats, we consider that it is very likely that they are and that the loss of some plantation habitat within the Project area from Hungry Creek to Perry Road will have a minor effect on long-tailed bats using those areas. This is because the areas of pine within which we recorded bats consisted of a very large area (>800ha) including well outside the proposed designation, and construction and operation of the road would directly affect only a small proportion (< 40ha). At the time of our surveys (2009), we did not consider any of the pines within the proposed designation to be suitable for communal roosting, though this may change with plantation maturity.

Long-tailed bat populations have also been recorded from at least 25 other plantation forests in the North Island alone (Borkin and Parsons 2010), including Riverhead (Bioresearches 2012), where they have survived through, or recolonised following, multiple harvest rotations.

Some loss of habitat would occur within the Project construction phase and potentially also during the operational phase, due to noise and light pollution affecting adjacent habitats. However, extensive planting of native vegetation (particularly good cavity bearing species such as puriri), and retention and protection of some areas of large pines within the proposed designation boundaries, would also reduce this effect.

Long-tailed bats have been observed foraging over streetlights (Lloyd 2010), so it is possible that the lit sections of the motorway would create foraging habitats for them. However, long-tailed bats have been found to avoid urban/ lit areas elsewhere (Dekrout 2009). The motorway will remain unlit except at access points (such as Warkworth ramps) and in areas of safety concern, therefore the potential effects of lighting are largely avoided and minor.

5.6.3 Potential creation of a barrier

Long-tailed bats require large areas to access widely distributed resources, with published estimates of home range size being up to 100km^2 (O'Donnell 2001b; Griffiths 2007; Dekrout 2009). The Project, when operational, may create a barrier over which bats will not fly (as a result of noise and light pollution), preventing access to foraging and roosting habitats on its far side.

However, long-tailed bats are known to fly along State highways in the Eglinton Valley and Marlborough (O'Donnell 2000b; Lloyd 2010), and even to forage over streetlights in Marlborough (Lloyd 2010). Although these roads are smaller and presumably subject to less traffic activity than the proposed Project, other bat activity studies near Cambridge have shown strong evidence that long-tailed bats will move along and over well-lit road corridors of State Highway 1 (Opus International Consultants Ltd. 2013).

In the Opus 2013 study, bats were recorded both flying over SH1 as well as moving along the road way, above the lit area, and in the presence of traffic. The lights along that area of SH1 were c. 10-11m high and the lit zone extended c. 30 – 40m either side of the lights. Although bats were not observed to enter the lit zone, the study suggested that the presence of lighting did not

prevent the movement of bats across and along the roadway corridor, and that their reluctance to enter it could reduce vulnerability to traffic collision (Opus International Consultants Ltd. 2013).

In contrast, a study of an urban population of long-tailed bats showed a negative relationship between bat presence and the density of streetlights, houses, and roads, with bats mainly restricted to the gullies on the southern side of the city (Dekrout 2009). During operation, the new motorway will remain largely unlit, and we consider that this will substantially increase the likelihood of long-tailed bats flying over it.

In addition, we also consider that there are large areas of native forest, to the east and west of the Project, which currently provide a greater quantity and quality of potential bat roosts than the >600ha of surrounding pine plantation. These areas are adjacent to the Project area or the wider pine plantation, or have good potential habitat connectivity with areas of pine within which we detected bats. They include (to the east of the Project), > 600ha of native forest that encompass SNAs from Pohuehue Scenic Reserve through to McElroy Scenic Reserve in Mahurangi. To the west of the Project area, there is approximately 250ha of native forest, including Waihunga/ Moirs Hill Scenic Reserve (SNA). Further areas of native forest connect these to an area south of Moirs Hill, of >1000ha of native forest which includes an area near Pūhoi from which long-tailed bats are known to occur (Bioresearches 2011). Therefore, we consider that bat populations will persist in habitats to the east and west of the proposed designation, and that it is unlikely that long-tailed bats will not cross the Project area during operation. We consider that the potential barrier effect of the Project will be minor.

5.6.4 Potential changes to bat distribution and habitat use by construction year

Pine plantations are a dominant bat habitat type in the landscapes between Pūhoi and Warkworth. However, habitats within plantations change over time as pines are felled, planted, and grow to felling age. The distribution of bats within and surrounding the pine areas would also change over time, as colonies move into areas as they become suitable, and move out and into adjacent habitats when pines are felled.

The current distribution of bats within the pine plantations and surrounding remnants should not be considered indicative of the exact areas they will occur in by construction year. Rather, bats should be considered likely to be present throughout any large areas of medium-sized pines, or larger, and in any surrounding areas of similar habitat. This may also include the pine block within Hungry Creek and Schedewys Hill sectors (Sites 7 and 9) where bats were not detected.

Further, while the pine plantations within the Project area were probably too young to provide communal bat roosts at the time of the survey (2009) this may not be the case at the time of construction.

Most trees in the managed forestry block through the Schedewys Hill and Moirs Hill Road sectors were around 8 to 12 years old at the time of the 2009 survey. Those trees would be expected to be harvest-mature towards the end of the 2016 – 2021 period at around 15 -26 years old. We therefore consider it likely that the areas of pine plantation that bats were detected in will be mature enough to support some communal roosts, and therefore more bats. In addition, areas where bats were not detected, including through the Hungry Creek Sector, may also be mature enough to support bats as well.

We also consider that areas of pine plantation throughout the proposed designation have probably supported long tailed bats throughout multiple harvest rotations, or that bat populations may have recolonised or re-entered plantation habitats from surrounding areas in between harvests.

5.6.5 Summary of effects on bats

We consider that the overall effects of the Project on long-tailed bats are potentially significant; however the effects would depend on the capacity of plantation habitats within the indicative alignment to support communal roosts at the time of construction. The magnitude of effect of felling any tree that contains an active communal roost is high.

We recorded potential communal roosting habitat in native vegetation at Sites 13, 14 and 15. Of these sites, only some trees at Site 15 would be cleared, but not those where we detected bats However, some trees at Site 15 may be used for communal roosting by bats by the time of construction.

We consider that the effect of the potential loss of foraging and commuting habitat for bats would be minor during construction. There are large areas of suitable potential habitat for bats in the wider landscape. We also consider that the loss of foraging and commuting habitat would be temporary, and that this effect would be minor in the long-term, as replanted trees mature.

