Ecology supplementary report - Vegetation

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NZ TRANSPORT AGENCY WAKA KOTAHI
Mt Messenger Bypass
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Glossary

Term	Meaning
AEE	Assessment of Effects on the Environment Report
AWA	Additional works area
District Council	New Plymouth District Council
DOC	Department of Conservation
DOC Assessment Guidelines	DOC's *Guidelines for Assessing Ecological Values*, developed by Davis *et al.* in 2016
EcIA guidelines	Ecological Impact Assessment guidelines
EIANZ	Environment Institute of Australia and New Zealand
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
SH3	State Highway 3
Transport Agency	New Zealand Transport Agency
Vegetation Assessment	AEE Volume 3 Technical Report 7a: Assessment of Ecological Effects - Vegetation

1 Introduction

The NZ Transport Agency (Transport Agency) is proposing to construct and operate a new section of State Highway 3 (SH3), generally between Uruti and Ahititi to the north of New Plymouth. The Transport Agency lodged applications for resource consents and a Notice of Requirement on 15 December 2017 to alter the existing SH3 designation, to enable the Mt Messenger Bypass project (the Project) to proceed.

This application included assessments of ecological effects attached as Technical Reports 7a – 7h, in Volume 3 of the Assessment of Effects on the Environment (AEE) report. The Assessment of Ecological Effects – Vegetation (Vegetation Assessment), dated December 2017, was completed as part of this package. The purpose of the Vegetation Assessment was to assess potential adverse effects of the Project on vegetation, and to inform the assessment of effects in the AEE and the proposed mitigation and offset package for the Project.

The Vegetation Assessment noted the conservative and precautionary approach taken in assessing potential adverse ecological effects from the Project, and that more information would be available following summer field investigations.

These field investigations, which have now concluded, have informed this supplementary report. The purpose of this report is to describe those investigations and corresponding results, and to update our original Vegetation Assessment as appropriate.

2 Further ecological investigations

2.1 Introduction

The Vegetation Assessment dated December 2017 included assessments of ecological values and potential adverse effects based on the information available at the time the assessment was completed. As noted in that report and in Section 1 above, a conservative approach was taken when assessing potential adverse effects, noting that future investigations would produce information to support and strengthen these ecological effects assessments.

The major focus of this supplementary report was to assess vegetation on private property within the northern Mangapepeke Valley. This area had not previously been investigated 'on the ground', though vegetation mapping and descriptions were developed from aerial images and surveying from adjoining properties.

In combination with high drone imagery, the information gathered from this field survey was used to update the vegetation map and calculate vegetation loss for different vegetation communities identified in the original Vegetation Assessment[1] (NSES 2017). Drone imagery from the Mangapepeke Valley was also used to check and verify the number and location of significant trees present.

2.2 Methodology

2.2.1 Field assessment methods

A site visit was undertaken on 31st October 2017. Field work involved undertaking a walk-through survey along the main proposed access track up the valley and throughout the Project footprint, mapping vegetation communities on aerial images. Specific attention was given to surveying and assessing the composition of valley floor vegetation communities, documenting species presence within the Project footprint and more specifically, in association with cover and condition within unbounded Recce plots (Hurst, & Allen 2007). An unbounded Recce plot was assessed within the 'Manuka, treefern, rewarewa forest community', and Manuka scrub and treefern scrub communities described. Utilising high resolution drone images flown in December 2017, the vegetation map was updated for private land and Ngāti Tama land in the Mangapepeke Valley. This enabled vegetation loss calculations to be adjusted using the intersect of the Project footprint and vegetation map layers in ArcGIS.

2.2.2 Assessment of effects methodology

As in the December 2017 report, the assessment of effects based on the summer investigations broadly follows the EcIA Guidelines (EIANZ, 2015), with some adaptation, including to allow for expert opinion to be applied within the context of the EIANZ framework. Section 2.3 of the December 2017 report sets out the methodology in full

[1] Refer figure 3.3 and table 3.1 of Technical Report 7a: Assessment of Ecological Effects – Vegetation

including the three-step assessment of ecological values, magnitude of unmitigated effects, and the level of unmitigated effects. Where appropriate, findings from this supplementary investigation update that original assessment.

