Assessment of Ecological Effects - Vegetation

December 2017

NSES Ltd

Technical Report 7a

NZ TRANSPORT AGENCY
WAKA KOTAHI
Mt Messenger Bypass

New Zealand Government

Quality Assurance Statement			
Prepared by:		Nick Singers	NSES Ltd
Reviewed by:		Roger MacGibbon	Opus International Consultants Limited
Approved for release:	[signature]	Duncan Kenderdine	Mt Messenger Alliance

Revision schedule		
Rev. Number	**Date**	**Description**
0	December 2017	Final for lodgement

ISBN: 978-1-98-851272-3

Contents

Glossary

Term	Meaning
AEE	Assessment of Effects on the Environment Report
AWA	Additional (Ancillary) works area
DOC	Department of Conservation
DOC Assessment Guidelines	DOC's *Guidelines for Assessing Ecological Values*, developed by Davis *et al.* in 2016
Eastern Ngāti Tama forest block	The area of land largely owned by Ngāti Tama located east of existing SH3, including the Project footprint, approximately 3,098ha in size
EcIA guidelines	Ecological Impact Assessment guidelines
EIANZ	Environment Institute of Australia and New Zealand
ELMP	Ecology and Landscape Management Plan
North Taranaki Ecological District	Part of the Taranaki Ecological Region, encompasses approximately 259,750ha, including the Project footprint
Parininihi	The area spanning the Waipingao Stream catchment located to the west of existing SH3, approximately 1,332ha in size
Pest Management Area	Area of land proposed to be actively managed for pests, across a number of parcels of land
Project	The Mt Messenger Bypass project
Project footprint	The Project footprint includes the road footprint (i.e. the road and its anticipated batters and cuts, spoil disposal sites, haul roads and stormwater ponds), and includes the Additional Works Area (AWA) and 5m edge effects parcel.
RMA	Resource Management Act 1991
RTC	Residual trap catch
SH3	State Highway 3

Term	Meaning
Transport Agency	New Zealand Transport Agency
TRC	Taranaki Regional Council
Wider Project area	An area approximately 4,430ha in size which encompasses Parininihi and the Ngāti Tama Eastern forest block, and includes the Project footprint.

Executive Summary

The NZ Transport Agency is to develop a new section of SH3, north of New Plymouth, to bypass the existing steep, narrow and winding section of highway at Mt Messenger. The Project comprises a new section of two lane highway, some 6km in length, located to the east of the existing SH3 alignment.

Mt Messenger is situated in the North Taranaki Ecological District, an area which is characterised by a warm and humid climate supporting broadleaved dominant indigenous forest over most hill country land, and kahikatea (*Dacrycarpus dacrydioides*), pukatea (*Laurelia novae-zelandiae*) forest and associated wetlands in valley floor areas. Parininihi which encompasses the Waipingao Valley to the west of the Project area and is unaffected by the Project, has a rare example of coastal to lowland vegetation sequences and, especially due to the pest control efforts of Ngāti Tama, very high vegetation values.

Fieldwork was undertaken from January to July 2017 and using the information gathered vegetation loss and ecological effects has been assessed. The Project involves a bypass running east of the existing highway approximately 6km long and has a final footprint of approximately 15.457ha. Including vegetation loss associated with construction, the Project footprint will result in the loss of a total of 44.4ha which is indigenous dominant or mixed exotic/ indigenous dominant. Within this area 19.466ha of primary vegetation communities are present, and 13.826 and 11.117ha of secondary scrub/forest and rushland, sedgeland mosaic respectively. The areas of highest ecological value are 1.231ha of forest dominated by kahikatea and areas of tawa (*Beilschmiedia tawa*), rewarewa (*Knightia excelsa*), kamahi (*Weinmannia racemosa*) forest south of the tunnel in the Mimi catchment.

North of the tunnel in the Mangapepeke catchment vegetation is of comparatively lower ecological value, having been subjected agriculture development and browsing by introduced pests, especially possums (*Trichosurus vulpecula*), cattle (*Bos taurus*), goats (*Capra hircus*) and pigs (*Sus scrofa*). These areas are of much lower quality. The project also impacts small areas of modified sedgeland wetland and cliff vegetation.

While the design has avoided many significant trees up to 15 will be lost, some of which are known to be hosts for a small number of the chronically threatened epiphytic shrub, kohurangi (*Brachyglottis kirkii* var. *kirkii*). Small numbers of two regionally distinctive plants are affected (swamp maire *Syzygium maire,* and *Pittosporum cornifolium)*.

The overall effect on vegetation of the Project is high because of the scale of vegetation loss, its composition, structure and that some impacts are permanent.

The overarching ecological aim for the Project is to ensure no net loss of biodiversity values, or to achieve a net benefit of biodiversity values, in the medium term. To achieve this a mitigation programme will be implemented, including integrated long-term pest management and 'like for like' habitat recreation and restoration programmes. Measured in the medium term, a net biodiversity gain is anticipated because the proposed management area is conservative and greater than measured by the Biodiversity accounting model. Further methods for pest control and habitat restoration are widely used and are very successful in achieving the gains expected.

1 Introduction

1.1 Purpose and scope of this report

This report forms part of a suite of technical reports prepared for the NZ Transport Agency's Mt Messenger Bypass project (the Project). Its purpose is to inform the Assessment of Effects on the Environment Report (AEE) and to support the resource consent applications and Notice of Requirement to alter the existing State Highway designation, which are required to enable the Project to proceed.

This report assesses the ecological effects on vegetation of the Project as shown on the Project Drawings (AEE Volume 2: Drawing Set).

To assess the ecological effects of the Project on vegetation this report:

- Identifies and describes vegetation characteristics and values in (Section 3):
  - the Project footprint (defined in Section 2.3.2 below); and
  - the wider Project area (Figure 1.2).
- Describes the magnitude of the potential effects of the Project on vegetation arising from construction, operation and maintenance (Section 4); and
- Recommends measures to avoid, remedy or mitigate potential adverse effects (Section 5).

1.2 Project description

The Project involves the construction and ongoing operation of a new section of State Highway 3 (SH3), generally between Uruti and Ahititi to the north of New Plymouth (refer Figure 1.1). This new section of SH3 will bypass the existing steep, narrow and winding section of highway at Mt Messenger. The Project comprises a new section of two lane highway, approximately 6km in length, located to the east of the existing SH3 alignment.

The primary objectives of the Project are to enhance the safety, resilience and journey time reliability of travel on SH 3 and contribute to enhanced local and regional economic growth and productivity for people and freight.

A full description of the Project including its design, construction and operation is provided in the Assessment of Effects on the Environment Report, contained in Volume 1: AEE, and is shown on the Drawings in Volume 2: Drawing Set.

Figure 1.1 – Location of the Project in the Taranaki Region

1.3 Ecological aim for the Project

The overarching ecological aim for the Project is to ensure no net loss of biodiversity values, or to achieve a net benefit of biodiversity values, in the medium term. The ecologists engaged to provide advice and assessments in respect of the Project have been closely involved in recommending measures, including design features, to achieve this aim.

The ecological aim for the Project will ultimately be achieved through a range of measures to avoid, remedy or mitigate effects on ecological values, including in particular through:

- The selection of a route option that avoids the generally higher ecological value land to the west of the existing SH3;
- The use of structures (i.e. a tunnel and bridge) to minimise habitat loss and severance;

- Within the proposed route, alignment optimisations through changes to design and construction methodologies that produce the best ecological outcomes (e.g. avoidance of wetlands);
- Monitoring programmes developed to minimise the potential for vulnerable species being harmed during road construction (e.g. North Island brown kiwi, *Apteryx mantelli*);
- Salvaging and relocation of important biodiversity values (e.g. lizards, large felled trees); and
- The establishment and operation of a long-term pest management programme.

These measures are discussed in more detail in section 5 of this report.

1.4 Background to the ecological assessment of the Project

In 2016, through the earlier stages of the Project, consideration of several options for the Project focused on Parininihi, located to the west of SH3 (Figure 1.2) and another route (MC71) east of SH3 (Singers & Bayler 2017). More recent ecological investigations have focused on the Project footprint. As a consequence a broad understanding of vegetation and ecological values across the wider Project area has been obtained.

Data have been gathered along the Project footprint during the 2017 autumn and winter periods to augment this earlier survey information, and to inform the assessment of the potential nature and scale of the Projects' effects.

The land to the west of SH3 (Parininihi) has had the benefit of some 15 years of intensive pest management which has resulted in healthier vegetation with a greater diversity and abundance of pest sensitive plant species. Large parts of the Project footprint have been logged and burnt and used for pastoral farming, or have otherwise been subject to browsing by stock. Accordingly, the biodiversity values associated with Parininihi are generally higher than those of the Projects' footprint.

1.5 The wider Project Area

The wider Project area (i.e. the area in Figure 1.1 below) is an area approximately 4,430ha in size which is situated in the North Taranaki Ecological District[1] (refer Figure 1.3) part of the larger Taranaki Ecological Region. The North Taranaki Ecological District occupies 259,750ha from Urenui in the south to 15km north of Awakino. It extends east to Ohura and to 10km west of Whangamomona (Bayfield et al. 1991). While most of the ecological district is steeply incised hill-country it includes other habitats, including coastal cliffs, alluvial terraces, uplifted marine terraces and cliff habitats. Flat land is mostly in pastoral farmland while indigenous vegetation occupies much of the steep hill country. Warm, humid summers and mild, wet winters create conditions suitable for dense broadleaved dominant forest with an abundance of lianes and epiphytic plants over mostly hill country land, and kahikatea, pukatea and swamp maire forest and associated wetlands in valley floor areas.

[1] http://www.doc.govt.nz/Documents/science-and-technical/Ecoregions1.pdf

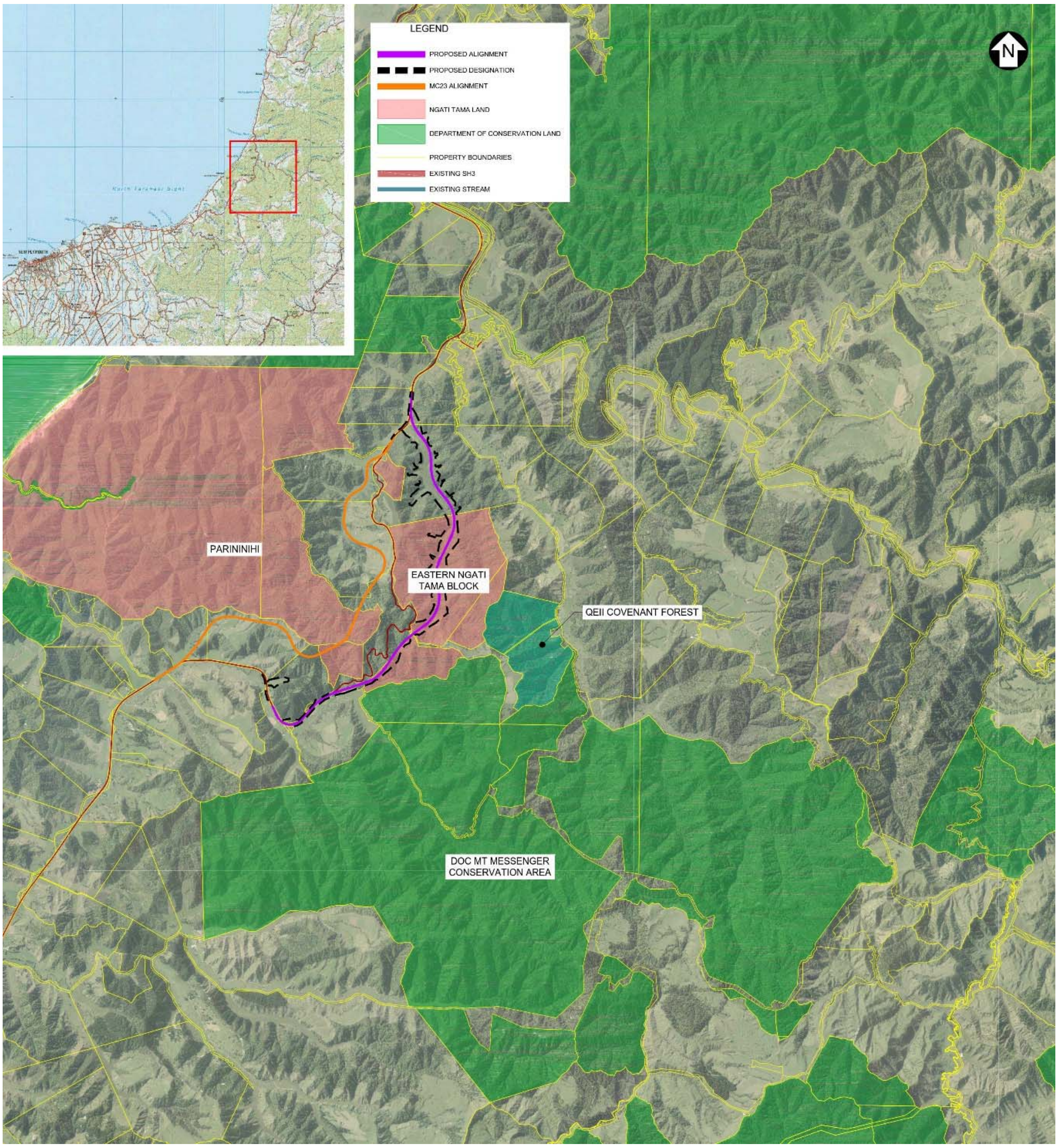

Figure 1.2 -The wider Project area, showing Parininihi and the previous MC23 alignment to the west of the existing SH3, and the Project footprint, Eastern Ngāti Tama forest block to the east, including areas of DOC and private land to the southeast.

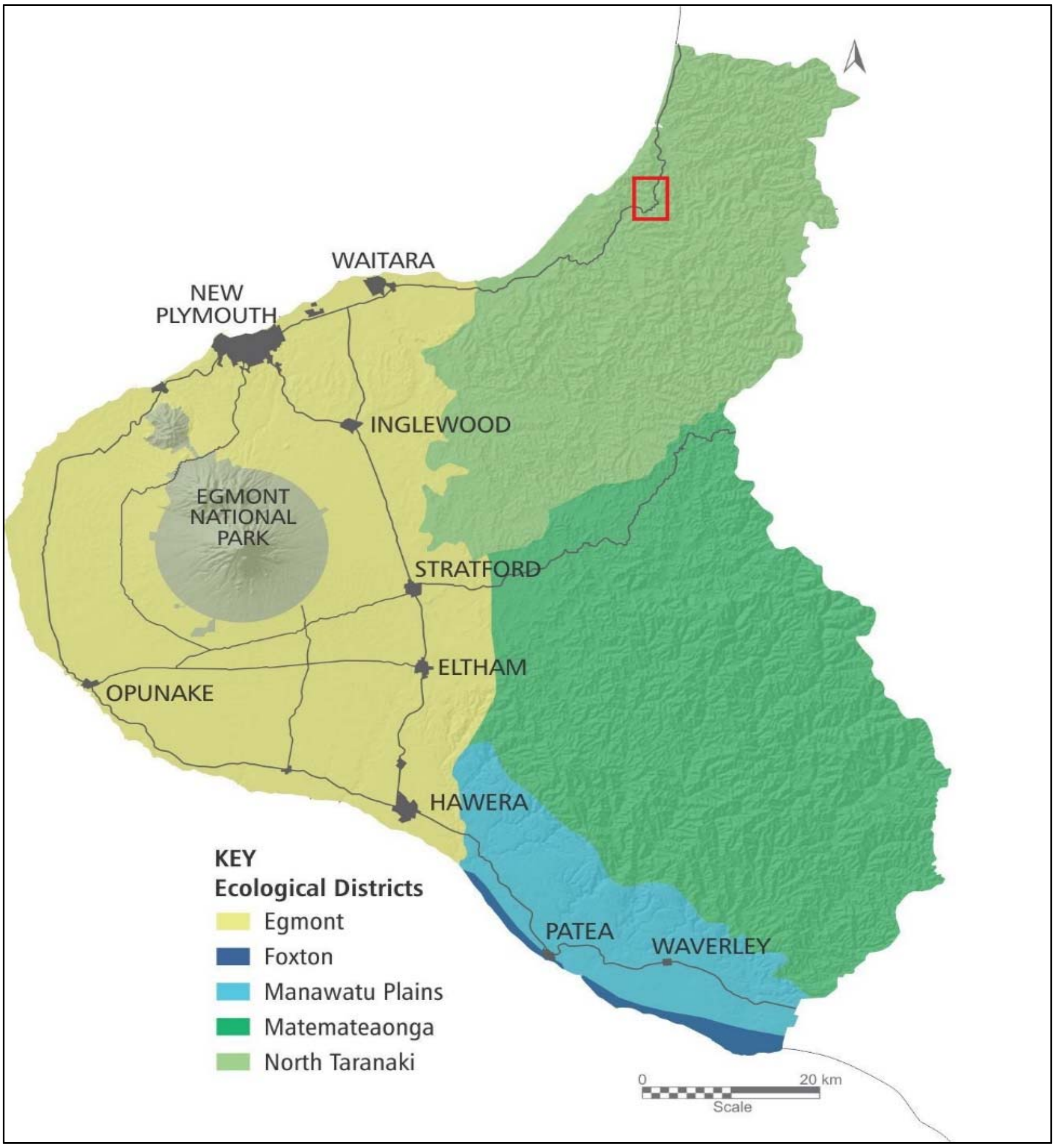

Figure 1.3 – Map showing the North Taranaki Ecological District, with the wider Project area shown in the red box (Taranaki Regional Council, 2017)

The wider Project area (Figure 1.2), within which the Project footprint is located, consists of predominately indigenous forest and farmland habitat. The indigenous forest includes:

- a contiguous area of 1,332ha of indigenous forest owned and managed by Ngāti Tama that is located to the immediate west of Mt Messenger known as Parininihi (see Section 1.5.1); and
- a contiguous forest (approximately 3,098ha in size) immediately adjacent to Mt Messenger and to the east of SH3 (see Section 1.5.2). This area is referred to as the Eastern Ngāti Tama forest block (but also includes public conservation land managed by DOC and private landowners).

1.5.1 Parininihi

Parininihi, previously known as "Whitecliffs Conservation Area" is 1,332ha of mainly primary forest centred on the Waipingao Stream catchment (shown to the west of SH3 in Figure 1.2). This area is classified as "Rimu tawa forest" within the New Zealand Forest Service class map (NZFSMS6). The area encompasses a rare continuous forest sequence through coastal, semi-coastal and lowland bioclimatic zones. As such, the area is regarded as being ecologically significant, and has been described as "the best example of primary coastal hardwood-podocarp forest on the west coast of the North Island" by eminent forest ecologist John Nicholls (Bayfield *et al.* 1991).

Ecological management of Parininihi was started in the early 1990s by DOC, and involved possum and goat pest control activities. Since the return of this land to Ngāti Tama in 2003, management of these pests has continued, and control of rodents, mustelids and feral cats has also occurred. Consequently, the health and ecological integrity of the area is now improving, with browse-sensitive plants regenerating and various predation-sensitive birds increasing in abundance.

Parininihi (and all land to the west of the existing SH3) is being avoided by the Project footprint, following the route selection process carried out in 2017.

1.5.2 Eastern Ngāti Tama forest block

The dominant forest to the east of the existing SH3 corridor covers approximately 3,098ha (refer Figure 1.2) and would have originally been very similar forest type to the eastern part of Parininihi; however, it has not had consistent pest control. Consequently, the ecological condition of this area is poorer, with fewer palatable canopy trees remaining, such as thin-barked totara (*Podocarpus laetus*) and northern rata (*Metrosideros robusta*). Within the Mangapepeke Stream catchment to the east of existing SH3 (shown in Figure 1.2 adjacent to and within the northern end of the Project footprint), vegetation communities are more modified and have been affected by stock grazing, fire and logging. Of greatest botanical significance in this area are the hydrologically intact swamp forest and non-forest wetland areas in the valley floor of the northern Mimi River catchment (shown in Figure 1.2 towards the southern end of the Project footprint). The wetlands also provide habitats for various threatened wetland bird species. The valley floor sequence within the northern tributary of the Mimi River represents a full range of swamp forest, scrub and non-forest wetland communities. This Project footprint avoids directly affecting these vegetation communities, but sedimentation from the Project has the potential to affect the communities.

