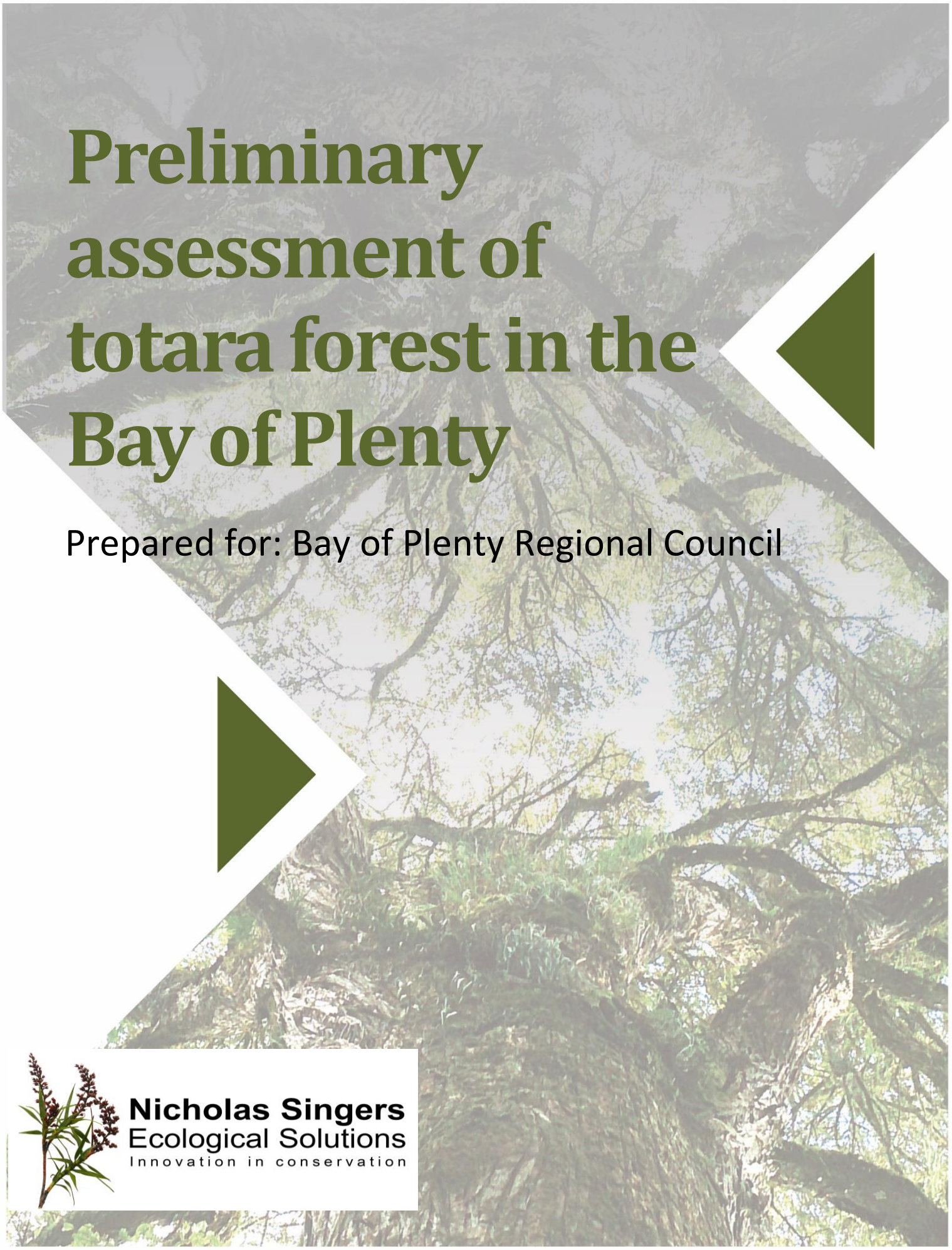
Preliminary assessment of totara forest in the Bay of Plenty

Prepared for: Bay of Plenty Regional Council



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1. Introduction

Totara dominant forest is rare today in the Bay of Plenty Region. Totara occurs on young land forms, and as seedlings are light demanding, regeneration requires frequent disturbance to maintain its abundance. In pre-Maori times, Bay of Plenty totara forest would have occurred in areas along many rivers with free draining stony soils and on recent pumice and ash soils at lower altitude, especially areas affected by the Taupo 232AD and Kaharoa (1280–1300AD) eruptions. Totara may have also been locally common on stable dunes, such as on Matakana Island. Maori burning had a devastating effect on totara forest and upon European arrival, totara forest was very restricted in extent. Early maps and paintings show large areas of the Bay of Plenty were deforested, especially coastal areas, fertile valleys and over most of the Kaingaroa Plateau (Figure 1).