Solitary bat roosts could occur throughout all sites where bats were detected as well as pine areas within the Hungry Creek sector, where we did not detect bats.

We consider that the potential effect of the Project to create an impassable barrier is low. We note that long-tailed bats have been recorded flying along and over active roadways, including over lit areas of SH1 during traffic. We also consider that there are also large areas of potential bat habitat on either side of the indicative alignment.

6. Recommendations

6.1 Vegetation and flora

The proposed designation contains some 40ha of native forest vegetation of which approximately 8.5 ha occurs within the indicative alignment, the largest single area being at Site 15A.

Several areas of high quality native vegetation have been avoided by the indicative alignment during the design process, these being the Pohuehue Scenic Reserve and Sites 13, 14 and 15B.

A number of totara trees carrying green mistletoe (*Ileostylus micranthus*) a species with a threat classification for the Auckland Region of "Regionally Critical" (Stanley et al. 2005) have also been avoided by the indicative alignment at Site 10 although some are within the Project area. These are found just west of SH1 opposite the Mahurangi West Road intersection. These trees should be avoided and a botanist will need to be consulted when siting access tracks and staging areas. Native bush containing "Naturally Uncommon taraire orchids" has also been avoided at Site 12. The Proposed National Policy Statement on Indigenous Biodiversity has been referred to in the preparation of mitigation strategies.

6.1.1 General recommendations for forest vegetation and flora

The following are our general recommendations that apply to all works within the designation to avoid or minimise the effects of the Project on native vegetation. Specific recommendations for each site are given in Section 6.1.2:

- Felling of native trees and clearance of native vegetation should be carried out under the supervision of a suitably qualified botanist. The botanists should also identify the significant trees to be avoided where practicable as recommended for individual sites in Section 6.1.2 and ensure that good hygiene practices are established with regard to the spread of weeds and kauri dieback disease.
- A high standard of hygiene needs to be observed at all sites where kauri are present. This means thoroughly cleaning all soil from machinery, equipment and work boots before they come onto the site and the use of a suitable disinfectant such as Sterigene(TM).
- The movement and establishment of exotic weeds within all sites should be prevented by cleaning all machinery and equipment when moving it between sites containing native vegetation. Surveillance and ongoing weed control should be undertaken until native edge vegetation re-establishes.
- Incidental deposition of spoil or sediment on native vegetation adjacent to construction works should be avoided where practicable.
- The effect of dust on adjacent native vegetation should be minimised where practicable and dust suppression practices implemented where dust may affect vegetation.

- To reduce the potential for movement of kauri dieback disease into sites that are clear of this disease, all removal of kauri trees should be undertaken during the driest months (January – February) and during dry weather only.
- We consider replacement planting of key canopy species that are lost during construction of the road (kauri, rimu, tanekaha, kahikatea, puriri, totara, rewarewa and taraire) should be carried out. We recommend replacement planting of significant trees that are removed as part of the Project works should follow the strategy set out in **Appendix C** and should be calculated according to the following formula:

  Where n = number of replacement trees required to be planted, = total basal area of trees lost and = calculated basal area of each planted tree after 20 years (estimated conservatively from known growth rates for each species).

- Suitable sites for replanting are available within the proposed designation and these should be chosen to improve habitat connectivity within the wider landscape.

- Eco-sourced plants from the Rodney ED should be used. In the case of kauri, seed needs to come from a site that is certified as being free of kauri dieback disease. If possible this should be Site 15A.

- Where practicable, the Project should seek to include other plant species that are threatened in the Auckland Region in replacement planting.

- We recommend planting fast growing native species characteristic of the edge environment and appropriate to the site along any newly created forest edges.

- We recommend revegetation and replanting within the designation to create a habitat corridor that connects the Pohuehue Scenic Reserve with Significant Ecological Areas at Moir's Hill Road. This corridor would form part of the overall mitigation for the loss of native vegetation and habitat throughout the Project Area and would include areas of mature pines that are retained as bat habitat.

- We recommend replacement planting of areas of lost wetlands using ecosourced plants on a 1:1 basis to ensure no net loss of wetlands. Integration of replacement wetland planting with some of the 17 proposed stormwater wetlands may also be possible and would provide additional wetland habitat.

- We recommend that mitigation planting for effects on vegetation be integrated with mitigation planting for effects on birds and with landscape planting to improve habitat connectivity and overall ecological values.

6.1.2 Specific recommendations for forest sites

Site 3: Dust or spoil deposition into the reserve should be avoided as far as practicable through standard industry practices. No specific mitigation recommended unless native canopy trees are removed in which case we recommend replacement planting of the lost trees as described in Appendix C.

Site 4: Fencing the kauri forest stand further up the ridge to prevent stock damage to tree roots would adequately mitigate for the loss of a few of the kauri trees on the end of the spur. Replacement planting of any individual large native trees that are removed should be undertaken as described in Appendix C if fencing of the remaining kauri is not planned.

Site 5: Colonies of short hair plume grass should be removed before construction and conserved in a nursery to be used as planting stock in the landscaping phase of the Project where practicable. Where practicable, the larger kauri and podocarp trees should be conserved by careful placement of the bridge structure and pylon. We recommend replacement planting to mitigate for the loss of any of these trees as they are the key components of the riparian vegetation (refer to Appendix C).

Site 6: Individual large totara and puriri trees should be avoided where practicable. Care should be taken to ensure spoil or silt from construction activities does not spill over the ridge into the adjacent native vegetation. We recommend replacement planting of individual large native trees that are removed should be undertaken as described in Appendix C.

Site 8: Large relict puriri trees should be conserved where practicable; however the indicative alignment avoids most of these trees. No specific mitigation recommended unless large puriri or other canopy trees are removed in which case replacement planting is recommended as set out in Appendix C.

Site 10A: Avoid damaging any totara trees that carry green mistletoe. A high level of dust control (e.g. wind fences) should be implemented in the vicinity of these trees to avoid dust deposition on green mistletoe plants. Monitoring should be undertaken to ensure the efficacy of the dust suppression measures.