2 Assessment methods

Vegetation characteristics and values within the Project area were assessed by reviewing existing information and data, and by undertaking field surveys along the Project footprint and other previously proposed alignments.

The assessment in this report broadly follows Ecological Impact Assessment (EcIA) guidelines developed by the Environment Institute of Australia and New Zealand (EIANZ 2015). As described in Section 2.3, professional botanical judgement and expertise have also been applied in the assessment process to reflect good practice.

The assessment has included both a desktop review and field assessments.

2.1 Desktop review

A desktop assessment was undertaken to review available information and data relating to the ecology of the wider Project area. This included:

- Identifying areas within and surrounding the Project footprint that are listed as having significant ecological values including:
  - Parininihi
  - Eastern Ngāti Tama forest block
- A review of key documents, reports and data including:
  - New Plymouth District Plan (District Plan), including Appendix 21: Criteria for Significant Natural Areas
  - Protected Natural Areas Programme (PNAP) report for North Taranaki Bayfield et al. (1991)
  - Forest and ecosystem classifications, including Nicholls (1976) and Singers & Rogers (2014)
  - Multiple plant species lists from Parininihi and Mount Messenger Conservation Area, including a list of regionally threatened and distinctive plants developed by the Taranaki Regional Council to identify possible plants of interest
  - Aerial imagery, high resolution drone imagery and relevant spatial layers including the Taranaki Potential Ecosystems (Singers 2015), the Landcover database 4 (Landcare), and the tree layer from NVS vegetation plots.

Consultation with:

- Professor Bruce Clarkson (Deputy Vice Chancellor) from the University of Waikato.
- Local conservation managers involved with ecological management at Parininihi and elsewhere in Taranaki including Conrad O'Carroll, Paul Pripp and staff from DOC, including on-site visits.

2.1.1 Identification of threatened and regionally distinctive plants

Review of existing documentation and advice from consultees, supported by the author's own knowledge of the vegetation of the wider Project area, formed the basis for identifying threatened and regionally distinctive plant species to be targeted during the field surveys. Three plant species lists from the wider Project area (Clarkson & Boase 1982; Ogle & Druce 1998; Jane & Donaghy 2005) and relevant information within the North Taranaki PNAP report (Bayfield *et al.*, 1991) were reviewed for the presence of threatened plants — listed by de Lange *et al.* (2013) as acutely threatened or at risk. This identified that the 'At risk-declining' king fern (*Ptisana salicina*) and kohurangi (*Brachyglottis kirkii* var. *kirkii*) were likely to be present within the wider Project area.

Recognising that these species lists may not be comprehensive, additional species were also identified for consideration, such as species present in the Northern Taranaki Ecological District and/or where suitable habitat exists within the wider Project area. Other threatened plant species that were also identified as potentially being present in the wider Project area included: *Brachyglottis turneri*, as it is present in the lower Mimi River Valley and Hutiwai Forest; *Pittosporum kirkii*, and pua-o-te-ringa (*Dactylanthus taylorii*).

Wetland areas often have a high diversity of threatened plants owing to their widespread reduction in extent. For this reason the northern Mimi River catchment suitable habitat was closely observed during the field survey for a wide range of threatened plants, such as *Myriophyllum robustum* and *Gratiola concinna*.

A list of regionally distinctive plants was also obtained from the Taranaki Regional Council. While not nationally threatened or uncommon, these plants are regarded as being uncommon in Taranaki. Four regionally distinctive plants were identified: kauri grass (*Astelia trinervia*), *Pittosporum cornifolium*, Coromandel tree daisy (*Olearia townsonii*) and swamp maire.

2.2 Field assessment methods

Vegetation surveys were carried out in January 2017 and June 2017 as part of the information gathering for the options assessment process for the Project. The surveys were carried out both to the west and east of the existing SH3 and covered seven different route options, including two eastern and five western. For this reason, the information gathered during the surveys covers a wider area than the Project footprint, although the analysis of vegetation loss in this report is solely focused on the Project footprint. A baseline survey was undertaken recording all plant species both within eastern and western options, including targeted surveying for known or potentially threatened plant species. A vascular plant list from this baseline survey of the wider Project area is included within Singers & Bayler (2017). Vegetation communities identified were sampled using the variable area Recce method (Hurst & Allen 2007) which included mapping in the field using aerial imagery and then using the QGIS programme.

Previous research on the landforms, abiotic environmental factors and their relationship with vegetation communities in the North Taranaki Ecological District (Singers & Bayler 2017; Singers 2015) enabled focused sampling and mapping of the variety of ecosystems and plant communities. The Project footprint is located in close proximity to one of the earlier proposed routes (MC71) which was evaluated in Singers & Bayler (2017).

Initially a provisional vegetation map was developed remotely, separating broad-scale land cover classes, such as farmland, exotic forest, native forest, native scrubland and wetland. Within areas dominated by indigenous vegetation, vegetation compositional variability was further recognised on high resolution aerial images in relation to known environmental factors (e.g. slope and aspect). Where distinct communities were recognised, sampling locations for Recce plot sampling were plotted in each community. For example visual differences were apparent between pole kahikatea forest and forest occurring on ridgelines and gully/hillslopes. Walking routes were also remotely planned to enable more thorough investigation along the Project footprint, in order to survey the full range of the vegetation compositional variability present, document plant species present (including habitats of potential threatened plants) and locate and measure significant trees. Vantage points were also remotely identified and visited in the field to provide an overview of canopy composition and record any significant emergent trees. From these locations specific species were also surveyed for, such as the epiphytic threatened shrub kohurangi *(Brachyglottis kirkii var. kirkii).*

Exotic dominated land cover and vegetation communities such as high producing pasture and exotic forestry, were not sampled using variable area Recce plots, though were visually checked for accuracy in the field. The exotic/indigenous mosaic community, "rushland, sedgeland pasture" which primarily occurs in the upper Mangapepeke Valley was sampled with a walk through survey.

Field work was undertaken in mid to late January 2017 and then in early June 2017, during fine weather. Due to steep terrain the cliff communities were only described from vantage points or from below. Wetland communities adjacent to the Project footprint in the northern Mimi River catchment were additionally described. This was undertaken to improve understanding of the significance of these communities, their hydrology and how they could be affected by the Project.

A vegetation map (see Figure 3.1 & Figure 3.2 in Section 3.4) was produced using information gathered on the ground, assisted by aerial imagery and high resolution drone imagery.

The northern Mangapepeke Valley (towards the north of the Project footprint in Figure 1.2), located in private land (i.e. north of the 'Eastern Ngāti Tama forest block') was unable to be accessed for surveys. Partial assessment of this area was however made from observations from adjoining land and aerial imagery. Vegetation on this property is secondary and dominated by manuka (*Leptospermum scoparium*), kanuka (*Kunzea robusta*) and tree-ferns with scattered pole sized rewarewa, kahikatea and rimu (*Dacrydium cupressinum*). In the valley floor rushland/ sedgeland mosaic occurs, some of which contains areas of sedgeland wetland areas. These sedgeland areas were mapped remotely from aerial images and are an approximation of these areas due to lack of access to private land. The property is currently heavily grazed by cattle, horses and feral goats — there is no fence between the private land

and Ngāti Tama land to restrict animal movement, so animals freely move onto Ngāti Tama land.

2.2.1 Recce plots

Recce plots are a standard field method used in New Zealand for measuring vegetation, including for forest classification (Allen, 1992), deriving vegetation maps (Newell & Leathwick, 2005) and to investigate relationships between forest types and environmental factors (Burns & Leathwick, 1996).

In the field the 'variable area' or unbounded Recce method was used to sample the range of communities (Appendix: Table 1). Variable area Recce plots are best suited to initial inventory, where there is no intention to re-measure. The size and shape of variable area Recce plots is determined in the field and is judged to be large enough to contain most species present in the plant community, but must be also small enough to sample uniform vegetation and landform in the plot (McNutt, 2012). A key determining factor of which communities were sampled was whether they were large enough to be spatially mapped.

2.2.1.1 Threatened and regionally distinctive plants

Suitable habitats of threatened and regionally distinctive plants were specifically surveyed. Specific habitats surveyed included areas of wet cliffs suitable for *Brachyglottis turneri*, areas where pigs and goats were uncommon for king fern, and treetops for epiphytic shrubs.

2.2.1.2 Significant trees

Significant trees were determined as having one or more of the following attributes:

- being large and old (typically emergent) trees;
- being relatively uncommon; and
- having significant habitat value for other flora and fauna such as, providing important flowering or fruiting resources, cavities for roost and nests, and supporting large epiphyte communities.

From observations and review of plant species lists, eleven tree species were determined as being significant and included:

- hinau (Elaeocarpus dentatus);
- kahikatea;
- miro (Prumnopitys ferruginea);
- narrow-leaved maire (Nestegis montana);
- maire taiki (Mida salicifolia);
- northern rata;
- rimu;
- thin-barked totara and hybrids with lowland totara;
- white maire (Nestegis lanceolata);
- swamp maire; and
- very large pukatea.

Canopy dominant trees such as tawa, rewarewa and kamahi were not considered as being significant, irrespective of size or other attributes.

Significant trees were identified from vantage points, drone aerial imagery and during walk through surveys. Tree locations were determined using a Garmin Rino GPS and were then plotted as a GIS significant tree layer. Some tree field GPS locations were later spatially altered to better align to trees plotted on aerial images.

The significant tree layer developed through these surveys has been used by the Alliance design team to shift the road in order to prevent loss of several significant trees. The number of significant trees within the Project footprint (Figure 3.19and Figure 3.20in Section 3.8) where additional vegetation loss potentially could occur is presented in Table 3.1. This process is likely to have missed some smaller-sized significant trees, such as very large pukatea, hinau and maire which are of similar or smaller height to dominant canopy trees such as tawa, rewarewa and kamahi.

2.3 Assessment of effects methodology

The assessment of ecological effects broadly follows the EcIA guidelines (EIANZ, 2015), with some adaptation, specifically using DOC's Guidelines for Assessing Ecological Values (DOC Assessment Guidelines) (Davis *et al.* (2016), to assist Step 1 of the EcIA guidelines, and supported by expert opinion. Davis *et al.* (2016) was specifically used to assist the assessment of ecological value because it includes a broader range of criteria such as 'Representativeness', 'Diversity and Pattern', 'Rarity and special features', 'Naturalness' and 'Ecological context'. These criteria are especially pertinent given that much of the land within the wider Project area is protected by a conservation covenant and this methodology has been designed by DOC.

The guidelines are useful in that they enable effects to be assessed in a systematic and transparent way, potentially enabling the ecological consequences of various development options to be compared meaningfully, both within and between projects.

The steps set out in the EcIA guidelines are set out below in Sections 3.3.1-3.3.3. The EcIA guidelines assess unmitigated effects only.

2.3.1 Assessment of Ecological Values (Step 1)

The DOC Assessment Guidelines (Davis *et al.* 2016) are aimed at assisting DOC staff to assess ecological values in a consistent and robust way. The DOC Assessment Guidelines are not specific to DOC staff, but can be used to guide ecological assessments. The DOC Assessment Guidelines were used alongside the EcIA guidelines.

The assessment of ecological value considered the range of vegetation communities in the Project footprint under the hierarchy of potential ecosystems. The five criteria used for this assessment process are:

- representativeness,
- diversity and pattern,
- rarity and special features,

- naturalness, and
- ecological context.[2]

Of these five criteria representativeness is widely recognised throughout the world as the key criterion especially in nature conservation programmes (O'Connor *et al.* 1990) and assessing ecological significance; Davis *et al.* 2016).

Using Davis *et al.* (2016), ecological values were then assigned the equivalent level on a scale of Low, Moderate, Moderate-High, High or Very High from the EIANZ framework (see Table 2.1):

Table 2.1 – Assignment of values within the Project footprint to species, vegetation and habitats (adapted from EIANZ, 2015)

Value	Species Value requirements	Vegetation/Habitat value requirements
Very High	Important for Nationally Threatened species	Meets most of the ecological significance criteria as set out in relevant statutory policies and plans.
High	Important for Nationally At Risk species and may provide less suitable habitat for Nationally Threatened species	Meets some of the ecological significance criterion as set out in relevant statutory policies and plans
Moderate-high	May provide less suitable habitat for Nationally At Risk species	Meets one of the ecological significance criteria as set out in the relevant statutory policies and plans.
Moderate	No Nationally Threatened or At Risk species, but habitat for locally uncommon or rare species	Habitat type does not meet ecological significance criteria as set out in the relevant statutory policies and plans but does provide locally important ecosystem services (e.g. erosion and sediment control, and landscape connectivity)
Low	No Nationally Threatened, At Risk or locally uncommon or rare species	Nationally or locally common habitat and supporting no Threatened or At Risk species, and does not provide locally important ecosystem services

[2] The three management criteria in the DOC Assessment Guidelines — Long term viability, Fragility and Threat and Management Input were not assessed.

2.3.2 Step 2: Magnitude of unmitigated effect assessment (Step 2)

Step 2 of the EcIA guidelines requires an evaluation of the magnitude of unmitigated effects on local ecological values based on footprint size, intensity and duration. The unmitigated 'Magnitude of the Effect' that the Project is expected to have on vegetation species found in the Project footprint is evaluated as being either 'No effect', 'Negligible', 'Low', 'Moderate', 'High' or 'Very High' (see Table 2.2).

The unmitigated 'Magnitude of Effect' is a function of:

- the scale of unmitigated effect *per se* (i.e. the areal extent of the Project footprint);
- the proportion of unmitigated habitat loss versus local availability (e.g. the proportion of habitat loss relative to the contiguous habitat that remains);
- the duration of unmitigated effect (e.g. permanent versus temporary); and
- the intensity of the unmitigated effect (i.e. the extent to which habitat loss within the Project footprint was complete or partial).

The 'Project footprint' is the principal spatial zone, where the effects of the Project on vegetation were considered to occur. The Project footprint includes:

- the road footprint (i.e. the road and its anticipated batters and cuts, spoil disposal sites, haul roads and stormwater ponds);
- the Additional Works Area (AWA), accounting for additional habitat loss for construction access, laydown areas and temporary stormwater drains (Figure 3, Appendix A); and
- 5m edge effects parcel.

Note that the AWA includes a smaller allowance for temporary works in habitats with 'High' 'Ecological Values' because temporary work activities will be focused on the road footprint and immediately adjacent areas, and more precautions will be taken in managing construction effects, in order to mitigate potential adverse effects on the surrounding habitat. These measures will be set out in the Construction and Environmental Management Plan attached to the consent application, which will include the Ecology and Landscape Management Plan.

The inclusion of the 5m edge effects parcel in the Project footprint accounts for the degradation of habitat suitability in close proximity to the direct effects footprint through edge effects. The creation of new edges where existing vegetation is removed is known to alter micro-climatic conditions (e.g. through increased exposure to temperature extremes, desiccation, and wind) with potential adverse effects on both habitat suitability and availability for a number of species (Young & Mitchell 1994; Davis-Colley *et al.* 2000). Moreover, a variety of other factors, including invasion of weeds and occupancy of mammalian predators and browsers are generally considered to be higher in edge habitats (Murcia 1995; Lahti 2009) though evidence for higher predation rates is mixed (Ruffell *et al.* 2014).

Edge effects are difficult to quantify for species, and the magnitude of effects is likely to vary specifically for each species and within each habitat type (Ruffell & Didham 2016).

However, recognising variability of edge effects on vegetation, the inclusion of a 5m zone as a habitat loss equivalent (that will be factored into the ecological mitigation and offset package, set out in detail in the Assessment of Ecological Effects – Ecological Mitigation and Offset (Technical Report 7h, Volume 3 of the AEE)) is considered appropriate.

Table 2.2 sets out how the magnitude of unmitigated effects is to be calculated, with the use of the EcIA guidelines.

Table 2.2 – Evaluation of the magnitude of unmitigated effects on ecological values based on footprint size, intensity and duration.

Magnitude of effect	Description
Very High	Total loss or major alteration of the existing baseline conditions; Total loss or loss of a very high proportion of the known population or range
High	Considerable loss or alteration of existing baseline conditions; Loss of high proportion of the known population or range
Moderate	Moderate loss or alteration to existing baseline conditions; Loss of a moderate proportion of the known population or range
Low	Minor shift away from existing baseline conditions; Minor effect on the known population or range
Negligible	Very slight change from the existing baseline conditions; Negligible effect on the known population or range

2.3.3 Level of effects assessment in the absence of mitigation (Step 3)

Step 3 of the EcIA guidelines requires the overall level of effect to be determined using a matrix that is based on the ecological values and the magnitude of effects on these values **in the absence of any efforts to avoid, remedy or mitigate for potential effects**. Level of effect categories include: 'No Ecological Effect', 'Very Low', 'Low', 'Moderate', 'High' and 'Very High'. Table 2.3 shows the EIANZ matrix outlining criteria to describe the overall level of ecological effects.

Table 2.3 – Criteria for describing overall levels of ecological effects as outlined in EIANZ, 2015.

Magnitude of effect	Ecological Value			
	Very High	**High**	**Moderate**	**Low**
Very High	Very high	Very high	High	Moderate
High	Very high	Very high	Moderate	Low

Magnitude of effect	Ecological Value			
	Very High	**High**	**Moderate**	**Low**
Moderate	Very high	High	Low	Very low
Low	Moderate	Low	Low	Very low
Negligible	Low	Very low	Very low	Very low
No effect	No ecological effect	No ecological effect	No ecological effect	No ecological effect

3 Results of vegetation classification

3.1 Background

Mt Messenger is situated in the North Taranaki Ecological District (see Figure 1.3 above), an area which is characterised by heavily eroded and dissected landforms of marine derived papa siltstone and sandstone sediments, much of which is still covered in indigenous forest. Valley floors, coastal terraces and most of the easily accessible, elevated land have been cleared for farming and locally exotic forestry (Bayfield *et al.* 1991).

The base rock geology of the Parininihi – Mt Messenger is Mt Messenger sandstone. Volcanic ash from Mt Taranaki has mantled the landscape and remains as a component of the soil on easier country. Much of the landscape is very steep and heavily dissected and consequently in these areas soils are skeletal. Dense fluvial and gley soils occur within valley floors.

Summers are warm and humid and winters are mild and experience on average over 200 mm of rainfall each month. Rainfall typically exceeds 1800mm per year, with only February having less than an average of 100mm of rain. Despite the moderately high rainfall the area typically experiences between 1900–2000 sunshine hours annually. These environmental conditions are suitable for dense broadleaved dominant forest with an abundance of lianes and epiphytic plants over most hill country land, and kahikatea, pukatea forest and associated wetlands in valley floor areas.

3.2 Description of ecosystem and vegetation types

Limited information exists about the synecology of the wider Project area. The area was sampled in 1948 during the National Vegetation Survey and from information gathered forest was mapped within the New Zealand Forest Service Forest class map (NZFSMS6) for Taranaki. This identified that the Mt Messenger area straddles an ecological boundary between two broad forest classes with podocarp, broadleaved forest largely in the Mimi catchment and the upper Mangapepeke Valley (mapped as “Rimu tawa forest”) and podocarp, broadleaved, beech forest (mapped as “Rimu tawa beeches”) within the lower Mangapepeke catchment and northwards. No plots were measured within the valley floor kahikatea forest in the northern Mimi River catchment and hence were not identified at that time.

