REPORT

Tonkin+Taylor

DRAFT Ecological Management Plan

Auckland Regional Landfill

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Glossary

Specific terms	
ABM	Acoustic Bat Monitor
AC	Auckland Council
ACO	Artificial Cover Objects
AEcE	Assessment of Aquatic and Terrestrial Ecological Values and Effects Report, Tonkin + Taylor, 2019
AMP	Avifauna Management Plan
AUP OP	Auckland Unitary Plan (Operative in Part)
BMP	Bat Management Plan
CEMP	Construction Environmental Management Plan
DBH	Diameter at Breast Height
DOC	Department of Conservation
ECR	Environmental Compensation Ratio
EIANZ	The Environment Institute of Australia and New Zealand
EMP	Ecology Management Plan
ESC	Erosion and Sediment Control
HFMP	Hochstetter's Frog Management Plan
IMP	Invertebrate Management Plan
LiMP	Lizard Management Plan
LMRP	The Landscape Mitigation and Restoration Plan
MCI	Macroinvertebrate community index
NFFFMP	Native Freshwater Fish and Fauna Management Plan
NSMA	Natural Stream Management Area
NZTCS	National Threat Classification System
OSSCP	Off-Site Stream Compensation Plan
PB	Plant bag
REMP	Residual Effects Management Plan
RMA	Resource Management Act
SEA	Significant Ecological Area
SEV	Stream Ecological Valuation
VCMP	Vegetation Clearance Management Plan
VES	Visual Encounter Surveys
VRP	Vegetation Removal Protocols
WMNZ	Waste Management New Zealand Ltd
General terms	
Auckland Regional Landfill or ARL	Project name, encompassing the landfill itself as well as all ancillary activities within the WMNZ landholdings.
Landfill footprint	The area (plan area) occupied by the landfill which has a lining system onto which waste is placed.

Project footprint	The area that includes the landfill footprint and also includes those areas outside the landfill footprint but within the WMNZ landholdings where ancillary activities are proposed to occur.
Project footprint	Areas where works are anticipated associated with ARL.
Waste Management NZ Limited or WMNZ	Company name of applicant.
WMNZ landholdings	The entire landholdings secured by WMNZ at Wayby Valley (approximately 1020 ha).
Landholding description	
Eastern Block	Pine forestry block which includes Valley 1 and 2.
Southern Block	Strip of land which access road runs through until it reaches the Eastern Block. This strip is mostly occupied by bush and forest plantation, within a separate valley across the southern side of the Western Block.
Valley 1	The southernmost of the two valleys currently in forestry suitable for landfilling.
Western Block	The farm property previously known as Springhill Estate.

1 Introduction

This Ecology Management Plan (EMP) has been prepared for the Auckland Regional Landfill (ARL) project on behalf of Waste Management New Zealand Ltd (WMNZ). The EMP encompasses a suite of management plans which will come into effect assuming that WMNZ obtains resource consents for the construction and operation of a new regional landfill facility on WMNZ landholdings, between Warkworth and Wellsford. The WMNZ landholdings are located near the Wayby Valley, adjacent to State Highway 1 (SH1) 13 km northwest of Warkworth, within the Rodney Ecological District in the northern part of the Auckland region (see Appendix A).

The ARL includes a landfill footprint located within a pine forested valley and will also require the construction of an access road, a bin exchange area, several smaller access roads and ancillary activities (such as office buildings), stockpiles, a clay borrow pit, and erosion and sediment controls (e.g. stormwater and sediment ponds and wetlands). The project activities are expected to have a range of effects on terrestrial, wetland and aquatic ecological values of the WMNZ landholdings. These proposed landfill ecological effects are described in the Assessment of Aquatic and Terrestrial Ecological Values and Effects Report (AEcE) (Tonkin + Taylor, 2019) that accompanied the resource consent application (Resource Consent Application, Volume 2, Technical Report G).

1.1 Purpose and objectives of the EMP

This EMP has been prepared to identify how the project will address potential adverse effects on the ecological and biodiversity values of the land within the ARL footprint and its surrounds. Specifically, the EMP sets out procedures for how ARL will avoid, minimise, offset or compensate for adverse effects on ecological values, including:

- Avifauna;
- Bats;
- Invertebrates;
- Lizards;
- Hochstetter's frogs;
- Freshwater fish and fauna; and
- Vegetation and habitat (including wetlands).

The EMP focusses on terrestrial flora and fauna, however also includes some measures to address freshwater effects. Specifically, management measures relating to freshwater fauna are included and some measures proposed to address stream habitat loss.

1.2 Status of the EMP

This draft EMP has been prepared following discussions with WMNZ to support the consent application. It will also be reviewed and updated over the course of the project following discussions with Auckland Council (AC) and Department of Conservation (DOC), and in conjunction with any updates to resource consent conditions. Amendments to the EMP may be made subject to the requirements set out in the resource consent conditions.

1.3 Responsibilities and competencies

Figure 1.1 below sets out the roles and responsibilities for implementation of the various management plans within this EMP. The WMNZ Regional Landfill Manager holds overall accountability for implementation of and compliance with this plan.

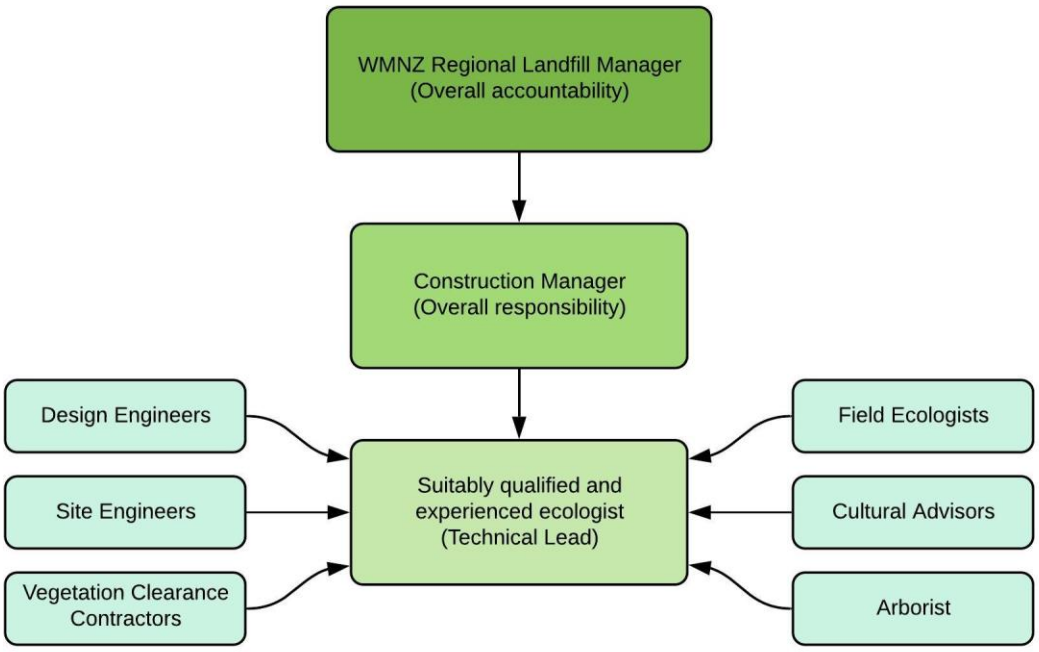

Figure 1.1: Roles and responsibilities for implementation of the various plans within this EMP.

1.4 EMP Structure

Section 1.5 of the EMP provides a summary of the ecological values and effects within the project footprint and surrounds, along with the general approach for managing the ecological effects resulting from construction of ARL.

This is followed by a suite of stand-alone management plans that outline in detail the management measures to be implemented during and following construction to avoid, remedy and mitigate effects on vegetation and specific fauna groups within the project area (such as vegetation clearance and salvage and relocation protocols).

The EMP also provides details on measures to manage any residual effects (effects that cannot be avoided, minimised or managed on site) through ecological mitigation, offset and compensation methods including pest management and restoration planting. These measures are detailed in the Residual Effects Management Plan (REMP, Section 9).

Collectively, the suite of management plans within this EMP set out the procedures for addressing adverse ecological effects associated with the landfill through proposed conditions provided in the resource consent application (primarily consent conditions 49 to 58 and 181 to 197). The plans also set out the monitoring and review processes to be undertaken both pre and post construction, with specific monitoring requirements described in the individual management plans, which have been prepared by the relevant ecological specialists.

The EMP is set out as follows:

- Section 1 – Introduction (this section);
- Section 2 – Avifauna Management Plan (AMP);
- Section 3 – Bat Management Plan (BMP);

- Section 4 – Invertebrate Management Plan (IMP);
- Section 5 – Lizard Management Plan (LiMP);
- Section 6 – Hochstetter's Frog Management Plan (HFMP);
- Section 7 – Vegetation Clearance Management Plan (VCMP);
- Section 8 – Native Freshwater Fish and Fauna Management Plan (NFFFMP); and
- Section 9 – Residual Effects Management Plan (REMP).

1.5 Ecological values and effects summary

A summary overview of ecology values and effects is provided in this section. The AEcE that accompanied the resource consent application (Resource Consent Application, Volume 2, Technical Report G) provides full details of ecological values and effects.

1.5.1 Site overview

The WMNZ landholdings (1020 ha) consists of three distinct land use types. The Eastern Block and Waiteraire Tributary Block comprises predominantly exotic radiata pine plantation forestry; the Western Block is currently an operational farm and has pockets of high ecological value vegetation and habitat; the Southern Block consists of wattle plantation and regenerating native vegetation. There are significant ecological areas (SEA) and natural stream management areas (NSMA) within the landholdings, however these are not located within the project footprint.

1.5.2 Terrestrial ecology values

The ARL project footprint (approximately 120 ha) is broadly dominated by exotic forest, pasture and includes native vegetation types of generally high ecological value, including several areas of mature and regenerating forest, as well as two wetland types. In descending order, the project footprint will result in the direct loss of approximately 86.88 ha of pine forest, 17.3 ha of pasture, 9.11 ha of wattle forest, 4.62 ha of native regenerating forest, 0.87 ha of native mature forest, 0.85 ha of indigenous wetlands and 0.48 ha of exotic wetland.

The native vegetation provides habitat for a number of nationally 'Threatened' or 'At Risk' species, some of which are present within the ARL project footprint. These include long-tailed bats, North Island fernbird, spotless crake, Hochstetter's frog, several lizard species and rhytid snails. Table 1.1 summarises the vegetation, habitat and fauna values within the ARL project footprint.

Table 1.1: Summary of terrestrial ecology values that are present or possibly present within the ARL project footprint.

Ecological features	Ecological value[1]	Area to be removed
Habitat/vegetation type		
Indigenous mature forest (non-SEA forest)	Very High	0.87 ha
Indigenous regenerating forest	High	4.62 ha
Exotic wattle forest	High	9.11 ha
Exotic pine forest	High	86.88 ha
Pasture	Negligible	17.3 ha
Indigenous wetland (non-SEA wetland)	Very High	0.85 ha

[1] Refer to section 7.2.10 in Technical Report G – Auckland Regional Landfill Assessment of Aquatic and Terrestrial Ecological Values and Effects. Prepared for Waste Management NZ Ltd by Tonkin & Taylor Ltd.

Ecological features	Ecological value[1]	Area to be removed
Exotic wetland	Moderate	0.48 ha
Species	**Ecological value**	**Threat status**
Swamp maire	Very High	Nationally 'Threatened'
Kauri (not in footprint)	Very High	Nationally 'Threatened'
Kawaka	Moderate	Locally uncommon
Kānuka	Very High	Nationally 'Threatened'
Mānuka	Very High	Nationally 'Threatened'
White rata	Very High	Nationally 'Threatened'
Long-tailed bat	Very High	Nationally 'Threatened'
Australasian bittern*	Very High	Nationally 'Threatened'
North Island kaka*	High	Nationally 'At Risk'
North island fernbird	High	Nationally 'At Risk'
Spotless crake (At Risk)	High	Nationally 'At Risk'
NZ pipit	High	Nationally 'At Risk'
Auckland green gecko*	High	Nationally 'At Risk'
Forest gecko*	High	Nationally 'At Risk'
Pacific gecko*	High	Nationally 'At Risk'
Ornate skink*	High	Nationally 'At Risk'
Copper skink	Moderate	Protected under the Wildlife Act 1953
Hochstetter's frog	High	Nationally 'At Risk'
Kauri snail*	High	Nationally 'At Risk'
Rhytid snail	High	Nationally 'At Risk'

Notes:

* Species that are assumed to be present or potentially present onsite but have not been detected.

1.5.2.1 Summary of terrestrial ecological effects

The terrestrial and wetland habitat loss has the potential to create a range of adverse effects on ecological values, both during enabling works construction (resulting from direct physical disturbance), seasonal construction, and on an ongoing basis from disposal operations (if any) that involve vegetation removal or habitat disturbance. The actual and potential adverse ecological effects associated with construction of the project are described in detail in section 7.3.1 of the AEcE and are summarised below.

Potential adverse effects on terrestrial and wetland values during and after construction could include:

- Vegetation and habitat loss through vegetation clearance and earthworks;
- The creation of habitat edge effects, altering the composition and health of adjacent vegetation (i.e. habitat degradation), which may affect habitat suitability for flora and fauna;
- Direct mortality or injury to species, for example all plants and most of the smaller less mobile species (e.g. lizards and invertebrates) may be harmed during vegetation clearance or earthworks activities, Likewise, roosting bats could potentially be harmed during vegetation clearance activities. Outside of bird breeding season, bird mortality would be low however

during breeding season vegetation removal has the potential to result in the destruction of nests, eggs and fledglings;

- Habitat fragmentation and isolation due to the loss and reduction of available habitat types and by reducing the ability for plants and animals to disperse across the landscape for food, shelter, and breeding purposes, i.e. severing or partially severing access to habitats that would otherwise be suitable;
- Construction and operations related noise and vibrations or dust effects; and
- Sediment runoff to wetlands and watercourses that may affect the quality of wetland habitat.

Potential long-term ongoing adverse effects could include:

- Ongoing habitat degradation associated with habitat loss, edge effects and fragmentation, which permanently affecting movement of some species, with possible effects on meta-population dynamics and increased vulnerability to local extinction;
- Ongoing disturbance effects, particularly on habitat margins/edges, through noise, dust and lighting associated with operational activities;
- Mortality or injury on roads through strike or road kill for some species;
- The increased presence of people and introduced species in previously less accessible areas;
- Lost opportunities for creating wildlife corridors; and
- Degradation of wetland and riparian habitat quality through:
  - Altered hydrology of wetlands;
  - Contaminated stormwater runoff (sediment, heavy metals and elevated temperature) from road surface to wetlands;
  - Risk of spills of potential toxins (for example, oil or chemicals) from cartage vehicles; and
  - Ongoing dust issues.

Section 1.6 below summarises the general approach to the management of these actual and potential ecological effects associated with ARL.

1.5.3 Freshwater ecology values

It is estimated that there is in the order of 135 km ephemeral, intermittent and permanent stream length within WMNZ landholdings. These streams are part of the wider Hōteo River catchment, which discharges into the Kaipara Harbour, approximately 35 km downstream of the landholdings. The streams comprise a combination of steep, vegetated catchments through to low lying floodplain streams adjacent to the Hōteo River.

Fish recorded across the site generally reflect species recorded in nearby catchments and include, longfin eels (*Anguilla dieffenbachii*) and shortfin eels (*Anguilla australis*), banded kōkopu (*Galaxias fasciatus*), inanga (*Galaxias maculatus*), various bullies (*Gobiomorphus* spp.) and kōura (*Paranephrops planifrons*). Macroinvertebrate communities were indicative of 'poor' condition in the Western Block through to 'excellent' condition in Southern and Eastern Blocks.

Parts of the freshwater systems across the WMNZ landholdings are of high ecological value, particularly those within the Eastern and Southern Blocks. The NSMA within the Southern Block has the highest value (as measured by the stream ecological valuation (SEV) method), a function of its relatively intact native riparian margins and natural undisturbed stream channel. Despite the presence of exotic forestry, streams within the Eastern Block have high ecological value. It is expected that during forestry activities, which would occur irrespective of the project proceeding, ecological values would decrease for a period of time until the stream systems recover. While the

Western Block has been modified and subjected to degradation through agricultural land use, the biodiversity values within these streams are still moderate and the headwaters, in particular, have high potential for enhancement.

1.5.3.1 Summary of freshwater ecological effects

The actual and potential adverse ecological effects associated with construction of the project are described in detail in section 5.3 of the AEcE and are summarised below.

Short term effects relate to those within the construction phase which could include fish injury and/or mortality, and water quality effects resulting from sedimentation and cut vegetation storage.

Potential long-term effects, if left unmitigated, may include reduced fish passage, water quality effects and changes to hydrology and permanent loss of stream ecological function and habitat area within the project footprint.

Under the Auckland Unitary Plan Operative in Part (AUP OP), permanent and intermittent streams are afforded protection[2]. Measures to address residual effects, that cannot be avoided, remedied or mitigated, are detailed in section 9 and the OSSCP.

Section 1.6 below summarises the general approach to the management of these actual and potential ecological effects associated with ARL.

1.6 Ecological mitigation framework

1.6.1 General approach and guiding principles

The purpose of the Resource Management Act 1991 (RMA) is to promote the sustainable management of natural and physical resources, while avoiding, remedying, or mitigating adverse effects on the environment. International guidelines on the management of ecological effects, particularly those espoused by the Business and Biodiversity Offsets Programme (BBOP), promote a "mitigation hierarchy" or an "effects management hierarchy" that prioritises the sequence with which management of the effects should be approached:

AVOID ⇨ REMEDY ⇨ MITIGATE

The term *mitigate* in the RMA does not include "biodiversity offsetting" as the mitigation relates to the reduction of effects at or on the site where the effects were created. Instead offsetting provides new positive effects at another location (ideally close by). While recognising that the RMA is not a "no effects" statute, development of offsetting in the New Zealand context has led to an extended effects management hierarchy or order of priority:

AVOID ⇨ REMEDY ⇨ MITIGATE ⇨ OFFSET ⇨ COMPENSATE

'Compensate' refers to positive effects that also provide positive benefits at another location but unlike for biodiversity offsets, those positive effects are not verifiably quantified.

Offsetting and compensating are relevant to the management of ecological effects on the ARL project as, highlighted in sections below, it is not possible to avoid, remedy or fully mitigate all adverse ecological effects within the ARL project footprint and these residual effects therefore need to be addressed.

All efforts to avoid or minimise adverse ecological effects in relation to construction activities are addressed in the VCMP (section 7) and the fauna management plans (AMP – section 2; BMP – section 3; IMP – section 4; LiMP – section 5; HFMP – section 6; NFFFMP – section 8). Measures to

[2] Chapter E3. Lakes, rivers, streams and wetlands. (2019) Auckland Council.

offset or compensate for effects that cannot be fully avoided, remedied or mitigated on site and will continue post-construction (and as such will be required over a longer timeframe) are addressed in the Residual Effects Management Plan (REMP; section 9).

1.6.2 Measures to avoid or minimise potential effects

Efforts to avoid or minimise the potential for adverse ecological effects have been undertaken though the optioneering and concept design phases of the project and have included refining the configuration of the project (e.g. soil stockpile sites and access roads). These measures are detailed in the Assessment of Effects (AEE) report[3].

Efforts to avoid effects or minimise effects based on the ARL project footprint will include:

- Minimisation of forest and wetland habitat loss through site management and appropriate construction methodology in ecologically significant areas. This would include avoidance of unnecessary vegetation clearance through the physical delineation of the footprint boundary or targeted efforts to avoid or minimise the potential for wetland sedimentation;
- Avoidance of large scale vegetation clearance within wetlands and native forests during peak bird breeding season (September to December inclusive);
- Adoption of bat tree-felling protocol to minimise the likelihood of direct harm to roosting bats, most importantly maternal bat roosts that may include several adult female and juvenile bats;
- Salvage and relocation of Hochstetter's frogs, native lizards, and invertebrates into suitable habitat that has been enhanced through long term control of introduced predatory mammals;
- Native freshwater fauna are present across the project footprint and include 'At Risk – Declining' species. There is high potential for injury or mortality of native freshwater fauna during dewatering of streams and construction of the landfill and ancillary activities in the absence of any controls. Implementation of fish salvage and relocation protocols will reduce the magnitude of effect;
- Standard erosion and sediment controls (ESCs) and management plans will be implemented across the project footprint to mitigate the residual risk of sedimentation from construction earthworks. Refer to the CEMP for controls;
- The overall potential effect from runoff of wood leachate resulting from storage of felled vegetation will be similar to that of sedimentation. However, risk of residual adverse effects is more a feature of practice and less dependent on weather conditions. Application of best practice in accordance with relevant guideline documents discussed are set out in the CEMP and VCMP;
- Culverts have the potential to restrict fish passage to upstream habitats if constructed poorly. Where practicable culverts will be constructed to be 'fish-friendly'. Refer to the CEMP; and
- Stormwater runoff can impact water quality and erosion potential of streams. Stormwater controls will be implemented across the site which address both quality and quantity and are consistent with best practice methods. Refer to the Stormwater Operation and Maintenance Plan.

These measures follow industry best-practice methods and are laid out in detail in the fauna specific management plans (sections 2 to 6 and 8), the vegetation clearance management plan (section 7), the CEMP and the Stormwater Operation and Maintenance Plan.

[3] Refer to section 7 in Technical Report G – Auckland Regional Landfill Assessment of Aquatic and Terrestrial Ecological Values and Effects. Prepared for Waste Management NZ Ltd by Tonkin & Taylor Ltd.

1.6.3 Measures to offset or compensate for residual ecological effects

Residual effects that cannot be avoided or minimised will be addressed through proposed wetland and forest revegetation and pest control initiatives (see REMP; section 9 for full details). A general overview of these measures is provided below and in Table 1.2.

1.6.3.1 Revegetation

Forest and wetland revegetation on the WMNZ landholdings will offset or compensate for habitat loss by providing habitat for forest and wetland plants and associated species that have been affected by the ARL. Revegetation efforts will focus on replacing plant species that have been affected and optimising ecological benefits through improving ecological connectivity between habitat types and protecting significant habitat types through buffer/margin plantings. Forest and wetland revegetation will include:

- Site preparation, including weed management and stock exclusion fencing (where necessary) and the deployment of felled logs into revegetation sites to improve biodiversity values. A minimum of 12 m of logs (> 60 cm DBH) per ha of revegetation will be deployed;
- Planting of eco-sourced native species;
- 10 years of plant maintenance, including weed management and infill planting (where necessary); and
- Covenanting to ensure long-term protection of revegetated habitats

1.6.3.2 Pest control

Long-term control of mammalian pests within the WMNZ landholdings and adjacent Sunnybrook Reserve will improve the ecological integrity of forest and wetland ecosystems within these areas and facilitate the recovery of a number of native plant and animal species. This includes nationally 'Threatened' or 'At Risk' fauna such as long-tailed bats, North Island fernbird, spotless crake, several lizard species, Hochstetter's frogs, and several invertebrate species that will be affected to varying degrees by the project. Pest mammal control will include the ongoing control of mustelids (stoats, ferrets, weasels), feral cats, rats, possums, goats and pigs using DOC approved standard practice methods and performance measures reflective of intensive pest management e.g. no detections for goats and pigs; < 5% (with a preferred target of <3%) Residual Tracking Index (RTI) for rats, and < 5% Residual Trap Catch (RTC) for possums.

Table 1.2: Proposed measures to address residual effects on forest and wetland habitats

Residual effect	Enhancement activity	Total area (ha)
0.87 ha of non-SEA mature forest (including high value trees), 4.62 ha of regenerating forest (including high value trees), Indirect effects on adjacent habitats and to varying degrees direct and indirect effects on forest species including long-tailed bats, forest birds, lizards, Hochstetter's frogs and invertebrates	Planting of native terrestrial vegetation within available areas on WMNZ landholdings.	9.9 ha
	Long term pest control of the entire WMNZ holdings and nearby Sunnybrook Reserve (TBC)	TBC
	Protection of all native forest habitats onsite by covenant	111.9 ha
0.85 ha of indigenous non-SEA wetlands, and 0.48 ha of exotic dominated wetlands. Indirect effects on adjacent habitats and to varying degrees direct and	Planting of native wetland vegetation within all degraded exotic wetlands on Springhill farm that are not affected by the project	4.63 ha

Residual effect	Enhancement activity	Total area (ha)
indirect effects on wetland species most notably North Island fernbird and spotless crake	10m wetland margin plantings around SEA wetlands (9.03 ha) and 5m wetland margin plantings (TBC) around all non-SEA wetlands (6.15 ha) to improve the quality of wetlands by buffering them from the potential effects of surrounding landuses	15.18 ha
	Long term pest control of the WMNZ landholdings (subject to agreed access) and nearby Sunnybrook Reserve (TBC) that will result in pest control across all wetland habitats within the WMNZ landholdings	25.59 ha
	Protection of all native wetland habitats onsite by covenant	25.59 ha

1.6.3.3 Stream habitat enhancement

The most substantial effects on freshwater ecology will occur from the permanent reclamation of up to 15.4 km of permanent and intermittent stream length across the site. It is not possible to remediate or mitigate stream reclamation at the point of impact however these effects can be offset or compensated.

The residual aquatic ecological effects resulting from stream reclamation and culverting are addressed through a combination of offset and compensation measures, on and offsite. Through the AEcE, the stream ecological valuation (SEV) and environmental compensation ratio (ECR) method has been used to quantify offset measures within the WMNZ landholdings.

Residual effects on aquatic habitats will be offset and compensated for through an array of enhancement and restoration activities detailed in section 9 and in the OSSCP. In brief this includes no less than 14 km of stream enhancement or protection within the WMNZ landholdings and up to 32.2 km of stream enhancement measures outside of the WMNZ landholdings (addressed in the OSSCP).

2 Avifauna management plan

2.1 Introduction

2.1.1 Plan purpose

This Avifauna Management Plan (AMP) sets out the methods that will be used to avoid or minimise potential adverse effects on avifauna.

Legislation affords protection to native avifauna. All native avifauna on site are protected by the Wildlife Act 1953 and the Resource Management Act 1991 (RMA) affords protection to significant habitats of indigenous fauna. Furthermore, several species identified on site are classified as 'Threatened' or 'At Risk' under the Department of Conservation (DOC) National Threat Classification System (NZTCS)[4].

2.1.2 Draft consent condition scope

This AMP has been developed in accordance with the proposed Auckland Regional Landfill (ARL) consent conditions 50 b and 53 (Consent application number BUN60339589).