Site 13: An access track is planned to run along the south western edge of the site which is on a ridge spur. Contractors should be made aware of the site's high botanical values and the track should not cause significant erosion at the base of the spur that could affect the trees on the ridge above.

Site 14A and 14B: These sites should not be affected by road construction activities. However contractors should be made aware of their values and restricted from undertaking works associated with road construction within these sites, such as access track construction, which may adversely affect these values.

Site 15A: The effects of the Project are significant at this Site because of the high botanical values of the forest that will be affected. We recommend that this Site be avoided in the first instance. If the Site cannot be avoided then we recommend that the loss of approximately 1.6ha of significant forest including some 0.44ha of kauri forest be mitigated through replacement planting of equivalent species, preferably contiguous with the remaining forest and having regard to maintaining and enhancing ecological connections. Suitable areas for replacement planting may be able to be found within the proposed designation depending on whether assessment of available sites shows that there are sites where kauri and other canopy species are likely to establish successfully. The key elements of the proposed replacement planting are set out in the general recommendations in Appendix C. Based on our replacement rationale we consider that between 1600 and 5000 kauri seedlings will need to be planted as mitigation for effects at this site

depending on a detailed investigation of available planting sites. Replanting of other canopy species would follow the formula given in Appendix C.

Site 15B: This site is avoided by the indicative alignment, although it remains inside the proposed designation. Any construction access tracks and other construction activities should be located away from this site. Dust deposition into the vegetation should be minimised during construction through standard industry practices.

Site 16: Any particularly large trees should be avoided where practicable when deciding on the exact siting of the bridge and pylons. If any large native trees are removed we recommend replacement planting as set out in Appendix C. A botanist should be consulted once the exact placement of the bridge has been decided upon and any large trees to be removed should be identified and measured.

Site 33: No specific mitigation is recommended.

Table 5: Effects on forest vegetation and flora and specific recommendations

Vegetation site	Botanical values	Expected effects of the indicative alignment on vegetation	Significance of effect without mitigation	Specific recommendations	Significance of effect with recommended mitigation
3	low	Loss of 0.5ha of mixed native and exotic vegetation	low	No specific recommendations unless native canopy trees are removed. Standard dust suppression practices.	negligible
4	low	Loss of 0.2ha of mixed kanuka and kauri forest	Low- moderate	Fencing of the rest of the forest on the ridge to protect it from stock, otherwise replacement planting of any large trees that are removed.	low
5	moderate	Loss of a small area for bridge pylon. Rain shadow effects of bridges and reduction in height of some trees under the bridge.	low	Remove any colonies of short hair plume grass that will be affected by the works and conserve in a nursery for use in the landscaping phase of the project. Replacement planting of lost riparian forest trees.	negligible
6	low - moderate	Cut and fill on about 5% of site. Removal of some large totara trees	low	Avoid individual large totara trees where practicable. Avoid spillage of spoil or silt over the crest of the ridge into the native vegetation to the south. Replacement planting of any large trees that are removed.	negligible
8	low	Indicative alignment passes directly through the area and it will also be affected by cut and fill. Potential removal of a few old puriri trees.	low	Avoid if practicable the large puriri trees identified in 4.1.2. Replacement planting of any large puriri trees that are removed.	low
10A	high	Potential construction access track may result in the loss of green mistletoes on totara trees	high	Construction track has been sited to avoid mistletoe trees. A high level of dust control should be taken implemented and monitoring undertaken.	negligible if mistletoes continue to be avoided

Vegetation site	Botanical values	Expected effects of the indicative alignment on vegetation	Significance of effect without mitigation	Specific recommendations	Significance of effect with recommended mitigation
12	high	Potential construction access track may result in the loss of taraire orchids and their habitat	high	Construction access track avoids the native forest containing taraire orchids.	negligible
13	high	Not affected by the indicative alignment	negligible	Ensure the access track on the south-western side does not cause erosion to the ridge above.	negligible
14A	high	Not affected by the indicative alignment	negligible	Be aware of this site when constructing access tracks or staging areas	negligible
14B	moderate	Not affected by the indicative alignment	negligible	As for Site 14A	negligible
15A	high	A viaduct, stream diversion and minor cut and fill will affect 1.6 ha of forest including 0.44 ha of kauri forest.	moderate - high	Avoidance recommended. If not avoided see detailed recommendations in Section 6.1.2 and in Appendix C Replacement planting recommended to mitigate for any loss of forest.	low - moderate
15B	high	Avoided by the indicative alignment	negligible	Site access tracks and other construction activities away from this area. Minimise excessive dust deposition in the forest.	negligible
16	low - moderate	This site will be bridged by a viaduct. Loss of a small area for bridge pylon. Rain shadow effects of bridges and reduction in height of some trees under the bridge.	low	Replacement planting of any large trees that are removed.	negligible
33	low	Loss of approximately half the vegetation (1.5ha)	Low	No specific recommendations	negligible

6.1.4 Recommendations for wetland sites

Wetlands in the Rodney District are under-represented due to historic drainage and clearance; therefore despite the poor quality of the affected wetlands, we consider mitigation for their loss is necessary.

Wetlands 7, 8, and 13 may present opportunities for restoration planting as part of the overall mitigation package for the Project since they are wholly or partly within the proposed designation but outside the indicative alignment footprint. Given the low values of the wetlands within the proposed designation and the limited effects of the Project construction on them, we recommend that mitigation results in the restoration of the same area of wetlands that will be lost. This approach will result in the establishment of high quality wetlands in the long-term that provide biodiversity gains. The approach reflects the aspirations of the Proposed National Policy Statement on Indigenous Biodiversity. Integration of wetland mitigation planting with stormwater wetlands, other mitigation planting for effects on birds and forest vegetation and with landscape planting will provide an opportunity to improve overall habitat heterogeneity and connectivity for native fauna. Such an approach would also confer biodiversity benefits over and above those obtained from establishing separate areas of mitigation planting for each of these aspects of the Project. Such mitigation should seek to contribute to sediment control strategies within either the Mahurangi or Pūhoi catchments where practicable.

We consider wetland restoration should be carried out according to accepted restoration principles as practiced in New Zealand and should include a range of native wetland plants appropriate to the Rodney ED and sourced from it. Consideration should be given to whether threatened or uncommon plants from the Rodney ED could be included and whether plants of significance to local iwi would be suitable for inclusion in such wetland restoration.