2.3 Results from further investigations

Three key factors have resulted in changes to the area of vegetation loss:

a Improvements in Project design, especially reducing the extent of the ancillary works area for access tracks and soil deposition areas;

b December 2018 drone imagery enabled more accurate vegetation community boundaries to be defined, especially areas shaded in the 2011 Taranaki Regional Council aerial imagery; and

c Field work on private land in the lower Mangapepeke Valley assessed the composition, structure and condition of native dominant communities and the valley floor 'exotic rushland'.

This has resulted in two additional vegetation communities being classified and described: 'Kahikatea treeland' and 'Treefern scrub', and the reclassification of the 'Rushland sedgeland mosaic community' as 'Exotic rushland'.

The revised assessment of vegetation loss within the amended Project footprint is presented in Table 2.1and Figure 2.1.

The Project will result in the combined loss of 31.277ha of indigenous dominant forest and secondary scrub vegetation, compared to the original report which measured a loss of 33.292ha.

The total loss includes 2.048ha of WF8: Kahikatea pukatea forest or treeland communities, 16.851ha of WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest communities and 0.813ha of WF14: Kamahi, tawa, podocarp, hard beech forest communities. The remaining 11.166ha is made up of several secondary scrub and regenerating forest communities. Approximately 0.399ha of cliff communities are additionally impacted.

Table 2.1 – Summary of indigenous dominant and mixed exotic — indigenous vegetation communities within the Project footprint

Potential Ecosystem Type	Vegetation community	Project footprint total (revised)	Original Assessment Project footprint total
WF8: Kahikatea pukatea forest	Kahikatea swamp maire forest	0.159	0.186
	Kahikatea forest	0.525	1.045
	Kahikatea treeland (*New vegetation community*)	0.641	NA

Potential Ecosystem Type	Vegetation community	Project footprint total (revised)	Original Assessment Project footprint total
	Pukatea treefern treeland	0.722	0.721
	Manuka scrub	0.582	0.372
	Exotic rushland	5.826	11.117 *
	Total	**8.455**	**13.441**
WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest	Tawa rewarewa kamahi forest	6.457	6.509
	Tawa nikau treefern forest	8.507	8.731
	Miro rewarewa kamahi forest	0.536	0.536
	Pukatea nikau forest	1.347	1.258
	Secondary mixed broadleaved forest	2.231	2.221
	Manuka treefern scrub	0.146	0.146
	Manuka succession	0.514	0.451
	Total	**19.738**	**19.852**
WF14: Kamahi, tawa, podocarp, hard beech forest	Hard beech forest	0.288	0.081
	Tawa rewarewa kamahi forest	0.526	0
	Manuka treefern rewarewa forest	3.291	3.599
	Manuka treefern scrub	3.164	5.929
	Treefern scrub (*New vegetation community*)	0.080	NA

Potential Ecosystem Type	Vegetation community	Project footprint total (revised)	Original Assessment Project footprint total
	Manuka scrub	1.560	1.108
	Total	**8.909**	**10.717**
CL6: *Hebe*, whararikiflaxland/ rockland	Dry cliff	0.399	0.399

* = the Exotic rushland community was previously called 'Rushland sedgeland mosaic'