The requirements of these consent conditions will be addressed through the implementation, monitoring and reporting procedures set out in the AMP and the following interlinking plans. The term 'vegetation clearance' in this AMP refers to all vegetation clearance proposed to enable construction earthworks associated with the ARL, and excludes the removal of all plantation forestry that is under Matariki Forests ownership and management. Further measures to address effects on birds are detailed in the following plans:

- **The Vegetation Clearance Management Plan (VCMP; section 7),** which provides detail on how adverse effects associated with vegetation clearance (including effects on breeding birds) will be avoided or minimised through vegetation clearance protocols. This includes seasonal constraints on felling native vegetation.
- **The Construction Environmental Management Plan (CEMP),** which provides detail on erosion and sediment control effects and mitigation protocols, which relate to the mitigation of sediment impacts on wetland bird habitat.
- **The Residual Effects Management Plan (REMP; section 9**), which provides detail on the location, magnitude and type of:
  - Native habitat restoration and enhancement measures that are proposed to offset or compensate for residual effects on ecological values affected by ARL, including for avifauna; and
  - Introduced mammalian predator control to offset or compensate for residual effects on avifauna.

2.1.3 Responsibilities and competencies

Figure 1.1 sets out the roles and responsibilities in relation to the AMP with the WMNZ Regional Landfill Manager holding overall accountability for implementation of and compliance with this plan. The Technical Lead role will be performed by a suitably qualified and experienced ornithologist.

[4]Robertson, H. A., Baird, K., Dowding, J. E., Elliott, G. P., Hitchmough, R. A., Miskelly, C. M., McArthur, N., O' Donnell, C. F. J., Sagar, P. M., Scofield, R. P. & Taylor, G. A. (2016). Conservation status of New Zealand birds. New Zealand Threat Classification Series 19. 27 p

2.1.4 Plan structure

The AMP is set out as follows:

- Section 2.1 – Introduction (this section);
- Section 2.2 – Summary of avifauna values and effects;
- Section 2.3 - Protocols for managing effects on avifauna; and
- Section 2.4 – Monitoring and reporting requirements.

2.2 Summary of avifauna values and effects

Detailed information on avifauna ecological values, effects and effects management is provided in the Assessment of Aquatic and Terrestrial Ecological Values and Effects Report (AEcE) and summarised below.

2.2.1 Ecological values for avifauna

As per section 7.2.5 of the AEcE, baseline surveys were undertaken in 2018 to assess avifauna composition on site.

The avifauna assemblage in the project footprint and immediate surrounds is dominated by native and introduced species that are ubiquitous in agricultural landscapes or forestry landscapes. In total, 26 avifauna species (21 native and five exotic species) were observed during site walkovers and through the use of Automatic Bird Monitors (established in wetland habitats).

The forest and wetland bird species observed or expected to be present along with their preferred habitat and threat status[4] are presented in Table 2.1 and Table 2.2 below. This included the following nationally 'Threatened' or 'At Risk' species[5] observed onsite:

- Australasian bittern (*Botaurus poiciloptilus*) (Threatened - Nationally Critical);
- Black shag (*Phalacrocorax carbo*) (At Risk – Naturally Uncommon);
- Long-tailed cuckoo (*Eudynamys taitensis*) (At Risk – Naturally Uncommon);
- NZ pipit (*Anthus novaeseelandiae*) (At Risk – Declining);
- Whitehead (*Mohoua albicilla*) (At Risk – Declining);
- Fernbird (*Bowdleria punctata*) (At Risk – Declining); and,
- Spotless crake (*Porzana tabuensis*) (At Risk – Declining).

Of particular note, a relatively high number of fernbird and spotless crake were recorded in wetland habitats within the WMNZ landholdings. Additionally, kākā ('At Risk – Recovering') and kākāriki ('At Risk – Relict') while not detected, may be occasionally present on site. Most of the wetland and forest habitats on WMNZ landholdings that support these species are located outside the project footprint. This includes 94.8% (24.26 ha) of the 25.59 ha available wetland habitat and 94.6% (97.01 ha) of the 102.05 ha available native forest habitat.

[5] DOC administers the NZ Threat Classification System which is used to assess the threat status of all NZ taxa. (Townsend et al., 2008). Relevant documents in the Threat Classification series, including the Robertson et al (2016) *Conservation status of New Zealand birds* report can be found at this website https://www.doc.govt.nz/about-us/science-publications/conservation-publications/nz-threat-classification-system/.

Table 2.1: Forest bird species observed or expected to occur on the WMNZ landholdings and their national threat status[6].

Common name	Scientific name	Observed on WMNZ landholdings?	Habitat	Threat status
Bellbird	*Anthornis melanura*	Yes	Indigenous forest	Not Threatened
Black shag	*Phalacrocorax carbo*	Yes	Streams within forest	At Risk – Naturally uncommon
Chaffinch*	*Fringilla coelebs*	Yes	Farmland	Not Threatened
Eastern rosella*	*Platycercus eximius*	Yes	Farmland	Not Threatened
European goldfinch*	*Carduelis carduelis*	Yes	Farmland	Not Threatened
Grey warbler	*Gerygone igata*	Yes	Indigenous and exotic forest	Not Threatened
House sparrow*	*Passer domesticus*	Yes	Farmland	Not Threatened
Kākā	*Nestor meridionalis*	No	Indigenous and exotic forest	At Risk - recovering
Kākāriki	*Cyanoramphus novaezelandiae*	No	Indigenous forest	At Risk - relict
Kererū	*Hemiphaga novaeseelandiae*	Yes	Indigenous forest	Not Threatened
Long-tailed cuckoo	*Eudynamys taitensis*	Yes	Indigenous and exotic forest	At Risk – Naturally Uncommon
Morepork	*Ninox novaeseelandiae*	Yes	Indigenous and exotic forest, farmland	Not Threatened
NZ fantail	*Rhipidura fuliginosa*	Yes	Indigenous forest	Not Threatened
NZ pipit	*Anthus novaeseelandiae*	Yes	Farmland	At Risk - declining
Paradise shelduck	*Tadorna variegata*	Yes	Wetland and farmland	Not Threatened
Pūkeko	*Porphyrio melanotus*	Yes	Wetland and farmland	Not Threatened
Sacred kingfisher	*Todiramphus sanctus*	Yes	Indigenous and exotic forest, wetland, farmland	Not Threatened
Shining cuckoo	*Chrysococcyx lucidus*	Yes	Indigenous forest	Not Threatened
Silvereye	*Zosterops lateralis*	Yes	Indigenous forest, farmland	Not Threatened

[6] Almost all of the wetland and forest habitat that support terrestrial and wetland bird species are located outside ARL activity areas.

Common name	Scientific name	Observed on WMNZ landholdings?	Habitat	Threat status
Song thrush*	*Turdus philomelos*	Yes	Farmland	Not Threatened
Spur-winged plover	*Vanellus miles*	Yes	Farmland	Not Threatened
Swamp harrier	*Circus approximans*	Yes	Wetland, farmland, pine	Not Threatened
Tomtit	*Petroica macrocephala*	Yes	Indigenous and exotic forest	Not Threatened
Tūī	*Prosthemadera novaeseelandiae*	Yes	Indigenous forest	Not Threatened
Welcome swallow	*Hirundo neoxena*	Yes	Farmland, wetland	Not Threatened
Whitehead	*Mohoua albicilla*	Yes	Indigenous forest	At Risk - declining

Notes:

*Exotic species, all other species are native.

Table 2.2: Wetland bird species known to be present or likely to be present within WMNZ landholdings.

Common name	Scientific name	Observed on WMNZ landholdings?	Location	Threat status
Fernbird	*Bowdleria punctata*	Yes	SEA wetland, degraded wetland (stockpile 1)	At Risk - declining
Spotless crake	*Porzana tabuensis*	Yes	SEA wetland, Wattle forest near access road	At Risk - declining
Australasian bittern[1]	*Botaurus poiciloptilus*	Yes	SEA wetland	Threatened – nationally critical
Marsh crake	*Porzana pusilla*	No	N/A	At Risk - declining
Pied stilt	*Himantopus himantopus*	No	N/A	Not Threatened

Notes:

1 Likely Australasian bittern booms were recorded via Automatic recordings. Recordings are difficult to confirm, however, so Australasian bittern have been assumed to be present on site within the SEA wetland. (This SEA wetland is not being directly affected by ARL.)

2.2.2 Effects on avifauna

Project effects on the majority of native ecosystems in which native avifauna are likely to be present on the WMNZ landholdings have been avoided by particular attention in the engineering design, including avoidance of all Significant Ecological Areas (SEAs).

A summary of impacts to key native avifauna as a result of the ARL is presented in Table 2.3.

Potential effects on avifauna as an immediate result of construction include:

- Direct mortality of nests and their contents;
- Direct removal or degradation of habitat used for nesting and or foraging;
- Habitat fragmentation and isolation;
- The creation of habitat edge effects;
- Sediment runoff to wetlands and watercourses affecting the quality of wetland bird habitat; and
- Construction noise, potentially with respect to Australasian bittern, light and dust disturbance.

Potential ongoing effects resulting from operation and maintenance of ARL include:

- Effect of vehicle noise and disturbance on birds:
  - Noise effects are expected to be most impactful during bird breeding season, when masking of calls between conspecifics may reduce breeding success; and
  - Effects are likely to be most severe for birds which call within a similar frequency to that of construction noise (e.g. Australasian bittern booming)[4].
- Decreased landscape and habitat connectivity through fragmentation until new habitat areas are established;
- Mortality or injury on roads through bird strike or road kill;

- Potential effects associated with the increased presence of people and introduced species in previously less accessible areas;
- Lost opportunities for creating wildlife corridors; and
- Degradation of the quality of the wetland and riparian habitat of wetland bird species through:
  - Altered hydrology of wetlands;
  - Contaminated stormwater runoff (sediment, heavy metals and elevated temperature) from road surface to wetlands;
  - Risk of spills of potential toxins (for example, oil or chemicals) from cartage vehicles; and
  - Ongoing dust issues.

Table 2.3: Summary of avifauna ecological values and adverse effects associated with the ARL project as detailed in the AEcE

Biodiversity values affected by ARL	Ecological Value (EIANZ categories)	Adverse ecological effects on habitats and species addressed in the AMP
Broad habitat types associated with native avifauna		
Native mature forest	High	0.87 ha of habitat loss + indirect effects
Native regenerating forest	High	4.62 ha of habitat loss + indirect effects
Indigenous wetland	High	0.85 ha of habitat loss + indirect effects
Exotic wetland	High	0.48 ha of habitat loss + indirect effects
Exotic wattle	Moderate	9.11 ha of habitat loss + indirect effects
Exotic pine	Low to Moderate	86.88 ha of habitat loss + indirect effects
Threatened or At Risk species* *The areal extent of habitat loss for each species overlaps with other species (i.e. it is not cumulative).*		
Australasian bittern*	Very High	1.33 ha of habitat loss (wetland habitats) + indirect effects (e.g. noise effects on the SEA wetlands on WMNZ that occur outside the project footprint
Spotless crake	High	Up to 1.33 ha wetland habitat loss and water quality effects + indirect effects
North Island fernbird	High	102.81 ha of habitat loss (forest and wetland habitats) + indirect effects
NZ pipit	High	17.3 ha of pasture/grassland habitat loss + indirect effects
Whitehead	High	101.48 ha of native and exotic forest loss + indirect effects
Long-tailed cuckoo	High	101.48 ha of native and exotic forest loss + indirect effects

*The likelihood that Australasian bittern breed or forage within the 1.33 ha of wetland habitat that is expected to be directly affected by ARL is considered very low but cannot be ruled out.

Black shag, kākāriki and kākā have high ecological value as they are classified as nationally 'At Risk', however effects on these species are considered low as they are likely to be occasionally present only, and not expected to breed on site.

Habitat loss would not all occur as a single event since vegetation clearance will take place over several seasons and new habitat establishment will be taking place at the same time.

2.2.3 Effects management for avifauna

Potential adverse effects associated with the construction and operation of the landfill will primarily occur through harm to eggs and chicks during breeding season, sedimentation effects on wetlands, potential effects on breeding success and habitat use through noise-related disturbance on sensitive wetland bird species. In summary, these effects will be avoided, remedied or mitigated through:

- Seasonal constraints on vegetation clearance of native forest and all wetland habitats during peak bird breeding season;
- Designation of vegetation clearance exclusion/buffer zones within 30 m of wetland habitats during peak bird breeding season;
- Time constraints on hours of landfill-related operation within the Western block (i.e. soil stockpile one and clay borrow areas) during peak bittern breeding call times (i.e. one hour either side of dusk and dawn);
- Pre-vegetation clearance checks for bird nests during bird breeding season when small-scale vegetation clearance activities are required;
- Deployment and maintenance of sediment control measures to protect wetlands, as detailed in the CEMP; and
- Protocols for managing accidental bird injury and mortality.

To address residual adverse effects on avifauna and other biodiversity values that cannot be avoided, remedied or mitigated, and as set out in the REMP, the following offset and compensation measures will be adopted:

- Wetland and terrestrial indigenous revegetation planting across suitable available sites within the WMNZ landholdings. This includes approximately 9.9 ha of terrestrial revegetation, 4.63 ha of infill wetland planting, and approximately 15.18 ha of wetland buffer planting;
- Long-term pest control (for the term of the consents) across appropriate areas within the WMNZ landholdings and Sunnybrook Reserve (subject to agreeing the basis of this work with DOC); and
- Long-term protection of remaining and appropriate native forest and wetlands on WMNZ landholdings via covenants.

2.3 Protocols for managing effects on avifauna

Best practice measures to avoid or minimise potential adverse effects of the landfill activities on key native bird species identified from baseline surveys are set out below. Native terrestrial habitats, and all wetland habitats are focal areas for managing effects on native birds. No constraints on the clearance of pine forest, wattle forest or other exotic non-wetland vegetation are required in respect of care for avifauna habitat, as effects on avifauna within these habitats are considered low and/or out of scope for this project. Matariki Forests will be responsible for managing the clearance of pine forests, including any associated potential effects on avifauna.

Table 2.4 provides a summary of the avifauna management measures along with consent conditions, and the relevant management plans that address each effect. A description of what each of these measures will entail follows in the section below.

Table 2.4: Summary of avifauna management associated proposed consent condition(s), and primary management plans relevant to each section

Avifauna management measures	Relevant consent conditions	Primary management plan(s)
Section 2.3.1: Constraints on vegetation clearance to avoid or minimise effects on birds	53 (a)	VCMP, AMP
Section 2.3.2: Constraints on construction associated noise to avoid or minimise effects on wetland bird species	53 (a)	AMP
Section 2.3.3: Wetland setbacks	53 (b)	AMP, VCMP
Section 2.3.4: Bird nest checks	53 (c)	AMP
Section 2.3.5: Accidental harm protocol	Not applicable	AMP

2.3.1 Constraints on vegetation clearance

All adult avifauna are expected to fly away during vegetation clearance activities and are therefore unlikely to be harmed. However, during breeding season there is the potential for direct harm to nests, eggs and chicks during vegetation clearance activities. Therefore, the following protocols will be undertaken to avoid or minimise effects on native birds:

- In addition to avoidance of vegetation clearance outside of earthworks season (1st May to 1st October inclusive), during peak bird breeding season (September to December inclusive);
  - Vegetation clearance within native forest habitat (e.g. regenerating forest or mature native forest) shall be avoided;
  - Vegetation clearance within native and exotic wetlands shall be avoided; and
  - Vegetation clearance within 30 m of wetland shall be avoided where practicable (see section 2.3.3 for details).
- In the event that unforeseen circumstances arise, small scale vegetation clearance (< 10 m²) may be allowed subject to constraints (see section 2.3.4 for details).

2.3.2 Constraints on noise disturbance

Wetland birds, particularly Australasian bittern, may become disturbed by loud or persistent construction related noise, and these effects are likely to be most harmful during the bird breeding season if breeding call activity is adversely affected.

The peak breeding season (and booming period) for Australasian bittern is September to December inclusive. During this time they typically boom from 90 minutes before sunrise to 30 minutes after sunrise and between 30 minutes before sunset to 60 minutes after sunset. Correspondingly, in addition to seasonal constraints on vegetation clearance, to avoid or minimise noise-related effects on Australasian bittern, during the peak bittern breeding season (September to December inclusive) works associated with construction and operational activities in the Western block (i.e., stockpile 1 and the clay borrow pit):

- Will begin at least one hour after sunrise; and
- Shall cease at least one hour prior to sunset to avoid peak booming times.

This will reduce noise effects on bittern that potentially breed within the large SEA wetland that is also located in the Western Block.

These temporal and spatial constraints on construction and associated noise are expected to also benefit spotless crake, which preferentially call at dawn and dusk.

Operation of stockpile 1 and the clay borrow area are also expected to be ongoing throughout the life of the landfill, but operations are not expected to be daily and the diurnal constraints stated above will also apply to these operational activities.

2.3.3 Wetland setbacks

Wetland setbacks for works within the project footprint (excluding forestry undertaken by Matariki Forests) are proposed during the wetland bird breeding season (September to December inclusive) to avoid noise and construction-related impacts to wetland birds and are as follows:

- No construction activities (unless unforeseen circumstances arise, see section 2.3.4 below) shall be undertaken within 30 m of wetland habitat during wetland bird breeding season (September to December inclusive);
- The 30 m exclusion setback zone from the margin of wetlands to any construction works is to be established prior to the wetland bird breeding season commencing and confirmed by a qualified ecologist; and
- The exclusion setback zone is to be marked clearly with temporary cordoning for the attention of construction workers to ensure personnel do not disturb wetland birds.

These protocols will additionally benefit NZ pipit ('At Risk – declining') which may nest onsite in rush habitats.

2.3.4 Bird nest checks where small scale vegetation clearance is proposed

In unforeseen circumstances, small scale vegetation clearance may need to be undertaken during peak bird breeding season. To avoid the loss of native bird nests, eggs and chicks associated with this clearance, the following protocols will be followed:

- Where clearance of contiguous native terrestrial vegetation is unavoidable, bird nest checking of vegetation in the proposed clearance area shall be undertaken by a qualified ecologist;
- Arborists may be required to assist with bird nest checks where trees are too tall or dense to properly assess. If no active nests are found, trees may be felled within two working days; and
- Where active nests are found, then individual trees and immediate surrounding vegetation are to be left in situ, clearly marked and cordoned off until nesting birds have fledged or nests naturally abandoned.

Wetland vegetation clearance or works within 30 m of wetlands during the peak wetland bird breeding (September to December inclusive) season shall not be undertaken, unless where unforeseen and exceptional circumstances arise which require such action.

In these circumstances, a wetland bird nest survey shall be undertaken by a qualified ecologist prior to vegetation clearance. This will consist of a suitably qualified ecologist undertaking a survey within the proposed area of clearance and surrounds. The protocols are as follows:

- Observation of bird behaviour from a distance to determine wetland bird nest presence;
- Careful and thorough transect walks through available habitat searching for nests and eggs;
- If active nests are found, then an exclusion zone of 30 m radius shall be established and marked. No works or personnel are to be enter within the exclusion zone until chicks have fledged or the nest has been naturally abandoned;

- If the area is deemed free of active nests by the ecologist, vegetation clearance or works may occur on the same day; and
- All vegetation clearance in wetlands and wetland margins shall be overseen by a suitably qualified ecologist.

2.3.5 Accidental harm during construction

In the event of finding a dead or injured native bird during construction of ARL, the following procedures will be implemented:

- Injured native birds will be taken immediately to a vet approved by DOC for assessment;
- Birds will be placed in a cool, dark, material-lined box/bag by or under the direction of a Project ecologist to ensure the bird is handled appropriately; and
- The local DOC office or DOC hotline (if after hours) will be contacted no longer than two hours after the injured or dead bird is found. The DOC hotline is 0800 DOCHOTLINE (0800 362 468).

The name of the contact information for approved contact in the event of native bird injury or mortality shall be advised by DOC.

DOC and veterinary advice shall be sought in conjunction with a suitably trained Project ecologist when considering the rehabilitation requirements of any injured native birds (for example, legislative requirements will need to be considered). Once the vet has made an assessment, the project ornithologist will, taking into account the advice from the vet, determine any rehabilitation action required and the longer-term future for the bird/s. If the bird is dead or euthanised by the vet, it must be taken to the local DOC office as soon as practicable.

2.3.6 Management effects summary

Effects to avifauna are to be managed through the avoidance of vegetation clearance during bird breeding season, construction noise constraints and the use of bird nest checks and are summarised below (Table 2.5).

Table 2.5: Avifauna effects management summary

Avifauna	Effect to be managed	Key timeframes	Effects management	Relevant Management plans
Forest avifauna	Vegetation clearance.	Breeding season September to December inclusive.	Avoid native terrestrial vegetation clearance during forest bird breeding season.	AMP and VCMP (see section 7)
			Bird nest checks during bird breeding season where native terrestrial vegetation cleared.	
Wetland avifauna and NZ pipit	Vegetation clearance.	Breeding season September to December inclusive.	Wetland disturbance undertaken outside wetland bird breeding season unless unforeseen circumstances arise.	
			30 m wetland exclusion fencing during breeding season.	
			Bird nest survey and checks prior to any wetland clearance during breeding season.	
			Erosion and Sediment controls for wetlands	CEMP
Australasian bittern	Noise effects.	Peak booming period September to December and at dawn and dusk.	Construction works in the Western Block to begin one hour after sunrise and to cease one hour before sunset during peak booming periods.	AMP
All avifauna	All residual effects.	All year.	Restoration plantings, enhancement and pest control of wetland and forest habitats.	REMP (see section 9)

2.4 Monitoring and reporting

Compliance or incident reports will be submitted to Auckland Council (AC) as set out below. A compliance monitoring report will be submitted annually to AC following completion of each season of vegetation clearance (by June 30th each year).

This report will be prepared by an appropriately qualified and experienced ecologist(s) certifying that the works have been carried out in accordance with the approved AMP, and shall provide details of the outcomes of any bird nest checking, or instances of native bird mortality. In light of findings and results, all proposed changes in management approaches described in this AMP will be undertaken in consultation with AC. Specialist and expert advice will be sought as appropriate to improve the management approach, if findings and results deem certain management actions non-effective.

2.4.1 Pre-clearance compliance monitoring and reporting

A pre-clearance compliance monitoring report shall be submitted no later than 30 working days before commencement of construction activities for each year in which construction is undertaken and include:

- An updated project footprint that illustrates site specific avifauna clearance effects management measures;

- Representative photos showing physical delineation of vegetation within the project footprint, high value wetland bird habitat immediately adjacent to the footprint, and erosion and sediment control measures to protect wetlands; and
- Details of any bird nest checks undertaken.

For all bird nest checks, the following variables will be recorded:

- Date and time;
- GPS location and/or area of checking; and
- Outcome of bird nest check (e.g. presence or absence of active nests).

A qualified ecologist will assess the establishment and delineation of any 30 m wetland buffer areas prior to the wetland bird breeding season commencing.

Compliance reporting on restoration planting and pest control that will address residual effects on avifauna are addressed in the REMP (see section 9).

2.4.2 Incident monitoring and reporting during vegetation clearance

Incident-based reporting will be provided to Auckland Council, within 5 working days of an unforeseen event (e.g. notable compliance failure that results in adverse ecological effects), and will include the following information:

- The causes of the incident, the emergency response measures (if applicable) and the response proposed to avoid a recurrence of the issue;
- An assessment undertaken by a suitably qualified ecologist which details any adverse effects of the issue; and
- Proposed measures to avoid, remedy or mitigate effects or to offset or compensate for residual effects of the issue that cannot be avoided, remedied or mitigated.

3 Bat management plan

3.1 Introduction

3.1.1 Plan purpose

The purpose of this Bat Management Plan (BMP) is to set out procedures to avoid, remedy or mitigate impacts on native long-tailed bats (*Chalinolobus tuberculatus*) ('Threatened - Nationally Critical'[7]) that may be adversely affected by the construction of the landfill project. Measures to address any residual adverse effects on bats are not included in this BMP but are addressed elsewhere in the Residual Effects Management Plan (REMP; section 9).

The BMP includes:

- A summary of the current knowledge of long-tailed bat activity and habitat suitability within the WMNZ landholdings;
- Potential adverse effects on bats that may eventuate during construction of the landfill; and
- Proposed measures to avoid, remedy or mitigate potential adverse effects on bats on site.

All native bats are protected under the Wildlife Act 1953 (Wildlife Act) (s 3). The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna (including native bats) is a matter of national importance in the Resource Management Act 1991 (s 6(c)).

Wildlife Act Authorities issued by the Department of Conservation (DOC) will be required in order to undertake vegetation clearance during enabling works. These Authorities will have conditions attached specific to long-tailed bats, which may necessitate revision of this plan. It is intended that this BMP be submitted in support of any application for a Wildlife Act Authority for works in a known or suspected bat habitat.

3.1.2 Draft consent condition scope

This BMP has been developed in accordance with the proposed Auckland Regional Landfill (ARL) consent conditions 50 and 52 (Consent application number BUN60339589).

The requirements of these consent conditions are addressed through the implementation, monitoring and reporting procedures set out in the BMP and the following interlinking plans. The term 'vegetation clearance' in this BMP refers to all vegetation clearance proposed to enable construction earthworks associated with the ARL, and excludes the removal of all plantation forestry that is under Matariki Forests ownership and management. Further measures to address effects on bats are detailed in the following plans:

- **The Vegetation Clearance Management Plan (VCMP; section 7),** which provides detail on how adverse effects associated with vegetation clearance will be avoided or minimised through vegetation clearance protocols. This includes seasonal constraints on felling native vegetation.
- **The Residual Effects Management Plan (REMP; section 9),** which provides detail on the location, magnitude and type of:

[7] The Department of Conservation (DOC) administers the NZ Threat Classification System which is used to assess the threat status of all NZ taxa. (Townsend et al., 2008). Relevant documents in the Threat Classification series can be found at this website https://www.doc.govt.nz/about-us/science-publications/conservation-publications/nz-threat-classification-system/.

- Native habitat restoration and enhancement measures that are proposed to offset or compensate for residual effects on ecological values affected by ARL, including for bats; and
- Introduced mammalian predator control to offset or compensate for residual effects on bats.

3.1.3 Responsibilities and competencies

Figure 1.1 sets out the roles and responsibilities in relation to the BMP with the WMNZ Regional Landfill Manager holding overall accountability for implementation of and compliance with this plan.

The project bat ecologist (chiropterologist) will implement this BMP and various phases of bat-related work on the ARL Project. The bat ecologist(s) will have the relevant competency classes (Table 3.1) for the type of bat work outlined in section 3.3. The project bat ecologist will liaise when appropriate with arborists, vegetation clearance teams and site engineers.