It is important to ensure that spoil is not deposited in wetlands outside the alignment footprint and that silt does not get carried into them as this may result in the wetland being filled in and lost. Weeds are often a problem in wetlands and precautions against the introduction of invasive weeds need to be taken.

6.2 Land snails

The land snail, *Amborhytida dunniae,* was recorded at least 25 m from the existing edge of native forest at [redacted] We recommend that, prior to construction, any rhytid snails and their leaf-litter habitat should be relocated to an area of suitable habitat inside the forest edge. The release location should:

a) Be under pest control prior to the relocation and for a minimum of three years after the relocation.
b) Be buffered from edge effects. If the release site includes the remaining area of forest, the edge should be buffered by way of enhancement plantings, weed control and a protective super silt fence along the newly created edge to limit sediment and dust movement. Be monitored for snail presence and habitat suitability, including temperature, light and moisture levels, and weed presence. Monitoring should be undertaken annually during summer for a minimum of three years.

We note that because the land snail, *Amborhytida dunniae,* is not listed as a protected invertebrate under Schedule 7b (WA s2), a Wildlife Act Authority would not be required for such relocations. We consider that the effects of the Project on land snails at [redacted] would be low if our recommendations are adopted.

6.3 Hochstetter's frogs

Native frogs were not identified within the proposed designation.

6.4 Reptiles

Copper skinks (*O. aeneum*) and forest geckos (*M. granulatus*) were identified within the Project area at [redacted] Of these, [redacted] is avoided by the indicative alignment. We consider that Project effects on reptiles at those sites would be mitigated by relocating the reptiles to protected, suitable habitat in accordance with the requirements of a Wildlife Act Authority. We also consider that these recommendations would mitigate any adverse effects on any other native lizard species potentially present at those sites, but which we did not detect during surveys. We recommend that lizard capture should be in accordance with the following:

- Be undertaken by an experienced herpetologist, outside winter months and in accordance with Department of Conservation Wildlife Authority requirements;
- Include a minimum two-week period of habitat searching and trapping at each site; and
- Include machine assisted rescue/ destructive search that avoids mulching any vegetation in situ. Vegetation clearance contractors should be aware of lizard relocation requirements that involve machine searching when providing tender.

We also recommend that the lizard release sites should:

- Be under pest control prior to the relocation and for a minimum of three years after the relocation. If the relocation site is remaining adjacent habitat, pest control should be undertaken prior to any vegetation clearance. This recognises that pest predators are likely to be displaced from cleared areas, and move into relocation sites during vegetation clearance;
- Be protected with a super-silt fence if the site is adjacent to any works activities to limit sediment and dust movement;
- Include habitat enhancement, such as plantings and the addition of organic debris piles. Enhancement plantings for lizards should not use woodchip, bark or mulch and should encourage rapid establishment of a mixed-native vegetation ground cover, including densely planted grasses, sedges and kanuka; and
- Be monitored for lizard presence, abundance and habitat suitability, including within habitat enhancement areas. Monitoring should be undertaken annually, outside winter months, and for a minimum of three years.

We consider that the effects of the Project on reptiles would be low if our recommendations are adopted.

6.5 Birds

6.5.1 Terrestrial birds

Large areas of remnant native vegetation, which are used by kereru and other native forest birds, occur throughout the footprint. Therefore we recommend that replanted areas should:

- Provide native fruit trees and nesting habitat, including puriri, kahikatea, taraire, totara and rimu in the planting composition;
- Reflect the resources that are removed (e.g. if a grove of kahikatea is removed then that should be replaced by kahikatea or an "equivalent" such as puriri that provides a source of food for the local avifauna). For that reason the mitigation planting should have a functional, ecological basis, rather than manuka/ kanuka or flax monocultures. Topsoil should be provided to native plantings to maximise success of establishment;
- Be removed from the carriageway as far as practicable within the Project area to minimise bird mortality as a result of collision with vehicles. In our view it would be more beneficial to native birds if the areas of new plantings were fewer, but larger and contiguous with existing native vegetation, rather than piecemeal or developed as narrow linear habitats along the motorway edges; and
- Be identified and planted prior to vegetation clearance commencing, where practicable, to reduce the temporary reduction in habitat. The most important sites as far as habitat loss is concerned are Site 6 (Pūhoi north), Site 8, Site 15 (Wyllie Road) and Site 33 (Perry Road).

With respect to clearance of vegetation, we recommend that:

- Clearance of native vegetation at Sites 1-8, 15 and 33 should be conducted outside of the bird breeding season (September to December inclusive) to avoid direct mortality of eggs and chicks. In particular, we note that the native scrub at the southern end of Site 7 contains "At Risk" fernbird, despite this area being comprised predominantly of plantation pines.

With respect to road lighting, we recommend that:

- Where necessary, lighting should be minimised. We understand that the proposed corridor will remain largely unlit except for localised areas such as at interchange areas and at Johnstone Hill tunnels where proposed road lighting meets the minimum national highway standards for safety reasons. Such lighting would not give rise to more than minor effects in our opinion.

6.5.2 Wetland birds

We consider that the effects of clearance of vegetation on the fernbirds at Site 7 would be mitigated under the following recommendations:

- Fernbirds should be translocated to protected, pest-controlled habitat in accordance with the requirements of a Wildlife Act Authority – Translocation.
- We recommend that the suitable relocation site be nearby or within the Project area.

6.5.3 Aquatic birds

The effects of the Project on aquatic birds (e.g. banded rail, white-faced heron, pied shag) are minor and no particular mitigation is recommended, as aquatic areas of the Project will be traversed via viaducts.

6.6 Bats

We consider that bats are most vulnerable to habitat clearance during winter (when physiological activity is greatly reduced) and from November to mid-February (when communal roosts are likely to contain reproductive females and flightless juveniles). We also consider that the effects of the Project on bats will depend on the capacity of plantation habitats within the indicative alignment to support communal roosts at the time of construction. Therefore, with respect to minimising the effects of vegetation clearance on bats, we recommend that a Bat Management Plan is prepared prior to construction. The Plan should be prepared by a suitably experienced ecologist and provide information, collected outside winter months, on habitat use, range and roost activity by bats that may use habitats within the proposed designation. The Plan would determine measures to avoid or minimise effects on bats during construction. In addition to that Plan, we also recommend that:

- Native vegetation that may provide quality roosting habitat for bats at Sites 13, 14 and 15 should be avoided where practicable.