More detailed and descriptive classification and mapping of the broad forest types of the area was never published however the forest would have included three types D12, H4 or L1 (Nicholls 1976). Singers & Rogers (2014) used Nicholls (1976) to develop ecosystem units in combination with environmental characteristics. Analogous forest ecosystem units are WF13: Tawa, kohekohe (*Dysoxylum spectabile*), rewarewa, hinau, podocarp forest; WF14: Kamahi, tawa, podocarp, hard beech forest; WF8: Kahikatea, pukatea forest; Singers & Rogers 2014). In the Taranaki Region these were mapped over the Parininihi – Mt Messenger area within a potential ecosystem map (Figure 4.1) (Singers, unpublished 2015).

Descriptions from Nicholls (1976) and Singers and Rogers (2014) are described below:

Class D — Rimu tawa. D12: Occasional rimu, miro, rata, among frequent tawa, kohekohe, kamahi; occasional hinau, rewarewa, pukatea. Occurs widely up to 300m a.s.l. and up to 15km inland in the eastern Bay of Plenty and North Taranaki, and occasionally on the western margin of the Tararua Range (Nicholls 1976).

WF13: Podocarp, broadleaved forest with occasional emergent rimu, miro, northern rata and locally kahikatea and with abundant tawa, kohekohe, hinau, rewarewa and pukatea. Locally includes tawari, kamahi, towai, puriri and mangeao, although towai and mangeao are locally absent or rare (e.g., Auckland and East Cape). Predominantly occurs in inland hill country and higher ground in Northland, Hunua and Coromandel where kauri is absent. More widespread in Waikato and Bay of Plenty, with southern limits at approximately New Plymouth and Wairoa (Singers & Rogers 2014).

Class H — Rimu tawa beeches. H4: Variable mixtures of rimu, miro, tanekaha, rata, tawa, hinau, rewarewa, pukatea, kohekohe, kamahi, hard beech. Occurs up to 300m a.s.l. within a few kilometres of the coast in the eastern Bay of Plenty and in North Taranaki (Nicholls 1976).

WF14: Podocarp broadleaved, beech forest of mosaics of abundant kamahi and tawa, occasional northern rata, rewarewa, supplejack (*Ripogonum scandens*), rimu, miro, Hall's totara, tawherowhero, tawari (*Ixerba brexioides*) and locally abundant hard beech generally on ridges. Also kohekohe, pukatea, nikau (*Rhopalostylis sapida*), kiekie (*Freycinetia banksii*), at low altitude. Predominantly occurs in coastal areas from western Herangi Range to northern Taranaki and eastern Bay of Plenty, Raukumara-Urewera. Small areas in South Is, Western Marlborough sounds and Wanganui Inlet (Singers & Rogers 2014).

Class L — Softwoods. L1: Abundant small trees and poles of kahikatea. The only sizable stands are near Te Kuiti (Nicholls 1976).

WF8: Podocarp, broadleaved forest of abundant kahikatea with occasional to abundant pukatea, kiekie, supplejack and locally rimu, tawa and swamp maire particularly on organic and gley soils with a high water table. Predominantly occurs west of the divide on poor draining alluvial, organic and gley soils in warm to mild, humid to sub-humid areas of the North Island, from Northland to Wellington (e.g. western Egmont National Park) and also localised areas in Nelson and Blenheim. East of the divide in semi-arid regions restricted to small areas in permanent wet depressions and lake margins (Singers & Rogers 2014).

These forest descriptions describe mature forests, though in reality the forests of the wider Project area are a mosaic of different age classes. Due to the steepness of slopes and the often high and intense rainfall events, landslides occur frequently, with areas of vegetation and soil slipping back to raw bed rock. This results in vegetation composition which is quite varied with a significant proportion in younger stages of succession, developing towards mature broadleaved dominant forest.

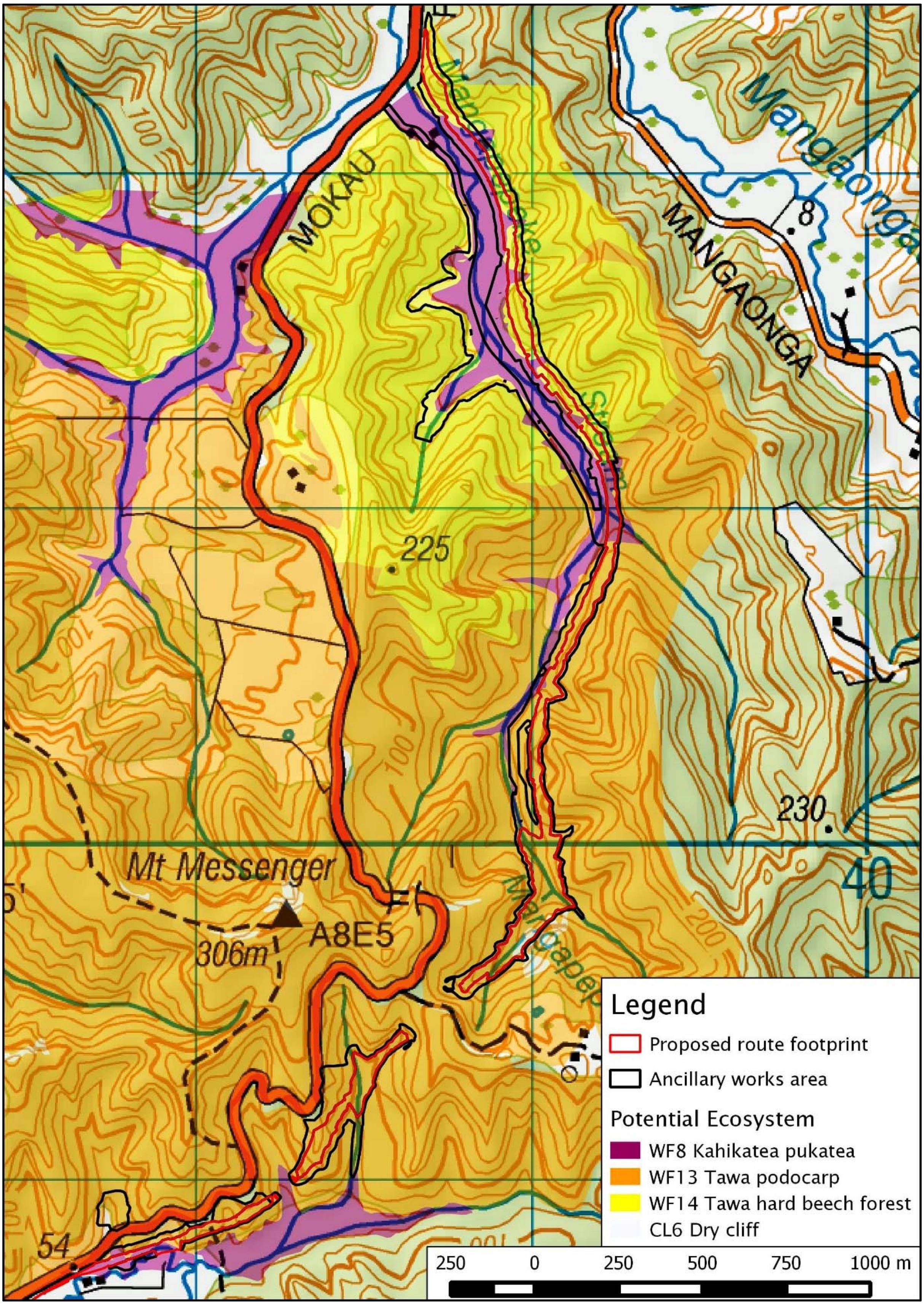

Figure 3.1 - Project footprint, Additional (Ancillary) Works Area and potential ecosystems

Modifications to the original forest pattern (as described in the forest type description above) have occurred as a result of both human land development and pest induced dieback. Human modification, largely caused by forest fires to clear land for agriculture has affected parts of the Mangapepeke Valley and the lower Mimi Valley. Human impacts to vegetation also occurred from the construction of the Mt Messenger road (SH3). In forest unaffected by fire the largest change has been the loss of kohekohe as a canopy dominant (or co-dominant) since the National Forest Inventory measured plots in the area in 1948. Later, extensive dieback of kamahi, northern rata and thin-barked totara was apparent from the early 1980's (Professor Bruce Clarkson, Waikato University, pers. comm.). Forest dieback changes are probably caused by possum browse as these tree species are preferentially selected (Clout 2006). Consequently, today in many areas the forest composition is now dominated by canopy trees of lower palatability such as tawa, rewarewa, nikau and tree-ferns.

Smaller areas of other ecosystem types and vegetation associations also occur in the wider Project area, which are described more fully from vegetation sampling. These include valley floor forest and wetland communities of kahikatea and wetland vegetation.

3.3 Vegetation Survey/assessment results

20 native dominant or native / exotic mosaic vegetation communities are described below of which 16 are directly affected by the Project footprint (44.4ha) or occur within the wider Project area. Four communities occur in the northern tributary of the Mimi Stream within the wetland and valley floor.

The vegetation communities include:

- Six indigenous forest communities
- Six indigenous wetland communities
- Seven indigenous scrub or successional forest communities
- One mixed native / exotic rushland, sedgeland community

The extent and distribution of indigenous communities impacted within the Project footprint is presented in Figure 3.2, Figure 3.3 and Table 3.1. Permanent vegetation loss of indigenous and mixed indigenous exotic vegetation on the actual road footprint amounts to 15.457ha. Of this, 14.446ha is indigenous dominant while 1.011ha is the mixed indigenous exotic rushland, sedgeland mosaic in the valley floor of the Mangapepeke Valley. In addition, as defined in Section 2, the Project footprint encompasses the AWA and edge effects parcel, which together occupy approximately an additional 28.952ha. Of this, 18.845ha is indigenous dominant and 10.107ha is the mixed indigenous exotic rushland, sedgeland mosaic.

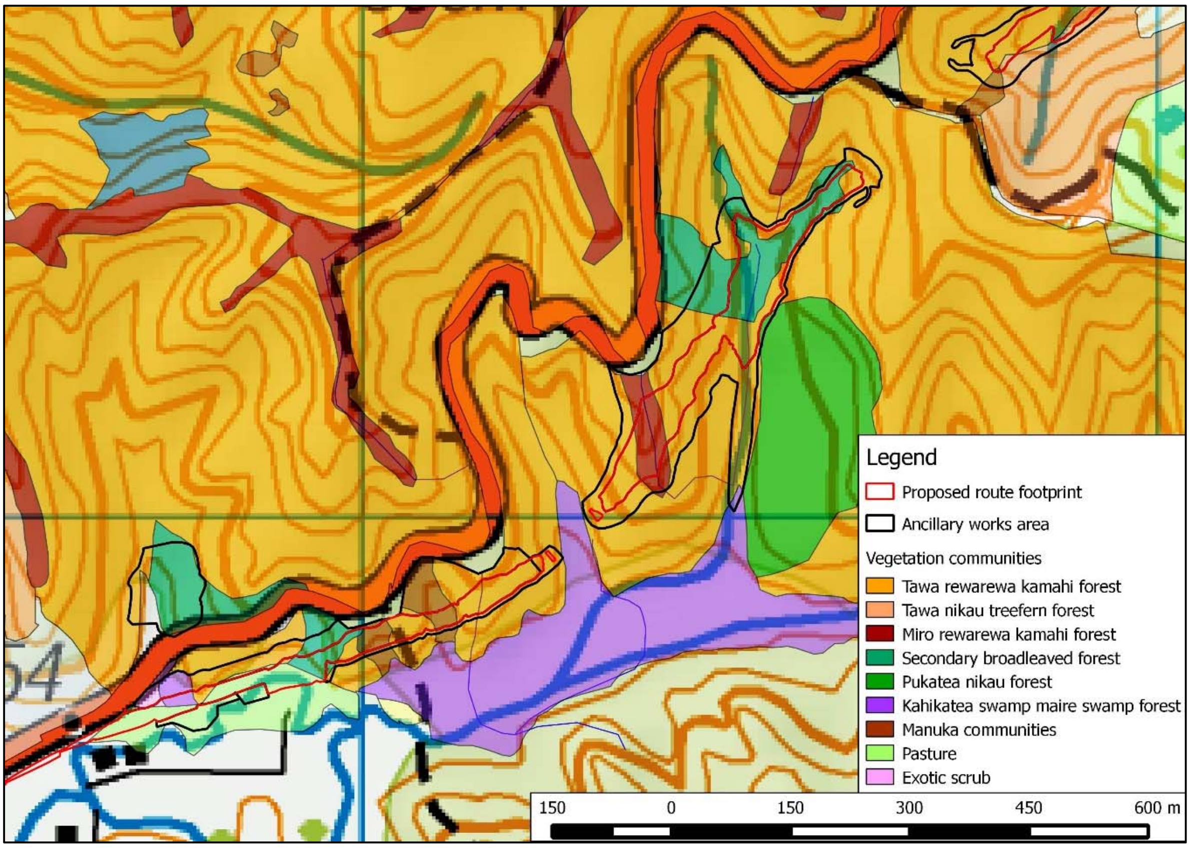

Figure 3.2 - Vegetation communities in the Mimi catchment within the Project footprint and the AWA.

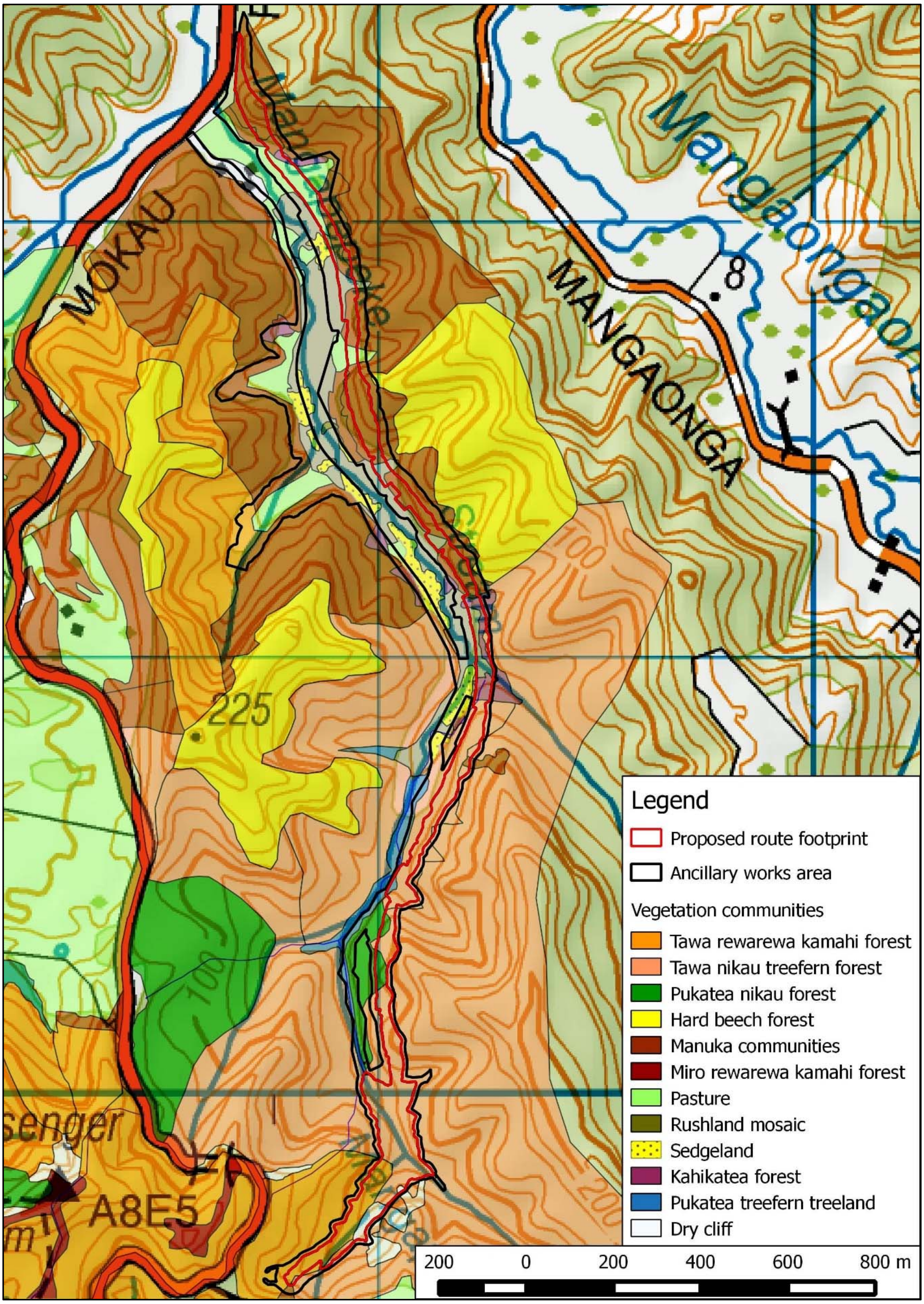

Figure 3.3 - Vegetation communities in the Mangapepeke catchment within the Project footprint and AWA.

Table 3.1 –Summary of values of indigenous dominant and mixed exotic — indigenous vegetation communities within the Project footprint (ha).

Potential Ecosystem Type	Vegetation community	Project footprint total	Ecological value (refer s4.2)
WF8: Kahikatea pukatea forest	Kahikatea swamp maire forest	0.186	High
	Kahikatea forest	1.045	High
	Pukatea treefern treeland	0.721	Moderate
	Manuka scrub	0.372	Low
	Rushland sedgeland mosaic*	11.117	Low — Moderate
WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest	Tawa rewarewa kamahi forest	6.509	High — Very High
	Tawa nikau treefern forest	8.731	Moderate
	Miro rewarewa kamahi forest	0.536	High — Very High
	Pukatea nikau forest	1.258	High
	Secondary mixed broadleaved forest	2.221	Moderate
	Manuka treefern scrub	0.146	Low
	Manuka succession	0.451	Moderate
WF14: Kamahi, tawa, podocarp, hard beech forest	Hard beech forest	0.081	Moderate
	Manuka treefern rewarewa forest	3.599	Low–Moderate
	Manuka treefern scrub	5.929	Low
	Manuka scrub	1.108	Low
CL6: *Hebe*, wharariki flaxland/ rockland	Dry cliff	0.399	Moderate
Total ha		44.409	High

*=Rushland sedgeland mosaic is a mixed indigenous and exotic vegetation community that includes approximately 1.37ha of *Carex virgata* sedgeland. In section 3 this is included with WL Swamp mosaic.

3.4 WF8 Kahikatea forest and wetland communities

3.4.1 Kahikatea swamp maire forest and Kahikatea forest

In the northern Mimi and Mangapepeke Valleys there are three valley floor forest types, dominated primarily by kahikatea and swamp maire occur (as shown in Figure 3.2 and Figure 3.3). All are young stands and possibly have developed following either logging and/or fire. They are dominated by closely stocked, small pole and ricker-sized trees with stems ranging in size from 15-60cm and a canopy height of 8-12m, potentially of 60-80 years age.