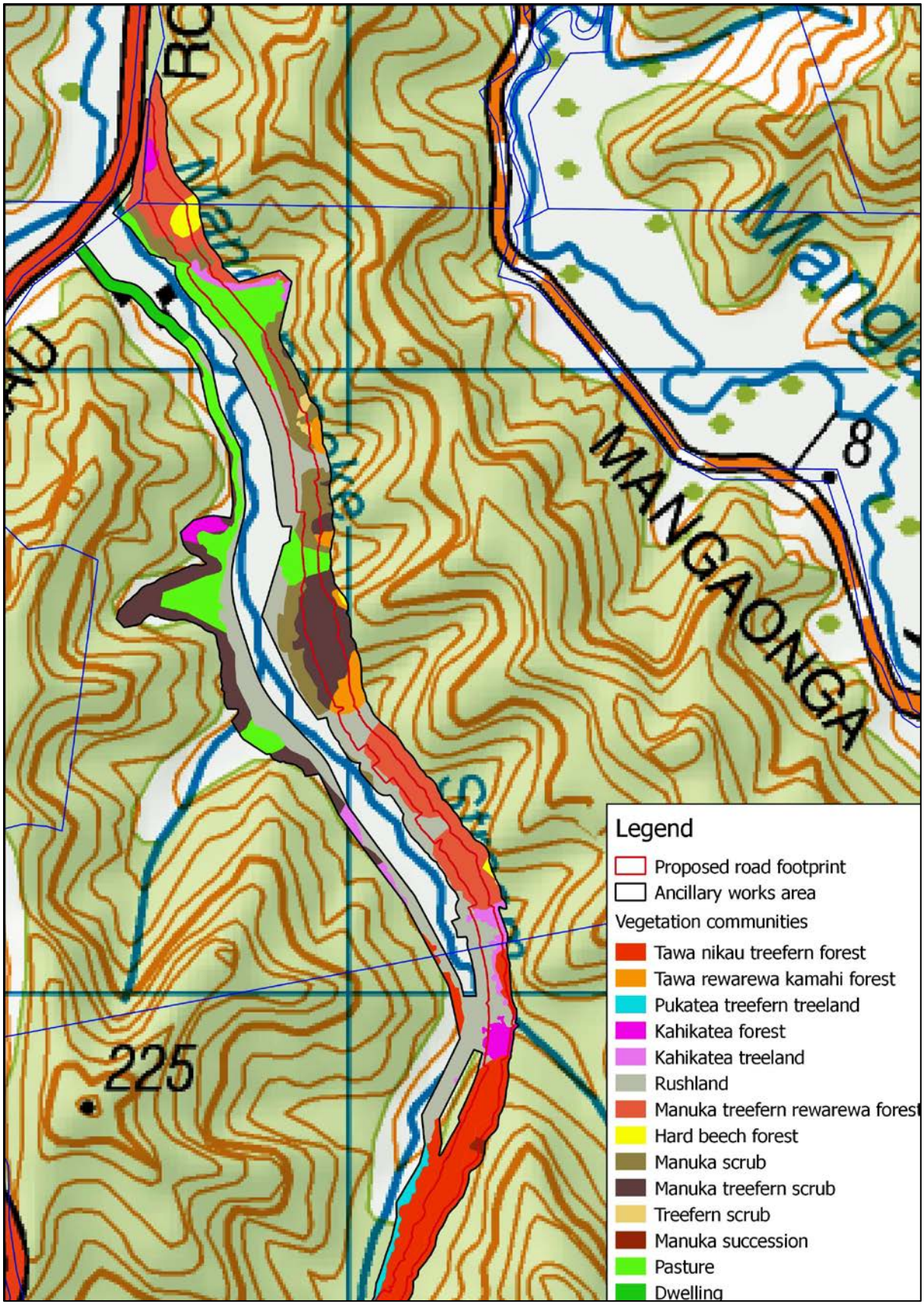

Figure 2.1 – Vegetation communities in the Lower Mangapepeke catchment on private land within the Project footprint and AWA

2.3.1 Vegetation communities

Three vegetation communities have been identified in the Mangapepeke Valley that are either new or had been previously misidentified from aerial imagery in the original report. These are:

- Kahikatea treeland;
- Exotic rushland; and
- Treefern scrub.

Further description is also provided for 'Manuka, treefern, rewarewa' forest. All other vegetation communities are described within the original report.

2.3.1.1 Kahikatea treeland

Kahikatea treeland includes areas which were previously classified as 'Kahikatea forest' and occurs only in the in the Mangapepeke Valley. This community is highly fragmented, occurring largely as margin between hillslope forest and valley floor rushland, and occasional scattered trees. Small sized kahikatea secondary trees, most between 8 – 14m, are dominant often fringed by or accompanying scattered manuka (Figure 2.2). Locally, sapling kahikatea are present though typically beneath manuka and occurring on raised surfaces. Kahikatea forest and kahikatea treeland differ in that kahikatea treeland is highly fragmented and has an understorey of light-demanding, mostly exotic pasture and rushland species (refer section 2.3.1.2 below). In contrast, kahikatea forest has a closed canopy with understorey species and a ground tier of typical native forest floor species such as hook grass and ferns and leaf litter.