- Areas of large pine trees, within the plantation, should be retained and protected on each side of the alignment where practicable (e.g. within the proposed designation and beyond the cut-fill zones but within sufficient separation distances to reduce risk of bird mortality as discussed above). The number of pines and most suitable locations for retention should be assessed by a suitably experienced ecologist. Protection of these pines would serve as foraging edges and roosting locations alongside planted areas. We consider that the retention and protection of these pines would allow them to mature to a greater age and provide better quality bat roosts than they would otherwise within normal harvest regimes. We also consider that retaining and protecting vegetation along the edge of cut and fill zones would create a new habitat edge along which bats could forage, roost and commute at distances of up to 120m from the carriageway, where noise and light levels would also be greatly reduced.

We consider that the Project offers potential opportunities to enhance roosting and foraging habitats for bats in the long-term. Therefore we recommend that:

- Where necessary, lighting should be minimised. We understand that the proposed corridor will remain largely unlit except for localised areas such as at interchange areas and at Johnstones Hill tunnels where proposed road lighting meets the minimum national highway standards for safety reasons. Such lighting would not give rise to more than minor effects in our opinion;
- Riparian vegetation should include large native tree species, including puriri, taraire and kahikatea, that would provide suitable cavities for bat roosts in the long-term. Riparian margins are important, natural foraging locations for bats. We support the recommendations for riparian planting as detailed in the Operational Water Assessment Report; and
- All revegetation planting within the proposed designation, particularly within Sectors from Hungry Creek to Site 15 (Southern Perry Road) should include native trees including puriri, taraire, totara kahikatea, karaka and rimu in the planting mix. These trees would provide

suitable cavities for bat roosts in the long-term. We consider that plantings in sectors between Hungry Creek and Schedewys Hill, and between Moirs Hill Road and site 15 in Perry Road sector, would greatly increase habitat connectivity for bats in the long-term.

7. Conclusions

Overall, we consider the effects of the Project on terrestrial ecology values to be low-moderate. These effects are generally highest where native vegetation is present, which also reflects areas where indigenous biodiversity values are highest. We note that the majority of vegetation cover within the Project area is pine plantation.

We consider that loss of native vegetation will be restricted to small areas at a limited number of sites and that the proposed mitigation will adequately mitigate for this loss. Over the long term we expect significant biodiversity gains as replacement planting of trees and wetlands will eventually result in the establishment of additional areas of high quality native vegetation. Integration of mitigation planting with landscape planting and with existing native vegetation within the wider landscape would provide improved habitat connectivity and overall biodiversity gains from the Project.

The proposed replacement planting of kauri and other canopy species will directly address the loss of large and long-lived trees and provide a high degree of certainty of outcome compared with the traditional successional planting approach.

The establishment of a habitat corridor between Pohuehue Scenic Reserve and Moir's Hill Significant Natural Areas would provide a significant biodiversity benefit to the wider landscape and to the Rodney Ecological District.

We consider that in most cases, native fauna values can be adequately mitigated through carefully managed wildlife relocations where land snails, reptiles and fernbird are present. The habitat values for long-tailed bats are strongly associated with areas of pine plantation and this may change over time. For this reason, careful management of bats is best approached by way of a Bat Management Plan that can adequately reassess bat habitat values within the Project area at a time closer to the start of construction.

Overall, we consider that the effects of the Project can be adequately mitigated under our proposed recommendations.

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Appendix A. Terrestrial sites assessed

A.1 Terrestrial ecology site descriptions

Site	Sector	Description	Affected	Significance of effect	Explanation (in accordance with the RMA (1991), ARPS (1999), WA (1953)).
1	Pūhoi	Mixed pine and native	cut and fill		NOT ACCESSED
2	Pūhoi	Okahu Creek tidal wetland	viaduct structures	Low	Site is a component of, is a buffer to, and adjoins a coastal margin. Site provides habitat to "At Risk" banded rail [redacted]
3	Pūhoi	Regenerating native forest	cut and fill	Low	Site grazed and poor understorey. Small area of pine, young totara and kanuka affected.
4	Pūhoi	Regenerating kauri - podocarp forest.	cut and fill	moderate	Site grazed and poor understorey. Small area of regenerating native forest. An area of raupo wetland vegetation present, though also heavily grazed.
5	Pūhoi	DOC Reserve: Pūhoi River Riparian	viaduct structures	Moderate-High	Small area affected, though site is representative of local area, is an important riparian buffer to Pūhoi River and has important habitat values [redacted] The area adds significantly to ecological connectivity and is an important habitat corridor. "Naturally uncommon" native short hair plume grass present.
6	Hungry Creek	Edge of Pūhoi Pioneers Memorial Park	cut and fill	Moderate	Few isolated trees [redacted] kereru and other native birds present.
7	Hungry Creek	Pine, some native scrub	cut and fill	Moderate	Southern end provides habitat for fernbird, where regenerating scrub occurs. Pine forest contributes to connectivity between native forest fragments to the east of SH1 and Pūhoi Pioneers Memorial Park [redacted]

Site	Sector	Description	Affected	Significance of effect	Explanation (in accordance with the RMA (1991), ARPS (1999), WA (1953)).
8	Hungry Creek	Native scrub, some remnant trees	cut and fill	Moderate to high	Site has dense taraire leaf-litter. It is in a landscape of depleted indigenous vegetation (pine plantation), though adds to the spatial characteristics of the protected areas networks by improving habitat connectivity between important areas of indigenous vegetation to the east and west. [redacted]
9	Hungry Creek	Pine	cut and fill	Low	Pine plantation- Young block, provides some habitat connectivity to surrounding landscape, including indigenous vegetation to the south and east. [redacted]
10	Hungry Creek	Pine	cut and fill	Low	Pine plantation, medium sized pine, provides some habitat connectivity to surrounding landscape, including indigenous vegetation to the east. Totara trees containing "Regionally Critical" green mistletoes (*Ileostylus micranthus*) are found on the eastern edge of the designation. [redacted]
11	Moirs Hill Road	Pine	cut and fill	Moderate	Pine plantation, provides some habitat connectivity to surrounding landscape, including areas that provide habitat to threatened bats [redacted]
12	Moirs Hill Road	Pine	cut and fill	Moderate	Pine plantation, provides some habitat connectivity to surrounding landscape, provides habitat to threatened bats. Small area of native forest provides habitat for "Naturally Uncommon" taraire orchid (*Danhatchia australis*).
13	Perry Road	Native forest	Avoided	Low	High ecological significance. Site is of good quality, representative of the Rodney ED and contributes to ecological viability of surrounding areas, including buffering a branch of the Mahurangi River. [redacted]
14	Perry Road	Native forest	Avoided	Low	High ecological significance. Site is of good quality, representative of the Rodney ED and contributes to ecological viability of surrounding areas, including providing important habitat connectivity with nearby areas of native forest and buffering good quality stream habitat. [redacted]