Table 3.1: Bat competency classes, adapted from the current DOC bat ecologist competency framework[8].

Class	Field activity	Competency
A	Acoustic monitoring	Setting up acoustic bat monitors (ABMs) for pre-felling surveys.
B	Analysing acoustic monitoring data	Setting up ABMs and analysing/interpreting results.
C1	Identifying short-tailed-bat roosts	Finding and identifying short-tailed bat roosts that are either occupied or unoccupied. This competency may also include arborists.
C2	Identifying long-tailed-bat roosts	Finding and identifying long-tailed bat roosts that are either occupied or unoccupied. This competency may also include arborists.
D	Handling bats	Handling bats (using one or more field methods) as outlined in DOC's best practice manual[9]
E	Training	Approved trainer for bat competencies A-D.

3.1.4 Plan Structure

The BMP is set out as follows:

- Section 3.1 – Introduction (this section);
- Section 3.2 – Summary of bat values and effects;
- Section 3.3 – Protocols for managing effects on bats; and
- Section 3.4 – Monitoring and reporting requirements.

3.2 Summary of bat values and effects

Detailed information on the ecological values within the WMNZ landholdings and effects on bats is provided in sections 7.1.3 and 7.3 of the Assessment of Aquatic and Terrestrial Ecological Values and Effects Report (AEcE) and summarised below.

3.2.1 Ecological values for bats

An acoustic bat survey was undertaken using Acoustic Bat Monitors (ABMs) during a three week survey period in October and November 2018. Fifteen ABMs were deployed in suitable habitat within the WMNZ landholdings and areas immediately adjacent, targeting bat habitat features including forest edges, isolated trees in pasture areas, potential bat flyways, watercourses and wetlands. The objectives of the survey were:

- To determine presence/absence of long-tailed bats within WMNZ landholdings;
- To determine key habitat features for long-tailed bats within WMNZ landholdings; and

To establish how long-tailed bats are utilising the site (e.g. foraging, commuting) to understand the importance of the WMNZ landholdings for the local bat population.

[8] DOC's bat ecologist competency framework is currently under review. As such the relevant competency classes may change following review.

[9] Sedgeley, J. & O'Donnell, Colin & Lyall, J. & Edmonds, H. & Simpson, W. & Carpenter, Jo & Monks, Joanne & Mcinnes, Kate. (2013). DOC best practice manual of conservation techniques for bats

3.2.1.1 Summary of acoustic survey results

Bat activity levels across the site ranged from very low to moderate (0.2 to 5.7 mean bat passes/night) with activity levels highest in direct impact sites on the proposed access road (on the edge of the exotic pine forest) and proposed bin exchange area (currently exotic wattle forest).

3.2.1.2 Foraging activity and habitat

Some of the bat activity recorded within the WMNZ landholdings is indicative of feeding/foraging behaviour. Feeding buzzes[10] were recorded across the WMNZ landholdings on the edge of the exotic pine forest, proposed bin exchange area and edge of indigenous mature native and indigenous regenerating forest areas (see Appendix B, Figure 8). The indigenous wetlands and watercourses on site also provide potential foraging habitat for bats.

3.2.1.3 Roosting activity and potential roost habitat

It is possible to infer bat roosting trees as long-tailed bats generally emerge from their roosts approximately 30 minutes after sunset[11]. However, minimal bat activity was recorded on the ABMs within 2 hours after sunset during the 2018 survey, indicating that it is unlikely bats were roosting in proximity to the 15 ABMs during the survey period. As long-tailed bats are highly mobile and change roosts regularly, roosting activity may still occur on site but no evidence of this was captured during the 3 week survey.

An initial high-level roost habitat assessment was also undertaken to determine presence of potential bat roost trees on site. Ten individual stands of mature pines with roost characteristics are located within the ARL project footprint, on edges of the exotic pine forest. At least another 55 potential bat roost trees have been identified based on an assessment of their characteristics (e.g. cavities, hollow limbs, flaky and loose bark) within the WMNZ landholdings, but these are outside of the ARL project footprint and will be retained.

While most potential roost trees within the WMNZ landholdings are located in areas that will be retained, a refined roost assessment will need to be undertaken within the ARL footprint prior to vegetation clearance to determine whether any potential roost trees are present within vegetation clearance areas (see section 3.3.1 Vegetation Removal Protocols later in this BMP). Areas within the footprint which may contain potential roost trees (in addition to the edges of the exotic pine forest) include:

- Indigenous mature native forest;
- Indigenous regenerating forest;
- Exotic wattle forest areas in the Southern Block, particularly trees with broken branches and loose limbs; and
- Linear habitat features such as roads, forest edges and water courses present within the ARL project footprint; bats may potentially use trees within these areas for roosts when commuting between other roost sites and foraging sites.

3.2.1.4 Potential bat habitat in wider landscape

Within the wider landscape beyond the ARL project footprint, there are several areas of mature native vegetation and mature pine forest stands which may offer potential roosting areas for bats. The Significant Ecological Areas (SEAs) outside of the footprint contain a large number of mature

[10] A feeding buzz is the terminal phase of an echolocation call that bats use when they are homing in on prey. As it is difficult to visually observe bat behaviour at night, feeding buzzes are used as a proxy for foraging behaviour.
[11] Griffiths R.W. 2007. Activity patterns of long-tailed bats (*Chalinolobus tuberculatus*) in a rural landscape, South Canterbury, New Zealand, New Zealand Journal of Zoology, 34:3, 247-258

native trees which likely provide potential roosting habitat for bats. Most of the wetland and forest habitats on WMNZ landholdings that provide foraging and commuting habitat are located outside the footprint. This includes 94.8% (24.26 ha) of the 25.59 ha available wetland habitat and 94.6% (97.01 ha) of the 102.05 ha available native forest habitat.

3.2.2 Effects on bats

Long-tailed bats are expected to be directly and indirectly impacted by the loss of vegetation within the ARL project footprint within WMNZ landholdings. 102.81 ha of potential roosting, foraging and commuting habitat suitable for bats will be lost comprising:

- 4.62 ha of native regenerating forest;
- 0.87 ha of mature native forest;
- 0.85 ha of indigenous wetland;
- 0.48 ha of exotic wetland;
- 86.88 ha of exotic pine forest; and
- 9.11 ha of wattle forest.

The effects of ARL on bats as a result of vegetation loss and construction include:

- Potential loss of roost habitat;
- Injury or death through clearance of occupied roost trees;
- Loss of foraging habitat including wetland, regenerating and mature native forest;
- Habitat fragmentation and increased edge effects; and
- Behavioural changes associated with construction noise, light and vibration disturbance.

Potential ongoing effects resulting from operation and maintenance of ARL include:

- Potential effects associated with the increased presence of people and introduced species in previously less accessible areas;
- An increase in presence of mammalian pests such as rats, cats and mustelids if no pest management is undertaken in and around the operating landfill;
- Effects of night works noise, vibration and lighting on bat behaviour; and
- Bat mortality on roads.

3.2.3 Effects management for bats

Potential adverse effects on bats that are associated with the construction of the ARL will primarily occur through habitat loss associated with vegetation clearance and earthworks.

Potential adverse effects on bats will be avoided, remedied or mitigated through:

- Refinement of the project footprint where possible through detailed design and construction methodology (detailed in the VCMP; section 7) to avoid as much bat suitable habitat as possible;
- Vegetation removal protocols to identify bat roosts prior to felling within WMNZ controlled felling areas (see section 3.3.1);
- Seasonal constraints for vegetation clearance (see section 3.3.1.4.1 and also detailed in the VCMP; section 7);
- Deployment of artificial bat roosts (see section 3.3.2);

- Vegetation retention (see section 3.3.4); and
- Management of lighting effects (see section 3.3.5).

To address residual adverse effects on bats and other biodiversity values that cannot be avoided, remedied or mitigated, and as set out in the REMP, the following offset and compensation measures will be adopted:

- Wetland and terrestrial indigenous revegetation planting across suitable available sites within the WMNZ landholdings. This includes approximately 9.9 ha of terrestrial revegetation, 4.63 ha of infill wetland planting, and approximately 15.18 ha of wetland buffer planting, which will provide foraging and potential roosting habitat for bats;
- Long-term pest control (for the term of the consents) across appropriate areas within the WMNZ landholdings and Sunnybrook Reserve (subject to agreeing the basis of this work with DOC); and
- Long-term protection of remaining and appropriate native forest and wetlands on WMNZ landholdings via covenants.

3.3 Protocols for managing effects on bats

3.3.1 Vegetation Removal Protocols (for potential roost trees)

3.3.1.1 Purpose

Vegetation Removal Protocols (VRP) will be used to minimise the likelihood of adverse effects on potentially occupied bat roosts during tree clearance activities. The protocols below detail the techniques that will be used to detect roosting activity (including the use of ABMs, visual and roost emergence surveys) immediately prior to clearance of vegetation, and procedures to guide the clearance process. The protocols are consistent with best practice guidelines which have been used on many large infrastructure construction projects[12] [13] [14]. The methodologies have been adapted for local site conditions.

The VRP aim to:

- Identify potential bat roost trees that exist within key habitats within the ARL project footprint prior to vegetation clearance;
- Provide clear, concise procedures that are to be followed prior to removal of all trees within the footprint, with the aim of avoiding mortality or injury to bats in the event that they are found; and
- Set out how any bat injury or mortality that may occur will be dealt with.

There are three protocols to be followed, including:

- Protocol A: Identification of potential bat roost habitat;
- Protocol B: Pre-felling procedures; and
- Protocol C: Bat injury or mortality.

[12]Smith, D., Borkin, K., Jones, C., Lindberg, S., Davies, F. and Eccles, G. 2017. Effects of land transport activities on New Zealand's endemic bat populations: reviews of ecological and regulatory literature. NZ Transport Agency research report 623. 249pp

[13] Connolly, T. 2015. Draft bat management plan part 1 and 2 WAIKATO EXPRESSWAY HUNTLY SECTION contract no: NZTA 2/09-007/601. Report prepared by Opus International Consultants Ltd, Hamilton for NZ Transport Agency and the Fulton Hogan-HEB Joint Venture

[14] Davies, F, T Matthews and K Borkin. 2013. Waikato Expressway: Tamahere – Cambridge section bat management plan (stage one: enabling works). Report prepared by URS and Wildland Consultants Ltd for HEB Construction Ltd

3.3.1.2 Definitions

3.3.1.2.1 'High risk' roost trees

For the purpose of this protocol, trees offering high potential as bat roosts will be considered 'High risk'. High risk trees are defined as being ≥15cm Diameter at Breast Height (DBH), with one or more of the following features:

- Cracks, crevices, cavities and/or fractured limbs large enough to support roosting bat(s);
- Sections of loose flaking bark large enough to support roosting bat(s);
- A hollow trunk, stem or branches;
- Deadwood in a canopy or stem of sufficient size to support roost cavities or hollows; and
- Bat droppings, grease marks and/or urine staining around cavities.

Trees with evidence of bat droppings, grease marks and/or staining around cavities will be noted and investigated as High risk probable roost trees, regardless of size.

3.3.1.2.2 'Low risk' roost trees

All trees ≤15 cm DBH that lack the potential roost features above will be considered 'Low risk' and may be felled at any time, subject to requirements of the other fauna management plans in this EMP, without the need for further assessment or monitoring for bats, and without the need for an approved bat ecologist to be present.

3.3.1.2.3 Dusk and dawn

For the purposes of the VRP, 'dusk' and 'dawn' are defined as official civil dusk and dawn times.

3.3.1.2.4 Project bat ecologist

All pre-felling tree assessments, and assessments of acoustic monitoring data and behavioural observations will be made by an appropriately qualified and experienced bat ecologist/s (competency level C2), as defined in section 3.1.3.

3.3.1.3 VRP Protocol A: Identification of Potential Bat Roost Habitat

1 All trees to be removed within the ARL project footprint that are within WMNZ felling control will be visually assessed prior to vegetation clearance and classed as either High risk or Low risk in terms of providing potential bat roost habitat (see section 3.3.1.2 for definitions of High and Low risk).

2 All High risk trees or contiguous groups of High risk trees shall be subjected to a pre-felling assessment using a combination of visual tree assessments of roost characteristics and acoustic surveys (see Protocol B). Pre-felling tree assessments and acoustic monitoring shall be undertaken by an appropriately qualified bat ecologist (see section 3.1.3).

3.3.1.4 VRP Protocol B: Pre-Felling Procedures

3.3.1.4.1 Seasonal constraints for tree removal

1 High risk trees will be removed between October 1st and April 30th, inclusive. High risk trees may be removed outside this period only with the written approval of Auckland Council (AC) and DOC. .

2 All Low risk trees may be felled at any time without the need for acoustic survey, subject to having regard for any requirements contained in other fauna management plans.

3.3.1.4.2 Presence of Project bat ecologist(s)

1 The project bat ecologist(s) (competency level D) will be on site for removal of all High risk trees but is not required to be present for removal of Low risk trees. However they should be on call if their presence becomes necessary in the event that bats are discovered accidentally.

3.3.1.4.3 Pre-felling procedures for High risk trees

1 All High risk trees or areas of High risk trees to be removed will be clearly marked by the project bat ecologist(s) in advance of removal.

2 To determine roosting activity, High risk trees will be acoustically monitored with ABMs overnight (from one hour before official dusk to one hour after official dawn) for a minimum of two consecutive nights (with suitable weather conditions) immediately prior to removal. The second night of acoustic monitoring will occur the night before tree removal. In the event tree removal does not occur the day after the second night of monitoring, a further night/s of acoustic monitoring will be undertaken to ensure two consecutive nights of monitoring are undertaken immediately before tree clearance.

3 Suitable weather conditions during this time must include:

- overnight minimum temperature no less than 7 degrees Celsius; and
- mean overnight wind speed no greater than 20 km/h; and
- maximum overnight wind gust of no greater than 60 km/h; and
- ≤2.5mm rainfall during the first two hours after dusk.

4 No monitoring should take place during a full moon, or one night either side of a full moon. Where a night of monitoring is lost or interrupted due to unsuitable weather conditions (as defined above) a further night of monitoring must take place to compensate, until a total of two consecutive nights of monitoring is achieved.

5 All ABM data gathered during the pre-felling survey shall be reviewed the same morning the survey specified in Protocol B ends, in order to give the tree felling contractor sufficient time to fell trees prior to dusk if no bats are recorded.

3.3.1.4.4 If no bat activity is recorded

1 If no bat activity is recorded during the two nights of acoustic monitoring, the bat ecologist(s) shall inform the Site Engineer within one hour of reviewing the data to give permission for the affected tree(s) to be felled.

3.3.1.4.5 If bat activity is recorded

1 If the bat ecologist considers that bat activity patterns recorded on the ABM(s) suggest that bats may be roosting in the vicinity of the ABM, or if a bat roost is observed, the bat ecologist shall inform the Site Engineer, within one hour of reviewing the data or of observing the roost, that the affected tree(s) cannot be felled until further investigations of the trees have been undertaken. In this case the tree will be identified as a 'likely roost tree'.

2 If considered appropriate by the bat ecologist(s), likely roost trees will be climbed as far as can be done safely by an arborist trained to identify bat roosts. The arborist must take care when climbing so as not to harm or disturb any roosting bats. The arborist will take photographs of any roosts or roost evidence found. If necessary, an endoscope and hand-held bat detector will be used to examine potential roost features suspected of housing bats.

3 If climbing is not considered safe or appropriate by the arborist and bat ecologist(s), the likely roost tree or trees may be observed by bat ecologists with hand-held bat detectors over the first two hours following dusk and the four hours prior to dawn on the next two consecutive suitable nights, to observe bats leaving or entering a roost within the tree or group of trees. If

the check or observations over the two consecutive nights reveals no bats are roosting in the tree/s at present, the Site Engineer will be informed that the tree/s can be felled on the morning after the second night of observation.

3.3.1.4.6 If bat/s confirmed to be roosting within a tree

1 The tree will not be removed until further acoustic monitoring (for seven nights) confirms that the bats have abandoned the roost.

2 Trees should be clearly marked and all relevant staff briefed to ensure the tree is not removed.

3 The immediate area will be cordoned off with safety fencing and signage erected in a 10m radius around the suspected roost, alerting any person approaching the area that a bat roost is present and to stay clear.

4 All adjacent construction and vegetation removal activities will be assessed for noise and vibration and where, in the opinion of the bat ecologist, the method of construction may disturb the roost, steps will be taken to eliminate, isolate or minimise the disturbance where possible.

5 Representatives of DOC and AC will be informed by email with relevant information and photos if applicable and the project bat ecologist will agree with DOC and AC on options for next steps in the event a bat/s is still roosting after seven nights.

6 If bats are still roosting in the tree after seven nights, the bat ecologist will contact the Site Engineer and representatives of DOC and AC to arrange a meeting or teleconference to be held within three days to decide an appropriate way forward

7 Immediately after tree felling, all High risk trees will be inspected for bats and evidence of bat roosts by the Project bat ecologist(s).

3.3.1.5 VRP Protocol C: Bat Injury and Mortality

1 Any living bat/s found during or after tree removal that are not able to fly away unassisted will be taken to a vet immediately for assessment. Bats will be placed in a clean, cool, dark cotton bag by a level D bat ecologist to ensure the animal is handled appropriately. Specific protocols for handling and transporting injured bat/s as outlined in Borkin (2019)[15] will be followed.

The initial contact vet is:

Mikaylie Wilson

New Zealand Centre for Conservation Medicine

Auckland Zoological Park

Gate 2, Motions Road, Western Springs

Auckland 1022

027 406 1943

2 The Site Engineer and relevant representatives of DOC and AC will be notified at the earliest opportunity within 24 hours after an injured or dead bat is found.

DOC Warkworth District Office – 09 425 7812

After Hours – 0800 DOCHOTline (0800 362 468)

3 Any bat that is found dead or injured and subsequently euthanised will be returned to DOC.

[15]Borkin, K. 2019. Initial veterinary care for New Zealand bats. Contract Report No. 4984 Wildlands Consultants

4 Bats assessed by the vet as uninjured will be transported back to site in the cotton bag and placed in an open, temporary artificial roost box suspended within a tree as close as possible to the site the animal was found, but outside of the project footprint. The roost box will be open to allow the animal to come and go as it chooses and will be placed within the tree prior to dusk on the same day the bat is found. Specific protocols for releasing long-tailed bats are outlined in Borkin (2019)[15].

3.3.2 Artificial bat roosts

To replace available roosting habitat following vegetation clearance of areas where High risk bat trees are found, artificial bat roosts will be provided in the form of bat roost boxes.

Artificial bat roosts will be installed in habitat suitable for bat roosting within WMNZ landholdings, outside of the ARL project footprint[16].

The total number of artificial roosts to be installed will be at a rate of one artificial roost for every 10 'High risk' bat roost trees removed during enabling works, with the final number to be determined following completion of all tree removal for ARL. Suitable locations shall be identified during pre-felling acoustic surveys. It is recommended that bat roost boxes may be more effective when placed near the potential roosts they are intended to replace[17] and orientated in relation to sunlight[18].

The artificial bat roosts should be deployed at a minimum height of 4 metres from the ground on an appropriate tree, with no clutter within 2 m of the roost opening. 'Possum coil' bandings will also be wrapped around the trunk of each tree containing an artificial bat roost (above and below the artificial roost) to deter mammalian predators. It is recommended that roost boxes be checked annually and are frequently emptied of nesting materials that may be brought in by birds.

The provision of artificial roost boxes has been used internationally with the aim of providing additional, or replacement potential roosts and enhancing biodiversity in a variety of habitats[19] [20] [21].Information on the effectiveness of artificial bat roost designs for long-tailed bats in New Zealand however is limited. In recent years, several bat box designs have been installed at sites in New Zealand:

- A timber 'Kent' bat box design (Auckland Council);
- A timber 'Microbat box' design (Auckland Council);
- A bespoke timber design similar to the 'Kent' (Waikato Regional Council); and
- Four Schwegler 'woodcrete' designs (models 2F, 2FN, 1FF and 1FD; DOC, South Canterbury).

Of these, long-tailed bats are known to have roosted in the bespoke WRC 'Kent' design and all four of the Schwegler designs. In South Canterbury, roost boxes installed in 2003 were used by bats within 2 years and were still in use five years after installation[22]. Boxes were used by bats at least occasionally, although further checks detected no apparent use by bats. In 2018, bats were found roosting in artificial bat boxes in Hamilton, five years after installation.

[16] Excluding pine forest that will be removed under Matariki Forests' management.
[17] White, E.P. 2004. Factors affecting bat house occupancy in Colorado. The Southwestern Naturalist 49: 344–349
[18] Dillingham, C.P, Cross, S.P & Dillingham, P.W. 2003. Two environmental factors that influence usage of bat houses in managed forests of Southwest Oregon. Northwestern Naturalist 84: 20−23.
[19] Bender, R 2009. White-striped freetail bats in boxes. The Australasian Bat Society Newsletter 33: 5−7
[20]Ciechanowski, M. 2005. Utilization of artificial shelters by bats (Chiroptera) in three different types of forest. Folia Zoologica 54: 31−37
[21] Smith, G.C & Agnew G. 2002. The value of 'bat boxes' for attracting hollow-dependent fauna to farm forestry plantations in southeast Queensland. Ecological Management and Restoration 3: 37–46
[22] Jones, C, Borkin, K & Smith, D. 2019. Roads and wildlife: the need for evidence-based decisions; New Zealand bats as a case study. New Zealand Journal of Ecology 43(2): 3376.Longcore, T. and C. Rich (2004) Ecological light pollution. Frontiers in Ecology and the Environment 2: 191– 198

3.3.3 Experimental ring barking

Time lags between roost establishment and utilisation by bats means that uptake will likely not be immediate and may take several years. Artificial roost boxes are less efficient at buffering temperature fluctuations compared to natural roost cavities. Therefore, bats are likely to prefer natural cavities where available[23]. As such, bat boxes are considered as a temporary solution.

An alternative, long-term strategy for creating natural cavities on site involves providing natural roosting structures such as chainsaw-carved cavities in mature trees[24] , using "ring barking" techniques to increase cavity formation and potential bat roost tree availability in the wider landscape. This approach has not been used in New Zealand before, however there are opportunities within the WMNZ holdings to undertake a ring barking trial in consultation with DOC and AC, focussing on exotic species suitable for bat roosts (e.g. eucalyptus spp. and macrocarpa). This practice is not recommended for standing native trees.

3.3.4 Vegetation retention

Where possible, any standing dead trees that do not need to be removed during vegetation clearance activities are to remain in situ, as these offer good potential roosting habitat for bats.

3.3.5 Managing lighting effects

There will be minimal lighting on the proposed access road and no lighting on the landfill footprint overnight outside of active face operating hours. However, the bin exchange area will be lit all night and the tip face will be lit during early mornings and late afternoons in winter months.

Although the effects of particular lighting regimes are likely to be species-specific[25], artificial lighting can affect bat behaviour in several ways[12]:

- Bat orientation and movements through the landscape may be compromised, leading to injury and mortality;
- Direct collisions and increased exposure to predation;
- Impacts on reproduction; reproductive cycles are mediated through light levels and illumination periods; and
- Feeding behaviour in species using darkness to avoid predators can be affected and light sensitive species may be deterred from normal commuting behaviours by increased artificial light levels[26].

Design and placement of lighting in the proposed bin exchange area and tip face has yet to be finalised at time of writing this BMP. Further development of the landfill lighting design will be required in collaboration with the project bat ecologist.

However, in general terms, lighting effects on bats can be avoided by:

[23] De Bruyn L, Van Der Wijden B, Verken S & Verhagen, R. 2003. Tree cavities, microclimate and bats: an experimental study. Proceedings of 3rd International Wildlife Management Congress, 1−5 December 2003, Christchurch, New Zealand. Christchurch, New Zealand, The Wildlife Society, Landcare Research New Zealand Ltd, Australasian Wildlife Management Society

[24] Griffiths, S.R, Lentini, P.E, Semmens, K, Watson, S.J, Lumsden, L.F & Robert, K.A 2018. Chainsaw-carved cavities better mimic the thermal properties of natural tree hollows than nest boxes and log hollows. Forests 9: 235

[25] Stone, E.L., Jones, G. and Harris, S. 2012. Conserving energy at a cost to biodiversity? Impacts of LED lighting on bats. Global Change Biology 18: 2458-2465

[26] Longcore, T., & Rich, C. (2004). Ecological light pollution. Frontiers in Ecology and the Environment, 2(4), 191-198.

- Where appropriate, avoiding light in areas of high habitat quality for bats and creating 'dark zones'[27] ;
- Using LED lighting that is directional (including installing baffles on lighting columns if necessary) to minimise light spill into the surrounding environment, as well as of low intensity, longer-wavelength and lower colour temperature if practicable;
- Avoiding using shorter-wavelength, whiter LEDs as these attract more invertebrates (prey for bats). LED colour temperature may not influence the attraction of invertebrates to LEDs in New Zealand[28];
- If technological advances allow, the use of LED lights that mix coloured light from three or more monochromatic LED sources will be investigated as this would potentially provide a high level of control over emitted wavelengths to allow adjustment if necessary; and
- Undertaking dense planting of trees to screen and limit light spill into the surrounding area [27] where appropriate.

Ultimately, lighting design will be determined by human health and safety considerations. The requirement for lighting is governed by the following standards:

- AS/NZS 1158.1.1:2005 Lighting for Roads and Public Spaces – Vehicular Traffic
- AS/NZS 1158.6:2010 Lighting for Roads and Public Spaces – Luminaires
- NZTA M30:2014 Specification and Guidelines for Road Lighting Design
- NZTA TM-2015 Guidelines for Flag Lighting (September 2015 –draft)
- CIE 88 – Guide for the Lighting of Roads Tunnels and Underpasses

3.4 Monitoring and reporting

3.4.1 Incident monitoring and reporting during vegetation clearance

Refer to Protocol B (section 3.3.1.4) and Protocol C (section 3.3.1.5) for monitoring and reporting requirements following findings of an active roost site or accidental death or injury to any bats found during vegetation clearance works.

3.4.2 Compliance monitoring

A compliance monitoring report will be submitted annually to AC following completion of each season of vegetation clearance (by June 30th each year).

This report shall include:

- Confirmation that vegetation removal operations were undertaken in accordance with the BMP protocols and associated consent conditions;
- Details of work undertaken prior to removal of all potential High risk roost trees under the requirements of the VRP, including the species, DBH, total number and GPS coordinates of the High risk trees removed, a description of acoustic monitoring undertaken and details of results; and
- Recommendations for potential changes to improve the effectiveness of bat management in relation to the scope of this BMP.