Figure 2.2 – Kahikatea treeland in the Mangapepeke Valley consists of kahikatea (erect conifer shaped trees) and scattered manuka (rounded shrubs) and exotic rushland (foreground), taken on the property margin of Ngāti Tama and private land (approximately NZTM 1739219; 5615107).

2.3.1.2 Exotic rushland

This community was previously named and mapped as 'Rushland sedgeland mosaic'. The exotic rushland community is dominated by exotic rush and pasture species and has fewer native species than similar habitat in the upper most parts of the Mangapepeke Valley within open areas of the 'Pukatea treefern treeland' community (Figure 2.3). The natural drainage pattern is similar to the upper parts of the valley however throughout there are drains, some of which have been infilled with sediment, which have modified these drainage patterns. Overall there are fewer natural poor draining areas with few native species. This community is dominated by the exotic soft rush (*Juncus effusus*) with an estimated cover of 50–60%. Other common species include floating sweet grass, creeping bent, buttercup, jointed rush, lotus and *Juncus edgariae*, each with cover estimates ranging between 5–10%. Lesser common species are mostly exotic, though there are a small number of native species which are presently restricted to the wettest areas and occupy <3% cover combined. These include *Carex virgata*, *C. maorica*, and spiked sedge (*Eleocharis acuta*). Changes to the AWA have led to a large reduction in the area of impact to this vegetation community.

Figure 2.3 – Scattered manuka scrub (rounded shrubs) amongst dominantly exotic rushland (foreground), with a fringe of kahikatea treeland on hillslope margin in the Mangapepeke Valley (approximately NZTM 1739100; 5695277). The lime green tussocks are the native Carex virgata.

2.3.1.3 Treefern scrub

Small areas of dense (>80% cover) tree ferns occur in small gullies and south-facing hillslopes in the lower Mangapepeke Valley. This community is dominated by wheki (*Dicksonia squarrosa*) and also includes ponga (*Cyathea dealbata*), mamaku (*C. medullaris*) and katote (*C. smithii*). This community has a very sparse and shaded understorey with *Blechnum fluviatile*, bush rice grass and hook grass most common. Older tree ferns have abundant epiphytes including several species of climbing rata, hound's tongue fern, *Asplenium flaccidum* and occasional shrubs of coprosma spp, five finger and kamahi. This community was previously mapped as manuka treefern scrub; however, the site visit and high resolution drone imagery have allowed us to more accurately define and separate these two communities.

2.3.1.4 Manuka, treefern, rewarewa forest

This is a variable community of an advanced secondary succession following land clearance. Both manuka and kanuka occur with some kanuka approaching 12m in height. Locally present are small sized (secondary) emergent trees of rewarewa, hinau, pukatea and rare podocarps (rimu, kahikatea). Broadleaved trees predominantly occur in gullies, south facing slopes and areas of deeper soils and include mahoe, heketara, putaputaweta, kaikomako and pigeon wood. Tree ferns are abundant especially wheki and ponga, though also present are katote, wheki ponga (*Dicksonia fibrosa*), gully tree fern (*C. cunninghamii*) and mamaku.

Canopy gaps and clearings are frequent in this community. Browse by cattle, horses and feral goats is greatly impeding regeneration of suitable canopy trees such as tawa, pukatea and kamahi. The understorey is also particularly open and is dominated by unpalatable species such as hook grass, bush rice grass, and *Blechnum fluviatile*. Local patches of meadow rice grass, sweet vernal and other pasture species occur in high light canopy gaps and especially in open kanuka.

2.3.2 Mapping improvements for measuring vegetation loss

Drone imagery has improved the accuracy of the vegetation community boundaries in the Mangapepeke Valley, especially where shading on southward facing hillslopes occurred on lower resolution 2011 Taranaki Regional Council aerial images.