Site	Sector	Description	Affected	Significance of effect	Explanation (in accordance with the RMA (1991), ARPS (1999), WA (1953)).
15	Perry Road	Native forest	cut and fill	High	High ecological significance. Site is of good quality, representative of the Rodney ED and contributes to ecological viability of surrounding areas, including buffering a branch of the Mahurangi River. [redacted]
16	Carran Road	Native riparian	viaduct	Low	Site provides important ecological connectivity, is an important riparian buffer to Mahurangi River and habitat to kereru where totara trees occur. [redacted]
33	Perry Road	Native scrub	Cut-fill	Low	Site includes a small, isolated area of kanuka scrub within a landscape of grazed pasture. The understorey is not of good quality, though provides habitat to native birds.

Appendix B. Vegetation plates

Plate 1: Kauri stands at Site 15A on southeast facing ridge running down to the stream. Note the tall stand of kauri in the middle background. The indicative alignment runs through the lower part of the ridge to the left of the photo

Plate 2: Stand of kauri near the top of the ridge in Site 15A. This stand is outside the designation and will not be affected by the Project

Plate 3: Site 15A from the south east looking up towards the western ridge showing kauri stand on the right within the larger area of forest that is mainly broadleaved forest with tanekaha and other podocarps

Plate 4: Densely aggregated kauri poles in Site 15A

Appendix C. Replacement planting rationale and calculation

Reasons for and objective of mitigation

Canopy trees in particular, are the keystone species of New Zealand's native forest community. The present Project involves the loss of significant canopy species. For example, kauri is an iconic species that comprises a key forest type in the Rodney ED. We consider that this forest type is under-represented in the Rodney ED.

In general, old-growth forest and long-lived trees cannot be reasonably re-created in the short to medium term. Therefore, for this Project, we consider that some measure of temporary loss must be accepted, but appropriate mitigation provided through well-managed replacement planting.

We support the view that an attempt should be made to replace key canopy species as far as possible on an equivalent basis. The replanted trees should generally be managed in such a way that the natural forest understorey is able to establish over time, so that the mitigation planting is placed on a similar trajectory to that of the impacted site. A new, integrated forest community would eventually be established that is similar to the lost community (Quetier and Lavorel 2011).

Difficulties with mitigating the loss of old growth forest and long-lived trees

The usual approach for replacement planting is to plant pioneer species that will theoretically provide more sheltered conditions required to establish the lost forest species later on in the planting programme. This programme occurs over a number of years. During that time, activities such as weed and pest control and successive plantings of different species are carried out as conditions become suitable for their establishment.

With this usual method, there is no guarantee that the lost forest community will eventually be replaced. The process can takes decades and the eventual outcome is unpredictable. Cost factors and governance or legal matters may influence how the revegetation project is managed and therefore what the ecological outcomes are.

Furthermore, applying a necessarily arbitrary ecological compensation ratio and expecting mass planting of first successional vegetation to eventually develop into mature forest over time is risky. This method may not adequately mitigate the loss of mature forest within any reasonable timeframe.

The loss of long-lived forest trees is also not easily mitigated given the time they take to re-establish. We consider a temporal component must therefore be incorporated into any mitigation plan to acknowledge the time taken for these species to grow to maturity and fulfil their normal ecological niche.

Our proposed method

The method we describe below seeks to provide for equivalent replanting using data relating to tree numbers lost, tree density, basal area and growth rates in a mathematical way. The method accounts for the temporal component.

The objective of our method is to ensure effective ecological replacement of the lost canopy species within a 20 year period. We consider that a 20 year replacement period is reasonable for

long-lived and slow growing species such as kauri to re-establish to a point that they can begin to fulfil their normal ecological niche and canopy role within the forest. Beyond that 20 year period for replacement, further growth of the trees will result in a significant biodiversity gain over the long-term.

Our method accounts for the variation in age and relative replacement requirements for the lost trees by establishing the total basal area of trees lost using the following process:

1. Establish the average growth rate of the relevant species based on known data for the species in a particular area (for example, there is extensive literature and data on the establishment and growth of planted kauri (see Bergin & Steward 2004) and other trees such as totara (Bergin 2003). If unavailable, growth rate data can be used from other similar areas.

2. Measure the dbh (diameter at breast height = 1.4m from the ground) of all kauri, tanekaha, puriri, totara, kahikatea, rimu, rewarewa and taraire trees greater than 15cm dbh that will be lost within the project footprint.

3. Calculate the basal area lost by each species as follows:

   Total basal area lost for each species = =

   Where *r* = — for each tree of a particular species.

The number of replacement trees that need to be planted to replace the mature trees that are lost is then established by the following formula:

–

= the number of replacement trees required

= the total basal area lost for each canopy species

= the expected basal area of each of the planted trees after 20 years.

The value of should be conservatively estimated to provide assurance that replacement of the required basal area will be reached within the 20 year time period.

Indicative calculation for site 15

To illustrate the use of our methodology and calculation, we have used measurements of the number of kauri from a 0.04ha circular plot (referred to as "Plot 2"- See Figure 6, Section 5.1.2) within the natural kauri stand at Site 15 in the Perry Road Sector. Plot 2 is located within the indicative alignment.