[27] Straka T.M., Wolf M., Gras P., Buchholz S., & Voigt C.C. 2019. Tree cover mediates the effect of artificial light on urban bats. Frontiers in Ecology and Evolution 7:91

[28] Pawson, S.M. and Bader, M.K.-F. 2014. LED lighting increases the ecological impact of light pollution irrespective of color temperature. Ecological applications 24(7): 1561-1568

3.4.3 Wildlife Act Authority Reporting

Reporting requirements outlined in Wildlife Act Authority (Authorisation no. XXX-FAU) will be adhered to. Confirmation that vegetation removal operations were undertaken in accordance with the BMP protocols and associated conditions outlined in the Wildlife Act Authority will be submitted to DOC annually (by June 30th each year).

This report shall include:

- Confirmation that vegetation removal operations were undertaken in accordance with the BMP protocols and Wildlife Authority conditions;
- Details of work undertaken prior to removal of all potential High risk roost trees under the requirements of the VRP, including the species, DBH, total number and GPS coordinates of the High risk trees removed, a description of acoustic monitoring undertaken and details of results;
- Recommendations for potential changes to improve the effectiveness of bat management in relation to the scope of this BMP; and
- Any other information DOC require.

4 Invertebrate management plan

4.1 Introduction

4.1.1 Plan purpose

This draft Invertebrate Management Plan (IMP) sets out the methods that will be used to avoid or minimise potential adverse effects on invertebrates. This IMP defines 'invertebrates' as the following species:

- Kauri snail (*Paryphanta busbyi*; 'At Risk'[29]);
- Rhytid[30] snail (*Amborhytida dunniae*; 'At Risk'); and
- Peripatus (*Peripatoides sympatrica*; 'Not Threatened').

Kauri snails are legally protected under the Wildlife Act 1953 and classified as 'At Risk'[31] under the Department of Conservation (DOC) National Threat Classification System (NZTCS). Rhytid snails in the genus *Amborhytida* are not protected under the Wildlife Act. However, the *A. dunniae* species is classified as 'At Risk'[31]

Peripatus are not protected under the Wildlife Act. The peripatus *P. sympatrica* is 'Not Threatened'[32] and is not listed in the IUCN Red List of Threatened Species, unlike some other peripatus species. It is included in this IMP because little is known about peripatus taxonomy or ecology[33] and therefore the threat to this species is difficult to quantify.

4.1.2 Draft consent condition scope

This IMP has been developed in accordance with Auckland Regional Landfill (ARL) consent conditions 50 and 58 (Consent application number BUN60339589).

The requirements of these consent conditions will be addressed through the implementation, monitoring and reporting procedures set out in the IMP and the following interlinking plans. The term 'vegetation clearance' in this IMP refers to all vegetation clearance proposed to enable construction earthworks associated with the ARL, and excludes the removal of all plantation forestry that is under Matariki Forests ownership and management. Further measures to address effects on invertebrates are detailed in the following plans:

- **The Vegetation Clearance Management Plan (VCMP; section 7)**, which provides detail on how adverse effects associated with vegetation clearance (including effects on invertebrates) will be avoided or minimised through vegetation clearance protocols. This includes seasonal constraints on felling native vegetation; and

[29] The Department of Conservation (DOC) administers the NZ Threat Classification System which is used to assess the threat status of all NZ taxa. (Townsend et al., 2008). Relevant documents in the Threat Classification series, including those relevant to invertebrates can be found at this website https://www.doc.govt.nz/about-us/science-publications/conservation-publications/nz-threat-classification-system/.

[30] Note that both *Paryphanta* and *Amborhytida* are both part of the family Rhytidae, and are therefore both 'Rhytid' snails. However, in this report the term used is 'Rhytid snail' to refer specifically to *A. dunniae*.

[31] Mahlfeld, K., Brook, F. J., Roscoe, D. J., Hitchmough, R. A., Stringer, I. 2012: The conservation status of New Zealand terestrial Gastropoda excluding Powelliphanta. New Zealand Entomologist 35(2): 103–109

[32] Trewick, S., Hitchmough, R., Rolfe, J., Stringer, I. 2018: Conservation status of New Zealand Onychophora ('peripatus' or velvet worm), 2018. New Zealand Threat Classification Series 26. Department of Conservation, Wellington. 3 p

[33] Gleeson, D.M., Ruhberg, H. 2010. Chapter 3. Phylum Onychophora: velvet worms, peripatus. Pp. 36-39 in: Ed. Gordon, D.P. New Zealand Inventory of Biodiversity Volume Two. Kingdom Animalia, Chaetognatha, Ecdysozoa, Ichnofossils. Canterbury University Press

- **The Residual Effects Management Plan (REMP; section 9)**, which provides detail on the location, magnitude and type of:
  - Native habitat restoration and enhancement measures that are proposed to offset or compensate for residual effects on ecological values affected by ARL, including for invertebrates; and
  - Introduced mammalian predator control to offset or compensate for residual effects on invertebrates.

4.1.3 Responsibilities and competencies

Figure 1.1sets out the roles and responsibilities in relation to the IMP with the WMNZ Regional Landfill Manager holding overall accountability for implementation of and compliance with this plan. The Technical Lead role will be performed by a suitably qualified and experiences entomologist.

4.1.4 Plan Structure

The IMP is set out as follows:

- Section 4.1 – Introduction (this section);
- Section 4.2 – Summary of invertebrate values and effects;
- Section 4.3 - Protocols for managing effects on invertebrates; and
- Section 4.4– Monitoring and reporting requirements.

4.2 Summary of invertebrate values and effects

Detailed information on ecological values, effects and effects management is provided in the Assessment of Aquatic and Terrestrial Ecological Values and Effects Report (AEcE) and summarised below.

4.2.1 Ecological values for invertebrates

As detailed in section 7.2.8 of the AEcE, baseline surveys were undertaken in January and February 2019 to determine the spatial distribution and relative abundance of peripatus and the snails across the site. Surveys were undertaken in representative suitable habitat across the WMNZ landholdings. Surveys involved turning over coarse woody debris and searching through leaf litter and low growing vegetation. Twenty-four 'rhytid snails ('At Risk- Declining') and three peripatus ('Not Threatened') were detected during 53.5 person hours searching (Table 4.1).

Kauri snail, which are protected by the Wildlife Act 1953 and are 'At Risk - Declining' were not detected during surveys despite their known presence within 5 km from the WMNZ landholdings in the nearby Dome Valley and within 10 km near the Woodcocks Road area, near Warkworth.[34] Due to difficulties associated with the detection of invertebrates, their presence cannot be ruled out, but if present, the population is likely to be localised and/or small.

Most of the forest habitats on WMNZ landholdings that support these species are located outside the project footprint. This includes 94.8% (24.26 ha) of the 25.59 ha of available wetland habitat and 94.6% (97.01 ha) of the 102.05 ha of available native forest habitat.

[34] Spencer, H.G., Brook, F.J., Kennedy, M. 2006: Phylogeography of kauri snails and their allies from Northland, New Zealand (Mollusca: Gastropoda: Rhytididae: Paryphantinae). Molecular Phylogenetics and Evolution 38: 835–842.

Table 4.1: Native invertebrates observed during surveys or expected to be present on the WMNZ landholdings, including within the project footprint.

Common name	Scientific name	Threat status	Observed on WMNZ landholdings during field surveys	Location of observations and suitable habitat
Kauri snail	*Paryphanta busbyi*	At Risk – declining[31]	No	Not detected during surveys but are present in nearby areas. If present, the population is likely to be localised and or small. These snails are usually found in moist habitats, usually with abundant leaf litter. They are known to occasionally enter or live permanently in plantation forests and can be found in the leaf debris that accumulates in epiphytic plants.
Rhytid snail	*Amborhytida dunniae*	At Risk – declining[31]	Yes	In moist areas across native and exotic forest habitats.
Peripatus	*Peripatoides sympatrica*	Not Threatened[32]	Yes	Found in pine forest but likely present across native and exotic forest habitats. Usually found in damp areas under rocks, in rotting wood, under bark and in leaf litter.

4.2.2 Effects on invertebrates

Construction of all works in the project footprint will result in the permanent loss of up to 101.48 ha of predominantly exotic forest that provides habitat for rhytid snails and potentially kauri snails. During earlier surveys peripatus (*Peripatoides sympatrica*) were found on site, however as they are not 'Threatened' or 'At Risk' species, and not protected under the Wildlife Act, specific management actions are not required. However, avoiding or minimising effects on peripatus will be managed through deployment of fallen logs (particularly decomposing fallen logs) which is their primary habitat. Forest types that will be permanently lost within the project footprint are as follows:

- Pine forest (86.88 ha);
- Wattle forest (9.11 ha);
- Regenerating indigenous forest (4.62 ha); and
- Indigenous mature forest (0.87 ha).

The potential effects of ARL on invertebrates as a result of initial vegetation loss and construction include:

- Injury or death as a result of vegetation clearance and construction activities;
- Construction noise, light and dust disturbance;
- Habitat fragmentation, isolation and increase in habitat edge effects; and
- Loss of habitat.

Potential ongoing effects resulting from operation and maintenance of ARL include:

- Decreased landscape and habitat connectivity through fragmentation;
- Mortality on roads;
- Potential effects associated with the increased presence of people and introduced species in previously less accessible areas; and

- Lost opportunities for creating wildlife corridors.

A summary of invertebrate ecological values and impacts to native invertebrates as a result of ARL are presented in Table 4.2.

Table 4.2: Summary of invertebrate ecological values and adverse effects of ARL as detailed in the AEcE.

Biodiversity values affected by ARL	Ecological Value (EIANZ categories)	Adverse ecological effects on species addressed in the IMP
Kauri snail (*Paryphanta busbyi*)	High	Permanent loss of up to 101.48 ha of forest habitat as follows: 86.88 ha pine forest; 9.11 ha wattle forest; 4.62 ha regenerating indigenous forest; and 0.87 ha of indigenous mature forest. Habitat and populations immediately adjacent to the project footprint may also be subject to edge effects, light and dust disturbance.
Rhytid snail (*Amborhytida dunniae*)	High	

4.2.3 Effects management for invertebrates

Potential adverse ecological effects on invertebrates will be avoided, remedied or mitigated through:

- Refinement of the project footprint through detailed design and construction methodology where possible (detailed in the VCMP; section 7);
- Seasonal constraints on vegetation clearance (vegetation clearance only during earthworks season – during these warmer months invertebrates are more active and may be less cryptic) (detailed in the VCMP);
- Vegetation clearance protocols (detailed in the VCMP); and
- Pre vegetation clearance surveys or salvage operations (as set out in this IMP).

To address residual adverse effects on invertebrates and other biodiversity values that cannot be avoided, remedied or mitigated, and as set out in the REMP (section 9), the following offset and compensation measures will be adopted:

- Terrestrial indigenous revegetation planting across suitable available sites within the WMNZ landholdings. This includes approximately 9.9 ha of terrestrial revegetation over existing farmland and the deployment of 12 m/ha of felled or fallen logs (> 60 cm diameter) into these habitats to provide habitat for invertebrates and other species, such as lizards (detailed in the VCMP, Lizard Management Plan (LiMP; section 5) and REMP);
- Long-term pest control (for the term of the consents) across appropriate areas within the WMNZ landholdings and Sunnybrook Reserve (subject to agreeing the basis of this work with DOC); and
- Long-term protection of remaining appropriate native forest and wetlands on WMNZ landholdings via covenants.

4.3 Protocols for managing effects on invertebrates

Snail salvaging is scheduled as described in this IMP to avoid mortality of salvaged individuals during vegetation clearance. Best practice protocols for invertebrate salvaging and relocation have been adapted for local site conditions.

High-level assessment of invertebrate habitat has already been undertaken and outlined in the AEcE and identified all native and exotic forest habitats as potential peripatus and snail habitat. The lead project entomologist has discretion to include or exclude areas based on the type and quality of habitat being cleared.

Salvage methodologies will only be undertaken during the period from 1st October to 30th April inclusive, apart from log relocation for peripatus (as detailed in section 4.3.2), which can take place at any time of the year. Salvage will be undertaken using methodologies described below. Snail salvage will be carried out in all forest types. The specific salvage methodologies will be guided by the project entomologist based on their assessment of the habitat prior to vegetation clearance.

4.3.1 Snail salvaging and relocation

This protocol applies to both kauri snails and rhytid snails. Searches will be carried out for both species concurrently. If live snails are salvaged then empty snail shells shall also be translocated to provide calcium for translocated snails.

4.3.1.1 Salvaging protocol

Salvage methodologies will only be undertaken during the period from 1st October to 30th April. Snails may be less active during periods of dry weather and therefore less detectable, making pre-clearance searches less effective. In this instance, searches shall be delayed until conditions are more conducive to snail surveys. The lead project entomologist has discretion to decide whether conditions are suitable for searches, noting that microclimates will vary over the site and therefore, some areas will be less affected by dry weather than other areas.

4.3.1.1.1 Daytime salvaging

Daytime salvaging will be carried out for live kauri snails and rhytid snails and their shells. Systematic salvaging will be undertaken in the two weeks prior to the commencement of vegetation clearance, and during and immediately following vegetation clearance in all forest habitats. An initial walkover of areas to be cleared will be carried out to identify moist areas with abundant leaf litter, debris and/or low growing vegetation that may provide suitable snail habitat. These areas will then be thoroughly searched (i.e. turning over all debris, raking through all leaf litter and searching all low growing vegetation). Areas with very little leaf litter, debris and low growing vegetation, or that are dry or permanently wet are not suitable snail habitat and shall not be searched.

Manual and destructive salvaging before vegetation clearance in both indigenous and exotic forest will include:

- Turning over coarse woody debris;
- Raking of leaf litter or ground cover; and
- Habitat searches of low-growing vegetation, loose tree bark, fern skirts and aboveground tree roots.

Construction (machinery) assisted salvaging during vegetation clearance activities will be undertaken in conjunction with:

- Mulching of low stature non-woody vegetation; and

- Removal of large cover objects that cannot be searched manually (e.g. large decomposing logs).

Manual and destructive salvaging after vegetation clearance will include:

- Turning over coarse woody debris; and
- Raking of leaf litter or ground cover.

4.3.1.1.2 Nocturnal salvaging

Kauri snails are frequently found under logs and leaf litter, but they have also been reported to burrow into soft soil[35]. This may make the species undetectable to daytime searches and therefore it is important to also carry out nocturnal searches for kauri snails only where it is safe to do so. Nocturnal searches should therefore also be carried out before vegetation clearance.

Native forest will be searched on a minimum of three separate nights during the four weeks leading up to the commencement of vegetation clearance of native forest. Nocturnal searches will be undertaken using torches focusing on leaf litter in humid, sheltered forest areas identified by the lead project entomologist as suitable for salvaging. Nocturnal searches will not take place in exotic forest due to limited suitable snail habitat and the health and safety risk associated with working around pine slash at night.

4.3.1.2 4.3.1.2 Snail salvage effort – placeholder

Protocols for snail salvaging effort will be consistent with good practice and will be developed following notification and further engagement with stakeholders.

4.3.1.3 Relocation protocol

4.3.1.3.1 Capture, handling, and transport

The following steps will be undertaken by the lead project entomologist to ensure appropriate handling of snails occurs.

- All field equipment that indigenous snails may come into contact with (e.g. plastic enclosures, collection bags, scales, etc.) will be sterilised;
- Hand sterilisation will be undertaken;
- Salvaged snails will be transported in suitable ventilated plastic containers. Care will be taken so that the containers are kept at a cool temperature. At least 30 mm of moist vegetation/leaf litter will be added to plastic containers to shelter and protect snails during transportation;
- Where practical, snails will be placed into ventilated two litre plastic containers for no longer than 8 hours for transportation and relocation to the relocation site;
- Salvaged snails will be released into appropriately prepared and protected habitat suitable for the species being translocated; and
- Snail shells will also be transported to the relocation site in a plastic bag or container.

4.3.1.3.2 Inadvertent snail death

The following steps will be implemented if any snails are killed due to salvage or construction activities, as per Wildlife Act Authority Permit (Authorisation no. XXXX-FAU):

[35]Gruijters, W.T.M. 2018. Predation at a snail's pace. What is needed for a successful hunt?. BioRxiv, 420042

- The project entomologist and relevant representatives of the regulatory authority will be notified at the earliest opportunity within 24 hours after a captured snail is killed;
- The snail will be photographed and frozen. DOC will be contacted to determine whether the specimen is required for research purposes or whether it should be taken to the translocation site (note that this will depend on the quality of the specimen); and
- Appropriate measures shall be undertaken to minimise further snail deaths.

4.3.1.4 Relocation site(s)

The snail relocation site(s) will be located within WMNZ landholdings). Key aspects of the snail relocation site(s) are:

- The relocation site(s) will occur along the margin of an area of native-dominated forest that includes regenerating and mature native forest and within a contiguous forest block that is a minimum of 10 ha in size;
- Any indigenous snails salvaged will be relocated into suitable micro-habitat within the relocation site(s);
- The relocation site will be covenanted and protected (if not already protected);
- The relocation site will have pest mammal control established prior to the release of any snails (see REMP; section 9 for detail) and continued for the term of the consents or as provided in the REMP;
- Pest mammal control at the relocation site will include the ongoing control of mustelids (stoats, ferrets, weasels), feral cats, rats, possums, goats and pigs using DOC approved standard practice methods and performance measures reflective of intensive pest management e.g. no detections for goats and pigs; < 5% (with a preferred target of <3%) Residual Tracking Index (RTI) for rats, and < 5% Residual Trap Catch (RTC) for possums.
- Farm livestock will be excluded completely by the construction of permanent eight-wire post and batten fences wherever effective fences do not currently exist; and
- Habitat enhancement will be undertaken at the proposed relocation site, consisting of the deployment of logs and the creation of shaded boulder piles[36] .

4.3.2 Peripatus habitat salvage and relocation

If peripatus are found during salvage operations for other species (e.g. snails, lizards), they will be salvaged indirectly through log salvage.

In the areas where peripatus are found logs shall be selected that are most likely to contain peripatus, as follows:

- Logs at the most suitable stage of decay for peripatus are those that can be broken by a hard blow, but not by a soft blow; and
- Logs shall be at minimum 60 cm in diameter.

Relocation of logs shall occur before any site clearance begins. Logs for the purpose of peripatus salvage shall relocated the same day during daylight hours, no more than four hours following extraction. Log relocation can take place at any time of the year.

Peripatus logs shall be relocated to sites adjacent to the salvage site that contain all or some of the following favourable habitat features:

[36] Efford, M.G. 1998. Distribution and status of native carnivorous land snails in the genera *Wainuia* and *Rhytida*. Department of Conservation

- South-facing moist slopes;
- Contiguous stands of forest trees with a well formed, linked canopy;
- Abundant decomposing woody material and organic matter on the forest floor;
- Plenty of cracks and crevices that are not accessible to rodents; and
- Minimal disturbance (i.e. low levels of human activity).

4.4 Monitoring and reporting

4.4.1 Compliance monitoring report

A compliance monitoring report will be submitted annually to Auckland Council (AC) following completion of each season of vegetation clearance (by June 30th each year).

This report shall include:

- Confirmation that invertebrate salvaging and relocation operations were undertaken in accordance with the IMP and associated consent conditions;
- Salvage and relocation results; and
- Recommendations for potential changes to improve the effectiveness of invertebrate management in relation to the IMP scope.

Notable changes to salvage and relocation protocol described in the IMP will be undertaken in consultation with AC.

The compliance monitoring report shall also include representative photos showing:

- Representative photos of the salvaging methodologies; and
- Photos of snails captured including salvage site photos and relocation site photos.

Annual reporting will cease once invertebrate salvage has been completed and all captured invertebrates have been relocated to the release site. A final report summarising the outcomes of IMP implementation will then be prepared and submitted to AC within 60 working days of the final invertebrate relocation.

No post-monitoring of invertebrates is proposed within the relocation site to determine if relocation has been successful. This is due to the inherent difficulties associated with detecting and marking individuals and with obtaining meaningful data. Furthermore, snails may well survive but may disperse away from the relocation site.

4.4.2 Wildlife Act Authority Permit Reporting

Reporting requirements outlined in Wildlife Act Authority Permit (Authorisation no. XXX-FAU) will be adhered to. Snail capture and relocation data will also be compiled, summarised and submitted to DOC annually (by June 30th each year). As a minimum, the report will include the following information:

- DOC Wildlife Act Authority number and Project name and location;
- A summary of the species, numbers and sizes of snails captured, including any empty shells;
- Locations and habitat types of snails captured and shells found; and
- Summary of salvage methodologies and salvage effort.

5 Lizard Management Plan

5.1 Introduction

5.1.1 Plan purpose

Legislation affords protection to native lizards. All native lizards on site are protected by the Wildlife Act 1953 and the Resource Management Act 1991 (RMA) which affords protection to significant habitats of indigenous fauna. Furthermore, several species identified on site are classified as Threatened or At Risk under the Department of Conservation (DOC) National Threat Classification System (NZTCS).

The Lizard Management Plan (LiMP) describes measures to salvage and relocate native lizard species that are known or suspected to be present and likely to be adversely affected by the landfill project, including the following species, which are all legally protected under the Wildlife Act 1953 and classified as either nationally 'At Risk' or 'Not Threatened'[37]:

- Auckland green gecko (*Naultinus elegans elegans*; 'At Risk');
- Forest gecko (*Mokopirirakau granulatus*; 'At Risk');
- Pacific gecko (*Dactylconemis pacificus*; 'At Risk');
- Ornate skink (*Oligosoma ornatum*; 'At Risk'); and
- Copper skink (*Oligosoma aeneum*; 'Not threatened').

5.1.2 Draft consent condition scope

This LiMP has been developed in accordance with proposed Auckland Regional Landfill (ARL) consent conditions 50 c and 54 (Consent application number BUN60339589).

The requirements of these consent conditions will be addressed through the implementation, monitoring and reporting procedures set out in the LiMP and the following interlinking plans. The term 'vegetation clearance' in this LiMP refers to all vegetation clearance proposed to enable construction earthworks associated with the ARL, and excludes the removal of all plantation forestry that is under Matariki Forests ownership and management. Further measures to address effects on lizards are detailed in the following plans:

- **The Vegetation Clearance Management Plan (VCMP)**, which provides detail on how adverse effects associated with vegetation clearance (including effects on lizard habitat) will be avoided or minimised through vegetation clearance protocols. This includes the felling and stockpiling of native forest vegetation (gecko habitat) against adjacent remaining native vegetation and the stockpiling protocol for felled or fallen (decaying) logs to be used in offset/compensation sites to enhance these areas for biodiversity (including lizards); and
- **The Residual Effects Management Plan (REMP),** which provides detail on the location, magnitude and type of:
  - Native habitat restoration and enhancement measures that are proposed to offset or compensate for residual effects on ecological values affected by ARL, including for lizards; and
  - Introduced mammalian predator control to offset or compensate for residual effects on lizards.

[37] Hitchmough, R., Barr, B., Lettink, M., Monks, J., Reardon, J., Tocher, M., van Winkel, D. & Rolfe, J. (2015). Conservation status of New Zealand reptiles. New Zealand Threat Classification Series 17. 14 p

5.1.3 Responsibilities and competencies

Figure 1.1sets out the roles and responsibilities in relation to the LiMP with the WMNZ Regional Landfill Manager holding overall accountability for implementation of and compliance with this plan.

The lead project lizard ecologist (herpetologist) must be suitably qualified and experienced in lizard salvage and relocation operations and hold a current Wildlife Act Authority Permit to survey or undertake salvage and relocations on native lizard species classified as either 'At Risk' or 'Not Threatened'[37] [38]. All ecologists and sub-contractors that will contribute to the LiMP protocols required before, during and after construction shall be suitably experienced in lizard surveys and safe handling of lizards and will be under the supervision of the project herpetologist.

5.1.4 Plan Structure

The LiMP is set out as follows:

- Section 5.1 – Introduction (this section);
- Section 5.2 – Summary of lizard values and effects;
- Section □ - Protocols for managing effects on lizards; and
- Section 5.4 – Monitoring and reporting requirements.

5.2 Summary of lizard values and effects

Detailed information on ecological values, effects and effects management, including figures showing the project footprint in relation to habitat and species values is detailed in the Assessment of Aquatic and Terrestrial Ecological Values and Effects Report (AEcE) and summarised below.

5.2.1 Ecological values for lizards

A qualitative assessment of habitat values for native lizards (skinks and geckos) was undertaken during site walkovers in September and October 2018, and lizard field surveys were undertaken in October and November 2018.

Native copper skinks and the exotic plague skink were recorded during manual searching and visual encounter surveys (VES) (see AEcE for methods) during lizard surveys. The native copper skink is classified as 'Not Threatened' but is protected under the Wildlife Act 1953. The introduced plague skink is not threatened and is not protected under the Wildlife Act. No geckos were found during spotlighting surveys (Table 5.1).

Up to four additional native lizard species (pacific gecko, Auckland green gecko, forest gecko and ornate skink; Table 5.1) are expected to be present within the WMNZ landholdings based on habitat suitability and known presence in the general area. All these species are nationally 'At Risk'[39] and protected under the Wildlife Act 1953. Most of the wetland and forest habitats on WMNZ landholdings that support these species are located outside the project footprint. This includes 94.8% (24.26 ha) of the 25.59 ha available wetland habitat and 94.6% (97.01 ha) of the 102.05 ha available native forest habitat.

[38] Townsend, A. J., de Lange, P. J., Duffy, C. A., Miskelly, C. M., Molloy, J., & Norton, D. A. (2008). New Zealand threat classification system manual. Department of Conservation, Wellington, 16, 2008-11

[39] The Department of Conservation (DOC) administers the NZ Threat Classification System which is used to assess the threat status of all NZ taxa. (Townsend et al., 2008). Relevant documents in the Threat Classification series, including the Hitchmough et al. (2015). *Conservation status of New Zealand reptiles* report can be found at this website https://www.doc.govt.nz/about-us/science-publications/conservation-publications/nz-threat-classification-system/.

Table 5.1: Native lizards observed during surveys, and lizards expected to be present on the WMNZ landholdings, including within the project footprint

Common name	Scientific name	Threat status[1]	Observed on WMNZ landholdings during field surveys	Location and habitat of observations
Copper skink	*Oligosoma aeneum*	Not Threatened	Yes	Native kānuka/mānuka forest edges, basking on fence posts and Forestry Road track under rockpiles. Two individuals found within project footprint.
Pacific gecko	*Dactylocnemis pacificus*	At Risk – relict	No	Areas of mānuka, kānuka, tōtara and in native bush. The flaking bark of wattle may provide habitat for this species.
Forest gecko	*Mokopirirakau granulatus*	At Risk – declining	No	
Auckland green (elegant) gecko	*Naultinus elegans elegans* (sub species)	At Risk – declining	No	Areas of mānuka, kānuka, tōtara and in native bush.
Ornate skink	*Oligosoma ornatum*	At Risk – declining	No	Beneath native leaf litter in mature or late stage regenerating forest.