For WF8 communities this has resulted in a small increase in overall extent from 2.324 to 2.629 relative to the original vegetation assessment, largely due to the increase of the open 'manuka scrub community'. Field work identified that approximately 0.6 ha of this is 'kahikatea treeland' which had previously been measured as closed canopy forest.

Areas that were shaded on 2011 Taranaki Regional Council aerial images had been mostly mapped as secondary (predominantly manuka and treefern) scrub, though also included areas of pasture and rushland. The greater resolution and quality of the drone images allowed these to be areas to be more accurately identified and mapped.

Additional areas of 'Hard beech forest' and 'Tawa, kamahi and rewarewa forest' were also located from field work and drone imagery, primarily on south-facing hillslopes within small tributary catchments. This difference in mapping resolution resulted in an increase in the areal extent of these two communities to 0.288 and 0.536 ha (Table 2.1).

2.3.3 Threatened Plants and Significant trees

No threatened or regionally distinctive plants were found on private land in the lower Mangapepeke Valley. This confirms that within the Project footprint the only threatened or regionally distinctive plants are a small number of kohurangi (*Brachyglottis kirkii*) and *Pittosporum cornifolium* plants, estimated to be at most 25 individuals of both species. *Astelia trinervia* and King fern (*Ptisana salicina*) were not found within the Project footprint Area but occur within the wider Project area.

Two additional significant trees have been tentatively identified from drone imagery, a large pukatea (NZTM 173106; 5694619) and a small miro growing on a steep ridge (NZTM 1739041; 5694619). Neither have been visited in the field and both occur in the upper Mangapepeke Valley on Ngāti Tama land.

Table 2.2 - The number of significant trees by species present on the road footprint and within the Project footprint (supplementary vs original assessment) * 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.

Species	Number of significant trees		
	On road footprint	Project footprint	Change relative to original assessment
Rimu	10	11*	0
Totara	2	2	0
Matai	0	1	0
Hinau	1	1	0
Miro	0	1	+1
Pukatea	1	1	+1
Total	**14**	**17**	**+2**

2.3.4 Vegetation condition in the Mangapepeke Valley

The vegetation condition on private land in the Mangapepeke Valley is dominated by secondary vegetation that has developed following land clearance for farming. Grazing by cattle, horses and feral goats has compromised vegetation succession and continues to impact vegetation condition. This has significantly affected the understorey vegetation composition and successional processes, resulting in dominance of a low diversity of browse-resistant plants, such as tree-ferns, hook grass and the fern *Blechnum fluviatile*. Much of the canopy is discontinuous with numerous gaps where tree falls and regeneration failure is occurring (Figure 2.4 and Figure 2.5). These gaps often contain areas of exotic grasses and herbaceous species. Browse has also resulted in a conspicuous absence of a shrub tier and what species are present are unpalatable and dominated by tree-ferns in moist sites and manuka and kanuka on more exposed ridges. Regeneration of some browse resistant species is occurring locally, such as the divaricating small tree, kaikomako (*Pennantia corymbosa*) where the soil is deeper and more fertile. Regeneration of palatable tree and shrub species is confined to epiphytic locations, primarily on large tree-ferns. While not numerous occasional small podocarp trees and saplings, including kahikatea, rimu and matai, are present beneath older and open manuka and kanuka canopies. This is a notable difference between the more shaded tawa, kamahi, rewarewa dominant forest to the south where podocarp regeneration is rare and almost entirely dominated by the more shade-tolerant miro.

Figure 2.4 – Canopy gap in manuka, treefern, rewarewa forest showing the sparse understorey and regeneration failure of shrubs and trees. (Approximately NZTM 1739068; 5695376).

Figure 2.5 – Canopy gap in manuka, treefern scrub showing the sparse understorey and regeneration failure of shrubs and trees. (Approximately NZTM 1739058; 5695405).

Possum sign and browse on palatable trees appeared to be less common and severe in the lower part of the valley, and while not common, trees including mahoe and kamahi had dense canopies and were flowering heavily — signs of a low(er) possum population.