Plot 2 contained 34 kauri stems greater than 15cm dbh with an average diameter of 29.2 cm. Because we did not count all the kauri trees within site 15, we extrapolated the results from Plot 2 to determine a total number of trees and an average diameter. The resulting number of kauri trees for Site 15 is 374 with an average diameter of 29.2 cm. (Note, using this process is sufficient to illustrate the use of our calculation, however, we would not recommend that sample sites be

used for determining the total basal area lost for the Project. This is because the number, size, age and species of trees will vary from area to area. Therefore a sample site may not be representative. We therefore recommend counting all trees and measuring each of their diameters at the time of intended vegetation clearance to ensure accurate results).

Data for the example calculations is below:

a. Number of kauri stems – 374

b. Diameter of measured kauri trees - 29.2cm (0.292m) per tree

c. Average growth rate = 6.9mm diameter per year[2]

Using the formula, the calculation is as follows:

Total basal area of kauri lost = $292/2)^2$ x 374:

= 25.08 m²

Mean diameter gain over 20 years (6.9mm x 20) =13.8cm. Expected diameter of trees after 20 years (assuming diameter at planting to be 1cm) = 14.8cm. Radius is 14.8/2:

r = 7.4 cm = 0.074m

Expected basal area after 20 years = x

= 0.0172m²

The number of replacement trees that need to be planted to replace mature trees that are lost to the Project is given by (–). 25.08/.0172:

= 1458 replacement trees

This equates to replacement planting of approximately four to five seedlings per lost tree if all of the affected forest were similar to Plot 2 in composition (although this is unlikely to be the case).

Stocking rates for planted kauri may be over 1000 stems per hectare. The number of replacement trees given above would therefore represent about 1.5ha in area of kauri tree planting.

[2] Pardy et al (1992) surveyed planted kauri stands and found that the predicted mean annual growth rate was 6.9mm. Annual growth rates up to four times that of natural stands have been reported (Bergin and Steward). The annual mean growth rate given by Pardy et al would be therefore be a reasonable assumption for the purposes of our calculation concerning the predicted growth rate of planted replacement kauri trees .This figure should be easily achieved on a sheltered and reasonably fertile planting site. The rate at which kauri grows in natural stands is variable, however two studies one at Coromandel and one at Mangatangi in the Hunua Ranges provide useful data that suggest the growth rate is somewhere between 4.5mm and 6mm diameter per year (Burns and Smale 1990, Bergin and Steward 2004). The higher figure was obtained for young sapling and pole kauri while the lower figure is for older trees 100 – 200 years old.

Replanting recommendations:

1. Replacement planting of lost trees from sites throughout the proposed designation should preferably all occur at one site so that a compact area of trees is established beneath which a native understorey will develop.

2. The selected site needs to be sheltered with free-draining soil of moderate fertility.

3. The site should contribute to the connectivity of forested sites in the landscape either through being situated adjacent to existing forest or by providing a "stepping stone" between other forest areas.

4. Kauri do not require a "nurse crop" of kanuka as is often advocated but can be planted directly into open ground at suitable sites (G Steward (SCION) Pers comm).

5. Some species such as puriri, rimu and taraire will require the establishment of a light nurse crop such as kanuka but others such as totara, tanekaha and kahikatea will not.

6. At least two year old kauri trees in PB3 planter bags should be planted out at 3-4 m spacing. Tanekaha trees of the same grade may be interspersed with these.

7. Replacement totara trees should be planted around the edges of the plantation to provide shelter and seal the edges.

8. Pest and weed control will be required until the trees are fully established and a native understorey has developed which reduces the likelihood of weed invasion. Periodic monitoring will also be required to ensure the planted trees are thriving as expected and that a native understorey develops over time.

9. Because kauri commonly grows as an almost pure stand in the forest it is also reasonable to plant a replacement stand that is almost pure kauri. Tanekaha is a frequent kauri associate however and this species could be planted amongst the kauri.

10. Other canopy trees such as rimu, tanekaha, totara, kahikatea, puriri, rewarewa and taraire, should planted where there are suitable microsites that will allow them to establish.

11. Seed for replacement planting should be sourced from the local area. In the case of kauri and tanekaha this should be from Site 15A if there is seed available here, otherwise nearby areas should be able to provide seed.

Adequacy of the proposed mitigation

The range of species proposed for replacement planting form the main components of the forest canopy that is typical of forest in the Rodney Ecological District.

We consider that the use of the above method for calculating the loss and required replacement planting of large forest tree species provides "like for like" or better mitigation, considers temporal aspects of the mitigation process and fulfils the principle of "no net loss". Restoring the keystone species in this way will provide more than adequate mitigation for the effects of the Project and will result in significant biodiversity gains over time.

This method does not use the usual "succession" pathway to mitigation but seeks to directly compensate for the loss of long-lived forest trees. There is good scientific evidence to suggest that the establishment of native trees in the landscape is key to the natural re-establishment of other native species since the avian dispersers of native species use the trees as perches and in so doing deposit seeds in their faeces which re-establish the native understorey plants. Re-establishment of the native understorey should happen relatively rapidly if the replacement planting area is close to existing native forest.

The necessary knowledge and experience to carry out the proposed mitigation method exists within the Rodney Ecological District and the Auckland Region. Local groups such as the Mahurangi Action Group and Tane's Tree Trust are already carrying out similar work and could be expected to take an interest in the proposed mitigation planting.

Appendix D. Native terrestrial bird species recorded

Common name	Scientific name	Site 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	33
Fantail	*Rhipidura fuliginosa placabilis*		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Grey warbler	*Gerygone igata*		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Silvereye	*Zosterops lateralis lateralis*		•	•	•	•			•	•			•	•	•	•	•	•
NI tomtit	*Petroica macrocephala toitoi*											•	•					
NI pipit *	*Anthus novaeseelandiae novaeseelandiae*												•					
Tui	*Prosthemadera novaeseelandiae novaeseelandiae*		•		•				•					•	•	•	•	•
Bellbird x	*Anthornis melanura melanura*												•					
Kereru	*Hemiphaga novaeseelandiae*						•		•					•	•	•	•	
Morepork	*Ninox novaeseelandiae novaeseelandiae*						•		•						•	•		
Harrier	*Circus approximans*		•	•	•	•		•		•	•			•	•	•	•	•
Shining cuckoo	*Chrysococcyx lucidus lucidus*					•	•		•				•	•	•	•		
Kingfisher	*Todiramphus sanctus vagans*		•	•		•	•	•	•	•	•	•	•	•	•	•	•	•
Welcome swallow	*Hirundo tahitica neoxena*		•	•	•	•					•				•		•	
Spur-winged plover	*Vanellus miles novaehollandiae*										•				•	•	•	•
Pukeko	*Porphyrio melanotus*		•	•	•	•								•			•	
Paradise shelduck	*Tardorna variegata*		•													•	•	•
White faced heron	*Ardea novaehollandiae*		•		•						•							
Pied shag *** x	*Phalacrocorax varius varius*					•							•					
Banded rail **	*Gallirallus philipensis assimilus*		•															
NI fernbird *	*Bowdleria punctata vealeae*							•										