5.2.2 Effects on lizards

Project effects on the majority of native ecosystems in which lizards are likely to be present on the WMNZ landholdings have been avoided by particular attention during the engineering design, including avoidance of all Significant Ecological Areas (SEAs).

A summary of impacts to native lizards as a result of the ARL are presented in Table 5.2. Copper skinks are expected to be directly and indirectly impacted by the loss of all non-wetland vegetation habitat within the footprint which includes 86.88 ha of pine forest, 17.3 ha of pasture, 9.11 ha of wattle forest, 4.62 ha of native regenerating forest and 0.87 ha of mature native forest.

Auckland green gecko, forest gecko, Pacific gecko and ornate skinks are expected to be directly and indirectly impacted by the loss of 5.49 ha of indigenous regenerating and mature forest.

The potential effects of ARL on lizards as a result of vegetation loss and construction include:

- Injury or death as a result of vegetation clearance and construction activities;
- Construction noise, light and dust disturbance;
- Habitat fragmentation, isolation and increase in habitat edge effects; and
- Loss of key habitats, which include primarily regenerating and mature native forest.

Potential ongoing effects resulting from operation and maintenance of Auckland Regional Landfill include:

- Decreased landscape and habitat connectivity through fragmentation until new habitat areas are established;
- Mortality or injury on roads through lizard strike or road kill;
- Potential effects associated with the increased presence of people and introduced species in previously less accessible areas; and
- Lost opportunities for creating wildlife corridors.

Table 5.2: Summary of lizard ecological values and adverse effects associated with the ARL project as detailed in the AEcE

Biodiversity values affected by ARL	Ecological Value (EIANZ categories)	Adverse ecological effects on habitats and species addressed in the LiMP
Broad habitat types associated with native lizards *The areal extent of habitat loss for each species overlaps with other species (i.e. it is not cumulative).*		
Native mature forest	High	0.87 ha of habitat loss + indirect effects
Native regenerating forest	High	4.62 ha of habitat loss + indirect effects
Exotic wattle	Moderate	9.11 ha of habitat loss + indirect effects
Exotic pine	Moderate	86.88 ha of habitat loss + indirect effects
Threatened, At Risk and protected lizard species *The areal extent of habitat loss for each species overlaps with other species (i.e. it is not cumulative).*		
Copper skink (*Oligosoma aeneum*)	Moderate	101.48 ha of habitat loss + indirect effects (all forest habitats)
Pacific gecko (*Dactylocnemis pacificus*)	High	5.49 ha of habitat loss + indirect effects (all native forest habitats)
Forest gecko (*Mokopirirakau granulatus*)		
Auckland green (elegant) gecko (*Naultinus elegans elegans* (sub species))		
Ornate skink (*Oligosoma ornatum*)	High	5.49 ha of habitat loss + indirect effects (all native forest habitats)

5.2.3 Effects management for lizards

Potential adverse effects on lizards that are associated with the construction within the ARL project footprint will primarily occur through habitat loss associated with vegetation clearance, earthworks and stream culverting. Potential adverse ecological effects will be avoided, remedied or mitigated through:

- Refinement of the project footprint through detailed design and construction methodology where possible (detailed in the VCMP; section 7);
- Seasonal constraints on vegetation clearance (vegetation clearance only during earthworks season – during these warmer months lizards are more active and less cryptic) (detailed in the VCMP);
- Vegetation clearance protocols (detailed in the VCMP); and
- Pre vegetation clearance surveys or salvage operations for nationally 'Threatened', 'At Risk' or legally protected lizards (as set out in this LiMP).

For residual adverse effects on lizards and other biodiversity values that cannot be avoided, remedied or mitigated, and as set out in the REMP, the following offset and compensation measures will be adopted:

- Wetland and terrestrial indigenous revegetation planting across suitable available sites within the WMNZ landholdings. This includes approximately 9.9 ha of terrestrial revegetation, 4.63 ha of infill wetland planting, and approximately 15.18 ha of wetland;
- Buffer planting and the deployment of 12 m/ha of felled or fallen logs (> 60cm diameter) into these habitats to provide habitat for lizards and other species; and
- Long-term pest control (for the term of the consents) across appropriate areas within the WMNZ landholdings and Sunnybrook Reserve (subject to agreeing the basis of this work with DOC); and
- Long-term protection of remaining and appropriate native forest and wetlands on WMNZ landholdings via covenants.

5.3 Protocols for managing effects on lizards

The protocols for lizard salvaging and relocation specified below are consistent with standard methodologies from DOC's Inventory and Monitoring Toolbox: Herpetofauna[40] and are commonly used on many construction projects. The methodologies have been adapted in this LiMP for local site conditions at ARL.

Table 5.3 below provides a summary of the management measures along with consent conditions and management plans that relate to each management measure. A description of what each of these measures will entail follows in section below.

Table 5.3: Summary of lizard salvaging and relocation measures and associated proposed consent condition(s) and management plans

Salvaging and relocation protocols	Relevant consent conditions	Relevant management plan (s)
Section 5.3.1: Salvaging footprint	49(a)(b)	LiMP
Section 5.3.2: Salvaging protocol (ACO checks, manual day salvaging and nocturnal salvaging)	49(a)(b)	LiMP
Section 5.3.3: Relocation protocol, including capture, handling and relocation site selection and release	49(c)	LiMP, REMP (section 9)
Section 5.3.4: Accidental death or injury protocol	49(a)(b)(c)	LiMP

5.3.1 Salvaging footprint

Lizard salvaging is proposed in order to reduce mortality or injury during vegetation clearance. High-level assessment of lizard habitat has already been undertaken and outlined in the AEcE, and identified all indigenous forest within the footprint as potential lizard (skink and gecko) habitat. Wattle and pine forest within the project footprint is considered low-value potential habitat for copper skinks (and is unlikely to support other lizard species that may be present onsite (Table 5.2).

[40]Lettink, M. (2012). Department of Conservation Inventory and Monitoring Toolbox: Herpetofauna. Department of Conservation, Wellington

Salvage methodologies will only be undertaken during the period from 1st October to 30th April inclusive. Lizard salvage will be undertaken using methodologies described below. The specific salvage methodologies will be guided by the project herpetologist (lizard ecologist) based on their assessment of the lizard habitat. The project herpetologist has discretion to include or exclude salvage in certain areas based on the type and quality of habitat being cleared.

5.3.2 Salvaging protocol

Salvaging will include a range of methods as described below and will be undertaken only during the warmer months (October – April inclusive) when lizard species are more active and therefore more likely to be detected during salvaging operations.

5.3.2.1 Artificial Cover Objects (ACOs)

Artificial Cover Objects (ACOs) can be used to monitor and or capture native lizards within native forest. Each ACO will consist of two stacked onduline sheets measuring approximately 500 mm x 450 mm.

A total of 280 ACOs (ca 50 ACOs per ha) will be deployed three months prior to vegetation removal within the 5.48 ha of native forest habitat that is present within the project footprint. Each ACO will be deployed in suitable microhabitat along transects containing 20 ACOs spaced at 5 to 20 m apart and transects will predominately be situated along the forest margins.

Checking of ACO's will commence four weeks prior to vegetation clearance and checked at 2 week intervals up to and immediately prior to vegetation clearance (i.e. 3 checks per ACO). The ACO checks will be undertaken during weather conditions and timeframes deemed by the project lead herpetologist to be suitable for ACO-based lizard capture.

5.3.2.2 Daytime salvaging

Systematic manual, destructive, and/or machine-assisted salvaging will be undertaken from two weeks prior to the commencement, during and immediately following vegetation clearance in native forests, which have the highest lizard values. Pre clearance salvaging will also be undertaken in exotic forest habitats.

Manual and destructive salvaging before vegetation clearance will include:

- Turning over or pulling apart cover objects (e.g. coarse woody debris or rocks);
- Raking of leaf litter or ground cover (e.g. pampas or tradescantia); and
- Habitat searches of low growing epiphytes, dense low-growing vegetation, loose tree bark, fern skirts and woody debris.

Construction (machinery) assisted salvaging during vegetation clearance activities be undertaken in conjunction with:

- Mulching of low stature non-woody vegetation; and
- Removal of large cover objects that cannot be searched manually (e.g. large decomposing logs).

Manual and destructive salvaging after vegetation clearance will include:

- Turning over or pulling apart cover objects (e.g. coarse woody debris or rocks);
- Raking of leaf litter or ground cover (e.g. native leaf litter, pampas or tradescantia); and

- Searching of felled vegetation and associated epiphytes[41].

5.3.2.3 Nocturnal salvaging

Native forest habitat will be searched on a minimum of three separate nights during the four weeks leading up to the scheduled commencement of vegetation clearance. Nocturnal searches will be undertaken using powerful torches (minimum 800 lumens) and binoculars to 'spotlight' and capture lizards. Nocturnal searches will focus on forest and shrubland edges, which provide suitable habitat for lizards and in which lizards are most readily detected. Nocturnal salvaging will also be undertaken in habitat away from the forest edge where this is considered by the project herpetologist to be suitable for salvaging.

5.3.2.4 Salvaging Effort - placeholder

Protocols for lizard salvaging effort will be consistent with good practice and will be developed following notification and further engagement with stakeholders.

5.3.2.5 Data collection

Each individual lizard will be assigned a number and the following information will be recorded:

- Date and time of capture and weather conditions;
- Capture methodology;
- Capture location (GPS coordinates), capture methodology, habitat type;
- Species, sex (reproductive status for females), age class and Snout to Vent Length (SVL) and tail status (regenerating versus original tail) and overall health and condition; and
- A minimum of one photograph of each captured lizard will be taken, including at least one photograph showing the dorsal surface clearly.

5.3.3 Relocation protocol

5.3.3.1 Capture, handling, and transport

The following steps will be undertaken by the project herpetologist to ensure appropriate handling of lizards occurs. The transportation of all lizards will comply with the Animal Welfare (Transport within New Zealand) Code of Welfare[42]

Capture, handling and relocation of lizards will be undertaken in accordance with the below methodologies:

- All field equipment that indigenous lizards may come into contact with (e.g. plastic enclosures, collection bags, scales, etc.) will be sterilised;
- Hand sterilisation will be undertaken;
- Salvaged lizards will either be transported in cloth bags (only during salvage, not during transportation), or in suitable ventilated plastic containers. Care will be taken so that the bags

[41] As detailed in the VCMP, to minimise mortality and injury to indigenous lizard not detected during the above salvaging operations, felled trees deemed to be suitable for indigenous lizards shall be cut into sections and stockpiled at the edge of remaining native vegetation for a minimum of one month, or until all foliage has fallen off. It is expected that indigenous lizards will disperse out of stockpiles and into adjacent habitat. The stockpiles can then be removed from the site and/or mulched with no further restrictions.

[42] Ministry for Primary Industries (2018). Code of Welfare: Transport within New Zealand. MPI, Regulation and Assurance Branch, Wellington 6140

and containers will be kept at a constant ambient temperature – vegetation/leaf litter will be added to plastic containers to shelter and protect lizards during transportation;

- Where practical, indigenous lizards will be placed into ventilated two litre plastic containers for no longer than 8 hours for transportation and relocation to the relocation site; and
- Salvaged lizards will be released into appropriately prepared and protected habitat suitable for the species being translocated.

5.3.3.2 Relocation site(s)

The lizard relocation site(s) will be located within WMNZ landholdings, further detail is provided in the REMP.

Key aspects of the lizard relocation site(s) are:

- The relocation site(s) will occur along the margin of an area of native-dominated forest that includes regenerating and mature native forest and within a contiguous forest block that is a minimum of 10 ha in size;
- Any indigenous lizards salvaged will be relocated into suitable micro-habitat within the relocation site(s);
- The site will be protected, including pest mammal control established prior to the release of any lizards (see REMP for detail);
- Pest mammal control at the relocation site will include the ongoing control of mustelids (stoats, ferrets, weasels), feral cats, rats, possums, goats and pigs using DOC approved standard practice methods and performance measures reflective of intensive pest management e.g. no detections for goats and pigs; < 5% (with a preferred target of <3%) Residual Tracking Index (RTI) for rats and < 5% Residual Trap Catch (RTC) for possums;
- Farm livestock will be excluded completely by the construction of permanent eight-wire post and batten fences wherever effective fences do not currently exist that would protect the relocation sites; and
- Habitat enhancement will be undertaken at the proposed relocation site, consisting of the deployment of logs.

For each lizard the following information will be recorded upon release

- Date and time of release and weather conditions;
- Release location (GPS coordinates), habitat type; and
- Release photograph(s).

5.3.4 Inadvertent lizard injury or death

The following steps will be implemented if any injured or dead lizards are found during lizard salvage as per Wildlife Act Authority Permit (Authorisation no. XXXX-FAU):

- The project herpetologist will notify DOC at the earliest opportunity within 24 hours after an injured or dead lizard found;
- Any lizard death of Threatened, At Risk, or Data Deficient species shall be sent to Massey University Wildlife Post Mortem Service for necropsy:
  - The body is to be chilled if it can be delivered within 24 hours, frozen if longer than 24 hours to deliver;
- Appropriate measures shall be undertaken to minimise further lizard deaths;

- Injured lizards found during salvage will be taken to a suitably qualified vet as soon as possible for assessment and treatment. Injured lizards will be kept in an appropriate portable enclosure (i.e., a clean, well-ventilated plastic container) under the direction of the project lizard ecologist to ensure the animal is handled appropriately until the lizard(s) can be assessed and treated;
- Lizards assessed by the vet or alternative specialist as uninjured, or otherwise in suitable condition for release, will be transported to the lizard relocation site in the portable enclosure and released into habitat suitable for the species being relocated; and
- Euthanasia of an injured lizard shall only be undertaken under direction from DOC.

5.4 Monitoring and reporting

5.4.1 Compliance monitoring report

A Vegetation Clearance Management Plan (VCMP) and Fauna Management Plan (FMP) incorporating this Lizard Management Plan will be provided to Council at least three months prior to the construction commencement date. The plan will be prepared by an appropriately qualified and experienced ecologist.

A compliance monitoring report will be submitted annually to AC following completion of each season of vegetation clearance (by June 30th each year) in which there were salvaging and relocation operations.

This report shall include:

- Confirmation that lizard salvaging and relocation operations were undertaken in accordance with the LiMP and associated consent conditions;
- Salvage and relocation results; and
- Recommendations for potential changes to improve the effectiveness of lizard management in relation to the LiMP scope.

Notable changes to salvage and relocation protocol will be undertaken in consultation with AC and the LiMP will be updated accordingly.

The compliance monitoring report shall also include representative photos showing:

- Representative photos of the salvaging methodologies; and
- Photos of lizards captured including salvage site photos and relocation site photos.

Annual reporting will cease once lizard salvage has been completed and all captured lizards have been relocated to the release site. A final report summarising the outcomes of LiMP implementation will then be prepared and submitted to AC within three months following final lizard release.

No post-relocation monitoring of lizards is proposed within the relocation site to determine if relocation has been successful. This is due to the inherent difficulties associated with marking individuals and with obtaining and interpreting meaningful data on the expectation that the number of lizards salvaged will be low, the lizards are difficult to detect and absence of detection does not constitute confirmation of relocation failure (e.g. lizards may all survive but may disperse away from the relocation site and outside of the monitoring footprint).

5.4.2 Wildlife Act Authority Permit Reporting

Reporting requirements outlined in Wildlife Act Authority Permit (Authorisation no. XXX-FAU) will be adhered to. Lizard capture and relocation data will also be compiled, summarised and submitted to

DOC's national data repository for lizard records (the Bioweb Herpetofauna database) annually (by June 30th each year). As a minimum, the report will include the following information:

- DOC Wildlife Act Authority number and Project name and location;
- A summary of the species, numbers and age/sex classes of lizards captured;
- Locations of lizards captured; and
- Summary of salvage methodologies, effort and success.

6 Hochstetter's frog management plan

[Placeholder – to be developed following further consultation with DOC, Auckland Council and other stakeholders]

7 Vegetation clearance management plan

7.1 Introduction

7.1.1 Plan purpose

This Vegetation Clearance Management Plan (VCMP) set out the methods that will be used to avoid or minimise adverse ecological effects on vegetation and associated habitats for flora and fauna during the construction phase of Auckland Regional Landfill (ARL).

7.1.2 Draft consent condition scope

This VCMP has been developed in accordance with the following proposed Auckland Regional Landfill consent conditions 49a, b, c and d (Consent application number BUN60339589).

These consent conditions are addressed through the implementation, monitoring and reporting procedures set out in the VCMP and interlinking plans. The term 'vegetation clearance' in this VCMP refers to all vegetation clearance proposed to enable construction earthworks associated with the ARL, and excludes the removal of all plantation forestry that is under Matariki ownership and management. Further measures to address effects on birds are detailed in the following plans:

- The various fauna management plans (sections 2 to 6);
- **The Construction Environmental Management Plan (CEMP)**, which provides detail on erosion and sediment control effects and mitigation protocols; and
- **The Residual Effects Management Plan (REMP**; section 9**),** which provides detail on the location, magnitude and type of:
  - Native habitat restoration and enhancement measures that are proposed to offset or compensate for residual effects on ecological values affected by ARL; and
  - Introduced mammalian predator control to offset or compensate for residual effects.

7.1.3 Roles and responsibilities

Figure 1.1 sets out the roles and responsibilities in relation to the VCMP with the WMNZ Regional Landfill Manager holding overall accountability for implementation of and compliance with this plan. The Technical Lead role will be performed by a suitably qualified and experiences botanist.

7.1.4 Plan structure

The VCMP is set out as follows:

- Section 7.1– Introduction (this section);
- Section 7.2 – Summary of ecological values and effects;
- Section 7.3 – Protocols for managing effects of vegetation; and
- Section 7.4 – Monitoring and reporting requirements.

7.2 Summary of ecological values and effects

Detailed information on ecological values, effects and effects management, including figures showing the project footprint in relation to habitat or species values is detailed in the Assessment of Aquatic and Terrestrial Ecological Values and Effects Report (AEcE) and summarised below.

7.2.1 Ecological values

The WMNZ landholdings (1020 ha) consists of three distinct land use types. The Eastern Block and Waiteraire Tributary Block comprises predominantly exotic radiata pine plantation forestry; the Western Block is currently an operational farm and has pockets of high ecological value vegetation and habitat; the Southern Block consists of wattle plantation and regenerating native vegetation. There are significant ecological areas (SEA) and natural stream management areas (NSMA) across the landholdings, each as defined by the Auckland Unitary Plan (Operative in Part) (AUP OP), however these are not located within the project footprint.

The site is broadly dominated by exotic forest, pasture and native habitat types. Native habitat types include several areas of mature and regenerating forest, as well as several wetland types. The native vegetation is generally of high ecological value and provides habitat for a number of nationally 'Threatened' or 'At Risk' species[43], some of which are present within the project footprint. These include long-tailed bats[44], North Island fernbird, spotless crake[52], Hochstetter's frog[45], several lizard species[46], rhytid snails, mānuka and kānuka[47]. Most of the wetland and forest habitats on WMNZ landholdings that support these species are located outside the project footprint. This includes 94.8% (24.26 ha) of the 25.59 ha of available wetland habitat and 94.6% (97.01 ha) of the 102.05 ha of available native forest habitat.

7.2.2 Ecological effects

Project effects on the majority of native ecosystems on the WMNZ landholdings have been avoided, including all effects on SEAs through avoidance of ecologically sensitive areas during the process of engineering concept design and layout planning. Ecological effects of vegetation clearance are summarised in Table 7.1.

In descending order and in relation to vegetation, works within the project footprint will result in the direct loss of approximately:

- 86.88 ha of pine forest (Mataraki is responsible for undertaking the pine forest clearance but ARL will nonetheless result in permanent loss of pine forest albeit with off-set planting of new pine forest);
- 17.3 ha of pasture;
- 9.11 ha of wattle forest
- 4.62 ha of native regenerating forest;
- 0.87 ha of native mature forest;
- 0.85 ha of indigenous wetlands; and
- 0.48 ha of exotic wetland.

[43]The Department of Conservation (DOC) administers the NZ Threat Classification System which is used to assess the threat status of all NZ taxa. (Townsend et al., 2008). Relevant documents in the Threat Classification series can be found at this website https://www.doc.govt.nz/about-us/science-publications/conservation-publications/nz-threat-classification-system/.

[44] Robertson, H. A., Baird, K., Dowding, J. E., Elliott, G. P., Hitchmough, R. A., Miskelly, C. M., McArthur, N., O'Donnell, C. F. J., Sagar, P. M., Scofield, R. P., and Taylor, G. A. (2016). Conservation status of New Zealand birds. New Zealand threat classification series 19. Department of Conservation

[45] Burns, R.J., Bell, B.D., Haigh, A., Bishop, P., Easton, L., Wren, S., Germano, J., Hitchmough, R.A., Rolfe, J.R., Makan, T. (2017) Conservation status of New Zealand amphibians, 2017. New Zealand Threat Classification Series 25. Department of Conservation

[46] Hitchmough, R., Barr, B., Lettink, M., Monks, J., Reardon, J., Tocher, M., van Winkel, D., and Rolfe, J. (2015) Conservation status of New Zealand reptiles. New Zealand threat classification series 17. Department of Conservation

[47]De Lange, P. J., Rolfe, J. R., Barkla, J. W., Courtney, S. P., Champion, P. D., Perrie, L. R., Beadel, S. M., Ford, K. A., Breitwieser, I., Schonberger, I., Hindmarsh-Walls, R., Heenan, P. B., and Ladley, K. (2017). Conservation status of New Zealand indigenous vascular plants. New Zealand threat classification series 22. Department of Conservation

7.2.2.1 Direct effects

- Vegetation and habitat loss through vegetation clearance and earthworks;
- Mortality or injury to species during vegetation clearance or earthwork; and
- Construction and operations related noise and vibrations or dust effects.

7.2.2.2 Indirect effects

- Creation of habitat edge effects, altering the composition and health of adjacent vegetation, which may affect habitat suitability for flora and fauna;
- Uncontrolled discharge of sediment and/or wood waste leachate to aquatic receiving environments that may affect the quality of wetland and stream habitats; and
- Habitat fragmentation and isolation due to the loss and reduction of available habitat types, which can reduce the ability for plants and animals to disperse across the landscape for food, shelter, and breeding purposes.

Table 7.1: Summary of ecological values and adverse effects associated with the ARL project as detailed in the AEcE

Biodiversity values affected by ARL	Ecological Value (EIANZ categories)	Adverse ecological effects on habitats and species addressed in the VCMP
Broad habitat types and associated species (excluding 'Threatened' or 'At Risk' species, which are addressed below)		
Native mature forest	High	0.87 ha of habitat loss + indirect effects
Native regenerating forest	High	4.62 ha of habitat loss + indirect effects
Indigenous wetland	High	0.85 ha of habitat loss + indirect effects
Exotic wetland	High	0.48 ha of habitat loss + indirect effects
Exotic wattle	Moderate	9.11 ha of habitat loss + indirect effects
Exotic pine	Moderate	86.88 ha of habitat loss + indirect effects
Threatened or At Risk species* *(based on the NZ Threat Classification Manual[48])* *The areal extent of habitat loss for each species overlaps with other species (i.e. it is not cumulative).*		
Kānuka (*Kunzea robusta*)/ Mānuka (*Leptospermum scoparium*)	Very High	1.29 ha of habitat loss + indirect effects
Long-tailed bat (*Chalinolobus tuberculatus*)	Very High	102.81 ha of habitat loss (all forest and wetland habitats) + indirect effects
Australasian bittern (*Botaurus poiciloptilus*)	Very High	1.33 ha of habitat loss (all wetland habitats) + indirect effects
Spotless crake (*Porzana tabuensis*)	High	

[48]Townsend, A.J., P.J de Lange, C.A.J Duffy, C.M Miskelly, J. Molloy and D.A. Norton 2008. New Zealand Threat Classification System manual. Science and Technical Publishing, Department of Conservation, Wellington, New Zealand

Biodiversity values affected by ARL	Ecological Value (EIANZ categories)	Adverse ecological effects on habitats and species addressed in the VCMP
North Island fernbird (*Megalurus punctatus*)	High	102.81 ha of habitat loss (all forest and wetland habitats) + indirect effects
Whitehead (*Mohoua albicilla*)	Moderate	101.48 ha of habitat loss (all forest habitats) + indirect effects
Green (*Naultinus elegans*), forest (*Hoplodactylus granulatus*), and Pacific gecko (*Dactylocnemis pacificus*) and ornate skink (*Cyclodina ornata*)	High or Moderate	5.49 ha of habitat loss (all native forest habitats) + indirect effects
Threatened or At Risk species *(based on the NZ Threat Classification Manual (Townsend et al. 2008) The areal extent of habitat loss for each species overlaps with other species (i.e. it is not cumulative).*		
Hochstetter's frog (*Leiopelma hochstetteri*)	High	10.5 km of stream habitat loss (ca 10km streams in exotic forestry and 500 m in native forest)
Kauri snail (*Paryphanta* spp.)	High	101.48 ha of habitat loss (all forest habitats) + indirect effects
Rhytid snail (*Amborhytida dunniae*)	High	101.48 ha of habitat loss (all forest habitats) + indirect effects
White rata (*Metrosideros perforata*)	High	5.49 ha of potential habitat loss (all native forest habitats)
Kawaka (*Libocedrus plumosa*)	Moderate	5.49 ha of potential habitat loss (all native forest habitats)
Kaikomako (*Pennantia corymbosa*)	Moderate	5.49 ha potentially present within 5.48 (all native forest habitats)

7.2.3 Effects management

Potential adverse effects associated with the construction and operation of ARL will primarily occur through habitat loss associated with vegetation clearance, earthworks and stream culverting. Potential adverse ecological effects will be avoided, remedied or mitigated through:

- Refinement of the project footprint through detailed design and construction methodology (where possible);
- Seasonal constraints on vegetation clearance;
- Vegetation clearance protocols; and
- Pre vegetation clearance surveys or salvage operations for nationally 'Threatened', 'At Risk' or legally protected species (including bats, birds, lizards, frogs, invertebrates and fish).