Exotic plant species occur throughout all native scrub and forest areas in the Mangapepeke Valley. African clubmoss is most abundant and locally on alluvial soils is the dominant ground cover. Pasture grasses and herbaceous species are common in canopy gaps and high light areas.

2.4 Discussion and recommended mitigation

Vegetation communities on private land are very similar in composition, structure and botanical value to those described in the initial Vegetation Assessment (Nicholas Singers Ecological Solutions Ltd 2017). This is summarised in Table 2.3. The main differences are the inclusion of three additional vegetation communities, 'Kahikatea treeland', 'Treefern scrub' and 'Exotic rushland', the latter having replaced the 'Rushland sedgeland mosaic' community.

The following summarises the main differences found:

- Approximately 0.641ha of 'Kahikatea treeland' occurs along the length of the lower Mangapepeke Valley. This vegetation was previously identified as Kahikatea forest. Exotic grass, rush and herbaceous species dominate beneath these trees and vegetation and soil is heavily impacted by grazing stock. Kahikatea readily regenerates within unimproved pasture grazed by cattle especially in areas which are seasonally wet, pugged by cattle and or have scattered manuka. While occurring in areas where WF8 Kahikatea, pukatea forest would have occurred before land clearance, this community has developed in the presence of grazing and its composition strongly represents this. Consequently these areas are of lesser value than closed canopy 'Kahikatea forest' or 'Kahikatea, swamp maire forest' which are more compositionally and structurally diverse and intact. This community has therefore been assessed as having 'moderate' ecological value considering the Davis *et al.* (2016) and EcIA guidelines (Table 2.3 below) and Section 21.1 of the District Plan. This difference in extent and ecological value has been evaluated within biodiversity offset calculations.
- The 'Exotic rushland' habitat is dominated by soft rush (*Juncus effusus*) and other exotic wetland grasses and herbaceous species. Numerous drains are present which have lowered the water table. While poorly draining areas fit within the wetland definition under the Resource Management Act (1991), they contain very limited indigenous character and don't appear to provide important habitat for indigenous wetland fauna such as fernbird and Spotless crake which are present in the Mimi Catchment. Further, *Carex virgata* was found to be of much lower abundance than previously estimated, occurring as scattered clumps often where drainage works have occurred, rather than as identifiable communities in more permanently saturated areas. Consequently, the 1.372ha of sedgeland estimated using the 2011 Taranaki Regional Council imagery was erroneous, greatly over-estimating the spatial extent and abundance of *Carex virgata* dominant sedgeland habitat. For these reasons this community does not trigger District Plan significance criteria and consequently 1:1 mitigation planting as previously proposed arguably is not required. However, restoration of sedgeland habitat may still be ecologically appropriate in small areas

with a high water table where forest restoration is unsuitable. This will be evaluated within the Mitigation report.

- The spatial extent of WF14 'Hard beech forest' and 'Tawa, kamahi, rewarewa forest' in the lower Mangapepeke Valley is greater than previously mapped. Forest areas consistently occurred on shady south-facing slopes within small sub-catchment streams. Much of this forest is of secondary sized trees and either escaped clearance fires or has regenerated following initial clearing. Canopy condition appeared to be better than further upstream where possum browse and sign was more common on palatable trees. Of note was the present of kamahi which is extremely uncommon further upstream, despite once likely having been a canopy dominant. These communities are of moderate ecological value, and while no change in the magnitude of effect is recommended for the increased area of these communities, this additional area has been included in biodiversity offset calculations for integrated pest management.
- In general, vegetation condition for all scrub and forest communities is as predicted, with significant modification of the shrub and ground cover tiers by cattle, horses and feral goats and minimal tree and shrub regeneration occurring. Stand structure is more open than indicated in aerial images with more frequent canopy gaps. Canopy condition of possum browse sensitive species was better than expected, when compared to the same species in the upper Mangapepeke Valley. No change in the magnitude of effect is recommended.
- Two additional significant trees have been tentatively identified from aerial drone imagery. These need to be ground truthed to confirm identification, size and ecological value in order to confirm compensation for their loss. If considered significant from this assessment, they should be included in the compensation planting programme for significant trees (an additional 200 trees of the same species for every significant tree that has to be felled).
- Section 4.3.5 'Sedimentation and effects on wetland vegetation and hydrology' of the original vegetation report discusses the risk of sedimentation detrimentally impacting the Mimi wetland. Investigations by the freshwater team (River & Lake 2018) identified that the two small streams that enter the Mimi wetland downstream of the Project footprint, end within the raupo and raupo rautahi (*Carex geminata*) swamp communities. While sediment control measures will be constructed, if a worst-case flood occurred and these were compromised, these dense and highly resilient wetland communities will greatly assist to capture sediment, reducing the likelihood of sediment reaching and affecting the kahikatea swamp maire forest.