Threat Classification (Miskelly *et al.* 2008)

* At Risk-declining
** At Risk-naturally uncommon
*** Threatened-Nationally vulnerable
X Species observed at 101 Moir Hill Road (G. Tewsley, 25.11.2010)

Appendix E. Plant Species List

Scientific name	Common name
Canopy trees	
Agathis australis	kauri
Alectryon excelsus	titoki
Beilschmiedia tarairi	taraire
Corynocarpus laevigatus	karaka
Dacrycarpus dacrydioides	kahikatea
Dacrydium cupressinum	rimu
Knightia excelsa	rewarewa
Kunzea ericoides	kanuka
Leptospermum scoparium	manuka
Nestegis lanceolata	white maire
Phyllocladus trichomanoides	tanekaha
Podocarpus totara	totara
Sophora chathamica	coastal kowhai
Vitex lucens	puriri
Weinmania silvicola	towai
Understorey shrubs	
Coprosma areolata	thin-leaved coprosma
Coprosma arborea	mamngi
Coprosma robusta	karamu
Coprosma spathulata	coprosma
Coprosma rhamnoides	
Geniostoma rupestre	hangehange
Hedycarya arborea	pigeonwood
Leptospermum scoparium	manuka
Leucopogon fasciculatus	mingmingi

Scientific name	Common name
Melicope simplex	poataniwha
Melicytus micranthus	manakura
Melicytus ramiflorus	mahoe
Myrsine australis	mapou
Olearia rani	heketara
Pomaderris kumeraho	kumarahou
Pseudopanax arboreus	five finger
Schefflera digitata	pate
Groundcover	
Acaena novae-zelandiae	bidibidi
Adiantum aethiopicum	native maidenhair fern
Adiantum hispidulum	rosy maidenhair fern
Austraderia spp	toetoe
Blechnum chambersii	lance fern
Blechnum fraseri	
Blechnum novae-zelandiae	kiokio
Carex dissita	forest sedge
Carex secta	pukio
Centella uniflora	centella
Cyathea dealbata	silver tree fern
Deparia petersenii subsp. *congrua*	
Dianella nigra	turutu/ native blueberry
Dichelachne crinita	long-hair plume grass
Dichelachne inaequiglumis	short-hair plume grass
Diplazium australe	
Doodia australis	rasp fern
Gahnia lacera	cutty grass

Scientific name	Common name
Lastreopsis glabella	smooth shield fern
Leptostigma setulosum	
Lindsaea trichomanoides	
Lygodium articulatum	mangemange
Microlaena stipoides	slender rice grass
Nertera dichondrifolia	nertera
Oplismenus hirtellus subsp. *imbecilis*	basket grass
Paesia scaberula	ring fern
Pneumatopteris pennigera	gully fern
Pteridium esculentum	bracken
Pteris tremula	shaking brake
Uncinia uncinata	hook grass
Epiphytes & parasites	
Asplenium flaccidum	hanging spleenwort
Asplenium oblongifolium	shining spleenwort
Asplenium polyodon	sickle spleenwort
Astelia solandri	perching lily
Blechnum filiforme	Thread fern
Collospermum hastatum	perching lily
Griselinia lucida	puka
Ileostylus micranthus	green mistletoe
Microsorum pustulatum	hound's tongue fern
Microsorum scandens	fragrant fern
Vines and climbers	
Clematis spp	clematis
Freycinetia banksii	kiekie

Scientific name	Common name
Metrosideros diffusa	white rata
Metrosideros fulgens	rata
Metrosideros perforata	white rata
Ripogonum scandens	supplejack
Ground orchids	
Danhatchia australis	taraire orchid
Microtis unifolia	onion orchid
Pterostylus graminea	grass-leaved greenhood
Thelymitra longifolia	white sun orchid
Thelymitra pauciflora	sun orchid
Monocot trees & shrubs	
Cordyline australis	cabbage tree/ ti kouka
Rhopalostylis sapida	nikau palm
Wetland plants	
Avicennia marina subsp. *australasica*	mangrove
Apodasmia similis	oioi
Carex geminata agg	rautahi
Cotula coronopifolia	water buttons
Cyperus ustulatus	giant umbrella sedge
Eleocharis acuta	sharp spike sedge
Juncus effusus	leafless rush
Juncus kraussii	sea rush
Lemna disperma	duckweed
Leptopsermum scoparium	manuka
Plagianthus divaricatus	marsh ribbonwood

Scientific name	Common name
Schoenoplectus tabernaemontanii	lake club rush
Triglochin striata	triglochin
Typha orientalis	raupo
Exotic species	
Acacia melanoxylon	Tasmanian blackwood
Anthoxanthum odoratum	sweet vernal
Arundo donax	giant reed
Cortaderia selloana	pampas grass
Crataegus monogyna	hawthorn
Crocosmia X crocosmiiflora	montbretia
Cupressus macrocarpa	macrocarpa
Eucalytus spp.	eucalypt/ gum tree
Hedychium gardnerianum	wild ginger
Hypericum spp	St John's wort
Leycesteria formosa	Himalayan honeysuckle
Ligustrum lucidum	tree privet
Ligustrum sinense	Chinese privet
Nephrolepis cordifolia	ladder fern
Phormium tenax	flax
Pinus radiata	radiata pine
Salix spp	willow
Selaginella kraussiana	selaginella
Tibouchina urvilleana	tibouchina
Tradescantia fluminescens	Wandering Jew
Ulex europaeus	gorse