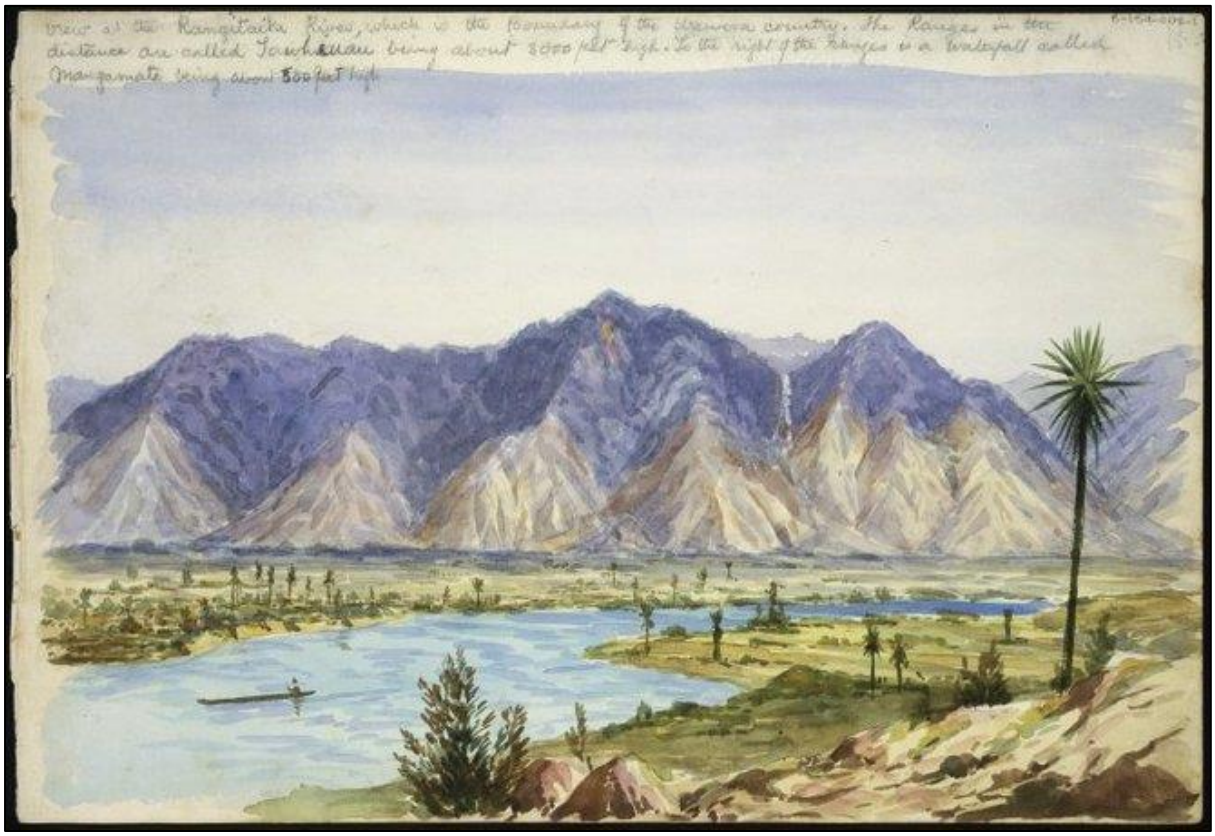

Figure 1: Water colour by Ryan Thomas 1891 of the Rangitaiki River, showing the lack of forest on the Galatea Plains and Galatea foothills — parts of this valley would have been ideal for totara forest.

Remnant totara forest however did occur in several locations in the 1800's, along some rivers and streams and within pumice tephra basins. Simpson (2017) includes an extract made in 1877 by Campbell-Walker [the first NZ Conservator of Forests], from near Fort Galatea.

> *" At Tauranga, the District Engineer, Captain Turner, told me of a fine block of totara forest in the Ahikereru Valley [near Fort Galatea] which is in Native hands and scarcely utilized, if at all. Captain Turner thought it would be advisable to explore it carefully, and, if possible, acquire it, as totara is scarce and in much demand in the neighbourhood."*

Ahikereru was a Pā on the Whirinaki River, southeast of Murupara. Best (1897) also describes totara forest as occurring on the left bank of the Whirinaki River and tributaries there-of. These observations were likely of the same forest, a former extension of Whirinaki Forest (as we know today).

As totara was in such high demand for European building uses, it was usually the first timber species felled in any forest. Regional annihilation of totara was repeated wherever land development occurred for housing, railways, bridges and fences, with land converted to farming after logging. Even in forests which were not cleared for farming, which formerly included much totara, selective logging greatly reduced its abundance. Despite the very limited resource left and the considerable ecological value of areas containing totara, clearance occurred until recent times. The best totara/ matai stand in the Mangawhiri basin (Beveridge, 1967) was largely clear-felled in 1973, and was replaced by a plantation of radiata pine and Douglas fir.

Consequently, original totara forest is one of the rarest ecosystem types remaining in the Bay of Plenty Region and wider New Zealand, though in places (especially Northland) it is rapidly regenerating in grazed farmland (Bergin & Kimberley 2014). Representative examples of 'natural' totara forest ecosystems are in urgent need of protection and conservation management. Even single or small groups of trees have conservation value, as seed sources for future local revegetation, especially where so little remains.

The objectives of this project were;

1.) Map the current extent of totara forest within areas mapped as MF10 and WF2 in the Bay of Plenty Region Potential Ecosystem Map.
2.) Improve the Potential Ecosystem Map for the Bay of Plenty Region with respect to totara forests, MF10 and WF2.
3.) Take photographs and collect information on forest type and condition, whilst undertaking aerial inspections of data poor sites.
4.) Identify sites requiring further inspection/ ground survey to confirm presence of totara forest or collect information on ecological integrity and condition.

While the focus was on totara forest, this work identified that a much larger number of podocarp forest remnants remaining are dominated by kahikatea. For this reason, the report has been expanded to include some information about these forests, which are also greatly reduced in extent and are now regionally threatened ecosystems.

2. Methods

Initial data, in the form of two shapefiles, were provided by the Bay of Plenty Regional Council of possible sites where MF10 and WF2 could occur. These shape files were created using ARCgis by intersecting the Bay of Plenty Potential Ecosystem Map (Singers 2014) and the Land cover database 4 (Landcare Research), using two potential ecosystem types; MF10 and WF2 and the LCDB4 indigenous forest units.

Using QGIS these layers were then manually inspected against several aerial images (NZ aerial imagery, World Imagery and Google Earth) displayed on an ultra-high definition monitor. Areas of exotic vegetation, likely identified due to errors in LCDB4, were excluded at this stage. Using this approach, the visual signature of common trees such as rimu, kahikatea, tawa, pukatea and often totara is readily discernible from each other. Differentiating individual matai and miro trees apart is not possible though where plot data is available, matai dominant stands can be identified.

Supporting this approach, forest type maps produced by John Nicholls (1966-69) and associated forest type descriptions were consulted. These type maps however don't provide sufficient resolution of forest types and lump areas of totara, matai, kahikatea forest and kahikatea and rimu forest within a single unit (L2). In my opinion these types are sufficiently different from each other to be recognised as discrete ecosystem units. National Forest Plot (late 1940's-early 1950's) tree data were also used as a reference where these were available. These two sources of data provided a greater scientific rigor for desk top determinations of forest composition and typing.

Areas identified for survey were hand digitised using QGIS as a separate shapefile for follow up after the initial aerial survey. An aerial survey was undertaken on the 5th May 2018 along the Whirinaki River and Galatea faces and all other sites on the 31st May 2018. Not all sites where surveyed as some were intended to be surveyed on foot e.g. Whirinaki Forest including Mangawhiri basin.

While the initial focus for verification was on areas dominated by totara, podocarp forests dominated or co-dominated by kahikatea or mixed podocarps where additionally identified, particularly on alluvial land-systems.

Areas of MF10 Totara, matai, kahikatea forest in Whirinaki were not surveyed but were mapped using aerial imagery displayed on an ultra-high definition monitor and the use of type maps and plot data.

3. Results

This report should be read in association with maps (Appendix 1) and the shapefile of areas podocarp forest area identified. Summary information is included as attributes within the shapefile.