For residual adverse effects that cannot be avoided, remedied or mitigated, and as set out in the REMP, the following offset and compensation measures will be adopted:

- Wetland and terrestrial indigenous revegetation planting across suitable available sites within the WMNZ landholdings. This includes approximately 9.9 ha of terrestrial revegetation, 4.63 ha of infill wetland planting, and approximately 15.18 ha of wetland buffer planting;

- Long-term pest control (for the term of the consents) across appropriate areas within the WMNZ landholdings and Sunnybrook Reserve (subject to agreeing the basis of this work with the Department of Conservation (DOC)): and
- Long-term protection of remaining and appropriate native forest and wetlands on WMNZ landholdings via covenants.

7.3 Protocols for managing effects of vegetation clearance

Set out below are the management processes and protocols to avoid, remedy and mitigate adverse effects on vegetation clearance as a result of ARL.

Table 7.2 below provides a summary of the vegetation management measures along with consent conditions, roles and management plans that relate to each vegetation management measure. A description of what each of these measures will entail follows in the section below.

Table 7.2: Summary of vegetation clearance measures and associated proposed consent condition(s), roles and responsibilities and management plans relevant to each

Vegetation clearance management measures	Relevant consent conditions	Primary responsibility and relevant roles	Primary management plan (s)
Before vegetation clearance (section 3.1)			
Design and Construction method refinements	49(a)	Lead project ecologist in consultation with project ecologist(s), design and construction engineers, the project arborist and vegetation clearance contractors	VCMP + CEMP
Physical delineation	49(a)	Lead terrestrial ecologist in consultation with project ecologist(s), arborist, and construction engineer(s)	VCMP
Seasonal constraints	49(b)	Lead terrestrial ecologist and Lead freshwater ecologist in consultation with ecology leads on relevant management plans	VCMP, AMP (section 2), BMP (section 3), IMP (section 4), LiMP (section 5), HFMP (section 6), NFFFMP (section 8)
Sediment and erosion control	49(a)	Lead freshwater ecologist in consultation with design and construction engineers	VCMP + CEMP
Salvaging (Fauna and Flora)	49(a) +	Ecologist lead for respective fauna management plans in consultation with lead terrestrial or lead freshwater ecologist (as applicable)	VCMP, IMP (section 4), LiMP (section 5), HFMP (section 6), NFFFMP (section 8)
Bat tree felling protocol	49(a)	Lead bat ecologist in consultation with lead terrestrial ecologist	BMP (section 3)
During vegetation clearance (section 3.2)			
Ecological oversight of vegetation clearance and	49(a) +	Lead terrestrial/ freshwater ecologists in consultation with project ecologists, ecologist leads for fauna management plans, arborist, clearance contractors and engineers	VCMP

clearance management measures			

Vegetation clearance management measures	Relevant consent conditions	Primary responsibility and relevant roles	Primary management plan (s)
Post vegetation clearance (section 3.3)			
Stockpiling felled gecko habitat	49(c-d)	Lead terrestrial ecologist in consultation with lead lizard ecologist, vegetation clearance and site engineer(s)	VCMP + LiMP (section 5)
Stockpiling logs for relocation to mitigation sites	49(c-d)	Lead terrestrial ecologist in consultation with project ecologist(s), vegetation clearance contractors and site engineer(s)	VCMP + REMP (section 9)
Mulching and storage of mulch	49(c)	Lead terrestrial ecologist in consultation with project ecologist(s), vegetation clearance contractors and site engineer(s)	VCMP

The vegetation clearance management measures are provided below in order of occurrence i.e. vegetation measures before (section 7.3.1), during (section 7.3.2) and after (section 7.3.3).

7.3.1 Vegetation clearance protocols – before clearance

7.3.1.1 Detailed design and construction methodology refinements

Minor adjustments will be made to the project footprint through detailed design and construction methodologies to minimise the need to remove native forests or wetlands and mature native trees or potential bat roosting trees (e.g. through the occasional use of retaining walls, slope/batter refinements or minor alterations to the footprint).

7.3.1.2 Physical delineation

All vegetated areas adjoining the project footprint have been identified during the design process (Appendix B, Figure 5). In these areas the project footprint will be physically delineated. Individual mature native trees or bat roost trees located in close proximity to, but outside, the project footprint will also be identified by a suitability qualified ecologist and marked by flagging tape or fencing to avoid inadvertent clearance and to minimise potential damage to branches and roots.

7.3.1.3 Seasonal constraints on clearance of high value vegetation

The vegetation clearance programme will be affected by specific timing restrictions for each fauna type (bats, birds, lizards, frogs, invertebrates, and fish) identified as being present or likely to be present by pre-clearance fauna surveys (see the Lizard Management Plan (LiMP; section 5), Hochstetter's Frog Management Plan (HFMP; section 6), Invertebrate Management Plan (IMP; section 4) and Native Freshwater Fish and Fauna Management Plan (NFFFMP) (section 8)). Table 7.3 provides a summary of seasonal vegetation clearance for each taxon group.

In some instances, and with council approval, small scale vegetation clearance of < 10 m^2 will be required but these activities will follow specific protocols set out in the respective fauna management plans.

Vegetation clearance should be avoided outside of earthworks season in areas where winter erosion risks are significant.

Table 7.3: Seasonal vegetation clearance for each taxa. Green cells = no constraints. Grey cells = constraints.

Taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Constraints
Bats (see BMP; section 3)													High-risk trees or contiguous groups of high-risk trees clearance to occur between October 1st and April 30th, inclusive, when the weather is warmer, and bats are likely to be more active (and therefore bat roosts are more likely to be detected if present).
Birds (see AMP; section 2)													Vegetation clearance to occur outside of peak bird breeding season (September 1st to December 31st, inclusive) to avoid and minimise potential direct mortality or injury to eggs, nesting chicks and fledglings.
Lizards (see LiMP; section 5)													Vegetation clearance to occur between October 1st to April 30th, inclusive, during these warmer months lizards, frogs and invertebrates are more active, easier to detect and more likely to survive relocation.
Hochstetter's frog (see HFMP; section 6)													
Invertebrates (see IMP; section 4)													
Fish													

7.3.1.4 Sediment and erosion control

Removal of vegetation can expose soil making it more prone to erosion, resulting in increased sedimentation into wetlands (and streams). Prior to vegetation clearance, sediment control measures will be undertaken to avoid or minimise effects on wetland birds and aquatic species due to effects on water quality. Procedures for minimising the area and duration of soil exposure from vegetation clearance will be undertaken in accordance with the CEMP.

Erosion and Sediment Control (ESC) works will be coordinated as much as practical with the forestry operator during harvest but ultimately the protocols and requirements affecting them are outside the scope of the VCMP.

7.3.1.5 Bat roost tree protocols

Procedures to avoid impacts to roosting bats prior to tree felling through pre-felling checks for signs of bat roosting activity and potential roost sites are addressed in detail in the Bat Management Plan (BMP; section 3).

7.3.1.6 Species surveys and salvaging

Procedures to avoid impacts to fauna (birds, lizards, birds, bats and fish) prior to vegetation clearance through surveys (birds only) or salvage and relocation operations are addressed in detail in the respective plans.

Fauna management surveys required prior to vegetation clearance are listed in Table 7.4 below. In addition, DOC permits allowing species specific salvaging and relocation operations will apply.

Table 7.4: Fauna management surveys required prior to vegetation clearance approval

Taxa	Pre–salvage surveys required	Salvage and relocation operations	Management Plan reference
Bats	• Acoustic surveys	Not applicable	BMP (section 3)
Bird	• Nest checks for when small-scale vegetation clearance is undertaken during peak bird breeding season (see AMP)	Not applicable	AMP (section 2)
Lizard	• Not applicable	• Gecko spotlighting searches • Skinks manual searches and reptile shelter checks	LiMP (section 5)
Frog		• Manual searching	HFMP (section 6)
Invertebrates		• Manual searching	IMP (section 4)
Fish		• Electro fishing • G-minnow traps	NFFFMP (section 8)

Salvaging and relocation of selected small kawaka and kaikomako seedlings will be undertaken with small seedlings relocated to nearby adjacent habitats with suitable microhabitat conditions. Salvage and relocation of only small seedlings (< 20 cm in height) will be undertaken as larger seedlings are much less likely to establish when relocated. A maximum of 100 small seedlings of each species will be relocated

7.3.2 Vegetation clearance protocols – during clearance

Vegetation clearance will only commence after all pre-clearance management measures have been undertaken or are in place and has been confirmed by the project botanist.

During vegetation clearance activities construction methodology refinements, maintenance of physical delineation barriers and erosion and sediment control measures as described in the CESCP will be ongoing.

Moreover, there will be a likely need for incidental salvaging and relocation of fauna not detected during pre-clearance salvaging. In addition to above, methodology to further reduce effects during vegetation clearance for the removal and pruning of vegetation includes:

- Vegetation will only be cleared immediately prior to construction works beginning in the ARL project footprint to reduce habitat effects and reduce the potential for erosion and sediment generation;
- Vegetation will be directionally felled away from the physically marked edge (ARL project footprint boundary), to prevent damage to the vegetation immediately adjacent to the footprint, unless deemed to be unsafe. Methods for undertaking vegetation removal will be site specific and commonly will include use of an excavator, grapple and chainsaw on suitable land, and directionally felling trees using experienced tree-fellers;
- Within native regenerating and native mature forest habitat types, removal will be managed by experienced arborists to reduce tree damage and to accommodate construction. This will

preferentially involve pruning branches of large trees rather than felling where this would accommodate the construction requirements;

- Within native regenerating forest, native mature forest, wetlands and wetland margins (vegetation <30 m from wetlands), vegetation clearance/habitat loss activities will be overseen by a suitably qualified ecologist; and
- Pre-vegetation clearance bat monitoring and implementation of tree-felling protocol for potential bat roost trees (See BMP).

7.3.3 Vegetation clearance protocols – after clearance

7.3.3.1 Stockpiling for lizard management

To minimise harm or injury to nationally 'At Risk' geckos and to the extent feasible, felled mature or regenerating native vegetation will be de-limbed (main trunk only) and stockpiled adjacent to remaining mature or regenerating forest for a minimum of 1 month prior to removal or mulching. This will enable geckos not detected during salvaging operations to disperse from felled vegetation into surrounding habitats.

Priority felled logs for stockpiling include large (> 60 cm diameter) felled logs or trees trunks of native (preferably) or exotic species. These should be cut up into manageable portions (3–5 m sections). Where suitable sites exist, large fallen and decaying logs and a proportion of cleared vegetation will be left in-situ adjoining the road footprint and placed into small and compact windrows within defined areas. Windrows should not be placed in locations where material could move and enter streams. In forest areas smaller volumes of material can be placed with minimal damage to existing sub-canopy and ground cover vegetation.

7.3.3.2 Log deployment for offset sites

Felled trees and already fallen logs in various states of decomposition are ecologically important to forest regeneration processes and as habitat for a wide range of species. Felled and already fallen decaying logs provide critical habitat for decomposers including invertebrates, fungi and bacteria, and lizards and are key sites for plant regeneration.

For reasons described, felled and fallen logs will be used for future deployment into appropriate terrestrial and wetland offset sites.

As detailed in the REMP (9) and once terrestrial and wetland offset site conditions are appropriate for deployment, a minimum of 12 m / ha of cut up manageable portions (3 – 5 m) stockpiled logs and already fallen decaying logs will be deployed into terrestrial and wetland offset sites.

7.3.3.3 Mulching

For practical reasons, most vegetation will need to be mulched and removed and used either for sediment/ erosion control during construction or used along with site-won topsoil for site rehabilitation and ecological restoration purposes. Vegetation not left in-situ will be mulched on-site using a mulching head on a large excavator. This process will result in mulch being distributed across the project area.

Mulching will be undertaken in a manner to prevent wood chips entering streams and ephemeral gullies. Where practicable, this will involve manually chipping in to the back of a truck, removing any vegetation that falls within 10 m of a stream or wetland and mulching this at a suitable location.

Mulched wood will be removed from the project footprint and placed into stockpiles. The storage of vegetation as chip or mulch can result in 'wood waste leachate' which has a high biochemical oxygen demand (BOD) and dissolved organic matter. Procedures for minimising the volume of vegetation to

be mulched, locating wood residue piles with an appropriate separation distance from streams and minimising potential wood waste leachate from these piles will be undertaken.

7.3.4 Summary of ecological effects management for biodiversity values

Table 7.5 below summarises for each biodiversity attribute the effects management measures relevant to vegetation clearance activities and as detailed in sections 7.3.1 - 7.3.3 above.

Table 7.5: Summary of vegetation clearance effects management measures for affected taxa

Biodiversity values	Vegetation management avoidance or minimisation measures
Broad habitat types (excluding 'Threatened' or 'At Risk' species, which are addressed below)	
Native mature forest Indigenous regenerating forest Exotic pine Exotic wattle	• If reasonably practical, further avoidance of habitat loss through detailed design refinement and construction methodology • Protection of all vegetation immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage to vegetation immediately adjacent to the project footprint • Salvaging of felled and fallen (decaying) logs for habitat enhancement
Indigenous wetland Exotic wetland Streams	• If reasonably practicable further avoidance of habitat loss through detailed design refinement and construction methodology • Protection of wetland or stream habitat immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage to vegetation or habitats immediately adjacent to the project footprint • Salvaging of felled and fallen (decaying) logs for habitat enhancement (wetlands only) • Erosion and sediment controls
Nationally 'Threatened' or 'At Risk' species (based on the DOC classification system) or Regionally 'Sparse' and 'Naturally uncommon' in Auckland[49] (Sawyer and Forbes, 2013).	
Threatened plants (mānuka, kānuka, white rātā, kawaka and kaikomako)	• If reasonably practicable further avoidance of habitat loss through detailed design refinement and construction methodology • Protection of all/vegetation immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage to vegetation immediately adjacent to vegetation • Salvaging and relocation of threatened plant seedlings from the footprint into surrounding habitats where microhabitat types are suitable
Long-tailed bat	• If reasonably practicable further avoidance of habitat loss through detailed design refinement and construction methodology • Protection of all/vegetation immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage to vegetation immediately adjacent to the project footprint • Pre-vegetation clearance bat monitoring and implementation of tree-felling protocol for potential bat roost trees (See BMP)
Wetland birds (Australasian bittern, spotless crake and fernbird)	• If reasonably practicable further avoidance of habitat loss through detailed design refinement and construction methodology • Protection of wetland habitat immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage to habitats • Seasonal constraints on wetland habitat loss to minimise effects on eggs and/or chicks during peak-breeding season • Erosion and sediment controls • Salvaging of felled and fallen (decaying) logs for wetland habitat enhancement

[49] Sawyer, J., Forbes, A. (2013). Threatened and unique biodiversity assets of Auckland. Auckland Council.

Native fauna (longfin eel, inanga)	• If reasonably practicable further avoidance of habitat loss through detailed design refinement and construction methodology • Protection of stream habitat immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage to habitats. • Fish salvage to be undertaken prior to vegetation clearance to maximise potential salvage • Erosion and sediment controls
Species that are not Nationally 'Threatened' or 'At Risk' species (based on the DOC classification system)	
Forest birds	• If reasonably practicable further avoidance of vegetation loss through detailed design refinement and construction methodology • Protection of terrestrial habitat immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage to vegetation • Seasonal constraints on vegetation clearance in native mature and native regenerating forest to loss to minimise effects on eggs and/or chicks during peak-breeding season • Salvaging of felled and fallen (decaying) logs for habitat enhancement in terrestrial revegetation sites
Green, forest, and Pacific gecko and ornate skink	• If reasonably practicable further avoidance of vegetation loss through detailed design refinement and construction methodology • Protection of terrestrial habitat immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage to vegetation • Lizard salvaging and relocation operations prior to vegetation clearance (see LiMP; section 5) • Stockpiling of cleared mature and native revegetation adjacent to remaining vegetation for 1 month prior to mulching to enable dispersal into remaining habitat
Hochstetter's frog	• If reasonably practicable further avoidance of habitat loss through detailed design refinement and construction methodology • Protection of habitat immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage • Erosion and sediment controls • Hochstetter's frog salvaging and relocation operations prior to vegetation clearance (See HFMP; section 6)
Rhytid and kauri snails	• If reasonably practicable further avoidance of habitat loss through detailed design refinement and construction methodology • Protection of habitat immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage • Salvaging and relocation operations prior to vegetation clearance (see IMP; section 4)
Fish	• If reasonably practicable further avoidance of habitat loss through detailed design refinement and construction methodology • Protection of habitat immediately adjacent to project footprint through physical delineation and felling procedures to minimise unintended damage to streams • Salvaging and relocation operations prior to vegetation clearance (see NFFFMP, section 8)

7.4 Monitoring and reporting

Compliance or incident reports described in this section will be submitted to Auckland Council. Reporting of pine forest vegetation clearance undertaken by Matariki is outside the scope of this VCMP.

7.4.1 Pre-clearance compliance monitoring and reporting

The pre-clearance compliance monitoring report shall be submitted no less than 30 working days prior to commencement of construction activities on an annual basis and include:

- An updated project footprint and ecological constraints map that illustrates site specific vegetation clearance effects management measures; and
- Representative photos showing physical delineation of vegetation within the project footprint, high value trees immediately adjacent to the footprint, sediment control measures and proposed stockpiling locations.

7.4.2 Incident monitoring and reporting during vegetation clearance

Incident-based reporting will be provided to Auckland Council as soon as practicable but no more than within 5 working days after an unscheduled event associated with vegetation clearance (e.g. notable compliance failure that results in adverse ecological effects or event that causes vegetation damage on a scale that requires an urgent remedy according to the project ecologist to return to compliance with any section of the site's ecological and landscape management plans and planting programmes), and will include the following information:

- The causes of the incident, the emergency response measures (if applicable) and the response proposed to avoid a recurrence of the issue;
- An assessment undertaken by a suitably qualified ecologist which details any adverse effects of the exceedance;
- Proposed, measures to avoid, remedy or mitigate effects or to offset or compensate for residual effects that cannot be avoided, remedied or mitigated; and
- Incidents will be tracked to resolution through the site's compliance management system.

7.4.3 Post-clearance compliance monitoring and reporting

A post-clearance compliance monitoring report shall be submitted annually to Auckland Council by June 30th each year pertaining to vegetation clearance undertaken the 12 months to May 31st that year. The report shall include confirmation that the vegetation clearance effects management activities were undertaken in accordance with the VCMP. This shall include, representative photos showing:

- Aerial photography showing actual vegetation clearance in relation to stated project footprint;
- Stockpiled native vegetation for minimising effects on lizards (pre-mulching); and
- Stockpiled logs for deployment to terrestrial and wetland mitigation sites.

8 Native freshwater fauna management plan

[Placeholder – this plan has already been submitted to Council as a stand-alone plan, but will ultimately form a section of this plan]

9 Residual Effects Management Plan

9.1 Introduction

9.1.1 Plan purpose and draft consent condition scope

This section of the Residual Effects Management Plan (REMP) sets out the methods that will be used to offset and compensate for residual effects associated with Auckland Regional Landfill (ARL), which cannot be avoided or minimised.

This section of the REMP has been developed in accordance with the following proposed Auckland Regional Landfill consent conditions 181d, e, g, h, i, j, k, l, m, n, o, and p, 182, 183, 184, and 185 (Consent application BUN60339589).

These consent conditions will be addressed through the implementation, monitoring and reporting procedures set out in this REMP and the following interlinking plans:

- The Avifauna Management Plan (AMP; section 2); Bat Management Plan (BMP;section 3); IMP (Invertebrate Management Plan; section 4); Lizard Management Plan (LiMP; section 5) and Hochstetter's Frog Management Plan (HFMP; section 6), Native Freshwater Fish and Fauna Management Plan (NFFFMP) (section 8) which provide detail on how adverse effects to native fauna including 'Threatened' or 'At Risk' species will be avoided or minimised through vegetation clearance protocols, seasonal constraints on earthworks, salvaging and relocation and other management action;
- **The Construction Environmental Management Plan (CEMP),** which provides detail on how erosion and sediment effects will be managed;
- **The Vegetation Clearance Management Plan (VCMP; section 7),** which provides detail on how adverse effects associated with vegetation clearance will be avoided or minimised through vegetation clearance protocols. This includes the felling and stockpiling of native forest against adjacent remaining native vegetation and the stockpiling protocol for felled or fallen (decaying) logs to be used in offset/compensation sites to enhance these areas for biodiversity;
- **The Off-Site Stream Compensation Plan (OSSCP),** which provides detail on how residual effects on stream will be addressed outside of WMNZ landholdings. The OSSCP provides a process to quantify the enhancement required to compensate for stream effects not otherwise addressed in the REMP and other management plans; and
- **The Landscape Mitigation and Restoration Plan (LMRP)**, which provides detail on the landscape planting of native-dominated species on engineered fill (e.g. on Stockpile 1). While these plantings will provide biodiversity benefits, they do not form part of the ecological compensation package and the Landscape planting specifications will be addressed separately in the LMRP.

9.1.2 Responsibilities and competencies

Figure 1.1 sets out the roles and responsibilities in relation to the REMP with the WMNZ Regional Landfill Manager holding overall accountability for implementation of and compliance with this plan. Broadly speaking, implementation of the REMP will be undertaken by terrestrial and freshwater ecologists under the supervision of a suitably qualified lead ecologist and in consultation with designers, site engineers, arborists and vegetation clearance contractors as required.

9.1.3 Plan structure

The REMP is set out as follows:

Section 9.1 Introduction (this section);

Section 9.2 Ecological values, effects and effects management;

Section 9.3 Ecological Enhancement and Restoration Plan;

Section 9.4 Off-Site Stream Compensation Plan;

Section 9.5 Pest Management Plan;

Section 9.6 Biosecurity measures; and

Section 9.7 Monitoring and reporting compliance requirements.

9.2 Summary of ecological values, effects and effects management

Detailed information on ecological values, effects and effects management (including figures) is provided in the Assessment of Aquatic and Terrestrial Ecological Values and Effects Report (AEcE) and is summarised below. The following section is divided into terrestrial and wetland biodiversity and aquatic habitat.

9.2.1 Terrestrial and wetland biodiversity

9.2.1.1 Values

The WMNZ landholdings (1020 ha) consists of three distinct land use types. The Eastern Block and Waiteraire Tributary Block comprises predominantly exotic radiata pine plantation forestry; the Western Block is currently an operational farm and has pockets of high ecological value vegetation and habitat; and the Southern Block consists of wattle plantation and regenerating native vegetation. There are significant ecological areas (SEA) and natural stream management areas (NSMA) across the WMNZ landholdings.

The site is broadly dominated by exotic forest, pasture and native habitat types. Native habitat types[50] include:

- Mature and regenerating forest
  - VS2 Kānuka scrub/forest
  - VS5 Broadleaved species scrub/forest
  - WF8 Kahikatea, pukatea forest
  - WF9 Taraire, tawa, podocarp forest
  - WF12 Kauri, podocarp, broadleaved, beech forest
- Wetland
  - WL12 Mānuka, tangle fern scrub/fernland
  - WL19 Raupō reedland

Part of the native vegetation is of high ecological value and provides habitat for a number of nationally 'Threatened' or 'At Risk' species (Table 9.1)[51], some of which are present within the

[50] Singers, N., Osborne, B., Lovegrove, T., Jamieson, T., Boow, A., Sawyer, J., Hill, K., Andrews, J., Hill, S., and Webb, C. (2017). *Indigenous terrestrial and wetland ecosystems of Auckland*. Auckland Council.

[51] The Department of Conservation (DOC) administers the NZ Threat Classification System which is used to assess the threat status of all NZ taxa. (Townsend et al., 2008). Relevant documents in the Threat Classification series can be found at this website https://www.doc.govt.nz/about-us/science-publications/conservation-publications/nz-threat-classification-system/.

project footprint. These include long-tailed bats[52], North Island fernbird, spotless crake[52], Hochstetter's frog[53], several lizard species[54], rhytid snails, mānuka and kānuka[55].

For the most part, direct effects on native ecosystems within the WMNZ landholdings have been avoided, including avoidance of all Significant Ecological Areas (SEAs), through particular consideration in the engineering design and site layout for the project footprint.

9.2.1.2 Effects

In broad terms, ARL will have a range of direct and indirect effects on terrestrial and wetland biodiversity values that include:

- Vegetation and habitat loss through vegetation clearance and earthworks;
- Mortality or injury to species during vegetation clearance or earthworks;
- Construction and operations related noise and vibrations or dust effects;
- Creation of habitat edge effects, altering the composition and health of adjacent vegetation, which may affect habitat suitability for flora and fauna;
- Potential for an uncontrolled discharge of sediment and/or wood waste leachate to aquatic receiving environments that may affect the quality of wetland habitats; and
- Habitat fragmentation (subject to corrective planting) by virtue of cutting a road and landfill valley through vegetated areas, and isolation due to the loss and reduction of available habitat types, which can reduce the ability for plants and animals to disperse across the landscape for food, shelter, and breeding purposes.

These effects will primarily occur through the permanent loss of approximately:

- 86.88 ha of pine forest: Mataraki Forests is responsible for the effects of pine forest clearance but ARL will result in permanent loss of pine forest albeit replaced by planting pines on the open farmland;
- 17.3 ha of pasture;
- 9.11 ha of wattle forest;
- 4.62 ha of native regenerating forest;
- 0.87 ha of native mature forest;
- 0.85 ha of indigenous wetlands; and
- 0.48 ha of exotic wetland.