Table 2.3 – Summary of indigenous dominant and mixed exotic — indigenous vegetation communities within the Project footprint and their ecological (botanical and ecosystem) value.

Potential Ecosystem Type	Vegetation community	Project footprint total	Ecological value (refer s4.2 of original report)
WF8: Kahikatea pukatea forest	Kahikatea swamp maire forest	0.159	High
	Kahikatea forest	0.525	High
	Kahikatea treeland	0.641	Moderate
	Pukatea treefern treeland	0.722	Moderate
	Manuka scrub	0.582	Low
	Exotic rushland	5.826	Low (not significant)
	Total (excluding exotic rushland)	**2.630**	
WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest	Tawa rewarewa kamahi forest	6.457	High
	Tawa nikau treefern forest	8.507	Moderate
	Miro rewarewa kamahi forest	0.536	High
	Pukatea nikau forest	1.347	High
	Secondary mixed broadleaved forest	2.231	Moderate
	Manuka treefern scrub	0.146	Low (not significant)
	Manuka succession	0.514	Moderate
	Total	**19.738**	
WF14: Kamahi, tawa, podocarp, hard beech forest	Hard beech forest	0.288	Moderate
	Tawa rewarewa kamahi forest	0.526	Moderate
	Manuka treefern rewarewa forest	3.291	Low—Moderate
	Manuka treefern scrub	3.164	Low
	Treefern scrub	0.081	Low

Potential Ecosystem Type	Vegetation community	Project footprint total	Ecological value (refer s4.2 of original report)
	Manuka scrub	1.560	Low
	Total	**8.909**	
CL6: *Hebe*, whararikiflaxland/ rockland	Dry cliff	0.399	Moderate
Total ha		**31.676**	**High**

3 Conclusions

Minimal changes to vegetation classification and extent have been identified as a result of field work undertaken and the use of high resolution drone imagery for mapping vegetation on private land within the lower Mangapepeke Valley. Changes including, the addition of 'Kahikatea treeland', and a greater area of 'Hard beech' and 'Tawa, kamahi, rewarewa forest' should be included within biodiversity offset calculations to determine what obligations are required to achieve no net loss of biodiversity, and net biodiversity gain in 10 – 15 years. Exotic rushland wetland vegetation within the Mangapepeke Valley does not trigger significance criteria within the District Plan.

Consequently the conclusions remain substantially the same with vegetation loss potentially resulting in the loss of approximately 31.277 hectares of indigenous forest, treeland and scrub. This includes vegetation of high ecological value which is significant under the District Plan. The areas of highest value are approximately 0.684ha of Kahikatea, swamp maire forest and Kahikatea forest as well as approximately 8.507ha of high condition Tawa, kamahi, rewarewa forest. Further the project will result in the loss of up to 17 significant trees and potentially 25 individual plants of kohurangi (*Brachyglottis kirkii* var. *kirkii*) and small populations of two regionally distinctive species, swamp maire (*Syzygium maire*) and *Pittosporum kirkii*.

4 References

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

River & Lake Ltd. Feb 2018. Mt Messenger Bypass Project Ecology Supplementary Report – Freshwater Ecology

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

Nicholas Singers Ecological Solutions Ltd (2017). Mt Messenger Bypass. Assessment of Ecological Effects Technical Report 7a.


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