3.1 Waiotane River Catchment

The upper Waiotane Valley retains a significant area of podocarp forest, including the largest remaining totara forest remnants in the eastern Bay of Plenty Region.

Even-aged totara dominant podocarp forest occurs on flood prone alluvial terraces of the Waiotahi River and the lower toe-slopes on the surrounding hillslopes (Sites 1 & 4 and Figure 2). Most of this forest is legally protected within public conservation land including; the Tukainuka Scientific Reserve and the Waioeka Conservation Area.

Totara is the dominant species in these remnants, though kahikatea, rimu, matai and tanekaha are also frequent (Figure 2). Tanekaha is locally abundant on ridges within the Waioeka C.A and some toe-slopes. The age of this forest is likely to be <150 years, being dominated by even-aged pole to small trees. Synchronous regeneration here probably occurred after a significant disturbance event such as a late Maori or early European fire. Regeneration may have also been promoted by cattle grazing eliminating palatable broadleaved trees, as is occurring through large parts of Northland today (Bergin & Kimberley, 2014).

Upstream of 'Kahikatea Pā' on the true right side of the Waiotahi Valley, secondary kahikatea forest with a substantial component of rimu and some tanekaha is present (Sites 2 & 3; Figure 3). This forest is situated on private land and appears to be younger than the stands in Tukainuka Scientific Reserve and the Waioeka Conservation Area, and still includes manuka amongst the podocarp trees. These remnants occur on shallow sloping land whichlikely has localised areas of gley soil next to ephemeral waterways, and mottled fluvial soil types, which are seasonally saturated favouring both kahikatea and rimu.

Figure 2: Totara dominant podocarp forest within the northern part of Tukainuka Scientific Reserve and on the lower toe slopes in the Waioeka Conservation Area.

3.2 Waimana and Whakatane River Catchments

Relict podocarp forest occurs along most of the upper Waimana Catchment, though stands are virtually all dominated by kahikatea and rimu. While not quantified, the Waimana Catchment likely contains the largest area of kahikatea dominant forest in the Bay of Plenty Region.

Only one alluvial forest stand was identified in the Whakatane River Catchment, which from aerial images appears to contain some kahikatea. This site was not aerially surveyed.

In these catchments, totara is comparatively rare and consists only of secondary wide-spreading trees within paddocks, open areas and occasionally adjacent to the rivers. The upper limit of totara seen was near Otane at Site 27 and several more trees nearby in former regenerating pasture. It may well grow further up these valleys. This suggests that pre-Maori, totara or mixed totara podocarp forests likely occurred on the most free-draining alluvial terraces, such as below Tauwharemanuka, where a small remnant of totara treeland is still present (Site 23). Simpson (2017) comments of several place names in Te Urewera named after totara (Paeatotara, Wharetotara, Totarapapa, Papatotara and Te Totara), indicating a locally significant feature. Suitable sites were likely the most recent flood prone and free-draining alluvial terraces, of which almost all are now in pasture.

Figure 3: Regenerating podocarp forest in the upper Waiotane Valley dominated by kahikatea and rimu.

Further downstream as far as Iwiroa, secondary podocarps are present in the valley, adjoining the river and as scattered trees in pasture.

Most of the alluvial terraces, especially those above flood heights, likely have imperfectly drained fluvial (silt based) soils, more suited to kahikatea and rimu in the humid climate of the Urewera Ranges, as represented by the remaining remnants.

Several ecosystems in which kahikatea is dominant are found in the Waimana Valley including WF8: Kahikatea, pukatea forest and MF4: Kahikatea forest. Below Tahora, forest representative of WF8: Kahikatea, pukatea forest occurs at sites 8 & 9. These remnants are situated on alluvial terraces below 100 m a.s.l. Further inland, frost severity probably limits the extent and abundance of pukatea on these frost prone valley floor sites. Pukatea is further south at site 10 at Tahora, but on a higher terrace which is likely above the worst frost. As this is a secondary pole stand, how abundant pukatea was pre-Maori is somewhat speculative. Modifications to the Bay of Plenty Potential Ecosystem map were made based on these observations.

3.2.1 WF8; Kahikatea, pukatea forest

The most representative example of this ecosystem type occurs at site 8 opposite Omuriwaka Marae which is approximately 5 ha in size (Figure 4). This remnant occurs on an alluvial terrace adjoining

the true left side of the Waimana River and is likely periodically flooded after heavy rains from run-off from the surrounding hillslopes. From aerial inspection, secondary kahikatea and pukatea occur in the canopy, with occasional tawa (upslope) and much of the canopy dominated by nikau palm and tree ferns. The site is partly within Urewera and private land and is buffered on the uphill side by tawa dominant forest, and also provides a continuous vegetation margin of the river.

Figure 4: Site 8, secondary kahikatea and pukatea amongst nikau palm and tree ferns.

3.2.2 MF4; Kahikatea Forest

Kahikatea forest remnants further upstream of site 10, consist mostly of secondary pole stands, such as sites 21 and 25. All appear to have been logged and are now recovering from this, though some such as sites 21 and 22 (Figure 5) contain a few large trees. These are mapped as MF4: Kahikatea forest, even though some associate species such as ribbonwood appear to be absent. These stands appear also to include other podocarp and broadleaved trees, such as matai, maire and possibly, kamahi. Tawa appears to be absent from the lowest lying sites, suggestive of cold air temperature inversion, although is ubiquitous upslope.

Figure 5: Kahikatea forest showing youthful conical trees and a number of larger trees on the margin of the river (site 22).

Forest on older alluvial terraces, situated well above flood height, are more mixed in canopy composition and often have very large kahikatea and rimu as emergent, over a canopy which is predominantly tawa. Some of these may include occasional totara and matai, though these podocarps appear to be relatively uncommon. These areas were typically mapped as 'Rimu, matai general hardwoods' in forest type maps (Nicholls 1966a), though given their notable abundance of tawa are more similar to surrounding hillslope 'Rimu, tawa forests'. These have been mapped in the Potential Ecosystem layer as MF7. The best examples of these occur in Te Urewera in the upper Tauranga River (sites 28–30) and sites downstream of Otane.