[52] Robertson, H. A., Baird, K., Dowding, J. E., Elliott, G. P., Hitchmough, R. A., Miskelly, C. M., McArthur, N., O'Donnell, C. F. J., Sagar, P. M., Scofield, R. P., and Taylor, G. A. (2016). *Conservation status of New Zealand birds. New Zealand threat classification series 19*. Department of Conservation

[53] Burns, R.J., Bell, B.D., Haigh, A., Bishop, P., Easton, L., Wren, S., Germano, J., Hitchmough, R.A., Rolfe, J.R., Makan, T. (2017) Conservation status of New Zealand amphibians, 2017. New Zealand Threat Classification Series 25. Department of Conservation

[54] Hitchmough, R., Barr, B., Lettink, M., Monks, J., Reardon, J., Tocher, M., van Winkel, D., and Rolfe, J. (2015) Conservation status of New Zealand reptiles. New Zealand threat classification series 17. Department of Conservation

[55] De Lange, P. J., Rolfe, J. R., Barkla, J. W., Courtney, S. P., Champion, P. D., Perrie, L. R., Beadel, S. M., Ford, K. A., Breitwieser, I., Schonberger, I., Hindmarsh-Walls, R., Heenan, P. B., and Ladley, K. (2017). Conservation status of New Zealand indigenous vascular plants. New Zealand threat classification series 22. Department of Conservation

Table 9.1: Summary of terrestrial and wetland ecological values and adverse effects associated with the ARL project as detailed in the AEcE

Biodiversity values affected by ARL	Ecological Value (EIANZ categories)	Adverse ecological effects on habitats and species addressed in the VCMP
Broad habitat types and associated species (excluding 'Threatened' or 'At Risk' species, which are addressed below)		
Native mature forest	High	0.87 ha of habitat loss + indirect effects
Native regenerating forest	High	4.62 ha of habitat loss + indirect effects
Indigenous wetland	High	0.85 ha of habitat loss + indirect effects
Exotic wetland	High	0.48 ha of habitat loss + indirect effects
Exotic wattle	Moderate	9.11 ha of habitat loss + indirect effects
Exotic pine	Moderate	86.88 ha of habitat loss + indirect effects
'Threatened' or 'At Risk' species *(based on the NZ Threat Classification Manual[56]*		
Kānuka (*Kunzea robusta*)/ mānuka (*Leptospermum scoparium*)	Very High	1.29 ha of habitat loss + indirect effects
Long-tailed bat (*Chalinolobus tuberculatus*)	Very High	102.81 ha of habitat loss (all forest and wetland habitats) + indirect effects
Australasian bittern (*Botaurus poiciloptilus*)	Very High	1.33 ha of habitat loss (all wetland habitats) + indirect effects
Spotless crake (*Porzana tabuensis*)	High	
North Island fernbird (*Megalurus punctatus*)	High	102.81 ha of habitat loss (all forest and wetland habitats) + indirect effects
Whitehead (*Mohoua albicilla*)	Moderate	101.48 ha of habitat loss (all forest habitats) + indirect effects
Green (*Naultinus elegans*), forest (*Hoplodactylus granulatus*), and Pacific gecko (*Dactylocnemis pacificus*) and ornate skink (*Cyclodina ornata*)	High or Moderate	5.49 ha of habitat loss (all native forest habitats) + indirect effects
'Threatened' or 'At Risk' species *(based on the NZ Threat Classification Manual (Townsend et al. 2008)*		
Hochstetter's frog (*Leiopelma hochstetteri*)	High	10.5 km of stream habitat loss (ca 10km streams in exotic forestry and 500 m in native forest)
Kauri snail (*Paryphanta* spp.)	High	101.48 ha of habitat loss (all forest habitats) + indirect effects

[56]Townsend, A.J., P.J de Lange, C.A.J Duffy, C.M Miskelly, J. Molloy and D.A. Norton 2008. New Zealand Threat Classification System manual. Science and Technical Publishing, Department of Conservation, Wellington, New Zealand

Biodiversity values affected by ARL	Ecological Value (EIANZ categories)	Adverse ecological effects on habitats and species addressed in the VCMP
Rhytid snail (*Amborhytida dunniae*)	High	101.48 ha of habitat loss (all forest habitats) + indirect effects
Peripatus (*Peripatoides* spp.)	Moderate	101.48 ha of habitat loss (all forest habitats) + indirect effects
White rata (*Metrosideros perforata)*	High	5.49 ha of potential habitat loss (all native forest habitats)
Kawaka (*Libocedrus plumosa*)	Moderate	5.49 ha of potential habitat loss (all native forest habitats)
Kaikomako (*Pennantia corymbosa*)	Moderate	5.49 ha of potential habitat loss (all native forest habitats)

Notes:

*areal extents of adverse effects for each species are not mutually exclusive, i.e. habitats are used by multiple species, so the areal extents of habitat loss referred to are often the same areas of vegetation, that provide for different fauna

9.2.1.3 Measures to avoid, remedy or mitigate effects

Potential adverse effects on terrestrial and wetland values that are associated with the construction and operation of ARL will be avoided, remedied or mitigated through:

- Further refinement of the project footprint through detailed design and construction methodology (where possible);
- Seasonal constraints on vegetation clearance (detailed in the VCMP);
- Vegetation clearance protocols (detailed in the VCMP); and
- Pre vegetation clearance surveys or salvage operations for nationally 'Threatened', 'At Risk' or legally protected species (including bats, birds, lizards, frogs, invertebrates and fish) (detailed in their respective fauna management plans).

9.2.1.4 Measures to address residual effects

Residual effects on indigenous forest habitats, indigenous and exotic wetlands, and aquatic habitats will be compensated for through an array of enhancement and restoration activities. These activities are detailed in Table 9.2. Locations of these on-site enhancement offset and compensation activities are illustrated in Appendix B, Figure 14.

Table 9.2: Impacted terrestrial and wetland ecosystems on site and their associated offset and compensation activities on WMNZ landholdings.

Category	AC Ecosystem Types[50] impacted and to be offset and compensated	Impact (ha)	Offset and compensation activities and quantity (ha)
Terrestrial Ecosystems	VS2 (Kānuka scrub/forest)	5.28	• **9.9 ha** of forest revegetation within the WMNZ landholdings (to include a high proportion of kānuka and mānuka). • Deployment of felled logs within offset sites and in existing habitats.
	VS5 Broadleaved species scrub/forest	0.03	
	WF8 Kahikatea, pukatea forest	0.01	

Category	AC Ecosystem Types[50] impacted and to be offset and compensated	Impact (ha)	Offset and compensation activities and quantity (ha)
	WF9 Taraire, tawa, podocarp forest	0.04	• Protection of **111.9 ha** of native forest areas by covenant. • Pest control on existing native terrestrial habitat on WMNZ landholdings and Sunnybrook Reserve
	WF12 Kauri, podocarp, broadleaved, beech forest	0.16	
Wetland Ecosystems	WL12 Mānuka, tangle fern scrub/fernland [Mānuka fern]	0.58	Enhancement planting of **4.63 ha** of degraded wetlands within the Western Block that are not affected by ARL. Planting of wetland buffers of 10 m or 5 m around SEA and non-SEA wetlands within the Western Block, approximately **15.18 ha.** Protection of all native wetland habitats by covenant, approximately **25.59 ha.** Pest control of **25.59 ha** on existing wetland habitat on WMNZ landholdings.
	WL19 Raupo	0.18	
	EW exotic wetland	0.57	

9.2.2 Aquatic habitat values and effects

9.2.2.1 Values

It is estimated that there is in the order of 135 km ephemeral, intermittent and permanent stream length within WMNZ landholdings. These streams are part of the wider Hōteo River catchment, which discharges into the Kaipara Harbour, approximately 35 km downstream of the landholdings. The streams comprise a combination of steep, vegetated catchments through to low lying floodplain streams adjacent to the Hōteo River.

Fish recorded across the site generally reflect species recorded in nearby catchments and include, longfin eels (*Anguilla dieffenbachii*) and shortfin eels (*Anguilla australis*), banded kōkopu (*Galaxias fasciatus*), inanga (*Galaxias maculatus*), various bullies and kōura (*Paranephrops planifrons*). Macroinvertebrate communities were indicative of 'poor' condition in the Western Block through to 'excellent' condition in Southern and Eastern Blocks.

Parts of the freshwater systems across the WMNZ landholdings are of high ecological value, particularly those within the Eastern and Southern Blocks. A NSMA within the Southern Block has the highest value (as measured by the stream ecological valuation (SEV) method), a function of its relatively intact native riparian margins and natural undisturbed stream channel. Despite the presence of exotic forestry, streams within the Eastern Block have high ecological value. It is expected that during forestry activities, ecological values would decrease for a period of time until the stream systems recover. While the Western Block has been modified and subject to degradation through agricultural land use, the biodiversity values within these streams are still moderate and the headwaters, in particular, have high potential for enhancement.

9.2.2.2 Effects and measures to avoid, remedy or mitigate

Short term effects relate to those within the construction phase which could include fish injury and/or mortality, and water quality effects resulting from sedimentation and cut vegetation storage:

- Native freshwater fauna are present across the project footprint and include 'At Risk – Declining' species. There is high potential for injury or mortality of native freshwater fauna during dewatering of streams and construction of the landfill and ancillary activities in the absence of any controls. Implementation of fish salvage and relocation protocols will reduce the magnitude of effect. Refer to the NFFFMP (section 8).
- Standard erosion and sediment controls (ESCs) and management plans will be implemented across the project footprint to mitigate the residual risk of sedimentation from construction earthworks. Refer to the CEMP for controls.
- The overall potential effect from runoff of wood leachate resulting from storage of felled vegetation will be similar to that of sedimentation. However, risk of residual adverse effects is more a feature of practice and less dependent on weather conditions. Application of best practice in accordance with relevant guideline documents discussed are set out in the CEMP and VCMP (section 7).

Potential long-term effects if left unmitigated may include reduced fish passage, water quality effects and changes to hydrology and permanent loss of stream ecological function and habitat area within the project footprint:

- Culverts have the potential to restrict fish passage to upstream habitats if constructed poorly. Where practicable culverts will be constructed to be 'fish-friendly'. Refer to the CEMP.
- Stormwater runoff can impact water quality and erosion potential of streams. Stormwater controls will be implemented across the site which address both quality and quantity and are consistent with best practice methods. Refer to the Stormwater Operation and Maintenance Plan.
- The most substantial effects on freshwater ecology will occur from the permanent reclamation of up to 15.4 km of permanent and intermittent stream length across the site. It is not possible to remediate or mitigate stream reclamation at the point of impact. While stream reclamation cannot be mitigated, it can be offset or compensated.
- Under the Auckland Unitary Plan Operative in Part (AUP OP), permanent and intermittent streams are afforded protection[57]. Measures to address residual effects, that cannot be avoided, remedied or mitigated, are detailed in the subsequent section.

9.2.2.3 Measures to address residual effects

The majority of stream loss will occur in Valley 1 of the Eastern Block as a result of the construction of the landfill base grade and lining system and provision of stormwater Ponds 1 and 2. It is assumed conservatively that all the streams in the Valley 1 sub catchment will be reclaimed, comprising 9.5 km of intermittent and permanent stream habitat.

Approximately 0.8 km of intermittent and 0.5 km of permanent stream will be reclaimed for Stockpile 1 within the Western Block, which equates to approximately 3.4% of the total stream length within the Western Block.

Within the headwaters of the Waiteraire Tributary Block, a 0.8 km intermittent and 0.6 km permanent stream will be reclaimed for Stockpile 2.

Construction of the Access Road requires several stream crossings and a cut face upslope of the road. The slope required for the cut face will result in almost complete loss of stream channels on the higher side of the Access Road. Of the 2.1 km of stream impacted by the Access Road, 1.9 km will be reclaimed and approximately 0.2 km will be culverted. The 2.1 km of intermittent and permanent stream impact, comprises approximately 22% of the total stream length within the Southern Block.

[57] Chapter E3. Lakes, rivers, streams and wetlands. (2019) Auckland Council.

In addition to the main project activities discussed above, just over 1 km of stream will be impacted by a top soil stockpile, clay borrow pit and ancillary activities. This comprises 0.4 km of intermittent stream and 0.7 km of permanent stream.

Table 9.3: Summary estimate of intermittent and permanent stream impact across the subject site (metres).

Landfill activity	Intermittent	Permanent	Total
Valley 1 Landfill (incl Pond 1 and Pond 2)	5479	4070	9549
Access Road	1026	1104	2130
Stockpile 1	801	456	1257
Stockpile 2	792	573	1365
Topsoil Stockpile	161	227	388
Clay Borrow and Stockpile	128	0	128
Combined ancillary stream length*	129	439	568
Total length (m)	**8516**	**6869**	**15385**

*Combined ancillary length includes forestry access roads, ancillary building footprints etc. resulting from ARL.

The residual aquatic ecological effects resulting from stream reclamation and culverting are addressed through a combination of offset and compensation measures, on and offsite. Through the AEcE, the SEV and environmental compensation ratio (ECR) method has been used to quantify offset measures within the WMNZ landholdings.

Residual effects on aquatic habitats will be offset and compensated for through an array of enhancement and restoration activities detailed in this REMP. This includes planting, enrichment planting, weed plant control, pest control, fencing, felled-log deployment and protection.

The proposed enhancement offset and compensation measures, as identified in the AEcE and, in relation to residual effects on aquatic habitats is detailed in Table 9.4. Locations of these on-site enhancement offset and compensation activities are illustrated in Appendix B, Figure 14. Further detail is provided in Table 9.5 for the onsite stream offset enhancement actions, including planting widths.

Table 9.4: Proposed offset (italics) and compensation (underline) activities on WMNZ landholdings all to be protected in perpetuity

Riparian Offset Enhancement Activities	Map reference (Appendix B, Figure 13)	Approximate stream length (m)
Stream length within Western Block to be planted and enhanced:		
• *One side of the stream parallel to airstrip*	2a	600 m
• *On stream between southern SEA wetland and Hōteo River and toward airstrip*	2b	1150 m
• <u>Degraded streams to the west of the clay borrow area</u>	2c	950 m
• *Between clay borrow pit and Stockpile 1*	2d	1,000 m

Riparian Offset Enhancement Activities	Map reference (Appendix B, Figure 13)	Approximate stream length (m)
• One side of the Waiteraire Stream, adjacent to SH1 and downstream of Access Road. Some of this is existing NSMA	2e	700 m
Protection of the main channel through the NSMA in the Southern Block (and the headwaters of this catchment)	2f	1,600 m (main channel)
Retirement and protection of the 10 m margins of waterways within Matariki Forests forestry areas (of permanent streams, greater than 3 m wide)	2g	2,000 m (downstream of landfill footprint)
Protection of the western margin of the Waiwhiu Stream within WMNZ land (~3 km).	2h	3,000 m
Hōteo River margins: We anticipate that this will involve approximately 3 km of protection and planting along one side of the Hōteo River. Whilst this will provide some additional protection to the Hōteo River, as the existing riparian margins are ~ 15 to 30 m in width, the ecological benefit of protecting the existing margins and providing infill planting will be limited, compared to new planting along un-vegetated riparian margins.	2i	3,000 m
Total length		**14,000 m (14 km)**

Table 9.5: Proposed offset enhancement activities with associated details

Offset Enhancement Activities	Map reference (Appendix B, Figure 13)	Approximate stream length (m)	Riparian planting width on each bank (m)	Additional notes
Stream length within Western Block to be planted and enhanced:				
• *One side of the stream parallel to airstrip*	2a	600 m	20 m (true right bank and infill planting on true left)	Short stature, low growing, groundcover and shrub species in accordance with height requirements of airstrip.
• *On stream between southern SEA wetland and Hōteo River and toward airstrip*	2b	1150 m	20 m both banks	Short stature, low growing, groundcover and shrub species in accordance with height requirements of airstrip.
• Degraded streams to the west of the clay borrow area	2c	950 m	20 m both banks	-
• *Between clay borrow pit and Stockpile 1*	2d	1,000 m	20 m both banks	Grading of streambank slope to create spawning habitat.

Offset Enhancement Activities	Map reference (Appendix B, Figure 13)	Approximate stream length (m)	Riparian planting width on each bank (m)	Additional notes
• One side of the Waiteraire Stream, adjacent to SH1 and downstream of Access Road. Some of this is existing NSMA	2e	700 m	20 m both banks	-

9.3 Ecological Enhancement and Restoration Plan

9.3.1 Restoration and enhancement objectives and approach

The overarching objective of the proposed restoration and enhancement actions is to compensate for residual effects to achieve a net gain outcome where possible. To optimise ecological benefits associated with the proposed compensation activities we have focused on the following ecological outcomes:

- Replacement or enhancement of all habitats, vegetation communities, plant species and native fauna habitat that have been affected by ARL;
- A substantial increase in the areal extent of native habitat types in the landscape (above and beyond what is currently present);
- Improved landscape/ecological connectivity through:
  - The linking of smaller habitat fragments to create larger contiguous habitat; and
  - Through linking of different habitat types (i.e. terrestrial, wetland, and freshwater streams);
- Providing ecological buffers to protect and enhance existing high value native habitat types;
- Improving the ecological integrity of existing habitats through the above measures coupled with long-term pest control and other means; and
- Long-term protection of all existing native habitats and sites proposed for native enhancement planting on WMNZ land through covenants.

Vegetation successional progress and trajectory is complex and determined by a wide range of interconnecting environmental factors such as soil types, microclimates, interspecies interactions, soil seedbanks, aerial seed sources, and predation[58]. Correspondingly, rather than attempting to restore each ecosystem type from the outset, the focus of restoration plantings is to include plant species that:

- Represent ecosystems types that have been impacted by ARL and are restored in approximate proportion to impact type areas);
- Have a high chance of survival and establishment within planted areas; and
- Allow for the eventual colonisation of flora and fauna that are representative of the affected ecosystem types in later successional stages (e.g. epiphytes, fungi, and bats).

[58] Davis, M., and Meurk, C. (2001) Protecting and restoring our natural heritage: a practical guide. Department of Conservation.

9.3.2 Implementation of restoration activities

The following sections describe restoration and enhancement activities that will compensate for residual effects that cannot be offset, with the notable exception of mammalian pest control, which will be addressed in section 9.5 of this REMP. The majority of these activities will be undertaken on existing pasture, riparian or degraded wetland habitats within the WMNZ landholdings that are currently located between existing forest areas.

The following sections step through the required methodology to encourage plant survival, promote suitable nursery conditions for secondary successional species establishment, and to support succession into the desired ecosystem types.

Table 9.6 below provides a summary of the proposed management measures set out in this section, with reference to associated consent conditions and management plans. Details are then provided in the sections below.

Table 9.6: Summary of and associated draft consent conditions of the REMP and inter-linking management plans which feed into each condition.

Ecological enhancement and restoration plan protocols		Relevant draft consent conditions	Inter-linking plan(s)
Section 9.2.1.4 and 9.2.2.2: Ecological enhancement and restoration		181 d, e, h, l, & k	Not Applicable
Section 9.3.2.1Site preparation	Section 9.3.2.1.1: Weed plant control	181 l	Not Applicable
	Section 9.3.2.1.2: Pest animal control	181 l	REMP
	Section 9.3.2.1.3: Stock-proof fencing	181 l	Not Applicable
	Section 9.3.2.1.4: Felled log deployment	181	REMP, VCMP (section 7), LiMP (section 5), IMP (section 4)
Section 9.3.2.2: Planting method, guidelines, and specifications		181 n	Not Applicable
Section 9.3.2.3: Post-planting maintenance		181 o	Not Applicable
Section 9.3.2.5: Programme		181 m	Not Applicable

Ecological enhancement and restoration plan protocols	Relevant draft consent conditions	Inter-linking plan(s)
Section 9.4: Biosecurity measures (Myrtle rust and kauri dieback)	183	Not Applicable
Section 9.7: Monitoring, compliance reporting, and adaptive management	181 p, 182, 184, 185	Not Applicable

All onsite offset and compensation enhancement will be protected in the form of covenants on the titles.

9.3.2.1 Site preparation

Site preparation inspections will be undertaken between December and February to inform the types of site preparation management actions required in preparation for offset planting in the areas defined in Table 9.4 and Table 9.5. Site inspections will include a site visit to confirm and record the following:

- Locations for felled-log deployment;
- Planting locations of specific tree species suitable for bats;
- Locations for fencing alignments;
- Identify the extent of bank grading necessary and target bank areas to create spawning habitat along streams;
- Identify the types and location of weed species to inform the necessary controls;
- Identify the pest species on site to inform the necessary controls; and
- Identify canopy gaps to inform necessary infill planting for wetlands and riparian margins (e.g. along the Hoteo River and within the Matariki Forests forestry).

Prior to planting, each site will be subjected to deployment of logs and, where required, fencing, and weed and animal pest control.

The addition of topsoil is not considered necessary as plantings will be planted into existing pasture and wetlands. Furthermore, mulching will not be used (despite reducing weed establishment) because mulching also suppresses the natural colonisation of native seedlings and reduces habitat suitability for ground-dwelling lizards and invertebrates.

9.3.2.1.1 Weed plant control

Pest and weed plants can smother and inhibit the growth of native species, typically by outcompeting for space and resources until the native planting is established and dominant. Pest and weed plants[59] recorded on site have been identified as posing a threat to the health of the proposed enhancement and restoration plantings. A list of pest and weed plant controls is detailed in Table 9.7.

[59] Auckland Regional Pest Management Plan 2019-2029. (2019). Auckland Council.

Table 9.7: Ecological pest and weed plant species to be controlled before and after enhancement and restoration planting efforts.

Species name	Common name	Category	Control[60](until native plantings dominate)
Cenchrus landestinus	Kikuyu grass	Exotic	Spot spray around planting holes.
Cortaderia selloana	Pampas	Pest	Grub out small plants or excavate large plants with digger. Spray during summer-autumn in dense sites where non-target damage is unlikely with glyphosate and penetrant.
Delairea odorata	German ivy	Pest	Hand pull or dig out scattered plants and seedlings. Cut and paint stems with glyphosate.
Leycesteria formosa	Himalayan honeysuckle	Pest	Dig out small plants. Cut and stump paint with glyphosate. Spray during summer with penetrant.
Ligustrum lucidum	Tree privet	Pest	Pull and dig seedlings. Cut and stump paint. Drill and poison with melsulfuron.
Passiflora 'Tasconia' subgroup	Banana passionfruit	Pest	Pull roots up. Cut off above ground or tie stems in air to prevent layering. Spray large masses on ground where roots cannot be pulled with glyphosate between spring-autumn.
Salix fragilis	Crack willow	Pest	Hand pull small plants, taking care to remove all parts and dispose appropriately. Cut or drill every 100 mm around truck diameter and fill each cut/hole with glyphosate in summer-autumn.
Selaginella kraussiana	African clubmoss	Pest	Rake and hand pull small infestations areas. Spray larger infestations with glyphosate.
Tradescantia flumenensis	Tradescantia	Pest	Rake and hand pull small infestation areas from edge towards the centre of the infestation. Caution when disposing and transporting as dropped fragments spread. Spray larger areas with glyphosate to achieve over 90%.
Ulex europaeus	Gorse	Pest	Hand pull seedlings and small plants. Cut and stump paint with glyphosate or 2,4D. Spray with herbicide penetrant between spring-autumn.
	Foxglove	Exotic	Spot spray around planting holes (pre-planting) and around plants (post-planting).
	Buttercup	Exotic	Spot spray around planting holes.

[60] Pest plant. (October, 2019). Auckland Council. Retrieved from http://pestplants.aucklandcouncil.govt.nz/.

Pest plants and weeds shall be controlled in summer to autumn (January - March inclusive) to a low-level prior to planting. Spot spraying should be carried out in planting spots to remove kikuyu grass in planting areas and riparian margins to limit the use of chemicals around waterways. Manual release of plantings or weed trimming is recommended where appropriate, particularly in wetland planting areas.

All chemical control will be carried out by qualified contractors trained in chemical application for weed control and adhere to NZS 8409:2004 "Management of Agrichemicals"[61] and policies in Chapter E34 in the AUP OP[62].

Removal of pest and exotic vegetation as part of weed and pest control along the riparian margin, wetland margin, within a wetland or stream may require a resource consent in accordance with Chapter E15 in the AUP OP[63].

9.3.2.1.2 Pest animal control

Pest animals can hinder enhancement and restoration planting efforts, typically through browsing of newly planted seedlings and saplings.

The site preparation inspection will inform which target species to control for each enhancement area. Hares (*Lepus europaeus*), rabbits (O*ryctolagus cuniculus*), possum (*Trichosurus vulpecula*), and pukeko (*Porphyrio melanotus*) have been previously observed on site and are likely to damage enhancement plantings. Pest animal control could include bait stations, kill traps, and/or pulse shootings. All pest animal control will be carried out by suitably qualified and certified contractors trained in pest control (e.g. use of poison).

Further pest management measures are outlined in section 9.5 of this REMP.

9.3.2.1.3 Stock-proof fencing

Livestock will be excluded from all revegetation enhancement and restoration sites[64].

Fit for purpose exclusion fence will be constructed to exclude livestock from enhancement sites. Setbacks of ≥ 1 m from plantings will be exercised to prevent livestock from grazing the planted edges.

Fencing locations will be determined during site preparation inspections. In locations where fencing may interrupt and inhibit temporary access requirements temporary fencing may be used. Temporary fences will be replaced with permanent fit for purpose exclusion fences when initial planting efforts are completed.

9.3.2.1.4 Felled log deployment

Felled trees and fallen logs in various states of decomposition are ecologically important to forest regeneration processes and as habitat for a wide range of species. Felled and fallen logs provide critical habitat for decomposers including invertebrates (e.g. peripatus), fungi and bacteria, and lizards (e.g. skinks) and are key sites for plant regeneration.

[61] New Zealand Standard (2004). Management of Agrichemicals, NZS 8409:2004.
[62] Auckland Council. (2019). Chapter E34. Agrichemicals and vertebrate toxic agents, Auckland Unitary Plan.
[63] Auckland Council. (2019). Chapter E15. Vegetation management and biodiversity, Auckland Unitary Plan.

[64] It is likely that fencing on WMNZ landholdings will be configured to enclose stock within the farm area rather than fence them out of planted areas given nature of land-use activities onsite

Felled native (preferably) or exotic log deployment into offset and compensation sites will be undertaken and is detailed in the VCMP. A minimum of 12 m / ha of cut up stockpiled logs will be deployed into terrestrial, wetland, and stream/riparian offset and compensation sites. Deployment of log materials will be placed in locations where materials cannot move and enter streams.

9.3.2.2 Planting methodology

Planting detailed in this section has been developed in accordance with Appendix 16 of the AUP OP (Auckland Unitary Plan (Operative in Part)) 'Guideline for native revegetation plantings'[65] to promote successful establishment and long-term persistence of plantings.

9.3.2.2.1 Planting guidelines

Eco-sourcing of plant species promotes and maintains genetic diversity and distinct unique character of plant species in a region (Appendix 16, AUP OP). Plant species may exist across multiple regions, however there are often subtle genetic differences between the same types of plants from different regions that contribute to differences in growth and tolerance of environmental conditions. To encourage planting success and survival, plant species will be eco-sourced from the Rodney Ecological District, preferably from a nearby source to the WMNZ landholdings. Species will be selected in consultation with local hapu and iwi.

Terrestrial, wetland buffer, and riparian margin planting will predominantly be carried out in the standard planting season between the months of April to October due to higher soil moisture.

Wetland infill planting of wetland species that grow in standing water and boggy ground are proposed to be planted at the end of summer (i.e. when water levels are low).

Optimal plant stock will be used in the planting which have the following attributes:

- Healthy, vigorous, and free from obvious signs of disease and pests;
- Of at least average size for the specified pot/plastic bag size (i.e. PB);
- Well-developed root system with a high amount of new root growth;
- Not root bound; and
- Well-branched and symmetrically shaped.