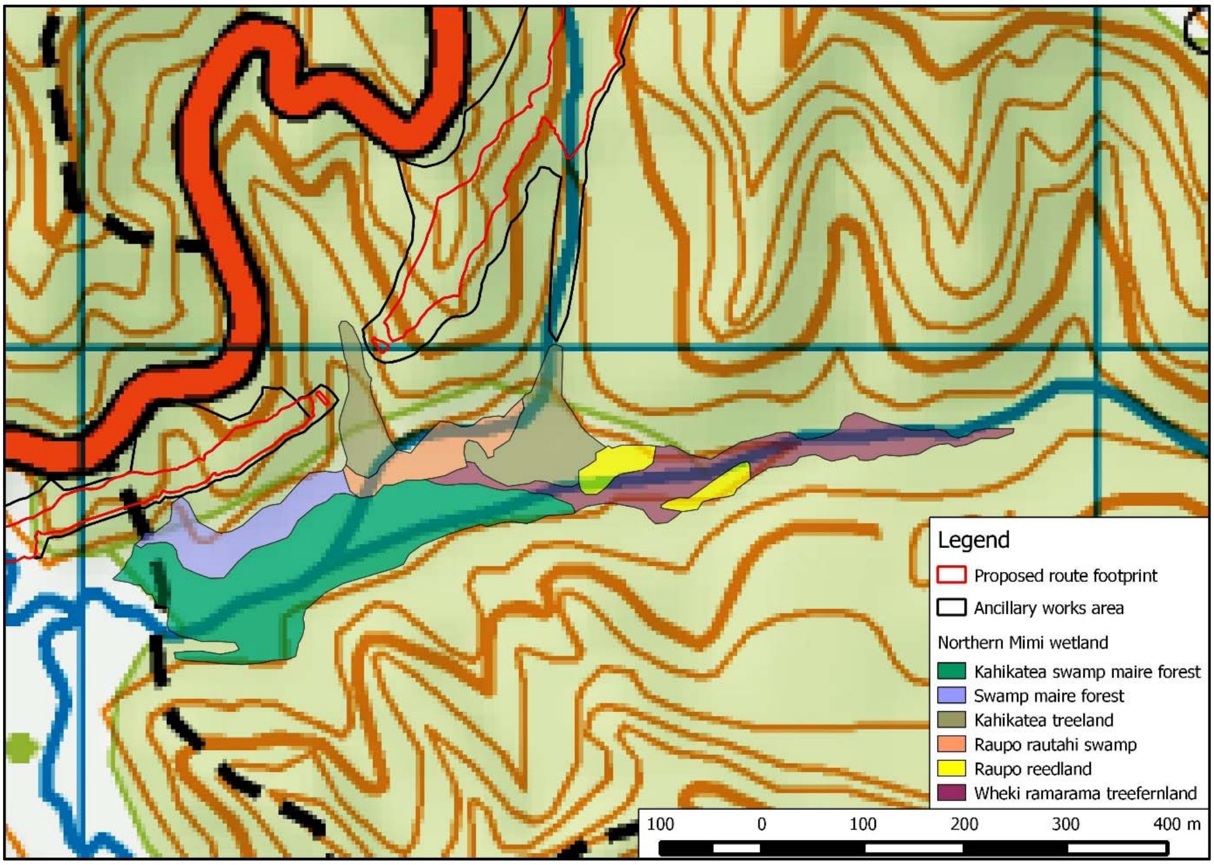

Figure 3.4 - Swamp forest and swamp wetland communities in the northern tributary of the Mimi Stream

The Project has been specifically designed to avoid the largest example of swamp forest and associated wetlands in the northern tributary of the Mimi Stream. These communities are ecologically diverse and important (Figure 3.4). While not in the Project footprint, wetland communities immediately downstream have been described (below) as there is a low risk of these being affected by sedimentation.

Two small areas are, however, affected: a small stand of kahikatea and swamp maire in the Mimi catchment and another area of pole kahikatea in the Mangapepeke Valley.

In the northern tributary of the Mimi Stream a small and young stand of 0.186ha of pole kahikatea and swamp maire, potentially 50-80 years old, is also affected (Figure 3.5). While the Project is expected to result in only limited clearance of this stand, post construction the stand will be situated in a depression between the current State Highway and the proposed new road. While culverts will be built to channel a small stream beneath the road, it is expected that this stand could be subjected to edge effects during construction of the road, culverts and possibly in-stream works. Post-construction, more frequent and prolonged flooding, increased sediment accumulation (than it currently experiences) is likely. This has the potential to cause tree death and or compositional change.

Figure 3.5 - Mimi catchment kahikatea (erect conifer shaped trees) and swamp maire (rounded) forest, taken from the edge of SH3 (NZTM 1737747; 5692806).

In the Mangapepeke Valley, several kahikatea pole stands of moderate to high ecological value occur. Scattered kahikatea treeland also occurs amongst rushes, sedges and pasture, primarily on imperfectly drained fluvial soils adjoining small streams (Figure 3.6). These stands are approximately 12-16m tall with most trees of less than 60cm (diameter at breast height), potentially of 50-80 years in age. Pukatea is present though uncommon. The regionally significant swamp maire is absent, though was highly likely to have occurred here prior to land development.

Figure 3.6 - Mangapepeke pole kahikatea forest situated on the Project footprint (NZTM 1739228; 5694961).

In the Mangapepeke Valley all areas are heavily grazed by cattle, horses, feral goats and pigs which have modified the understory vegetation, with very little vegetation within the sub-canopy. Additionally much of the forest floor is covered by the weed, African clubmoss. Approximately 1.045ha of this community has been mapped within the Project footprint.

3.4.2 Kahikatea/ *Carex* spp. treeland

In the northern catchment of the Mimi River Kahikatea/ *Carex* spp. treeland occurs within the two gullies downstream of the Project footprint (see Figure 3.4). This vegetation type covers approximately 1.2ha and has scattered emergent pole sized kahikatea, typically only 5-8m tall, over a dense canopy of sedges including *Carex geminata*, *C. secta*, *C. virgata* and locally raupo (*Typha orientalis*). Also present are occasional scattered wheki, hukihuki (*Coprosma tenuicaulis*) and manuka (Figure 3.7).

Figure 3.7 – Kahikatea treeland amongst raupo and carex species (NZTM 1738411; 5692874).

Figure 3.8 – A small area of raupo reedland in the northern tributary of the Mimi River (NZTM 1738485; 5692873).

While none of this vegetation type occurs in the Project footprint and so cannot be directly affected, it potentially could be affected by sedimentation. The greatest risk of this occurring is in the initial stages when sediment controls measures are being constructed and during vegetation clearance. The risk of this occurring is specified in the Construction Water Assessment Report (Technical Report 14, Volume 3 of the AEE).

3.4.3 Raupo reedland and Raupo rautahi swamp

In the northern catchment of the Mimi River raupo and raupo rautahi (*Carex geminata*) swamp occurs within the two gullies downstream of the Project footprint (Figure 3.4, Figure 3.8 & Figure 3.9). These two communities occupy approximately 0.9ha. Raupo and sedges are the dominant species and two communities are present, raupo reedland and raupo rautahi swamp.

Raupo reedland occurs in two area where raupo is abundant (>80% cover) while also present are *Carex secta* and on the margin *C. virgata* (Figure 3.7). Raupo typically grows in areas which are permanently saturated.

Figure 3.9 – Raupo rautahi swamp grading into kahikatea, Carex spp treeland (NZTM 1738354; 5692888). The Project footprint would be situated on the hillslope above this wetland in line with the large emergent rimu on the skyline. This community is not directly affected.

Raupo and rautahi sedgeland occurs as localised swards, though also present are *C. virgata* and several exotic wetland species including tall fescue (*Lolium arundinaceum* subsp. *arundinaceum*), Yorkshire fog grass (*Holcus lanatus*) and lotus (*Lotus peduculatus*) (Figure 3.9). While the soil was saturated when visited, the water table in this community is likely to be ephemeral falling below the surface at times, based on the presence of rautahi and tall fescue which typically occur on wetland edges. This also suggests that this community is possibly successional and may have been induced through historic sedimentation from a nearby stream. While not affected within the Project footprint, this community occurs on the lower fan downstream of the unnamed small stream which a fill area will cover, as the road ascends towards the southern tunnel portal. For this reason this community could be detrimentally affected by sedimentation as described in Section 3.4.1.

3.4.4 Wheki ramarama tree-fernland

In the upper northern Mimi Stream catchment dense wheki ramarama (*Lophomyrtus bullata*) tree-fernland (see Figure 3.4) occupies recent flood prone alluvial terraces on the margin of kahikatea forest and small wetlands (Figure 3.10). It also occurs along the two small tributaries south of the Mt Messenger summit within steep sided gullies, though these areas are too small to map.

While not located within the road itself, this community type potentially could be affected as it is present beneath the bridge and downstream of the Project. For this reason there is potential for it to be modified through construction or sedimentation.

Soil drainage within this community type is variable, ranging from imperfectly drained (adjoining the stream) to poor draining (adjoining wetland areas). Tree-ferns including wheki and Smith's tree-fern are locally common in association with a wide range of shrubs and small trees such as putaputaweta (*Carpodetus serratus*), ramarama, mahoe (*Melicytus ramiflorus*), kaikomako (*Pennantia corymbosa*) and bush lawyer (*Rubus cissoides*). Sapling and pole sized kahikatea are also present indicating that without major disturbance from flooding, succession to alluvial forest is likely. The canopy of this vegetation community is very dense and consequently limited ground tier vegetation is present due to shading. Recent silt deposition from flooding is common and is likely to also limit ground vegetation coverage.

In more free draining areas, bush rice grass (*Microlaena avenacea*), bush nettle (*Urtica sykesii*), hook grass species and occasional ground ferns occur, while in more poorly draining areas carex sedges are more common. Very small wetland areas occur throughout this community mostly dominated by *Carex virgata* and *C. secta*.

Figure 3.10 – Wheki ramarama tree-fernland. Note: the sapling, small tree sized pukatea and kahikatea (NZTM 1738484; 5692868).

3.4.5 Pukatea treefern treeland

Within the Project footprint, this community type only occurs in alluvial areas adjoining the upper Mangapepeke Stream (Figure 3.4). It is a novel community which has formed as a result of land development activities, potentially including logging and burning of the original kahikatea, pukatea forest and a long history of grazing by ungulates (Figure 3.11).

Approximately 0.72ha of this community have been mapped on the Project footprint.

Small pukatea (which are in poor health) in association with wheki are co-dominant, each occupying up to 5-10% cover. Wheki typically have epiphytes of which rata vines are most numerous. Occasional kahikatea and rimu are also present in the sparse canopy, though only below 5% cover. Beneath this is a heavily grazed rushland — sedgeland — pasture community within which *Juncus edgariae* and soft rush are abundant, *Carex virgata* is common, intersperse with grazed patches of lotus, creeping buttercup (*Ranunculus repens*) and floating sweet grass (*Glyceria* sp.). Numerous dead and dying pukatea and wheki are present suggesting this community is on a successional pathway towards kahikatea treeland and rushland, sedgeland mosaic (described below).

Figure 3.11 – Pukatea tree fernland in the Mangapepeke Valley (NZTM 1739049; 5694595).

3.4.6 Rushland sedgeland mosaic

This vegetation community occurs within the modified and grazed valley floor of the Mangapepeke Stream (Figure 3.3). Approximately 11.117ha of this community have been mapped on the Project footprint which encompasses the AWA. It is a novel community which prior to land development would have been a mosaic of alluvial and swamp kahikatea forest locally with pukatea and swamp maire, and potentially areas of hukihuki and *Carex* sedgeland in the wettest areas.

The community encompasses the valley floor area and occupies a variety of subtle landform changes, from imperfectly drained alluvial stream terraces to very poorly drained wetland depressions in former stream oxbows. Much of this valley floor is induced marsh and is dominated by a mosaic of exotic and indigenous wetland and grassland species. Most abundant are areas of rushland of which several species are present, especially the native *Juncus edgariae*, though occasional *J. effusus* and *J. procerus* also occur. Beneath this, the exotic willow weed (*Persicaria* sp.) is the most common species.

In ponded depressions sedgeland is present dominated by *Carex virgata*, in association with the exotic floating sweet grass (*Glyceria maxima*) and creeping bent (*Agrostis stolonifera*). From aerial imagery this community has been mapped as occupying 1.372ha.

Exotic pasture species dominate the small areas of imperfectly drained soils that occur close to the margin of the Mangapepeke Stream and include creeping bent, Yorkshire fog, creeping buttercup and lotus. Occasional scattered small manuka shrubs are also present within this area (Figure 3.12). The vegetation in much of the Project footprint within this property has been cleared and is degraded, and is heavily grazed.

This community was surveyed only from land owned by Ngāti Tama though appears to occur on private land beyond this boundary. It is assumed from this observation and assessment of high resolution aerial imagery that areas affected in the lower Mangapepeke Valley are similar to those described above.

Figure 3.12 – Rushland sedgeland mosaic on the valley floor in the Mangapepeke Valley Stream (NZTM 1739189; 5694960). The Project footprint is indicated approximately by the red line.

3.5 Hill-country WF13 and WF14 forest communities

3.5.1 Tawa rewarewa kamahi forest

This vegetation community historically would have been the most common forest type at Mt Messenger, occurring on predominantly steep hillslopes (37 – 45°+). Approximately 6.509ha of this community have been mapped in the Project footprint, most within the Mimi catchment.

The canopy is generally continuous with tawa the dominant canopy tree occupying between 20-50% cover within the canopy tier (12 – 25m). Rewarewa is the next most abundant tree typically between 6-25% cover. Pukatea is also present but generally restricted to dip-slopes and small gullies where moisture availability is higher. Emergent trees are infrequent though include rimu, miro and northern rata (Figure 3.13). Kamahi, mahoe and pigeonwood (*Hedycarya arborea*) are the most common sub-canopy trees, though this tier is dominated more by nikau and tree-ferns, including ponga and mamaku. On the forest floor kiekie and small nikau palms are locally abundant, occupying greater than 50% cover. The ground tier is heavily shaded and has a relatively sparse cover though includes a range of ferns and parataniwha where the soil is often saturated.

Occurring on steep hillslopes vulnerable to wind-throw and landslides, this forest type typically has a discontinuous canopy and a range of successional stages. Successional areas are most common in gullies and are occupied by nikau, tree-ferns and typical sub-canopy trees such as mahoe, pigeonwood, heketara and sapling canopy trees.

Figure 3.13 - Tawa, rewarewa, kamahi forest south of the Mt Messenger summit, looking towards NE towards the location of the southern tunnel portal, showing the typically discontinuous canopy with scattered emergent rimu and a canopy of tawa and rewarewa (NZTM 1738364; 5693358).

Pest animal modifications to this forest type have likely occurred, including a reduction in kohekohe and potentially northern rata and kamahi. In the understorey there has been a similar decline of large-leaf shrubs such as shrubby honeysuckle (*Alseuosmia macrophylla*) and palatable ferns such as pikiopikio (*Asplenium bulbiferum*). The reduction of kohekohe likely occurred at the peak in possum abundance, resulting in a major decline as only a few seedlings/ saplings of this species were seen during all field work on or near the Project footprint. Conversely, in 1948 kohekohe was recorded widely in plots within both Parininihi and Mt Messenger, including in one plot east of the Project footprint where it was the dominant tree (National Vegetation Survey plots).

The understorey has a variable condition which is largely due to the presence and abundance of feral goats and pigs. In the south, where the Kiwi Road (DOC) walking track enters the forest, goats are at a very low abundance due to control to protect Parininihi. Here there is a high abundance of palatable understorey shrubs and ferns such as hangehange, shrubby honeysuckle and hen and chicken fern. Further northwards, goat browsing pressure gradually increases and these species quickly reduce in abundance and are largely restricted to inaccessible locations.

3.5.2 Tawa, nikau, tree-fern forest

This community was likely once of identical composition to tawa, rewarewa, kamahi forest and is probably the result of severe forest collapse caused by a combination of possum and goat browse. Within the Project footprint it occurs only on hill slopes in the upper part of the Mangapepeke Valley. Approximately 8.731ha of this community have been mapped on the Project footprint.

Emergent trees are uncommon with rimu most numerous, while northern rata and matai (*Prumnopitys taxifolia*) are rare. The canopy is discontinuous with scattered, typically small stemmed tawa, rewarewa and locally pukatea (in gullies and on shallow slopes) usually of 12-18m metres in height occupying between 20-40% cover. Where canopy trees are absent, nikau and tree ferns (mostly wheki and ponga) are abundant forming most of the canopy. It is likely that palatable trees such as kamahi and kohekohe were once common in these areas. Pigeonwood and heketara (*Olearia rani*) are also common in this tier (Figure 3.14). Animal tracks are common and limited sub-canopy vegetation community occurs due to severe browse by feral goats and cattle. Locally present are nikau and tree fern saplings especially crown fern (which is more common on ridge-lines), kiekie, bush rice grass and hook grass. On the forest floor the weed African clubmoss (*Selaginella kraussiana*) is present throughout much of this community.

Figure 3.14 - Typically sparse and heavily browsed understorey vegetation within tawa, tree-fern, and nikau forest within the Mangapepeke Valley. Note the abundance of nikau and tree-ferns. NZTM 1739130; 5694658.

Of significance is that kamahi is extremely uncommon in this vegetation community while is abundant within adjoining areas where possums are managed.

3.5.3 Miro rewarewa kamahi forest

On well-defined narrow ridgelines tawa (see Section 3.4.2 above) is considerably less abundant within the canopy (typically less than 20% cover). Approximately 0.536ha of this community have been mapped on the Project footprint, most within the Mimi catchment.

Rewarewa, kamahi, miro and locally thin-barked totara are the canopy dominants. Locally present also are white maire (*Nestegis lanceolata*), hinau and northern rata, however both northern rata and thin-barked totara are sparse, though dead trunks of these species are often standing. Willow-leaved maire (*Mida salicifolia*) was also observed in this vegetation unit in the upper reaches of the Mangapepeke Stream. On the main ridge affected by the Project footprint, kamahi is the dominant canopy tree and only two emergent thin-barked totara trees are affected. Limited sub-canopy shrubs or small trees are present, though includes lancewood, tawheowheo, red mapou, heketara, and soft mingimingi (*Leucopogon fasciculatus*). These areas are focal points for browsing feral goats, and compared to similar sites in Parininihi, goat palatable sub-canopy shrubs such as shining karamu (*Coprosma lucida*) and kanono (*Coprosma grandifolia*) are uncommon. Crown fern (*Lomaria discolor*) is typically the most abundant ground cover plant, along with local patches of kiekie, rata vines, *Gahnia* spp., hook grass species, bush rice grass and locally *Astelia trinervia.* Several epiphytic orchids were noted in this community including *Drymonanthus adversus.*

3.5.4 Pukatea nikau forest

Pukatea, nikau forest occurs on landforms of shallow relief and is most abundant on dip-slopes and stream terraces where soil conditions are moist (Figure 3.15). Approximately 1.258ha of this community have been mapped in the Project footprint, most of which is on the access road in the upper Mangapepeke Valley.

Emergent trees are more common than in the dominant tawa, rewarewa, kamahi forest type described above. In the Mangapepeke Valley these include rimu and northern rata and matai. Pukatea (up to 50% cover) is marginally more abundant than tawa (up to 40% cover), with rewarewa and hinau also present. The sub-canopy tier is dominated by a dense cover of nikau (26 -75 % cover), with small trees and tree-ferns, including pigeonwood, ponga and wheki. The forest floor is heavily shaded and sparse, with a low cover of ground ferns. Browse by feral goats and pigs is common in this vegetation community and the sparse ground cover may be a result of regular pig rooting, which is typically more severe on shallow gradient slopes.

Figure 3.15 – Pukatea, nikau forest in the upper Mangapepeke Valley (NZTM 1738921; 5694299)

3.5.5 Hard beech forest

Within the Project footprint hard beech forest occurs only on ridgelines in the middle to lower reaches of the Mangapepeke Valley where a change in forest class, ecosystem type occurs — this vegetation community is encompassed within the broader forest ecosystem WF14. A small area of 0.081ha of this forest type is situated within the Project footprint on private land and was not assessed as access permission was not granted. Hard beech is easily discernible from aerial images and the delineation of this community is expected to be accurate.

3.6 Indigenous scrub and secondary forest

Indigenous scrub and secondary communities occur wherever forest clearance or modification (and subsequent) recovery has occurred. The variability of successional vegetation communities is largely a response of time and the age of vegetation recovery. Other ecological drivers such as whether ungulates are present also influence the composition of secondary successions.

3.6.1 Secondary mixed broadleaved forest

This vegetation community occurs in areas adjacent to the existing SH3 where land clearance activities such as fire, logging and degradation have modified the original forest composition and structure. It also occurs in steep gullies where natural erosion processes results in landslips and subsequent vegetation succession, such as downstream of the southern tunnel portal (Figure 3.16).