3.3 Upper Rangitaiki (Galatea Plains), Whirinaki and Wheao Catchments

Forest composition and structure of Whirinaki is described in depth within Morton et al. (1984). Figure 1 in this book shows the forest profile in the Tauranga Stream basin showing three associations;

- a narrow stream side association of kahikatea over silver beech and red beech
- the basin association with matai and emergent kahikatea and totara
- the slope association dense rimu, matai over tawa

In Whirinaki MF10: Totara, matai, kahikatea forest (Singers & Rogers 2014) is equivalent to the 'basin association' of Morton et al. (1984). This ecosystem principally remains in the Tauranga Stream basin and along the Waipaeta Stream. Some totara also surrounds the Mangawhiri Basin, which prior to clear felling was dominantly totara, presumably in association with matai and kahikatea. Descriptions of this area do not mention these two species though two NFS plots were located here. In one plot matai was the dominant species with and minor amounts of totara, kahikatea and rimu, while the other was almost solely dense totara. These areas of MF10 are at the upper altitude of this ecosystem type, and all other examples down-stream were presumably cleared with human occupation.

The Tauranga Stream basin is the most intact remaining example as only a small area of logging occurred here, at the southern end. The Waipaeta stand was partially logged so is less representative of its former state, with broadleaved trees such as kamahi now dominating large areas where totara, matai and kahikatea once occurred. Small areas of secondary matai, totara and kahikatea also occur at site of former Maori occupation such as near the Okarea Pā site, in the Oriuwaka Stream catchment (Morton et al. 1984).

Podocarp forests stands occur along the Wheao River which formerly included numerous totara (presumably sites 42–45). Morton et al. (1984) commented that most of the totara was standing dead, likely witnessed in the late 1970's–early 1980's, which presumably died from possum browse. These stands are now dominated by kahikatea, matai with some rimu. Totara is still present but uncommon.

Morton et al. (1984) did not map these associations and the highest resolution map is the Te Whaiti Forest Type Map (Nicholls 1966), which does not separate associations as described by Morton. Areas were not surveyed from the air and were mapped using the type map, aerial images, and interpretation of Figure 1 from Morton et al (1984).

Beyond Whirinaki Forest boundaries, totara occurs as scattered secondary stands, which progressively get less dense with increasing distance away from Whirinaki. The area of secondary vegetation which contains the greatest abundance of young totara is situated immediately adjacent to Whirinaki Forest (Site 60). Totara is the most common podocarp present along with other associates of riparian forests such as kowhai and kanuka.

In the Whirinaki Gorge, opposite Okui Hut, secondary totara occurs on the shallow sloping hillslope along with other podocarps, especially kahikatea, while matai and rimu appear to be uncommon (Figure 6; Site 33).

Figure 6: Vigorous secondary totara and kahikatea regeneration succeeding kanuka forest, Site 33, opposite Okui Hut, Whirinaki River

In podocarp stands on lower alluvial terraces along much of the upper Whirinaki Gorge, such as upstream of Okui Hut, kahikatea and matai dominate, though a small amount of rimu and red beech are present. Similar forest occurs upstream to Te Whaiti (Sites 30–32, 34–40) both on alluvial terraces and hillslopes. These stands were mapped as L2 in Nicholls (1969a). It is highly likely that some totara also occurred in these stands, especially considering the prolific regeneration at site 33, but was selectively logged, given a forestry road was built all the way to the Okui Hut.

These stands are very similar to those occurring in the Waipunga Gorge, adjoining State Highway 5 and Ball's Clearing Scenic Reserve, near Puketitriri, in the Hawkes Bay Region. All of these areas were affected by the Taupo 232 AD eruption and occur on pumice podzol soils (MOZ). Within the potential ecosystem classification system (Singers & Rogers 2014), a variant MF11.4; Kahikatea, rimu forest was created initially for Hawkes Bay (Singers 2014) and modifications to the Bay of Plenty Region Potential Ecosystem map were made (described below).

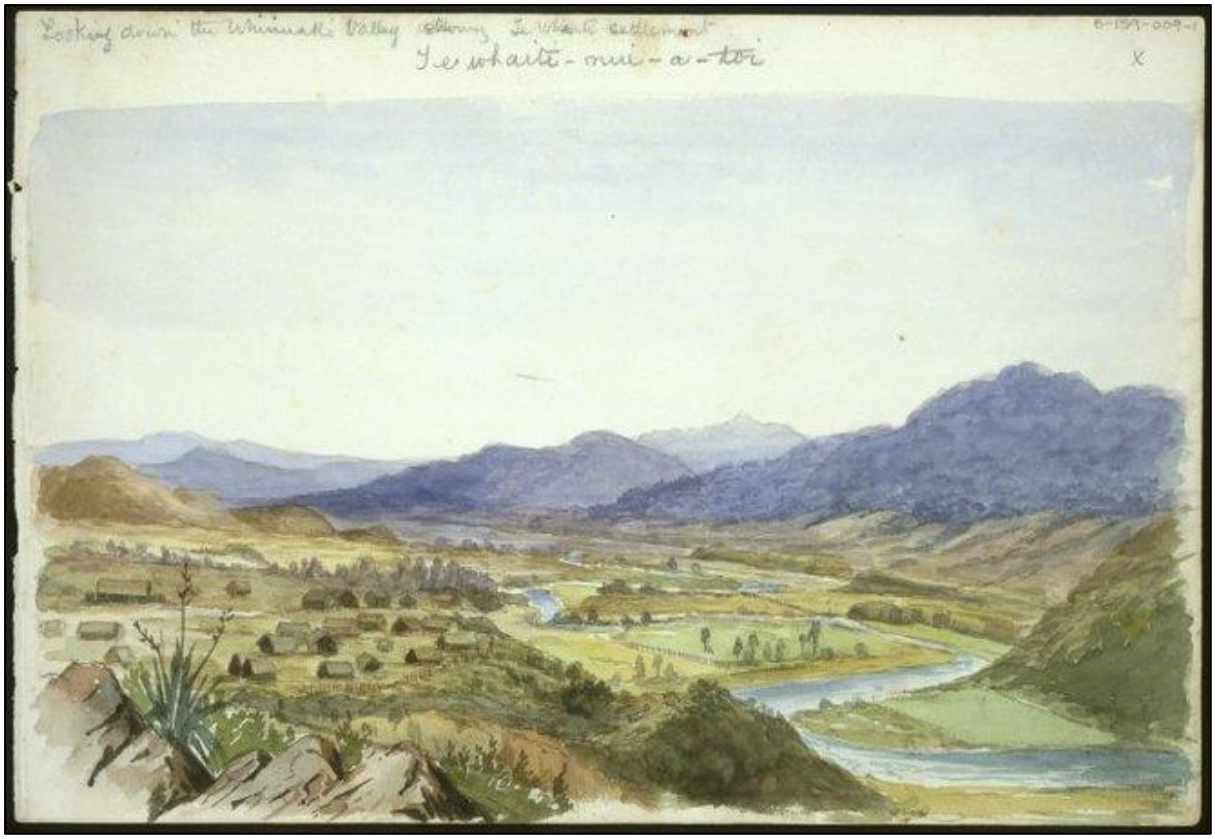

Figure 7: Water colour by Ryan Thomas 1891. Te Whaiti-nui-a-toi; looking up the Whirinaki Valley showing Te Whaiti settlement. Courtesy of the National Library.