Appropriate plants will be selectively placed in particular replanting areas based on the locality of the planting and the immediate in-situ conditions to ensure the success of the revegetation. Site specific factors that will be considered include:

- Slope topography (i.e. steepness affects establishment success);
- Soil characteristics (i.e. species grow in specific types of soil conditions);
- Wind (i.e. certain species have tolerance to wind);
- Aspect (i.e. direction of slope may affect the duration of sunlight and dryness of soil);
- Shading (i.e. certain species are adapted to grow in full sunlight, while other species are shade-tolerant and require establishment under a canopy);
- Moisture (i.e. certain species are adapted to grow in regularly wet soils, while other species require wet soils to survive); and
- Frost (i.e. tolerance to frost).

[65] Auckland Council. (2019). Appendix 16 Guideline for native revegetation plantings, Auckland Unitary Plan.

Plant holes shall be dug according to spacing requirements and each plant hole is to be dug deep and wide enough so the plant collar is approximately 1 cm below ground level. Grass will be cleared away from each planting hole to ensure the new plants get enough light and nutrients.

Fertilizer tablets are to be placed in a planting hole before planting if not already included in the nursery root ball. The soil will be loosened at the bottom of the hole, to allow the roots to penetrate the soil more freely. The plant is to be secured in the ground by filling the space surrounding the roots with soil and then lightly compressing to fill any voids that might be present around the roots to avoid waterlogging.

Marking plants with bamboo stakes is recommended for ease of monitoring and maintenance purposes. Mulch or any other ground conditioning is not considered necessary for these sites.

9.3.2.2.2 Plant species specifications

The native enhancement and restoration planting mix selected for each enhancement area and type are guided by species:

- Within ecosystem types that have been impacted by the project footprint;
- That would naturally occur historically;
- That have been recorded in the surrounding SEA and/or non-SEA fragments/remnants;
- Within the Rodney Ecologist District;
- That offer food resources and refuge/shelter for a range of native fauna to help address fauna habitat that have been impacted by ARL; and
- That are selected after considering the views of cultural advisers.

Planting will be carried out in two phases. The first phase is aimed at allowing colonisation of pioneer plant species that are adapted to high sunlight, lower soil moisture content, and exposure to wind. Pioneer plant species will help to increase the diversity of a habitat, create more stable and fertile soils for other secondary successional species to establish. The second phase is aimed at enrichment planting and guiding succession by planting species that are adapted to secondary succession; such as shade tolerant and greater soil moisture.

Therefore, the starting crop species matrix for each enhancement site has been selected based on their tolerance of site specific environmental stresses (e.g. shade intolerant species), location (e.g. riparian margin) and associated characteristics of ecosystem types[50] (i.e. WL12, WL18, WL19 wetlands and WF7, WF8, and WF9 forests). Enrichment planting species matrix has been selected based on secondary successional species associated with each of the ecosystem types impacted by ARL.

Additional considerations have been incorporated into the species selection for riparian margin planting. Riparian margins are being planted to improve aquatic ecosystem health and therefore species have been selected to provide shade, organic matter input, bank stability and overland flow filtering capability. Opportunities for mana whenua participation in species selection will be provided where possible. Inclusion of the assumptions behind the SEV values proposed in the AEcE has been a key consideration for these riparian areas.

Starting crop and enrichment species matrix for each category (i.e. riparian, terrestrial, and wetland) are described in Table 9.8, Table 9.9, and Table 9.10 below.

Table 9.8: Riparian margin starting crop and enrichment species matrix.

Common name	Scientific name	Threat status[55]	Planting phase
Mamaku	*Cyathea medularis*	Not Threatened	Phase One - Starting crop
Harakeke	*Phormium tenax*	Not Threatened	Phase One - Starting crop
Cabbage tree	*Cordyline australis*	Not Threatened	Phase One - Starting crop
Mānuka	*Leptospermum scoparium*	At Risk - declining	Phase One - Starting crop
Māhoe	*Melicytus ramiflorus*	Not Threatened	Phase One - Starting crop
Kānuka	*Kunzea robusta*	Threatened - nationally vulnerable	Phase One - Starting crop
Koromiko*	*Veronica stricta var. stricta*	Not Threatened	Phase One - Starting crop
Māpou	*Myrsine australis*	Not Threatened	Phase One - Starting crop
Kiekie*	*Freycinetia banksia*	Not Threatened	Phase One - Starting crop
Whekī	*Dicksonia squarrosa*	Not Threatened	Phase One - Starting crop
Mapere*	*Gahnia xanthocarpa*	Not Threatened	Phase One - Starting crop
Swamp astelia*	*Astelia grandis*	Not Threatened	Phase One - Starting crop
Kiokio*	*Blechnum novae-zelandiae*	Not Threatened	Phase One - Starting crop
Twiggy coprosma*	*Coprosma rhamnoides*	Not Threatened	Phase One – Starting crop
Mingimingi*	*Leucopogon fasciculatis*	Not Threatened	Phase One – Starting crop
Scrambling pohuehue*	*Muehlenbeckia complexa*	Not Threatened	Phase One – Starting crop
Pūriri	*Vitex lucens*	Not Threatened	Phase Two - Enrichment
Kahikatea	*Dacrycarpus dacrydioides*	Not Threatened	Phase Two - Enrichment
Kohekohe	*Dysoxylum spectabile*	Not Threatened	Phase Two - Enrichment
Nīkau	*Rhopalostylis sapida*	Not Threatened	Phase Two - Enrichment
Rimu	*Dacrydium cupressinum*	Not Threatened	Phase Two - Enrichment
Northern rātā	*Metrosideros robusta*	Not Threatened	Phase Two - Enrichment
Taraire	*Beilschmiedia taraire*	Not Threatened	Phase Two - Enrichment

Common name	Scientific name	Threat status[55]	Planting phase
Hīnau	*Elaeocarpus dentatus*	Not Threatened	Phase Two - Enrichment
Rewarewa	*Knightia excelsa*	Not Threatened	Phase Two - Enrichment
Pukatea	*Laurelia novae-zelandiae*	Not Threatened	Phase Two - Enrichment
Miro	*Prumnopitys ferruginea*	Not Threatened	Phase Two - Enrichment
Karaka	*Corynocarpus laevigatus*	Not Threatened	Phase Two - Enrichment
Swamp maire	*Syzygium maire*	Threatened - nationally critical	Phase Two - Enrichment
Tawa	*Beilschmiedia tawa*	Not Threatened	Phase Two - Enrichment
Tītoki	*Alectryon excelsus*	Not Threatened	Phase Two - Enrichment
Supplejack	*Ripogonum scandens*	Not Threatened	Phase Two - Enrichment
Taraire	*Beilschmiedia taraire*	Not Threatened	Phase Two - Enrichment
Parataniwha*	*Elatostema rugosum*	Not Threatened	Phase Two - Enrichment

Note: * refers to low stature plant species proposed for riparian margins near the airstrip (max height of 1.5 m) and species that are less likely to attract high volumes of birds into the airstrip area.

Table 9.9: Terrestrial starting crop and enrichment species matrix.

Offset site	Common name	Scientific name	Threat status[55]	Planting phase
NT1 – adjacent to Hoteo riparian margin	Mamaku	*Cyathea medullaris*	Not Threatened	Phase One - Starting crop
	Harakeke	*Phormium tenax*	Not Threatened	Phase One - Starting crop
	Cabbage tree	*Cordyline australis*	Not Threatened	Phase One - Starting crop
	Mānuka	*Leptospermum scoparium*	At Risk - declining	Phase One - Starting crop
	Māhoe	*Melicytus ramiflorus*	Not Threatened	Phase One - Starting crop
	Kānuka	*Kunzea robusta*	Threatened - nationally vulnerable	Phase One - Starting crop
	Koromiko	*Veronica stricta var. stricta*	Not Threatened	Phase One - Starting crop
	Māpou	*Myrsine australis*	Not Threatened	Phase One - Starting crop
	Pūriri	*Vitex lucens*	Not Threatened	Phase Two - Enrichment

	Kahikatea	*Dacrycarpus dacrydioides*	Not Threatened	Phase Two - Enrichment
	Kohekohe	*Dysoxylum spectabile*	Not Threatened	Phase Two - Enrichment
	Nīkau	*Rhopalostylis sapida*	Not Threatened	Phase Two - Enrichment
	Rimu	*Dacrydium cupressinum*	Not Threatened	Phase Two - Enrichment
	Northern rātā	*Metrosideros robusta*	Not Threatened	Phase Two - Enrichment
	Taraire	*Beilschmiedia taraire*	Not Threatened	Phase Two - Enrichment
	Hīnau	*Elaeocarpus dentatus*	Not Threatened	Phase Two - Enrichment
	Rewarewa	*Knightia excelsa*	Not Threatened	Phase Two - Enrichment
	Pukatea	*Laurelia novae-zelandiae*	Not Threatened	Phase Two - Enrichment
	Miro	*Prumnopitys ferruginea*	Not Threatened	Phase Two - Enrichment
	Karaka	*Corynocarpus laevigatus*	Not Threatened	Phase Two - Enrichment
NT2 and NT3 Areas north of SEA on northern boundary and east of borrow pit.	Māhoe	*Melicytus ramiflorus*	Not Threatened	Phase One - Starting crop
	Kiekie	*Freycinetia banksii*	Not Threatened	Phase One - Starting crop
	Whekī	*Dicksonia squarrosa*	Not Threatened	Phase One - Starting crop
	Mapere	*Gahnia xanthocarpa*	Not Threatened	Phase One - Starting crop
	Swamp astelia	*Astelia grandis*	Not Threatened	Phase One - Starting crop
	Kiokio	*Blechnum novae-zelandiae*	Not Threatened	Phase One - Starting crop
	Mānuka	*Leptospermum scoparium*	At Risk - Declining	Phase One - Starting crop
	Swamp coprosma	*Coprosma tenuicaulis*	Not Threatened	Phase One - Starting crop
	Tangle fern	*Gleichenia dicarpa*	Not Threatened	Phase One - Starting crop
	Baumea	*Machaerina rubiginosa*	Not Threatened	Phase One - Starting crop
	Kahikatea	*Dacrycarpus dacrydioides*	Not Threatened	Phase One - Starting crop
	Pukatea	*Laurelia novae-zelandiae*	Not Threatened	Phase Two - Enrichment
	Rimu	*Dacrydium cupressinum*	Not Threatened	Phase Two - Enrichment
	Swamp maire	*Syzygium maire*	Threatened - Nationally critical	Phase Two - Enrichment
	Tawa	*Beilschmiedia tawa*	Not Threatened	Phase Two - Enrichment

	Tītoki	*Alectryon excelsus*	Not Threatened	Phase Two - Enrichment
	Supplejack	*Ripogonum scandens*	Not Threatened	Phase Two - Enrichment
	Taraire	*Beilschmiedia taraire*	Not Threatened	Phase Two - Enrichment
	Kohekohe	*Dysoxylum spectabile*	Not Threatened	Phase Two - Enrichment
	Parataniwha	*Elatostema rugosum*	Not Threatened	Phase Two - Enrichment

Table 9.10: Wetland buffer and infill starting crop and enrichment species matrix.

Category	Common name	Scientific name	Threat status[55]	Planting status
Infill	Swamp astelia	*Astelia grandis*	Not Threatened	Phase One - Starting crop
	Kiokio	*Blechnum novae-zelandiae*	Not Threatened	Phase One - Starting crop
	Mānuka	*Leptospermum scoparium*	At Risk - declining	Phase One - Starting crop
	Swamp coprosma	*Coprosma tenuicaulis*	Not Threatened	Phase One - Starting crop
	Tangle fern	*Gleichenia dicarpa*	Not Threatened	Phase One - Starting crop
	Baumea	*Machaerina rubiginosa*	Not Threatened	Phase One - Starting crop
	Harakeke	*Phormium tenax*	Not Threatened	Phase One - Starting crop
	Toetoe	*Austroderia toetoe*	Not Threatened	Phase One - Starting crop
	Purei	*Carex secta*	Not Threatened	Phase One - Starting crop
	Swamp sedge	*Carex virgata*	Not Threatened	Phase One - Starting crop
	Round-leaved willow herb	*Epilobium rotundifolium*	Not Threatened	Phase One - Starting crop
	Cabbage tree	*Cordyline australis*	Not Threatened	Phase One - Starting crop
	Raupō	*Typha orientalis*	Not Threatened	Phase One - Starting crop
	Pūrua grass	*Bolboschoenus fluviatilis*	Not Threatened	Phase One - Starting crop
	Lake clubrush	*Schoenoplectus tabernaemontani*	Not Threatened	Phase One - Starting crop
	Jointed twig rush	*Machaerina articulata*	Not Threatened	Phase One - Starting crop
	Kutakuta	*Eleocharis sphacelata*	Not Threatened	Phase One - Starting crop
	Club rush	*Ficinia nodosa*	Not Threatened	Phase One - Starting crop

	Kahikatea	*Dacrycarpus dacrydioides*	Not Threatened	Phase One - Starting crop
Buffer	Harakeke	*Phormium tenax*	Not Threatened	Phase One - Starting crop
	Mānuka	*Leptospermum scoparium*	At Risk - declining	Phase One - Starting crop
	Swamp coprosma	*Coprosma tenuicaulis*	Not Threatened	Phase One - Starting crop
	Toetoe	*Austroderia toetoe*	Not Threatened	Phase One - Starting crop
	Cabbage tree	*Cordyline australis*	Not Threatened	Phase One - Starting crop
	Tangle fern	*Gleichenia dicarpa*	Not Threatened	Phase One - Starting crop
	Kaikomako	*Pennantia corymbosa*	Not Threatened	Phase One - Starting crop
	Swamp maire	*Syzygium maire*	Threatened - nationally critical	Phase Two - Enrichment
	Kahikatea	*Dacrycarpus dacrydioides*	Not Threatened	Phase Two - Enrichment

9.3.2.3 Post-planting maintenance

9.3.2.3.1 Replacement planting

To ensure plantings are healthy and thriving, enhancement plantings will be inspected twice a year, once in spring and once in autumn, for the first three years.

Plants that do not survive are to be replaced with either the same species or an alternative appropriate species from the planting species matrix in the following planting season.

Replacement of plants which do not survive is important in order to ensure gaps are not created which could allow weeds to enter the planting area.

9.3.2.3.2 Weed plant control

Post-planting weed plant control is required to suppress the growth of weeds to ensure long-term persistence of plantings. Control actions will be carried out as detailed in 9.3.2.1.1.

In the first three years after the initial planting has been carried out, chemical and/or manual weed control in the enhancement and restoration areas will be carried out twice a year, once in spring and once in autumn. This is aimed at reducing weed and pest plant pressure on the plantings and to deplete pest plant seedbank stores.

In the fourth and fifth years, then yearly until 90% canopy coverage, pest and weed plants will be controlled annually during summer.

Pest plants will be controlled for:

- Five years for wetland enhancement and restoration planting areas; and
- Five years for terrestrial plantings then annually until 90% canopy closure is achieved.

9.3.2.4 Habitat enhancement of existing habitats

9.3.2.4.1 Artificial bat roosts

As described in the Bat Management Plan (BMP; section 3), artificial bat roosts will be utilised to supplement available roosting habitat following vegetation clearance. Artificial bat roosts will be provided in the form of bat roost boxes in suitable existing habitats within WMNZ landholdings.

Artificial bat roosts will be installed in habitat suitable for bat roosting within WMNZ landholdings, outside of the project footprint at the density or spacing defined in the BMP.

Locations, placement, and types of artificial bat roosts to be utilised are detailed in the Bat Management Plan.

9.3.2.4.2 Peripatus habitat

As described in the Invertebrate Management Plan (IMP; section 4), deployment of felled-logs in existing habitats will form favourable peripatus habitat.

Placement of felled-logs in existing habitats will be determined by the following features:

- South-facing moist slopes;
- Contiguous stands of forest trees with a well formed, linked canopy;
- Abundant decomposing woody material and organic matter on the forest floor;
- Plenty of cracks and crevices that are not accessible to rodents; and
- Minimal disturbance (i.e. low levels of human activity).

9.3.2.4.3 Matariki Forests forestry margins

Riparian margins along two streams that flow through Matariki Forests forestry will be protected and/or retired. The western margin of Waiwhiu Stream within WMNZ landholdings, approximately 3 km, will be protected by covenant and 10 m of riparian margin along each bank along 2 km of the main waterway within the Matariki Forests forestry area will be retired and protected (refer to '2g' '2h' reference in Appendix B, Figure 13).

Additionally, felled logs will be deployed within forestry riparian margins to increase habitat for lizards and other insects. Smaller volumes of material will be placed to minimise damage to the existing sub-canopy and ground cover vegetation.

9.3.2.4.4 Threatened plant seedling relocation

As described in the VCMP (section 7), selected small kawaka and kaikomako seedlings will be salvaged and relocated into suitable existing habitats and microhabitat conditions. Salvage and relocation of only small seedlings (< 20 cm in height) will be undertaken as larger seedlings are much less likely to establish when relocated.

9.3.2.5 Programme

The implementation of enhancement and restoration planting activities will be driven by specific timing restrictions. A calendar for seasonal staging for all activities is summarised in Table 9.11.

This REMP is based on the expectation that all enhancement and restoration offset and compensation planting described in this REMP will be completed within three years of the initial construction and enabling works being completed.

Table 9.11: Seasonal staging for the implementation of enhancement and restoration activities detailed in this REMP.

Enhancement and restoration activities	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Phase One (Years One to Three) – Initial planting of starting crop												
Site preparation inspection	✓	✓										✓
Weed plant control	✓	✓	✓									
Pest animal control	✓	✓	✓									
Stock-proof fencing	✓	✓	✓									
Felled log deployment			✓	✓								
Wetland infill (starting crop)		✓	✓									
Riparian margin planting (starting crop)				✓	✓	✓	✓	✓	✓			
Terrestrial and wetland buffer planting (starting crop)				✓	✓	✓	✓	✓	✓			
Phase 2 (Year Three to Five) – Enrichment planting												
Riparian margin planting (enrichment planting)				✓	✓	✓	✓	✓	✓			
Terrestrial and wetland buffer planting (enrichment planting)				✓	✓	✓	✓	✓	✓			
Phase 3 (Year Two to Ten) – Maintenance												
Replacement planting			✓	✓	✓				✓			
Weed plant control			✓	✓	✓				✓	✓	✓	

9.4 Off-Site Stream Compensation Plan

[Placeholder – this plan has already been submitted to Council as a stand-alone plan]

9.5 Pest Management Plan

Placeholder for insertion

9.6 Biosecurity measures

9.6.1 Myrtle rust

Myrtle rust is a fungal disease that attacks plants of the Myrtaceae family which can result in slower plant growth, or plant death. Enhancement and restoration plantings will include species in the Myrtaceae family that are susceptible to myrtle rust. These include mānuka, kānuka; and swamp maire.

To reduce the risk of spreading myrtle rust, contractors sourcing plant species from the Myrtaceae family must follow standard procedures set out by the New Zealand Plant Producers Incorporated (NZPPI) Biosecurity Declaration – Myrtle Rust Registration Process when sourcing plants from nurseries. A copy of a signed Myrtle Rust Nursery Management Declaration[66] that certifies that plant producer has implemented the Myrtle Rust Nursery Management Protocol[67], and must be provided to the Auckland Council Team Leader Northern Monitoring, within five days of being obtained. Written confirmation and approval (letter or email) from the Auckland Council Team Leader Northern Monitoring must be obtained before the plants are delivered to site.

9.6.2 Kauri dieback

Kauri dieback disease is caused by a microscopic fungus-like organism, called *Phytophthora agathidicida* (PA), which specifically attacks kauri. It is spread through soil movement (e.g. soil carried on footwear, equipment, and vehicles) and kauri are infected through root contact.

Kauri has been identified and recorded on site in the Southern Block and adjacent to Stockpile 1 in the Western Block.

To reduce the risk of spreading PA and potentially infecting kauri trees with kauri dieback, the following management steps will be taken:

- All deployment of felled-logs for lizard and peripatus habitat will be excluded from within 30 m of a kauri tree;
- All relocation of kawaka and kaikomako seedlings will be excluded from within 30 m of a kauri tree;

[66] New Zealand Plant Producers Incorporated. (2017). Myrtle rust nursery management declaration, V6, October.
[67] New Zealand Plant Producers Incorporated. (2017). Myrtle Rust Nursery Management Protocol, V6, October.

- Artificial bat roosts will not be mounted to kauri trees; and
- Boots and other gear that could carry soil will be scrubbed cleaned with a brush to remove excess soil and disinfected with strigene prior to entering and after exiting kauri areas.

All prevention management actions as described is in accordance with Standard Operating Procedures for Kauri Dieback[68].

9.7 Monitoring and reporting requirements

9.7.1.1 Compliance confirmation report

A compliance confirmation report will be submitted to Auckland Council (AC) within 30 days of completion of the restoration and enhancement activities to confirm that all enhancement and restoration planting activities have been completed in accordance with this REMP. The report shall include, but not be limited to, confirmation on:

- Planting species matrix and number of plants planted;
- Areal extent and location of plantings;
- Stock exclusion fencing locations;
- Felled log deployment locations in terrestrial, riparian margin, and wetland offset and compensation sites; and
- Proof of covenant/encumbrance and terms therein.

9.7.1.2 Incident reporting

Incident-based reporting will be provided to Auckland Council within 30 working days of an unscheduled event that causes ecological harm (e.g. flood, fire, and disease) or event that sets back an element of the ecological enhancement and restoration programme by a season or more. Reporting will include the following information:

- The causes of the incident, the emergency response measures (if applicable) and the response proposed to avoid a recurrence of the issue;
- An assessment undertaken by a suitably qualified ecologist which details any adverse effects of the exceedance;
- Proposed, measures to avoid, remedy or mitigate effects or to offset or compensate for residual effects that cannot be avoided, remedied or mitigated; and
- Incident resolution will be tracked through the site's compliance management system.

9.7.1.3 Compliance monitoring report

Annual inspection surveys shall be undertaken during normal conditions (i.e. not during flooding events) to monitor the following:

- Identify weeds;
- Identify pest animal damage;
- Estimate planting survival and densities of facultative wetland species in wetlands and all terrestrial plants within compensation sites; and
- Estimate canopy coverage.

[68] Allport, J., and Hill, L. (2017). Standard Operating Procedures for Kauri Dieback. Auckland Council.

Findings will inform the types of weed and pest animal management requirements for the next subsequent year.

Compliance monitoring reports will be submitted to Auckland Council every second year from the initial planting establishment until closure, i.e. once all plantings are 5 years in age and native canopy closure targets have been met. The monitoring report shall include:

- Representative photos showing progress of terrestrial, riparian and wetland revegetation, including photos of sites where plantings are 10 years in age and 90% canopy closure has been achieved (where applicable);
- Information/data on plant survival, infill planting, and progress towards 90% canopy closure targets and weed and animal pest management requirements; and
- Information on incidents and adaptive management responses.

10 Applicability

This report has been prepared for the exclusive use of our client Waste Management New Zealand, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement. We understand and agree that this report will be submitted to Auckland Council in support of an application for resource consent for the works described herein and that council will rely on this report for the purpose of assessing that application.

Tonkin & Taylor Ltd

Report prepared by:

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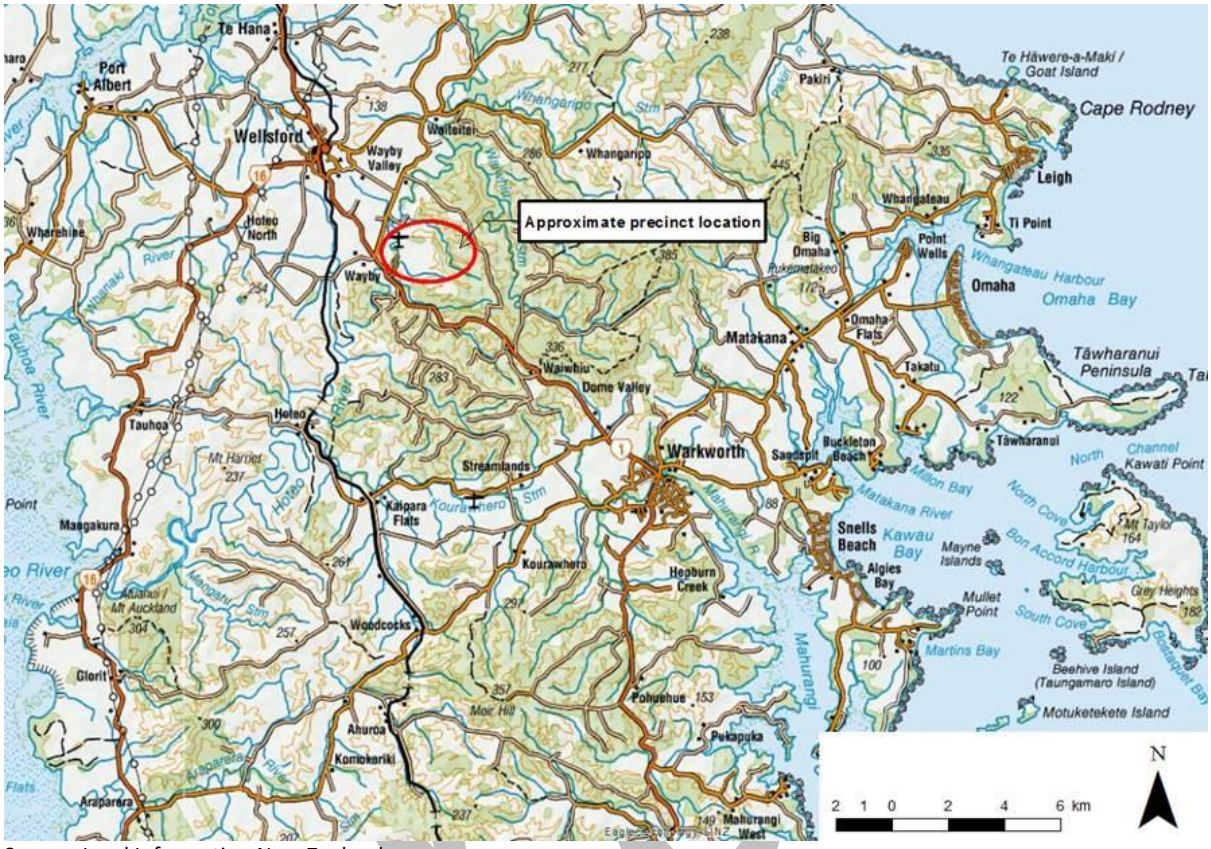
Appendix A: Location plan



Source: Land Information New Zealand