Figure 3.16 - Secondary broadleaved forest (foreground) on landslip debris within the gully floor of a small unnamed stream, south of the Mt Messenger tunnel portal (NZTM 1738510; 5693339 looking downstream towards the Mimi swamp forest).

Approximately 2.221ha of this community have been mapped on the Project footprint. These areas are now in an advanced stage of regeneration, and the canopy is a mosaic of mamaku (*Cyathea medullaris*), ponga and wheki tree ferns, small forest trees, occasional nikau palms and pole sized canopy trees. Common small trees in these areas include; mahoe, putaputaweta, pigeonwood, wineberry (*Aristotelia serrata*), pate (*Schefflera digitata*) and kanono.

3.6.2 Manuka succession, Manuka scrub, Manuka treefern scrub, and Manuka treefern rewarewa forest,

These vegetation associations are similar having developed from disturbance events. Manuka successions are natural and occur when land slips occur back to bed-rock and only occupy small areas. The other three communities are anthropogenic, caused by human land clearance fires and almost exclusively occur on private land in the Mangapepeke Valley. Manuka has a very wide ecological niche and manuka vegetation successions occur whether the potential vegetation was formerly WF8, WF13 or WF14 forest. In the Mangapepeke Valley these vegetation successions were not thoroughly assessed as access permission was not granted. Consequently ecological descriptions (below) are preliminary.

3.6.3 Manuka succession

Manuka succession was only mapped within mature forest — 0.451ha were mapped on the Project footprint and occurs primarily in the upper Mangapepeke Valley. While manuka is typically the dominant pioneer shrub species, the associated vegetation is highly variable and is dependent on the age since slipping (Figure 3.17). Patterns are apparent. On slopes which receive high levels of light, manuka scrub dominates with grasses such as *Poa anceps*, toitoi, crown fern and koromiko. With time tree ferns and seedlings of taller trees colonise, eventually replacing manuka as the canopy dominant. The presence of goats also influences successional processes, as they often target sunny examples of these communities.

Figure 3.17 – Manuka scrub over crown fern at the head of the Mangapepeke Valley

3.6.4 Manuka scrub

There is approximately 1.108ha of manuka scrub in the Project footprint. Manuka scrub occurs in the Project footprint in the lower Mangapepeke Valley. Manuka scrub communities are likely to be less than 30 years old and are relatively simple vegetation associations dominated by a near monoculture of closely stocked manuka. Wheki and ponga may also be present though typically in the understory. The ground cover is often dominated by pasture species and browse resistant ferns and small shrubs.

3.6.5 Manuka treefern scrub

There are approximately 6.075ha of manuka treefern scrub within the Project footprint, located in the lower Mangapepeke Valley. Manuka treefern scrub communities are likely to be between 25 and 50 years old and are relatively simple vegetation associations dominated by manuka, wheki and ponga tree-ferns. This vegetation community typically contains an understorey of browse resistant shrubs such as mingimingi (*Leucopogon fasciculatus*).

3.6.6 Manuka treefern rewarewa forest

There are approximately 3.599ha of manuka treefern rewarewa forest in the Project footprint. Manuka treefern rewarewa forest occurs in the lower Mangapepeke Valley. Manuka treefern rewarewa forest is an older succession and includes kanuka as well as occasional pole sized canopy trees including rewarewa, kahikatea and rimu. Growing on tree-ferns epiphytic trees and shrubs may be present above the browse tier, of which kamahi and Tawheowheo (*Quintinia serrata*) can be locally common.

3.7 Cliff vegetation

Cliffs and very steep high erodible slopes, which are unable to support forest vegetation, occur in two locations; below main ridge lines, where erosion and slumping has occurred and near permanent or semi-permanent streams. Cliff ecosystems are locally important for several rare and threatened plant species in North Taranaki Ecological District, and these were identified within the Project footprint. Broadly two types of cliff vegetation occur; colloquially described as dry cliffs and wet cliffs. On very steep hillslopes, non-forest successional vegetation also occurs in areas where land slips have recently occurred, often in small gullies.

3.7.1 Dry cliff vegetation

Dry cliff vegetation occurs on northerly facing steep to near vertical slopes in the upper tributary of the Mangapepeke Valley. Approximately 0.399ha of this community have been mapped within the Project footprint. The vegetation in these areas is dominated by manuka, koromiko, while *Dracophyllum strictum* and *Machaerina sinclarii* are locally common.

Similar habitat in Parininihi is considerably more diverse and includes native broom, wharariki, shining karamu, puka, kamahi, *Olearia townsonii*, *Gaultheria paniculata, G. oppositifolia*, *Pseudopanax laetus* and closer to the coast *Veronica townsonii* and *Veronica speciosa* (Clarkson pers.com). These species were not found in the Project footprint.

3.7.2 Wet cliff vegetation

Small areas of wet cliff vegetation adjoin streamside areas in the upper catchment areas within the Project footprint, and were too small to map and quantify loss (Figure 3.18). They typically occur as a narrow band of between 2-5m (above stream height) where trees and shrub vegetation is absent, and include the rheophytic zone affected by flooding.

Three species dominate — parataniwha (*Elatostema rugosum*), kiokio (*Blechnum novae-zelandiae*) and *Machaerina sinclarii*. Mosses and liverworts are also particularly abundant in this community. Other common species present include *Gunnera monoica*, *Anaphalioides trinervis*, *Nertera depressa*, *Blechnum colensoi* and a range of other ferns. Several species of spider orchids including *Corybas papa* were observed in this community. This community is often saturated by seeping ground water.

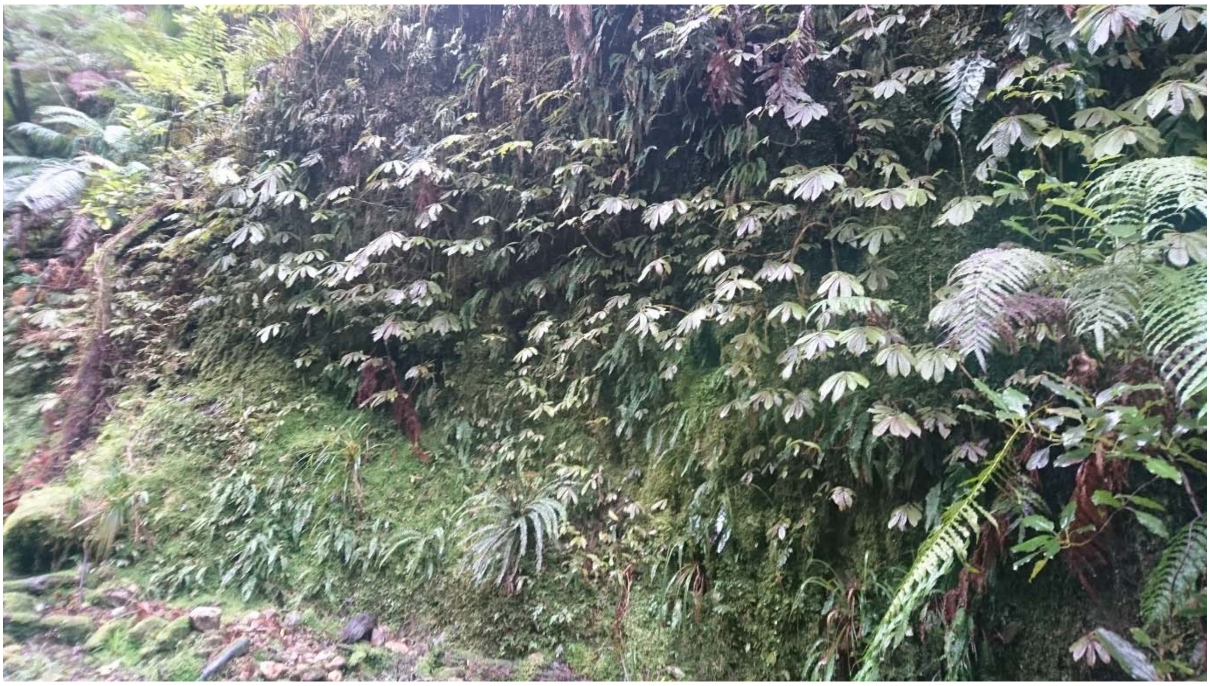

Figure 3.18 – Wet cliff vegetation of parataniwha and kiokio in the southern tributary of the Mangapepeke Stream

3.8 Significant trees

Most of the forest in the wider Project area is dominated by relatively small sized canopy trees of which tawa, rewarewa and locally kamahi are abundant. Significant podocarp and broadleaved trees occur at relatively low abundances (<5 per ha) within hill-country forests of the North Taranaki Ecological District. Higher abundances (6-12) do however occur in specific landforms such as on stream terraces, gullies, shallow sloping hillslopes and ridgelines. Conversely, significant tree abundance is very low on steep terrain, such as in both of the gullies leading to the tunnel where frequent landslips are evident.

The Project footprint is located in an area of comparatively lower significant tree abundance and during the design stage the road alignment has been shifted to reduce the loss of several significant trees. Significant trees occurring within the Project footprint include rimu, totara, matai and hinau (Table 3.2; Figure 3.18 & Figure 3.20). Rimu is the most common with 11 trees present on the road footprint. Most of these are mature and very tall likely to be greater than 500 years old.

Table 3.2 – The number of significant trees by species present on the road footprint and within the Project footprint.

Species	Number of significant trees	
	On road footprint	Project footprint
Rimu	10	11*

Species	Number of significant trees	
	On road footprint	Project footprint
Totara	2	2
Matai	0	1
Hinau	1	1
Total	13	15

*Note: One rimu may still be able to be avoided through modifications in design and construction as it occurs on the edge of a fill area approaching the southern tunnel portal.

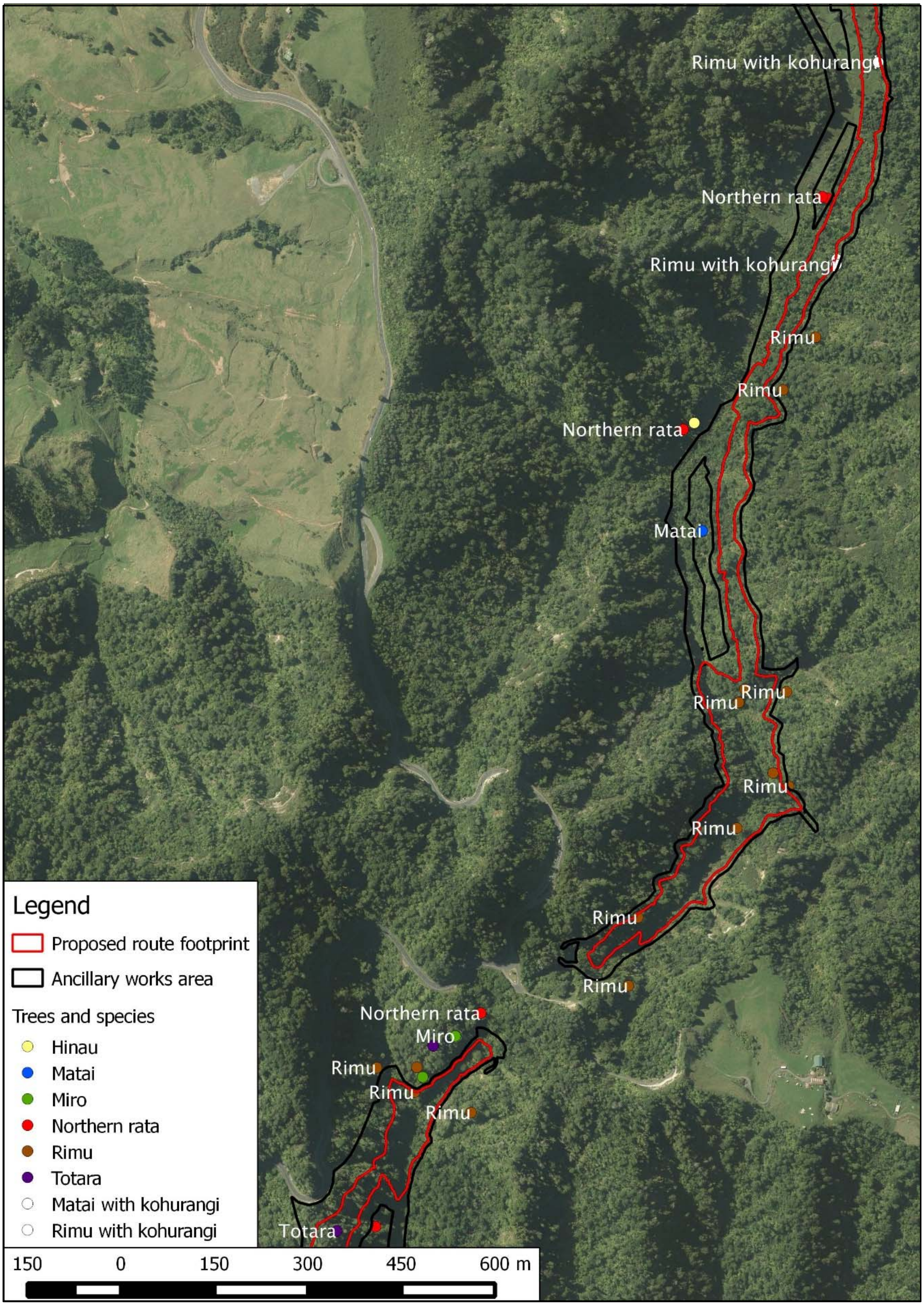

Figure 3.19 – Significant trees and rare plants in the Mangapepeke catchment within the Project footprint and the AWA

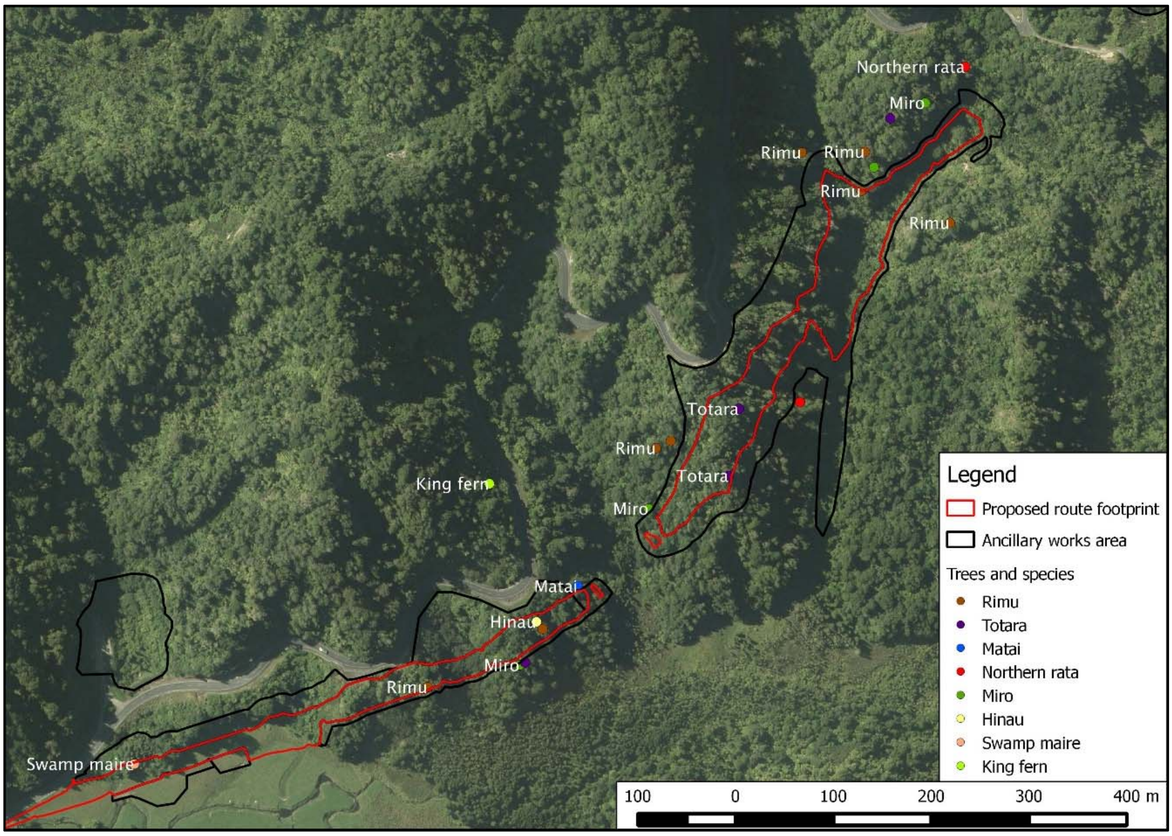

Figure 3.20 – Significant trees in the Mimi catchment within the Project footprint and the AWA

3.9 Rare and threatened plants

New Zealand's threatened species classification system (Townsend *et al.* 2008) separates species into two broad categories of risk of extinction; acutely threatened species and chronically threatened species. Acutely threatened species include species at greatest risk of extinction, while chronically threatened species are more common but are declining. Within the wider Project area no acutely threatened plant species were found while two chronically threatened plants classified as 'At risk – declining' were found — king fern and kohurangi (Figure 3.19 and Figure 3.20).

The Taranaki Regional Council has also produced a list of regionally distinctive species. These are not nationally threatened species, but are comparatively uncommon in the Taranaki Region and may be declining locally. Three regionally distinctive plants were found in the wider Project area — swamp maire, maire taike (*Mida salicifolia*) and *Pittosporum cornifolium*.

Of these rare and threatened plants only kohurangi and *P. cornifolium* were found in the Project footprint, growing epiphytically on two large rimu and one matai. It is expected that additional kohurangi and *P. cornifolium* will occur on other host trees within the Project footprint (<20 individuals), most likely on tall rimu which seem to be the most common host. These two shrubs likely occur at similar abundances in adjoining areas of native forest, such as in the Mt Messenger Conservation Area. Both species were also seen within Parininihi.

King fern (*Ptisana salicina*) is highly palatable to ungulates and because most of the forest on the Project footprint has a long history of feral goats and pigs, it is likely absent, or extremely uncommon. The largest sub-population seen during all field work consisted of nine plants at the start of the Mt Messenger track near SH3, outside of the Project footprint (see Figure 1.1 & Figure 3.20). Several other plants were also seen elsewhere in Parininihi. Forest of relatively low goat abundance occurs within 100m of this sub-population within the Project footprint, adjacent to the Kiwi Road track. While this area has been surveyed it is possible that undetected king fern could occur in this area.

The small stand of swamp maire is described above (Section 3.4.1).

In summary, the Project footprint appears to contain small numbers of kohurangi as well as similarly small numbers of two regionally distinctive plant species, *P. cornifolium* and swamp maire.

4 Assessment of unmitigated effects on vegetation and botanical values

4.1 Introduction

The vegetation communities across the Project footprint were assessed, with reference to the Davis *et al.* (2016), EcIA guidelines (Table 4.1) and Section 21.1 of the District Plan, with adaptions based on expert opinion to determine the overall unmitigated 'level of effect' of the Project on vegetation.

The District Plan significance criteria have also been assessed as follows when making evaluations of ecological value:

- Criterion 1: Threatened species includes any vascular plant listed as "acutely or chronically threatened' by de Lange et al. (2013) and 'regionally threatened or limited abundance' refers to plants listed within the Taranaki regionally distinctive list. The presence of non-vascular threatened plants, lichens and fungi were not evaluated.
- Criterion 3: Nationally rare ecosystems, habitat or sequences defined either by Williams *et al.* (2007) or occupying <20% of their original extent which conforms to Priorities 1 and 2 within Ministry for the Environment (2007). When assessing ecological value for this criterion higher importance has been given for ecosystems, habitats and sequences which trigger several of the four sub criteria.

All criteria from Section 21.1 of the District Plan were considered. Criteria 2, 4, and 6 were considered not to be relevant for this vegetation assessment. In addition, while the footprint has an impact on 'connectivity' (criteria 5), this is more relevant to fauna rather than flora.