Secondary totara and kahikatea trees were seen within kanuka forest in the lower Whirinaki Gorge on an alluvial terrace (Figure 8; site 28). Kanuka forest provides ideal conditions for the regeneration of light demanding podocarps such as totara, kahikatea and matai (Sullivan et al 2007). It is highly likely that areas of kanuka forest in the general area here will eventually develop into podocarp forest, potentially including kahikatea, matai, totara and also possibly rimu and miro. Of additional interest is that kowhai (*Sophora* sp.) also is present in riparian and cliff sites here and titoki (*Alectryon excelsus*) occurs in gullies above the terrace, both species which are likely to persist. With low ungulate numbers titoki has the potential to become the dominant understorey tree beneath a podocarp canopy.

Suitable podocarp habitat is also present in some other adjoining areas, the most suitable sites being secondary kanuka forest, which is widespread along the Galatea foothills (Site 68) and other sites in the Whirinaki River gorge (Site 29). In previous discussions with DOC staff, comments were made that secondary totara being was present on the Galatea foothills. Totara was not seen at these other kanuka sites, but this is not to say that totara is absent at these, rather no totara was apparent in the canopy. It is likely that totara seedlings and saplings area present given the suitability of this site for its regeneration and that trees are known in the vicinity.

Figure 8: Site 28. Kanuka, rewarewa forest with a small number of kahikatea and totara near the Whirinaki River

On the Galatea Plains podocarp trees are known from only three small remnants, two near Fort Galatea (Sites 65 & 66) and another east of Murupara (64). Scattered secondary trees possibly also occur adjoining the Rangitaiki and Whirinaki Rivers. Further up the Rangitaiki River, a series of alluvial terraces are present which were likely tall (MF10) podocarp forest prior to Maori fires. Most of these terraces occur on the east side of the river in Whirinaki Te Pua-a- Tane Conservation Park. The current vegetation of these terraces appears to be a mosaic of emergent wilding pines (some of which appear to have been recently poisoned), over a mixed secondary broadleaved and tree fern forest. Podocarp regeneration, especially of totara can often be prolific under wilding pines (pers.obs. Tongariro River Reserves). Dense tree fern cover, however, is likely to suppress the regeneration of light demanding trees including totara and kahikatea. This may result in epiphytic regeneration of shade tolerant species such as kamahi (Brock et al. 2016) at the expense of light demanding podocarps.

The lack of podocarp forest in the Rangitaiki catchment is not unsurprising given that most of the alluvial flat land and Kaingaroa Plateau, had been burnt in early Maori times and was deforested prior to European arrival (Figure 1).

3.3.1 MF11.4 Kahikatea, rimu forest

This forest type occurs near Te Whaiti in the Whirinaki catchment including Sites 30–40 (excluding site 33) and were mapped by Nicholls (1969a) as forest type L2. Nicholls describes stands as being dominated by rimu and containing a considerably lesser amount of kahikatea (mean of 19 rimu to 2.5 kahikatea). While qualitative my assessment of these remnants is that kahikatea is often more abundant than rimu. The description of this forest type on the type map does not recognise this. This variant appears to be associated with pumice podzol (MOZ) soil type, occurring in humid climates below 500 m a.s.l. These environmental conditions, likely result in a high water table, suited to kahikatea and rimu. It occurs on alluvial terraces and shallow to moderate sloping hill-country landforms.

The compositional description was based on examples from the Hawkes Bay Region;

Abundant emergent large kahikatea and rimu over an infrequent canopy of miro, maire and locally matai and locally kamahi. The sub-canopy is typically infrequent restricted to canopy gaps and is dominated by mahoe, kotukutuku, horopito and wheki-ponga.

Figure 9: MF11:4 Kahikatea, rimu forest (Site 40) near Te Whaiti

3.4 Other podocarp forest sites without totara

3.4.1 East Coast sites

Alluvial terrace sites were identified in the Kereru and Raukokore Rivers in the eastern Bay of Plenty. These sites were not surveyed from the air however aerial images show that kahikatea appears to be the most abundant podocarp and sites 46 and 51 appear to be highly ecologically significant and representative of WF8: Kahikatea, pukatea forest. Two secondary kanuka, manuka forest stands were identified which adjoin the Raukokere River (sites 49 & 50), both of which appear to be suitable for the regeneration of podocarps including totara, kahikatea and matai. Site 50 occurs on public conservation land in the Raukumara Forest Park.

3.4.2 Kaingaroa Forest

Oruatewhehi Forest Conservation Area is situated east of Kaingaroa Village on the Kaingaroa Plateau and was inspected from the air. The forest occupies a ridge with two gullies either side, which join at the lower end. The majority of this forest is secondary dominated by tall kanuka and mixed broadleaved forest including kamahi and rewarewa, though the dominant emergent on the ridge are wilding pines. In the northern gully is a remnant of primary forest dominated by tawa and in the bottom of the gully here are several massive kahikatea trees (and possibly matai). This forest is representative of MF7: Tawa, kamahi, podocarp forest.

3.5 Modifications to the Bay of Plenty Potential Ecosystem Map

Modifications were made to the Bay of Plenty Potential Ecosystem Map (Singers 2014). These are included within various polygon references. The main changes resulted in less area of extent of MF10 present within Whirinaki. Whilst totara can grow to 600 m a.s.l and mature MF10 forest occurs to this height at Kuratau (south western Taupo), in Whirinaki MF10 is more associated with 'basin areas' below 400-450 m a.s.l. This change resulted in large areas on the Kaingaroa Plateau being mapped as MF11.3 Rimu, matai forest.

An additional variant was also included; MF11.4 Kahikatea, rimu forest which was mapped to pumice podzol soils (MOZ) below 400 m a.s.l.

4. Discussion

Primary MF10: Totara, matai, kahikatea forest occurs within two alluvial terraces/ basin areas in Whirinaki, Tauranga and Waipaeta Stream. Smaller areas remain around the margin of the Mangawiri Basin. Part of the treaty settlement between Ngāti Whare and the crown is a requirement to regenerate 640 hectares of the Whirinaki Forest from pine to native, which includes the Mangawiri Basin. These areas are protected within the Whirinaki Te Pua-a-Tane Conservation Park and being important ecological management units receive a significant level of conservation management. While restoration of 640 hectares will be multi-generational, the future of this ecosystem type is bright.

Beyond the boundary of Whirinaki Te Pua-a-Tane Conservation Park, all other totara forest within the Bay of Plenty Region is secondary. Within the Whirinaki catchment at least three sites contain areas of secondary totara, typically growing in association with kahikatea. One of these occurs immediately adjacent to Whirinaki, while the other two are situated below Te Whaiti in the

Whirinaki Gorge. These areas are small in size (only several hectares each) though adjoining these areas there is significant scope for further revegetation into kanuka dominant secondary vegetation.

All of these secondary stands are of high ecological significance — they represent the future of totara forest in this part of the region. Without major disturbance, such as fire, they have the capacity to naturally increase in extent as well as develop a more representative composition and structure.

Totara forest in the catchments that drain Te Urewera is even more rare and excluding the relicts in the Waimana River, primarily occurs in the Waiotahi Catchment, at and surrounding the Tukainuka Scientific Reserve. Despite this stand being secondary, it is nationally significant and is the best example of totara forest on an alluvial landform in the Bay of Plenty Region.

5. Recommendations

Conservation management of podocarp forest containing totara, matai and kahikatea, requires a long-term view, given that these trees are capable of living up for many centuries, some up to 1000 years or more. With the massive loss of these ecosystems in the Bay of Plenty Region owing to human exploitation, all remaining examples are ecologically important, irrespective of area of occupancy and tree size. In the long-term secondary podocarp forest is just as, if not more important, for the persistence of these ecosystem types. Fortunately, most of the secondary stands or suitable areas for regeneration occur within conservation reserves and some are under active conservation programmes.

Ngāti Whare are leading the way with restoration of podocarp forest at Whirinaki, however restoration opportunities also occur elsewhere. Regionally, the upper Waiotane Catchment is the next most important area where a range of management activities could occur. Suitable land, which would be ideal for podocarp forest restoration occurs within the Tukainuka Scientific Reserve and the Waioeka Conservation Area. These clearings are large and are currently dominated by bracken, rank grass and blackberry which could easily be cleared and planted into a nurse crop of manuka, kanuka and suitable podocarps. Natural podocarp regeneration will rapidly occur under manuka and kanuka resulting in a more natural stand than if planted entirely. Restoration of riparian margins on private land, downstream along the Waiotane River and sub-catchment streams, for soil and water protection purposes would also improve the connectivity between these remaining remnants.

Given the current government's focus to plant a billon trees and the generous subsidises to plant natives, restoration of these areas should be seen as a very high priority for enhancing totara forest. This is likely to be substantially subsidised by government afforestation grants for carbon sequestration.

The aerial survey was very useful in identifying sites and major types, but has not provided the next level of detail, such as current threats and management required. On conservation land, improving knowledge principally sits with the management agencies responsible. At Whirinaki improved understanding of the ecosystem pattern, especially to better define MF10 and MF11 types is a high priority.

Elsewhere knowledge gaps remain about the distribution, composition and structure of podocarp forest within the region, especially where natural regeneration is or isn't occurring within secondary vegetation. This project has identified that most remaining remnants along alluvial terraces, are dominated more by kahikatea (often with either matai and or rimu) while totara is extremely restricted in distribution. Surveying defined catchment areas or rohe (as described in the sections of this report) focusing on better mapping and describing ecosystem pattern and condition, assessing threats and management needs is recommended rather than focusing on specific types.

Given the complex landownership of Maori land involved, treaty settlements and the desire of Maori to participate in conservation, an essential component of any future surveying and conservation will involve early consultation and engagement with landowners and mana whenua about the value and management needs of these areas. For this reason, it is recommended that catchments (rohe) be the focus for this work. The priorities are; Waiotahi, Waimana, Kereru–Raukokore, Rangitaiki–Whirinaki.