4.2 Vegetation values assessment

This assessment of ecological values of vegetation within the Project footprint is broadly based on the EcIA guidelines and DOC Assessment Guidelines and adapted based on expert opinion, as set out in Section 2.1of this report. Using step 1 of the EcIA guidelines, the ecological value of different ecosystem units has been weighted in accordance with the five significance criteria within the DOC Assessment Guidelines and their presence within the Project footprint.

Table 4.1 – Ecological values of ecosystem units within Project footprint

Ecosystem unit	Value	Comments
WF8: Kahikatea pukatea forest	'High'	All vegetation communities of this ecosystem type have functional water regimes, a fundamental environmental characteristic. The main influence affecting ecological value is related to representativeness and naturalness. The small area in the Mimi Catchment is most representative, natural and includes swamp maire a regionally distinctive species. Areas in the

Ecosystem unit	Value	Comments
		Mangapepeke are less representative and natural largely due to having a simpler composition, potential due to modifications from herbivores. Further these communities are regionally and nationally rare ecosystems.
WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest	'Moderate-High'	The difference in ecological value is largely due to the gradient of animal pest impacts. In the south, composition and structure is highly representative where animal pest impacts are minimal and areas contain a high abundance and diversity of palatable species and several significant trees. This community diversity and complexity declines northwards with a dominance and relatively uniformity of unpalatable species especially in the sub-canopy. Further these communities are nationally uncommon ecosystems.
WF14: Kamahi, tawa, podocarp, hard beech forest	'Moderate'	Vegetation communities are secondary and have developed in the presence of farming practices. As such composition and structure is relatively simple and dominated by species tolerant of or unpalatable to herbivores. Both secondary and primary examples of this ecosystem type and the variety of vegetation communities are common within the ecological district.
CL6: *Hebe*, wharariki flaxland/ rockland	'Moderate'	While vegetation communities are naturally uncommon, areas present appear to be recent in origin and lack diversity compared to similar examples nearby. Areas include several invasive species.
WL19 & 20 'Swamp mosaic'	'Moderate'	Vegetation communities are modified being grazed and have lost considerable species diversity and community structure. Most examples however appear to have functional water regimes. Wetlands are regionally and nationally rare and threatened habitats.
Overall assessment	High	While the alignment includes ecosystems and vegetation communities which are modified, areas include ecosystems which are nationally rare and uncommon, some of which are highly representative, natural and regionally are some of the best remaining.

Further detail about the ecological value of vegetation within the Project footprint is set out in Sections 5.2.1-5.2.6 below.

4.2.1 Summary of vegetation values across Project footprint

The area of vegetation communities affected within the Project footprint is presented within Table 3.1(Section 2.1). The permanent area of vegetation loss of indigenous dominant vegetation in the Project footprint amounts to 15.457ha, of which 9.699ha are primary vegetation communities with a further loss of 4.751 and 1.011ha of secondary scrub/forest and rushland, sedgeland mosaic respectively. Total vegetation loss including within the AWA has been calculated as 19.466ha of primary vegetation communities with a further loss of 13.826 and 11.117ha of secondary scrub/forest and rushland, sedgeland mosaic respectively.

Three forest ecosystem units (WF8: Kahikatea pukatea forest, WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest & WF14: Kamahi, tawa, podocarp, hard beech forest) of Singers & Rogers (2014) encompass all of the forest vegetation variability within the affected area. Assessments for the small area of cliff and wetland vegetation communities could not be undertaken using the methodology in Section 2, because of incomplete data and a lack of equivalent units of classification between the two spatial layers used. While nationally rare ecosystems, indigenous cliff communities are common in the North Taranaki Ecological District.

Leathwick (2016 unpublished) calculated the remaining extent of potential ecosystems (Table 4.2) which remain within the Taranaki Region and the North Taranaki Ecological District (Table 4.3) by intersecting relevant types within two spatial layers: Potential Ecosystem Layer of the Taranaki Region (Singers unpublished 2016) and Landcover Database 4 (Landcare Research). This project undertaken for the Taranaki Regional Council also identified that the wider Project area includes forest habitat that is in the top 10-20% of ecosystem sites within the region (Leathwick, 2016 unpublished). These results strongly support the conclusion that both WF8 and WF13 primary and modified secondary vegetation units meet the District Plan significance criteria of 3, 4 and 5 (Appendix 21 of the District Plan).

Table 4.2 – Historic and current extents of WF8, WF13 and WF14 forest ecosystem units in the Taranaki Region present in the wider Project area

Ecosystem unit	Historic extent in Taranaki Region (Ha)	Current primary extent in Taranaki Region (Ha)	Current secondary extent in Taranaki Region	Percentage remaining in Taranaki Region (%)
WF8	37,432	917	2.4	2.45%
WF13	140,052	16,217	6,660	11.4%
WF14	12,297	9,790	1,447	91.4%

Table 4.3 – Historic and current extents of WF8, WF13 and WF14 forest ecosystem units in the North Taranaki Region. Note: Figures for WF14 in Tables 5.2 and 5.3 are identical as this type is exclusively found in North Taranaki Ecological District.

Ecosystem unit	Historic extent in North Taranaki Ecological District (Ha)	Current extent in North Taranaki Ecological District (Ha)	Percentage remaining in North Taranaki Ecological District (%)
WF8	5,212	397	7.6 %
WF13	49,633	18,350	37.0 %
WF14	12,297	11,237	91.4%

4.2.2 WF8: Kahikatea, pukatea forest

This ecosystem unit encompasses all of the alluvial and swamp forest vegetation communities present within the northern tributary of the Mimi River and the Mangapepeke Stream including kahikatea forest, kahikatea swamp maire forest, swamp maire forest, and kahikatea treeland. While this ecosystem type occurs throughout the North Island, it is greatly restricted in extent, primarily occurring as modified fragments on farmland with a few large and hydrologically intact examples remaining.

Within the Taranaki Region and the North Taranaki Ecological District 2.45% and 7.6% of this ecosystem unit remain, respectively (Table 4.2 and Table 4.3). Approximately 397ha of this ecosystem unit remains in North Taranaki Ecological District. The North Taranaki Ecological District proportionally contains approximately 47% of this ecosystem type in the Taranaki Region, much of it (46%) within one large site; Hutiwai River which is 189ha in extent, and is regarded as one of the best remaining areas in New Zealand. The remaining three largest remnants (Totara Stream, Lower Mangaawakino Stream, Mokau River) amount to an additional 81.3ha. These remnants are located outside the wider Project area and therefore are unaffected.

The majority of the remaining remnants are small fragments, most of which occur on farmland and are grazed and have been drained. In other regions of New Zealand typically greater loss has occurred and though a national assessment of remaining extent has not been assessed, it is regarded as being nationally rare and threatened ecosystem at region and national levels.

During the Project's design, effects on this ecosystem have been avoided as much as possible, though loss of forest and treeland/scrub communities amounts to 1.231 and 1.093ha respectively within the whole Project footprint. This amounts to approximately 0.59% of the area remaining in the North Taranaki Ecological District, based on the remaining area analysed in Leathwick (2016 unpublished). Most of the area impacted affected by this the Project development is protected under the Conservation Act 1986.

For these reasons an ecological value score of "High" using Davis *et al.* (2016) and the EcIA guidelines have been given (Table 2.1and Table 4.1).

4.2.3 WF13: Tawa, kohekohe, rewarewa, hinau, podocarp forest

This ecosystem unit encompasses most the forest community variability from south of the Ngāti Tama boundary in the Mangapepeke Valley southwards. It occurs on hillslopes dip-slopes and ridges including; tawa, rewarewa kamahi forest; miro, rewarewa, kamahi forest; pukatea, nikau forest; secondary mixed broadleaved forest and successional variants of these communities resulting from "normal" environmental events e.g. land slips and wind-throw from storms.

This forest type has been significantly reduced in extent with only 11.4% remaining in the Taranaki Region, though a higher proportion (37%) remains in the North Taranaki Ecological District (Table 4.2and Table 4.3). This amounts to approximately 18,350ha in the North Taranaki Ecological District. The Project footprint includes approximately 19.852ha of vegetation of the ecosystem unit WF13. This constitutes approximately 0.11% and 0.04% of the remaining vegetation of this unit in the North Taranaki Ecological District and the Taranaki Region, based on the remaining area analysed in Leathwick (2016 unpublished).

At the ecological district scale this does not trigger criterion 3 (Section 21.1) of the District Plan, but nationally would trigger this criterion because the national extent is likely similar to the regional extent (11.4% remaining). As a comparison in the neighbouring Waikato Region approximately 16.4%, of all warm climate forest ecosystems remain (Leathwick 2016b), so available evidence suggests it is nationally uncommon. Nationally this ecosystem is also ecologically threatened, especially by browsers which are capable of modifying forest composition and structure.

Some of the WF13 vegetation affected by the Project, particularly in the upper Mimi catchment, is highly representative and in a high ecological condition – considered by Leathwick (2016 unpublished) to be within the top 10% remaining in the North Taranaki Ecological District and Taranaki Region. Field assessment undertaken supports this opinion. Legal protection has also ensured that some modifying effects have not occurred such as harvesting of tall forest trees, while many private land examples have been modified by these factors. For these reasons, areas of WF13 vegetation, at least in the Mimi catchment, are some of the best remaining and consequently score a 'High – Very High' value as defined by the Davis *et al.* (2016) and EIANZ guidelines (Table 4.1). The presence of associated threatened species within this ecosystem only further supports this score.

In the Mangapepeke Valley, the vegetation community 'Tawa nikau treefern forest' is less representative and of a lower condition having been affected by neighbouring land development impacts including fire, grazing by stock and feral animal pests, and possibly logging. Locally, herbivory appears to have removed palatable canopy species such as kohekohe and kamahi. Within the browse tier herbivory is so extreme in some places that there is a near complete lack of forest tree regeneration. The weed, African club moss is the most abundant ground cover species and much of the area appears to be in a slow state of forest collapse. For these reasons this community scores a 'Moderate' ecological value score. Viewed holistically all primary areas however are of high value, especially considering their wider ecological context.

4.2.4 WF14: Tawa, kamahi, hard beech forest

In the Project footprint, this ecosystem unit occurs only in the Mangapepeke Valley from south of the Ngāti Tama boundary northwards. It occurs on hillslopes dip-slopes and ridges. A large area (11,237ha) of this vegetation type occurs in the North Taranaki Ecological District, much of which is protected under the Conservation Act 1986. Approximately 91.4% of the historic extent of this forest still exists in the North Taranaki Ecological District. While animal pests are having a modifying impact on this ecosystem it is not considered to be rare or threatened.

The Project footprint will encompass approximately 10.717ha of vegetation type WF14 almost all of which is secondary forest. This amounts to approximately 0.09% of the total area in existence across the North Taranaki Ecological District.

Areas affected by the Project are not identified as having values that constitute it as being significant within the District Plan (based on the criteria in Appendix 21 of the Plan). Of highest ecological value in these areas are the secondary pole sized podocarp trees including kahikatea — podocarp trees have declined throughout the ecological district due to logging and land clearance activities.

For these reasons the ecological values within these communities, are considered to be 'Moderate', as defined by the Davis *et al.* (2016) and EIANZ guidelines (Table 2.1), primarily for ecosystem services such as soil and water protection.

4.2.5 Wetland habitat

Wetland habitat has been greatly reduced in extent in New Zealand, with only 4.9% remaining in the North Island and 5.2% in the Taranaki Region (Ausseil et al. 2008). Wetlands are also a national priority for protection on private land (Ministry for the Environment 2007). Within the Project footprint small areas of induced and highly modified mixed exotic native wetland occurs within the rushland sedgeland mosaic vegetation unit in the upper Mangapepeke Valley, most of which was not surveyed due land access restrictions on private land. These wetlands conform to the definition of a marsh wetland type of Johnson & Gerbeaux (2004) despite much of this habitat being novel, induced by land clearance and grazing. The areas with the highest water tables may have been similar communities to the Mimi wetland (described above), including Kahikatea/ *Carex* spp. treeland and potentially raupo reedland and raupo rautahi swamp.

While 11.117ha of the rushland/sedgeland mosaic community will potentially be affected, this community contains areas of low producing pasture and rushland in the areas of imperfectly drained soils and intermittently wet ground. In the permanently wet areas *Carex virgata* is present and these areas retain some former ecosystem character. From aerial imagery sedgeland dominant areas have been mapped as occupying 1.372ha. *C. virgata* is a common component beneath swamp maire and *Coprosma tenuicaulis* in swamp forest and wetland scrub ecotones in the northern tributary of the Mimi River. While modified from grazing and exotic weed invasion, these sedgeland communities conform to the wetland definition in the Resource Management Act 1991. Further they likely qualify as rare and threatened habitat (criteria 3) in the District Plan, given that the Taranaki Region has been estimated as retaining only 5.2% of its original wetlands. For this reason and that most examples of this vegetation community likely have unmodified water regimes, these areas are likely to be of moderate ecological value. The mitigation package proposes that loss of these sedgeland areas will be mitigated through the creation or restoration of similar wetland habitat. This will include planting of suitable species such as *C. virgata* and hukihuki in order to restore examples to a similar composition to communities in the Mimi wetland (section 3.4.3).

High condition wetland habitat occurs in the northern tributary of the Mimi Stream downstream of the Project footprint. In a worst case scenario, this area could potentially be affected through sedimentation (discussed in 4.3.5). Sedimentation controls have specifically been developed to avoid this occurring and so loss of this wetland habitat has not been assessed.

4.2.6 Cliff habitat

Cliffs in North Taranaki are encompassed within 'Basic cliffs, scarps and tors' ecosystem (Williams *et al.* 2007) hence, for this reason cliff habitat within the project footprint triggers the rare and threatened habitat (criteria 3) in the District Plan.

Cliff habitat is characterised by slopes that are too steep and unstable to support forest vegetation. Though relatively spatially restricted, cliff habitat is widespread occupying potentially hundreds of hectares in the North Taranaki Ecological District, typically adjoining rivers, streams and steep escarpments that have formed by large landslides or gradual erosion processes. In North Taranaki cliff habitat provides habitat for a range of specialist cliff species, including the nationally endangered herb, *Brachyglottis turneri*, which was surveyed for but not found within the wider Project area.

Most of the loss of cliff habitat caused by the Project is situated in the upper section of a tributary of the Mangapepeke Stream north of the tunnel portal. These areas appear to be recent successions following slips and are dominated by young manuka and locally *Machaerina sinclarii*. Some potentially could, with the removal of goats and possums, potentially regenerate to low forest, including kamahi and other small trees. Compared to examples nearby these examples are relatively species poor and also have a higher abundance of weeds including pampas, Spanish heath and exotic grasses. It is anticipated that the loss of cliff habitat will be entirely mitigated for through the creation of and facilitated natural succession of the constructed roadside batters.

Approximately 0.399ha of cliff habitat occurs on the Project footprint. It is expected that the road side batters will create up to 2.49ha of constructed roadside batters suitable for cliff specialist species. Therefore the Project should have a positive effect on these communities long-term.

Figure 4.1 – A roadside batter which has developed since the late 1980's, now dominated by cliff specialists including Machaerina sinclarii (strap leaves), kiokio, koromiko and manuka. Locally older road side batters include a greater diversity of species includin

Roadside batters on the existing SH3 have developed into very similar cliff habitat (Figure 4.1) and locally even include uncommon species including; native broom, *Pseudopanax laetus* and *Olearia townsonii*. They are also notable for their local abundance and diversity of terrestrial orchids including being the place which *Corybas papa* was first discovered. As papa siltstone rapidly weathers in the warm and humid climate, natural succession of these areas is expected to occur rapidly. Within the landscape plan native vegetation regeneration will be assisted through preventing weed establishment, especially of pampas, gorse and Spanish heath. Localised planting of suitable cliff specialist species such as native broom (*Carmichaelia australis*) and potentially *Veronica townsonii* and *Olearia townsonii* at the top edge of road cuttings is also proposed which would also facilitate natural colonisation of uncommon species.

In summary, vegetation values within the Project footprint range from 'High' for Kahikatea, swamp maire forest to 'Low' for manuka scrub. In general primary vegetation communities range from moderate to high ecological value while secondary scrub/forest range from low to moderate ecological value.

Table 4.4 sets out a summary of the ecological values of vegetation communities in the Project footprint. Further detail about the types of vegetation, and how the values were determined, is set out in Sections 2.3 and 4.2.

Table 4.4 – Summary of indigenous dominant and mixed exotic — indigenous vegetation communities within the Project footprint and their ecological value.

Potential Ecosystem Type	Vegetation community	Ecological Value
WF8: Kahikatea pukatea forest	Kahikatea swamp maire forest	High
	Kahikatea forest	High
	Pukatea treefern treeland	Moderate
	Manuka scrub	Low
	Rushland sedgeland mosaic	Low — Moderate
WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest	Tawa rewarewa kamahi forest	High
	Tawa nikau treefern forest	Moderate
	Miro rewarewa kamahi forest	High – Very HIgh
	Pukatea nikau forest	High
	Secondary mixed broadleaved forest	Moderate
	Manuka treefern scrub	Low
	Manuka succession	Moderate
WF14: Kamahi, tawa, podocarp, hard beech forest	Hard beech forest	Moderate
	Manuka treefern rewarewa forest	Low–Moderate
	Manuka treefern scrub	Low
	Manuka scrub	Low
CL6: *Hebe*, wharariki flaxland/ rockland	Dry cliff	Moderate
WL: 'Swamp mosaic'	*Carex virgata sedgeland*	Moderate

4.3 Magnitude of unmitigated effects assessment

4.3.1 Summary of magnitude of effects

The magnitude of unmitigated effects of the Project on vegetation was determined using the methodology set out in Section 2. This involved applying step 2 of the EcIA guidelines, with the DOC Assessment Guidelines, and evaluating the magnitude of effects based on footprint size, intensity and duration within the Project footprint. A summary of the magnitude of effect of the Project on ecosystem units in the Project footprint is set out in Table 4.5.

Table 4.5 – Magnitude of unmitigated effects on vegetation types in the Project footprint

Name	Magnitude of effect	Notes
WF8: Kahikatea pukatea forest	'Very High'	Loss of approximately 1.231ha and 1.093ha of forest and treeland/ scrub, being in total 0.59% remaining in Taranaki Region of a nationally rare ecosystem type
WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest	'High'	Loss of approximately 19.852ha national uncommon ecosystem type
WF14: Kamahi, tawa, podocarp, hard beech forest	'Low'	Loss of 10.717ha of secondary and a common ecosystem type
CL6: *Hebe*, wharariki flaxland/ rockland	'Low'	Loss of 0.4ha of a national rare ecosystem type
WL: 'Swamp mosaic'	'Moderate'	Loss of potentially 1.37ha of a regionally and nationally rare ecosystem type

Following this methodology and applying professional judgement, the overall magnitude of unmitigated effects on vegetation from the Project is considered 'High' (refer Table 4.5). This is because the key effects on vegetation associated with the construction and operation of the Project include the loss of representative habitat some of which is nationally rare or uncommon, highly representative and natural, as well as many large emergent or notable trees, loss of small populations of kohurangi (a chronically threatened plant) and populations of two regionally distinctive species and ongoing edge effects (described below).

4.3.2 Loss of large emergent or notable trees

A recent paper by Lindenmayer & Laurance (2016) found that large old trees play an extraordinary range of critical ecological roles in a forest ecosystem. The authors developed a list of 25 specific ecological roles played in forest ecosystems by large old trees by reviewing a range of other scientific papers. These include providing habitat for other plants, fungi and animals, providing key sources of food for wildlife, providing key habitat for wildlife (e.g. roosting and nesting sites), and acting as a source of pollinators for the rest of the ecosystem (e.g. bats in particular may be more attracted to large trees which provide roosting sites).

The Project footprint includes a minimum of 15 large significant trees including potentially 11 rimu. These large trees are typically festooned with a diverse range of epiphytes, including kohurangi and potentially provide habitat, nesting and roosting sites for a range of birds, lizards and invertebrates. Podocarp trees especially rimu and totara provide seasonal fruit sources which can be functionally important for the breeding life cycles of birds such as tui, bellbird and kereru. While the proposed biodiversity offset package cannot replace the physical presence of large significant trees, multi-species pest management will mitigate some of the loss. Without pest control further dieback and death of possum palatable trees such as thin-barked totara and northern rata will likely occur which will be prevented with possum control. Pest control will also result in enhanced flowering and fruiting of trees such as of northern rata and hinau, thereby providing more resources for birds and other wildlife.

4.3.3 Edge effects

New road corridors constructed through areas of unmodified primary forest result in direct physical effects and long term environmental changes on forest edges. Trombulak & Frissell (2000) in a review of the ecological effects of roads on ecosystems found that roads of all kinds have seven key adverse effects. The vegetation related effects include alteration of the physical environment; alteration of the chemical environment; spread of exotics; and increased use of the area by humans.

Direct edge effects on vegetation occur during the construction phase, such as mechanical damage to root systems. These can result in immediate plant death or ill-thrift often caused by reduced ability to uptake water and infection from plant pathogens. Tree death from mechanical damage could occur many years after construction.

Loss of vegetation could potentially result in soil erosion especially of uphill of road cuttings or around already erosion prone areas such as within gullies. The scale of these effects is dependent on the size of the forest edge and its position relative to the forest.

Environmental changes result from opening up of the forest canopy and exposing the new edge. Forests within 50-100m of edges experience greater diurnal fluctuations in light, temperature and humidity, being typically drier and hotter than forest interiors, with elevated tree mortality (Laurance *et al.* 2009). Environmental effects are not uniform; rather they typically exacerbate micro sites that already experience environmental stress factors, such as windy or north facing and drought prone sites. Large roads can also alter wind patterns within a forest, and combined with a loss of vegetation shelter, branch damage and or wind-throw (especially of tall trees) adjoining the new road, adverse effects are likely to occur, potentially for several decades after construction. Predicting the scale of these effects is speculative because wind-throw could also have occurred even if the forest remained intact. It is reasonable however to expect that edge effects will occur from the road construction and will result in impacts to adjoining vegetation. Tall trees are likely to bear the greatest impact of this effect, especially those which suffer root damage during construction and/or exposure to increased windiness.

As noted in Section 2.3.2, the calculations of 'Project footprint' include an addition of 5m of edge effects where vegetation is present. This is provided for as a habitat loss equivalent that will be factored into the ecological mitigation and offset package (set out in the Assessment of Ecological Effects – Mitigation and Offset (Technical Report 7h, Volume 3 of the AEE). This is considered to be appropriate for addressing edge effects.

4.3.4 Loss of species which are at chronically threatened or regionally distinctive

King fern (*Ptisana salicina*) and kohurangi (*Brachyglottis kirkii* var. *kirkii*), both classified as at risk declining (de Lange *et al.* 2013) were found within the wider Project area. Kohurangi was however the only plant within the Project footprint observed on three host trees.

Determining the actual abundance of rare and threatened plants can be problematic principally because of their rarity. As such estimates of abundance are approximate only. Incidental and targeted surveying for both king fern and kohurangi suggested that king fern is extremely uncommon, with only a single plant found east of SH3 and nine plants west of SH3 at the start of the Mt Messenger track (both within the wider Project area, but not within the Project footprint). Whilst all suitable habitat within the Project footprint was not surveyed and some was too inaccessible, it is my expectation that there are very few (<10), if any king fern plants within the Project footprint due to browsing by introduced mammals. It is possible however that a small population of king fern could be present undiscovered, such as near the Kiwi Road track where goats are at a very low abundance, given the proximity to the nine king fern plants surveyed across SH3 in Parininihi, 100m away.

Kohurangi principally grows as an epiphyte in association with trees containing large epiphytes such as *Astelia* sp., though it can also grow as a sub-canopy shrub on fallen wood in browser-free habitat. The Project footprint, especially north of the tunnel, has been subject to widespread browsing, ranging from domestic stock, and wild goats to pest mammals such as possums. Kohurangi was found growing only on podocarp trees including; rimu and matai. Despite other large trees such as northern rata, tawa, thin-barked totara, hinau and miro supporting these same epiphytes, it was not found in any of these species — all coincidentally common dietary components of possums. At least nine plants were found on three trees within the wider Project area. This would suggest that kohurangi is still widely scattered over the general area. If present on 30-50% of large rimu and matai hosts, the number of affected plants is likely to be fewer than 30 plants on the Project footprint.

Pittosporum cornifolium grows in similar locations to kohurangi and was found in a much wider range of host trees in the wider Project area. Whilst not nationally threatened, *Pittosporum cornifolium* is regarded as being regionally distinctive.

The most abundant regionally distinctive plant found was swamp maire and approximately 40 pole sized trees occur within the small remnant in the northern tributary of the Mimi River. While the construction footprint does not directly affect most of these trees, it is expected that changes in stream alignment will be required, such as straightening and ongoing post-construction management of the unnamed stream within this stand. Post-construction this is likely to result in changes in hydrology, sedimentation and edge effects which could result in this stand dying following construction. Wetland plants can be particularly sensitive to changes in hydrology and sedimentation.

Astelia trinervia is palatable to goats and consequently, while abundant in Parininihi, was only seen east of SH3 in two locations, though not within the actual road alignment. Suitable habitat should be thoroughly searched and salvaged plants cultivated in a nursery and replanted following the establishment of pest control within the off-set site. *Astelia trinervia* is a plant which would be expected to increase in abundance in the off-set site with goat control as it is abundant on ridgelines in Parininihi.

4.3.5 Sedimentation and effects on wetland vegetation and hydrology

The Project footprint is located on steep hill slopes above the wetland and alluvial flood plain of the northern tributary of the Mimi River. The Project design team has shifted the Project footprint away from the wetland, including constructing a bridge over one tributary. However there remains the potential for road construction to cause adverse sedimentation affecting downstream vegetation, prior to the construction of sediment control measures or if control measures are overwhelmed during significant storm events. Sedimentation could affect vegetation by smothering and killing low growing vegetation, changing water flow and hydrology leading to vegetation change.

A wide range of sediment control measures over and above best practice measures will be put in place to prevent erosion and contain sediment in these areas, as these areas are regarded as being high risk. Sediment retention ponds will be designed to receive the flows from the upstream catchment during up to a 100-year ARI rain event (Ridley Dunphy Environmental, Tonkin & Taylor Ltd 2017). However in higher rainfall events sediment control measures and structures will be less efficient and will result in release of sediment downstream, potentially over and above naturally expected levels

Areas of greatest risk from sedimentation occur downstream of the two gullies which the road traverses over. These areas are dominated by early successional vegetation including tree-ferns and then further downstream on the fans, sedges, raupo and occasional young pukatea and kahikatea. Periodic sedimentation events here may actually be frequent and why raupo and sedges occur in the Mimi wetland at these locations, when most of the wetland is forest or shrubland. Personal observation of similar wetland vegetation at Matata on private land (post the extreme 2005 flood) highlighted the resilience of sedges and raupo to sedimentation, and these species are likely quite effective at capturing and well adapted to grow through it. At the Matata wetland, affected sedge and raupo wetland vegetation recovered within 3 years after being mostly smothered during this event. As such it is my expectation that raupo and sedgeland vegetation in these areas would assist to capture sediment if control measures were compromised during a heavy rain event and would be unlikely to be affected by it. Compositional change could occur however if sedimentation, over and above natural levels, resulted in permanent changes in hydrology.

In a worst case scenario, such as in a 1:100 year flood event and control measures failed, sedimentation would likely affect the habitat quality of the northern tributary of the Mimi Stream well before it detrimentally affected wetland vegetation. If this situation eventuated, further stream habitat protection works would likely be warranted, such as retirement of areas currently being grazed elsewhere in the Mimi catchment. Excluding stock from two gully areas currently being grazed within the Mt Messenger Conservation Area would be appropriate options for this.

4.4 Overall level of unmitigated effects assessment

The assessment of the level of potential effects of the Project on vegetation, in the absence of mitigation, is set out in Table 4.5. This was assessed by applying 'Step 3' of the EcIA guidelines (described in Section 2.3.3) and applying professional judgement.

In summary, based on the overall 'High' ecological value and a 'High' predicted unmitigated magnitude of effects on vegetation, the overall level of effects in the absence of any efforts to avoid, remedy or mitigate for potential effects is considered 'High' (Table 4.6).

The level of effect varies by ecosystem, as per the EcIA framework. The level of effect on the five ecosystem types has been as assessed as 'Very high' to 'Low'.

Table 4.6 – Overall level of potential unmitigated effect of the Project on vegetation

Name	Level of effect	Notes
WF8: Kahikatea pukatea forest	'Very High'	Effect due to rare habitat lost and area lost relative to the limited area remaining regionally.
WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest	'Very High'	Effect due to the large area lost and representativeness of the best areas present
WF14: Kamahi, tawa, podocarp, hard beech forest	'Low'	Effect due to modified condition of vegetation communities present and that the ecosystem and communities are regionally common
CL6: *Hebe*, wharariki flaxland/ rockland	'Low'	Effect due to modified condition and small area lost
WL 'Swamp mosaic'	'Low'	Effect due to modified condition and small area lost
Overall magnitude of unmitigated effect	'High'	Effect due to large area of vegetation lost including rare, uncommon habitat some of which is highly representative

In summary, based on the overall ‘High’ ecological value and a ‘High’ predicted unmitigated magnitude of effects on vegetation, the overall level of effects in the absence of any efforts to avoid, remedy or mitigate for potential effects is considered ‘High’ (Table 4.6).

The level of effect varies by ecosystem, as per the EcIA framework. The level of effect on the five ecosystem types has been as assessed as ‘Very high’ to ‘Low’.

5 Proposed measures for addressing potential adverse effects

5.1 Avoiding or minimising potential adverse effects

Extensive and ongoing effort has been made to avoid, remedy, mitigate or offset potential ecological effects of the Project on vegetation. Several route designs have been proposed and by the inclusion of structures (a tunnel and bridge), and design and construction methods for the Mt Messenger Bypass, ecological effects on vegetation have been either avoided or reduced in magnitude.

Through the process of selecting the alignment, the inclusion of structures (a tunnel and bridge), and design and construction methods for the Mt Messenger Bypass, ecological effects on vegetation have been either avoided or reduced in magnitude.

While it may be difficult to avoid effects on vegetation through further design optimisation, some design improvements could be made, for example, reducing the loss of secondary pole kahikatea forest on private land within the Mangapepeke Valley. Until physically surveyed these cannot be made. Further design improvements should continue to be investigated, including identifying whether any loss of significant trees can be prevented on the Project margins. These improvements have been discussed with the design team and are likely to be able to be implemented.

To mitigate for residual significant effects that cannot be avoided or mitigated, the Project mitigation package will include restoration planting and habitat enhancement, and most importantly, a large scale pest control programme. This programme will be designed to improve similar habitat to off-set the loss on the Project footprint. While long term benefits of this management would occur following 20-30 years of management, such as the regeneration of ungulate palatable trees, most gains would quickly be lost within 10-20 years if management stopped and pressures returned. As an example, loss of most highly palatable understorey vegetation would likely occur within 5-10 years if goats increased back to their current density. For this reason it is recommended that pest densities be suppressed to target levels until necessary to maintain the benefits accrued. Through these efforts, there is expected to be positive biodiversity outcomes from this project in the medium term.

Measures that will avoid, remedy or mitigate potential adverse effects on vegetation are set out below. These measures will be detailed and actioned through the development and implementation of an Ecology and Landscape Management Plan (ELMP) that includes a section that sets out vegetation management and monitoring requirements and provides further detail on all measures discussed below.

5.2 Project measures to avoid or minimise effects

A number of adverse ecological effects on vegetation (and other ecological values) have been avoided through the selection of the proposed Project alignment, which (unlike many other options) completely avoids the considerably higher ecological value land to the west of the existing SH3.

5.2.1 Avoidance through the options assessment process

The options assessment process was carried out in two stages. Initially, 24 options were considered in 12 alignment corridors during the first multi-criteria analysis workshop (MCA1 reference). Following this, five options were shortlisted and considered in a second MCA process.

The options considered included alignments to the west of SH3 which traversed areas with significant biodiversity values, including the Waipingao catchment and adjacent Parininihi land. Potential adverse effects identified for options to west of SH3 are described in the options assessment reports (Volume 4 of the AEE). These effects include loss of significant habitats, severance of a nationally important vegetation sequence and effects on associated regionally and nationally significant flora. Moreover, half of these options excluded the use of structures (bridges and tunnels) and had large cuts and fills, which would have resulted in much more significant ecological effects through both habitat loss and potential effects on fauna.

5.2.2 Avoidance of effects through optimisation of the Project footprint

The Project footprint traverses areas of significant vegetation types to the east of Mt Messenger. All vegetation types and significant trees have been mapped and delineated to identify the most ecologically significant areas in the wider Project area. Project ecologists have worked closely with design and construction engineers to avoid ecological effects on these significant habitat types. Such efforts include:

- Inclusion of a 235m long tunnel through the ridge dividing the Mangapepeke and Mimi catchments. This has greatly reduced the size of the 'cut and fill area' that would otherwise have been required reducing loss of vegetation and significant trees.
- Incorporation of a 120m bridge across a tributary valley to the Mimi River on the south side of the route. This bridge sits very close to the ecologically significant wetland area and has substantially reduced the effect that a cut and fill approach would have had on the wetland and will preserve east-west ecological connectivity
- Introduction of construction techniques to reduce ecological impact. The bridge mentioned above has been designed in a way that will allow it to be constructed from each side rather than the valley bottom. This will reduce the amount of ground and vegetation disturbance compared to a more conventional approach of building the bridge from the valley bottom and it will also reduce the risk of sediment erosion down into the wetland.

- Minor adjustments to the route to avoid and reduced overall loss of significant trees. The number of trees potentially needing to be felled has been reduced from 22 to 15 by this means.
- Avoidance or minimisation of effects on significant ecological values (i.e. significant vegetation/habitat types and trees through):
    - Realignment of the corridor, including shifting part of the corridor further from the ecologically significant wetland area.
    - Location of construction yards, laydown areas, construction access tracks and haul roads away from ecologically sensitive/significant areas to minimise the extent of disturbance and vegetation clearance.
    - Use of retaining walls to avoid loss of significant trees where possible.
    - Undertaking vegetation/habitat clearance in accordance with the Construction Environmental Management Plan (CEMP) and the ELMP to further reduce effects on significant habitat, such areas adjoining the ecologically significant Mimi wetland and where high densities of significant trees occur. The CEMP is supported by a suite of sub-plans, which outline the management of specific construction effects such as construction-related ecological effects in more detail.
    - Physical delineation (such as fencing or flagging tape) will be used to clearly mark the extent of vegetation clearance to be undertaken, along with vegetation to be protected.
    - Vegetation will be cleared only prior to construction works beginning in the Project footprint in order to reduce habitat effects and reduce the potential for erosion and sediment generation.
    - Use of forest material including duff, soil, wood and vegetation such as tree ferns and nikau for rehabilitation of the AWA.
    - Collecting of locally sourced plants for rehabilitation purposes to ensure the integrity of local genetics and that vegetation communities restored are appropriate, in terms of species composition for the variety of habitats.
    - Relocation or cultivation (from seeds or cuttings) of threatened plants found, such as collecting cuttings of kohurangi and *Pittosporum cornifolium* when significant trees are felled or transplanting king fern found within the Project footprint. Kohurangi and *Pittosporum cornifolium* (being epiphytes) could potentially be cultivated on cut wheki tree-ferns and then be returned on site to suitable locations.
    - Installing an effective waste management system to minimise the chances of attracting pest mammals; and
    - Having an ecologist on site to advise the construction teams when vegetation is being cleared near wetlands.
    - Management of light spill associated with construction lighting through careful consideration of the layout and arrangement of temporary lighting (including

shrouding and spectrum limits to minimise impacts on adjacent ecological habitats).

5.2.3 Monitoring actual vegetation loss and impacts

This report provides an assessment of expected vegetation and botanical values loss. It is anticipated that in some areas a lesser actual loss of vegetation will occur – for example access corridors of 8m width are required though up to 20m has been allowed for. Greater vegetation loss could occur, such as if landslips result from earthworks, which are greater than the expected 5m edge effect loss. Upon completion of the construction the actual vegetation loss should be quantified.

Sedimentation resulting from construction and earthwork areas during a significant storm on wetland vegetation within the northern tributary of the Mimi Stream is another area of risk. As this area is ecologically valuable monitoring of both wetland vegetation composition and structure as well as sedimentation should be undertaken downstream of construction areas, prior to and during the construction period, targeting areas of highest risk.

5.3 Mitigation of residual adverse effects

While the measures proposed above will go some way to avoiding and minimising the adverse effects of the Project on vegetation, there will still be residual adverse effects. Residual effects will predominately occur through the loss or degradation of approximately 33.292ha native scrub and forest vegetation communities. A further 1.372ha of sedgeland wetland occur within the 11.117ha of rushland/ sedgeland mosaic.

Details of the Transport Agency's measures to mitigate for residual effects on ecological values are set out in detail in the Assessment of Ecological Effects – Mitigation and Offset (Technical Report 7h, Volume 3 of the AEE) (Mitigation and Offset Report). The amount/ area of restoration planting and pest management to be undertaken has been determined through utilisation of the Biodiversity Offset Calculation Report (attached as Appendix A to the Mitigation and Offset Report) ensuring offsetting measures are 'like for like' in order to the balance loss of vegetation communities directly affected by the Project. Measures undertaken have been designed to achieve positive biodiversity benefit in the medium term and are highly conservative, including management and vegetation restoration over a greater area than proposed in the Biodiversity Offset Calculation Report. The extent of stream and riparian restoration to be undertaken has been determined by using the Stream Ecological Valuation method and the details about how this method was used for this Project are set out in the Assessment of Ecological Effects – Freshwater (Technical Report 7b, Volume 3 of the AEE).

The key measures that are expected to contribute to mitigating/ offsetting potential adverse effects on vegetation are summarised below. The measures include a comprehensive pest management programme to control introduced animals as the major focus of mitigation, coupled with restoration planting and habitat enhancement. This mitigation package will ensure that excluding some components of the habitat value of the loss of potentially 15 large significant trees, significant residual effects on vegetation are adequately addressed.

5.4 Pest Management

A key threat to indigenous biodiversity in New Zealand is the adverse impact of introduced mammals (Clout 2006). Most unmanaged, or minimally managed, natural forested sites exhibit reduced and altered plant and animal diversity, elevated indigenous plant and animal mortality and decreased plant and animal recruitment as a result of the impact of pest animals (Byrom *et al.* 2016; Leathwick *et al.* 1983; O'Donnell 1996; Timmins 2002; Wilson *et al.* 2003; *Gillies et al.* 2010). The initiation of effective, targeted and enduring animal pest control has repeatedly shown improvements to forest health and condition including reduced mortality, increased seedling regeneration and increased foliage growth in forest vegetation (Meads 1976; Timmins 2002; Gillies et al 2003; Wilson et al 2003). These same actions should be highly beneficial for assisting the recovery of kohurangi, the only at-risk plant species found within the area affected. These conservation outcomes are readily apparent in the Parininihi Project.

The proposed long-term pest management programme will include a ground-based poison and trapping regime over a minimum area of 560ha, with a core of 222ha where animal pest numbers will be sustained at permanently low levels.

Weeds are comparatively uncommon in the wider Project area however a small amount of weed control will be required focusing on a small selection of highly invasive species which have the potential to affect ecological values. Species requiring control include wild ginger, Chinese privet, cotoneaster and pampas.