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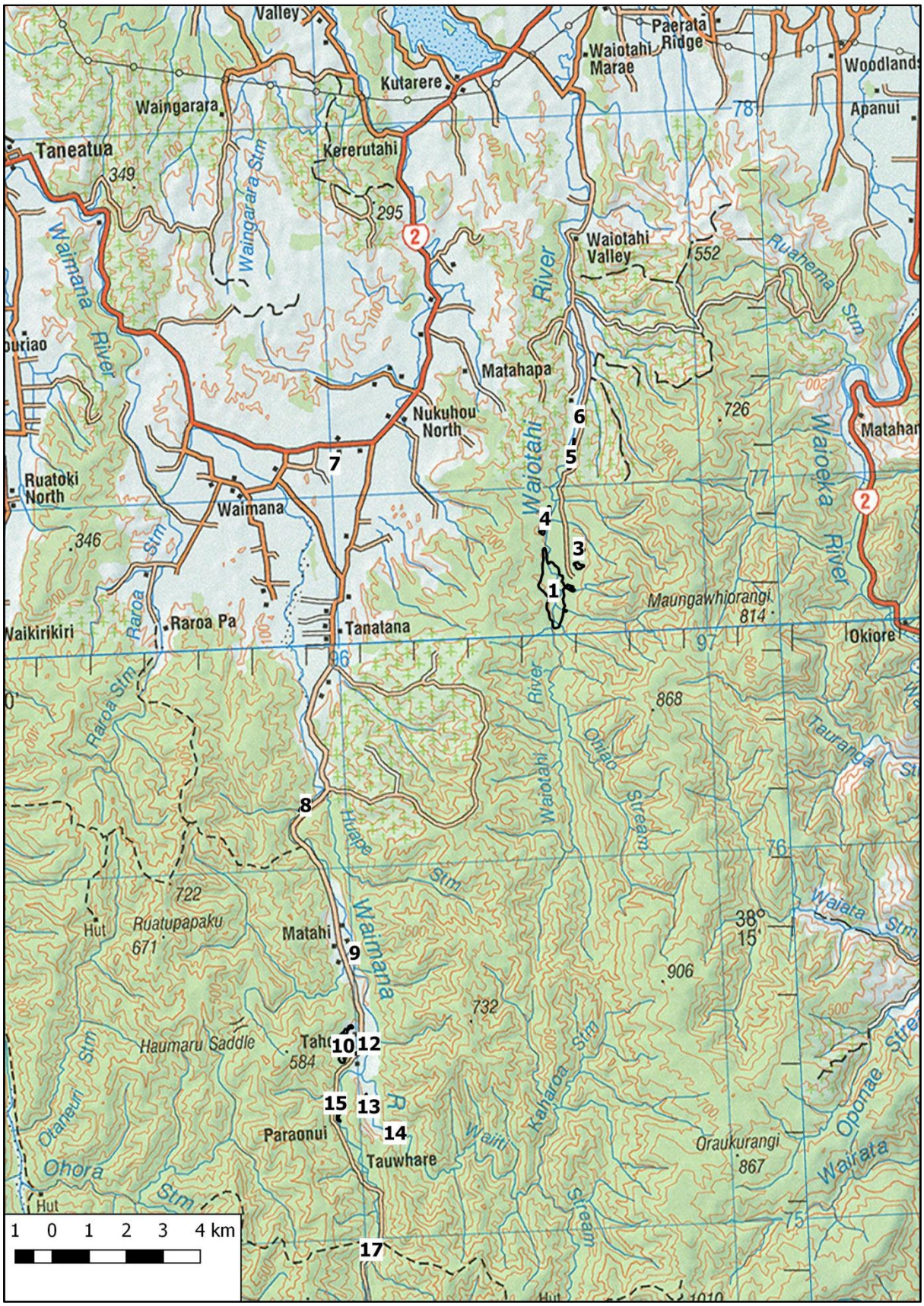
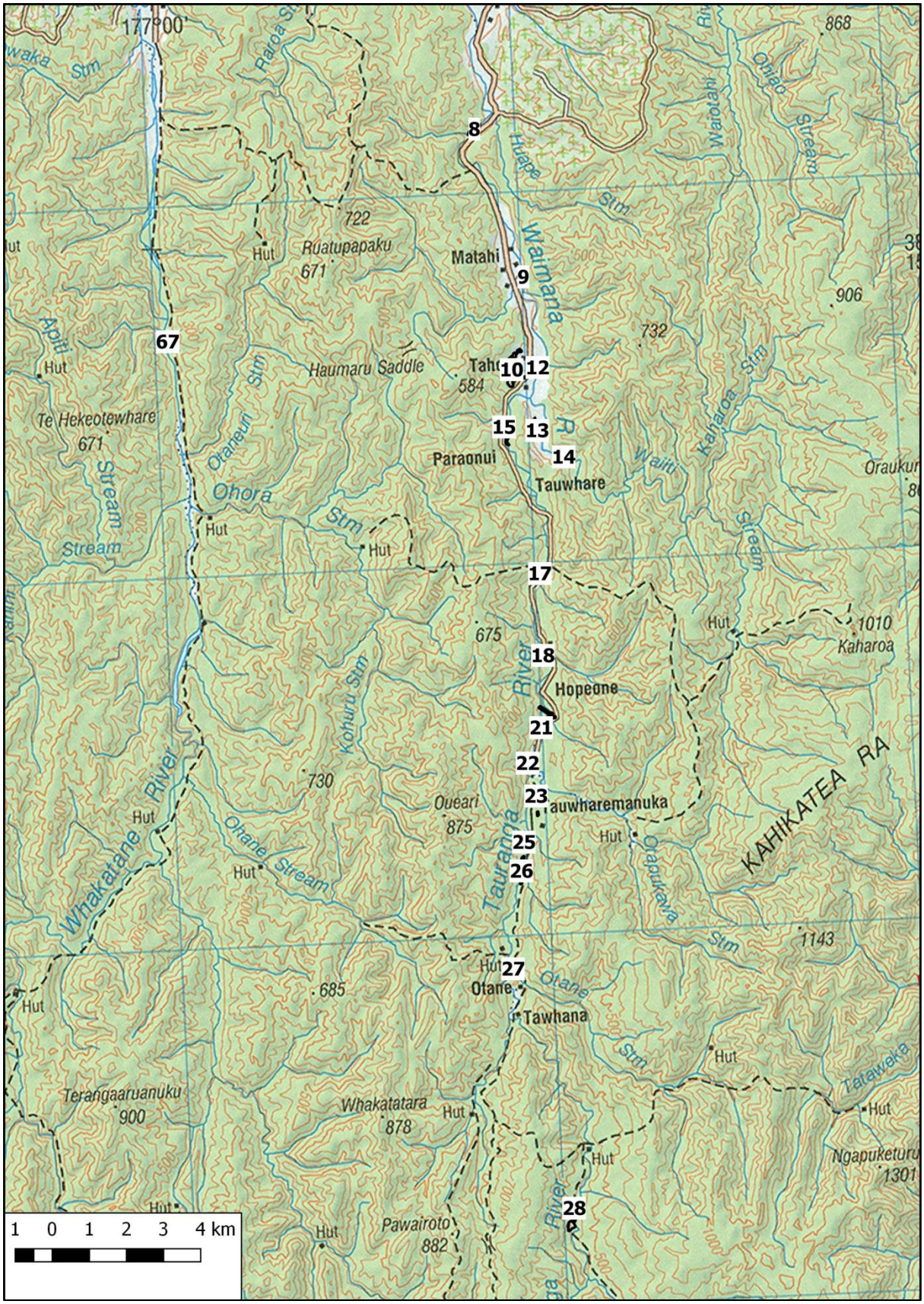
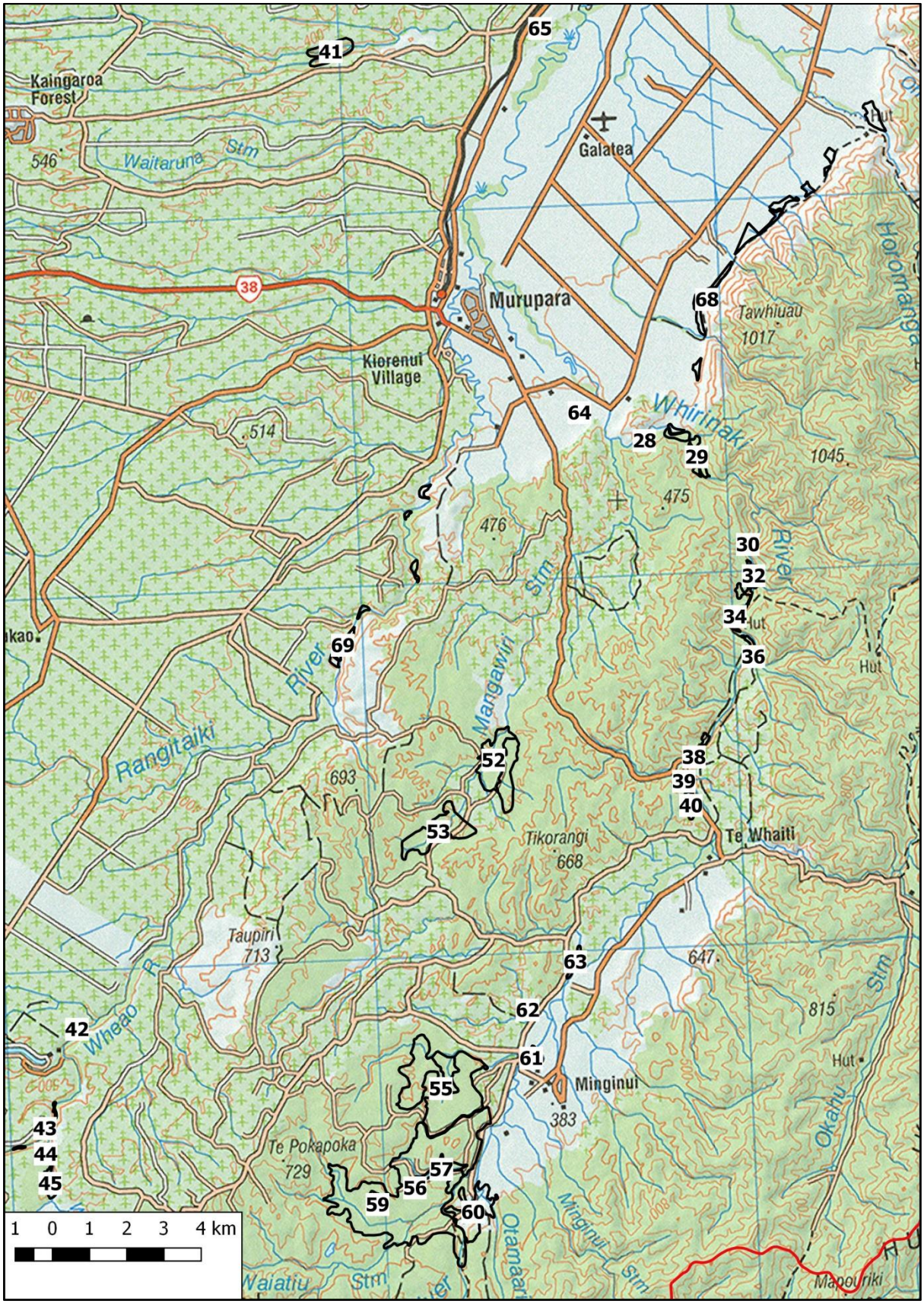
Appendix 1 – Maps of podocarp forest or suitable podocarp landforms assessed