5.5 Restoration Planting

In time, restoration planting and habitat enhancement can create habitat, improve ecological connectivity and reduce edge effects on existing vegetation. The following mitigation measures will be implemented as part of the Project (as set out in the Assessment of Ecological Effects - Mitigation and Offset (Technical Report 7h, Volume 3 of the AEE)):

- Planted riparian margins of 10m each side of the channel will be created;
- Restoration planting of all secondary scrub areas along the footprint plus temporary access tracks and storage areas that retain soil, hydrology and growing conditions suitable for reinstatement (up to 9ha); and
- Deployment of felled logs within mitigation sites to improve biodiversity values for a number of plants and animals (including forest and wetland birds, such as tomtit, fantail, whiteheads and spotless crake).

The Project will also provide for offsets to address significant residual effects, including:

- Restoration planting of up to 8ha of swamp forest and wetland;
- Planting of 200 seedlings of the same species for every significant tree that has to be felled;
- Protection (fencing) and riparian planting of approximately 8.9km of existing stream.
- Swamp forest habitat restoration will be undertaken using eco-sourced plants and preferably will occur in the upper Mimi and Mangapepeke catchments so that existing

remnants here increase in size and overall condition. These areas largely have natural flooding regimes which is a fundamental requirement for the long term integrity of this ecosystem. Restoration should ensure that the appropriate vegetation communities are restored for the site over the hydrological gradient, including kahikatea forest on imperfectly drained soils and swamp maire forest on poor draining soils. Further at least 20% of the tall forest trees planted will be locally eco-sourced swamp maire, to offset the loss of this regionally distinctive species.

5.6 Monitoring and reporting requirements

The amount/ area of restoration planting and pest management to be undertaken to address residual adverse effects will be refined through further field work undertaken between October 2017 and March 2018 within the mitigation site. The purpose of this pre-construction vegetation monitoring is to provide more detailed baseline information on forest condition including the composition and abundance of palatable vegetation.

6 Conclusion

Vegetation loss associated with the Project footprint may result in the loss of 44.4ha, which includes indigenous dominant or mixed exotic/ indigenous dominant vegetation. Within this area 19.466ha of primary vegetation communities are present, and 13.826 and 11.117ha of secondary scrub/forest and rushland, sedgeland mosaic respectively. The Project will also result in the loss of up to 15 significant trees, including potentially 11 large rimu. A small number of the chronically threatened epiphytic shrub, kohurangi (*Brachyglottis kirkii* var. *kirkii*) and two regionally distinctive plants, swamp maire (*Syzygium maire*) and *Pittosporum cornifolium* are present.

The Project footprint includes vegetation of high ecological value and regarded as being significant under the District Plan. The areas of highest ecological value are 1.231ha of valley floor forest dominated by kahikatea and the area of hill-country forest dominated by tawa, rewarewa, kamahi forest south of the tunnel in the Mimi catchment.

A range of measures have been implemented or proposed to avoid, remedy or mitigate effects. This includes 'like for like' biodiversity off-set programmes including habitat preservation using integrated long-term pest management and habitat creation using restoration planting.

7 References

Allen, R.B. (1992). RECCE: an inventory method for describing New Zealand vegetation (No. 181). Forest Research Institute, New Zealand.

Ausseil, A. G., Gerbeaux, P., Chadderton, W. L., Stephens, T., Brown, D., & Leathwick, J. (2008). Wetland ecosystems of national importance for biodiversity: Criteria, methods and candidate list of nationally important inland wetlands. *Landcare Research Contract Report LC0708/158*.

Awakino Gorge to Mount Messenger Programme: Community consultation on options summary booklet, November 2016.

Bayfield, M.A.; Courtney, S.P.; Wiessing, M.I. (1991). North Taranaki District: Survey report for the Protected Natural Areas Programme. Protected Natural Areas Programme Survey Report No.16. Department of Conservation, Wanganui, New Zealand.

Burns, B.R., & Leathwick, J.R. (1996). Vegetation-environment relationships at Waipoua Forest, Northland, New Zealand. *New Zealand Journal of Botany*, *34*(1), 79-92.

Clarkson, B.R., & Boase, M.R. (1982). Scenic reserves of west Taranaki. *Biological survey of reserves*, *10*, 254.

Clout, M.N. (2006). Keystone aliens? The multiple impacts of brushtail possums. In: *Biological Invasions in New Zealand.* Allen, R.B & Lee, W.G. (eds). Ecological Studies Series Vol. 186. Springer Berlin Heidelberg.

Davies-Colley, R.J., Payne, G.W and van Elswijk, M. 2000. Microclimate gradients across a forest edge. New Zealand Journal of Ecology 24(2): 111-121.

Davis, M., Head, N. J., Myers, S. C., & Moore, S. H. (2016). Department of Conservation guidelines for assessing significant ecological *of* values. *Science for Conservation 327. Department Conservation, 71p*.

EIANZ, 2015. Ecological Impact Assessment (EcIA): EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems.

Hurst, J.M., & Allen, R.B. (2007). A permanent plot method for monitoring indigenous forests: field protocols. Landcare Research, New Zealand.

Jane, G. and Donaghy, G. (2005). Mount Messenger - Kiwi Road Track Start. NZPCN.

Johnson, P., & Gerbeaux, P. (2004). *Wetland types in New Zealand*. Department of Conservation.Lahti D (2009) Why we have been unable to generalize about bird nest predation. Animal Conservation 12: 279-281.

de Lange, P.J.; Rolfe, J.R.; Champion, P.D.; Courtney, S.P.; Heenan, P.B.; Barkla, J.W.; Cameron, E.K.; Norton, D.A.; Hitchmough, R.A. (2013). Conservation status of New Zealand indigenous vascular plants, 2012. *New Zealand Threat Classification Series 3*. Department of Conservation, Wellington.

Laurance, W.F.; Goosem, M.; Laurance, S.G.W. (2009). Impacts of roads and linear clearings on tropical forests. *Trends in Ecology & Evolution, Vol. 24*(12): 659-669.

Leathwick, J.R. (2016 unpublished). Biodiversity rankings for the Taranaki Region. Taranaki Regional Council Document Number FRODO#1709206.

Leathwick, J.R. (2016b) Integrated biodiversity ranking and prioritisation for the Waikato region. Waikato Regional Council Technical Report 2016/12.

Lindenmayer, D.B. and Laurance, W.F. (2016). The ecology, distribution, conservation and management of large old trees. *Biological Reviews*, doi:10.1111/brv.12290.

Maseyk, F.; Maron, M.; Seaton, R.; Dutson, G. (2014). A Biodiversity Offsets Accounting Model for New Zealand. Department of Conservation, Hamilton.

Murcia C (1995) Edge effects in fragmented forests: implications for conservation. Trends in Ecology & Evolution 10: 58-62.

McNutt, K. (2012). Vegetation: RECCE plots v1.0. Science and Technical Publication DOCDM-359575. Department of Conservation, New Zealand.

Ministry for the Environment. (2007). Protecting our Places Information about the Statement of National Priorities for Protecting Rare and Threatened Biodiversity on Private Land. http://www.mfe.govt.nz/sites/default/files/protecting-our-places-detail.pdf

Newell, C.L., & Leathwick, J.R. (2005). Mapping Hurunui forest community distribution, using computer models. Department of Conservation.

Ngāti Tama Claims Settlement Act (2003).

Nicholls, J.L. (1976). A revised classification of the North Island indigenous forests. *New Zealand Journal of Forestry 28*: 105–132.

O'Connor, K.F., Overmars, F.B., Ralston, M.M. (1990). Land evaluation fore Nature Conservation. A scientific review compiled for application in New Zealand. Conservation Sciences Publication Number 3, Department of Conservation Wellington.

Ogle, C.C. and Druce, A.P. (1998). Pukearuhe, Whitecliffs. Wanganui Conservancy Plant List Number 110.

Ridley Dunphy Environmental Ltd, Tonkin & Taylor Ltd. Mt Messenger Bypass Construction Water Assessment Report. September 2017.

Ruffell, J., & Didham, R. K. (2017). Conserving biodiversity in New Zealand's lowland landscapes: does forest cover or pest control have a greater effect on native birds?. *New Zealand Journal of Ecology*, *41*(1), 23.

Ruffell, J., and Didham, R.K. 2016. Towards a better mechanistic understanding of edge effects. Landscape Ecology 31(1): 2205-2213.

Ruffell J, Didham RK, Barrett P, Gorman N, Pike R, Hickey-Elliott A, et al. (2014) Discriminating the Drivers of Edge Effects on Nest Predation: Forest Edges Reduce Capture

Rates of Ship Rats (*Rattus rattus*), a Globally Invasive Nest Predator, by Altering Vegetation Structure. PLoS ONE 9(11): e113098. https://doi.org/10.1371/journal.pone.0113098

Singers, N. J. D. unpublished. Potential Vegetation of the Taranaki Region (2015) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.

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

Singers, N and Bayler, C. (2017). Mt Messenger Bypass Investigation. Botanical Investigation and Assessment of Effects. Unpublished Contract report for Opus International Consultants Ltd by Nicholas Singers Environmental Solutions.The Road Ahead: Economic development study on State Highway 3 north. Venture Taranaki Trust. September 2012.

Townsend, A. J., De Lange, P. J., Duffy, C. A. J., Miskelly, C. M., Molloy, J., & Norton, D. A. (2008). New Zealand threat classification system manual. *Wellington, Department of Conservation*, *30*.

Trombulak, S.C. and Frissell, C.A. (2000). Review of ecological effects of roads on terrestrial and aquatic ecosystems. *Conservation Biology, Vol. 14*(1): 18-30.

Williams, P.A.; Wiser, S.; Clarkson, B.; Stanley, M. (2007). New Zealand's historical rare terrestrial ecosystems set in a physical and physiognomic framework. *New Zealand Journal of Ecology 31 (2)* : 119–128.

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

Appendices

Appendix A: Maps and Figures

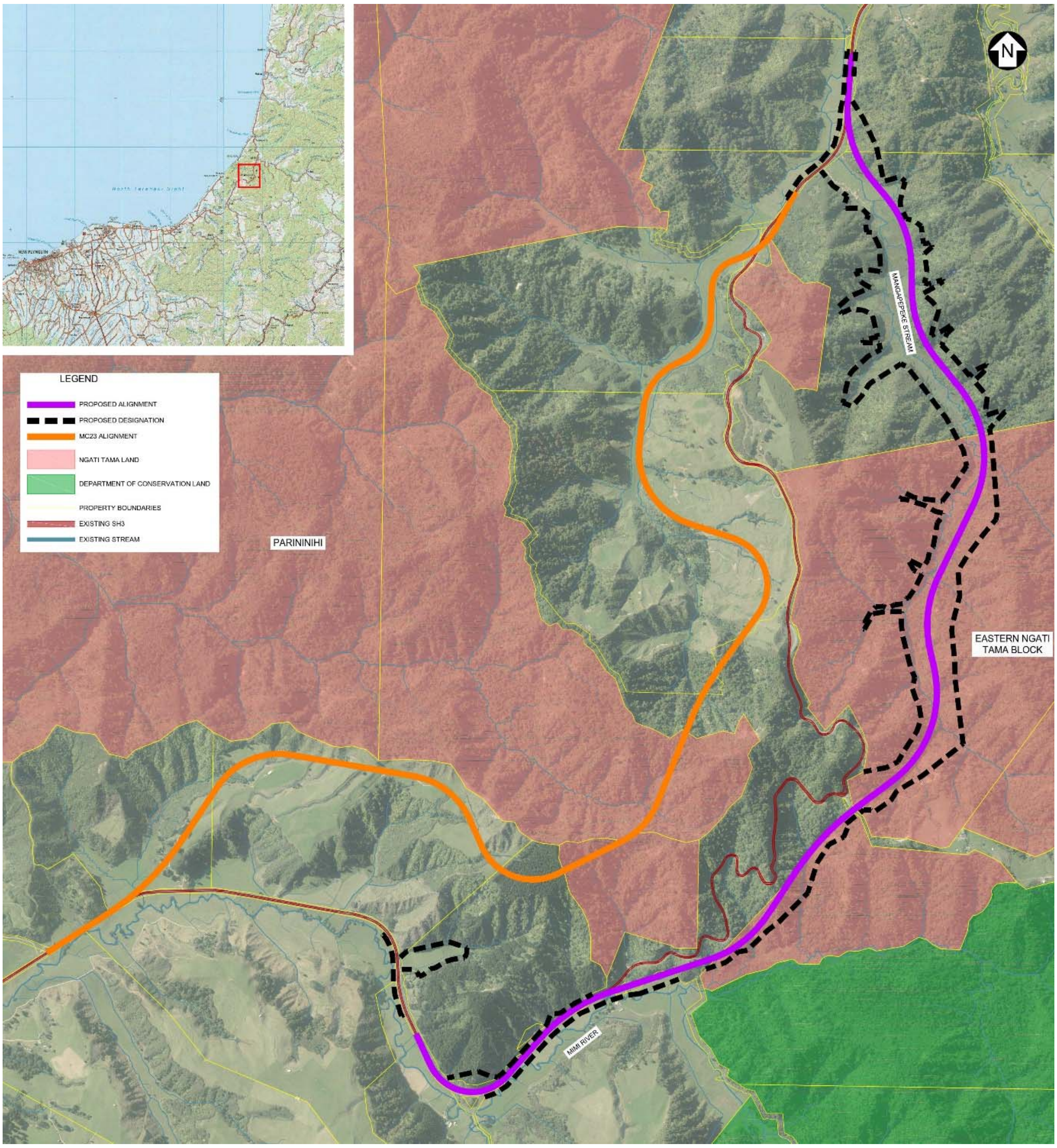

Figure A 1 - Wider project area, including the Project footprint, designation, MC23 alignment and property and land tenure boundaries in relation to the existing SH3. Parininihi refers to land to the west of existing SH3 owned by Ngāti Tama and which has been subject to sustained pest management

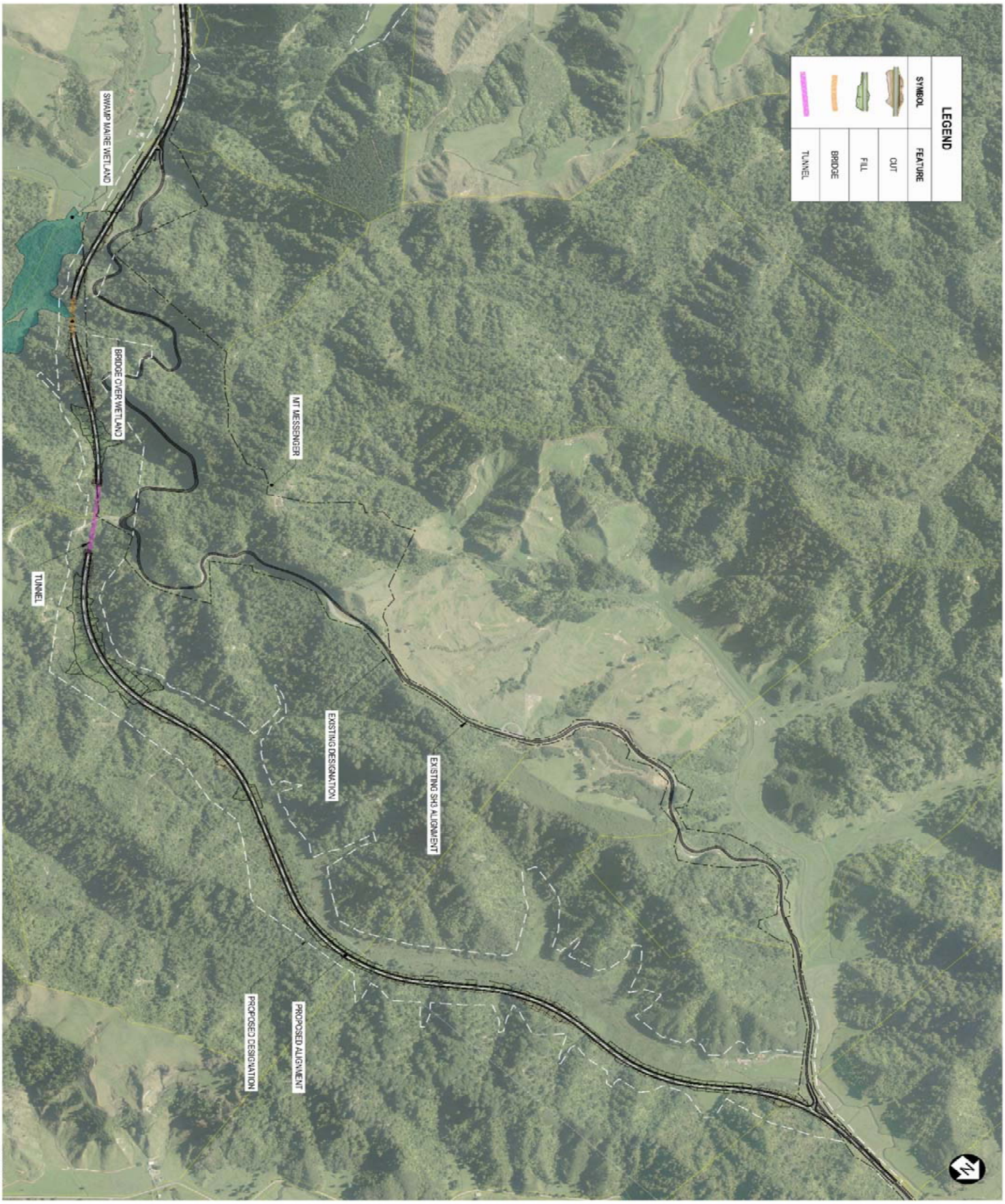

Figure A 2 – Proposed route alignment

Table A 1 – Location of variable area Recce Plots in wider Project area

Recce Plot number	Vegetation community	NZTM Easting	NZTM Northing
MC23 # 1 (Parininihi)	Tawa rewarewa kamahi forest	1737664	5693319
MC23 # 2 (Parininihi)	Miro rewarewa kamahi forest	1737799	5693409
MC23# 3 (Parininihi)	Pukatea nikau forest	1737975	5693795
MC23# 4 (Parininihi)	Tawa rewarewa kamahi forest	1737932	5693741
MC23# 5 (NZTA land west side of SH3)	Tawa rewarewa kamahi forest (logged)	1738188	5694108
MC23# 6 (Parininihi)	Secondary mixed broadleaved forest	1738070	5693967
MC71# 1 (Mimi Catchment)	Kahikatea, pukatea swamp forest	1738113	5692764
MC71# 2 (Mimi Catchment)	Kahikatea alluvial forest	1738234	5692772
MC71# 3 (Mimi Catchment)	Kahikatea, raupo, sedgeland treeland	1738413	5692871
MC71# 7 (Mimi Catchment)	Wheki, ramarama tree-fernland	1738775	5692910
MC71# 8 (Mimi Catchment)	Pukatea nikau forest	1738910	5692897
MC71# 9 (Upper Mangapepeke)	Tawa rewarewa kamahi forest (logged)	1739144	5693141
MC71# 10 (Upper Mangapepeke)	Pukatea, nikau forest	1738930	5694230
MC71# 12 (Upper Mangapepeke)	Pukatea, treefern treeland	1739060	5694599
MC71# 13 (Upper Mangapepeke)	Rushland, sedgeland mosaic	1739198	5694924

Recce Plot number	Vegetation community	NZTM Easting	NZTM Northing
MCA2-E #1 (Upper Mangapepeke)	Kahikatea forest	1739259	5694926
MCA2-E #2 (Upper Mangapepeke)	Tawa, nikau, treefern forest	1739210	5694814
MCA2-E #3 (Upper Mangapepeke)	Tawa, nikau, treefern forest	1739018	5694725
MCA2-E #4 (Upper Mangapepeke)	Tawa, nikau, treefern forest	1739026	5694253
MCA2-E #5 (Upper Mangapepeke)	Miro rewarewa kamahi forest (Canopy collapsed forest)	1739084	5694977
MCA2-E #6 (Mimi South of Bridge)	Tawa, nikau, treefern forest	1738166	5692913
MCA2-F #3 (Mimi catchment, Parininihi)	Miro rewarewa kamahi forest	1737533	5693113