Preliminary assessment of totara forest in the Bay of Plenty Region. Prepared for the Bay of Plenty Regional Council. © Nicholas Singers Ecological Solutions Ltd. NSES Ltd Report Number X: 2018/19, January 2019.


177°00'
8
9
67
10
12
15
13
14
17
18
21
22
23
25
26
27
28
Matahi
Paraonui
Tauwhare
Hopeone
Tauwharemanuka
Otane
Tawhana
Haumaru Saddle
Ruatupapaku
671
722
584
675
730
875
685
878
882
900
906
732
868
1010
1143
1301
Kaharoa
KAHIKATEA RA
Waimana River
Whakatane River
Tauarana River
Ohora Stm
Ohane Stream
Oraukawa Stm
Kohuru Stm
Waiiti Stream
Kaharoa Stm
Te Hekeotewhare
Apiti
Hut
1 0 1 2 3 4 km


65
41
Kaingaroa Forest
546
Waitaruna Stm
Galatea
Hut
38
Murupara
68
Tawhiuau
1017
Horomanga
Kiorenui Village
64
514
Whirinaki
28
29
1045
475
476
30
River
32
Stm
34
Hut
69
River
Mangawiri
36
Hut
Rangitaiki
52
38
693
39
40
53
Tikorangi
668
Te Whaiti
Taupiri
713
63
647
Stm
62
815
42
Wheao R
61
Hut
55
Minginui
383
43
Te Pokapoka
729
44
57
56
45
59
60
Otamaari
Minginui Stm
Waiatiu Stm
Mapoririki
1 0 1 2 3 4 km


Kopongatahi Pt
Whangaparaoa
Whangaparaoa Bay
Orete Point
15
Otamaroa
Waihau Bay
Taratuia Point
Oruaiti Beach
Raukokore
402
Papatea Bay
Papatea
Whanarua Bay
289
Whanarua Bay
Mangairoa
495
Mangahinatore Stm
Waikura
Raukokore R
Te Waiti Stream
Maraehako Stm
361
495
35
686
Pohueroro Stream
Mokuku Stm
785
Kereu River
48
49
51
50
46
47
Kaikoura
884
810
766
678
Ngahore
836
Kereu River
Waikakariki River
Pukerimu
942
Wharehinu
944
Hut
Rangipoua
1054
Hauhauponamu Stream
Raukokore River
1405
Potts Peak
1428
Whanokao
1618
1 0 1 2 3 4 km

Appendix 2: Attribute data for podocarp forest or suitable podocarp landforms assessed

Site id	Site Name	Vegetation Type	Potential Ecosystem unit	Vegetation Structure	Forest Type (Nicholls 1966-1969)	Surveyed
1	Tukainuka Scenic Reserve	Totara dominant with some rimu, matai & tanekaha	WF2	Secondary	L1; Rimu, miro, matai, totara, kahikatea	Aerial
2	Kahikatea Pa	Pole kahikatea	WF8	Secondary		Aerial
3	Kahikatea Pa	Pole kahikatea, some rimu, tanekaha	WF8	Secondary		Aerial
4	Kahanui Village	Pole totara & tanekaha, kahikatea, rimu	WF2	Secondary		Aerial
5	Motumakau	Pole totara, kahikatea	WF2/WF8 Mosaic	Secondary		Aerial
6	Motumakau	Mostly pole kahikatea	WF8	Secondary		Aerial
7	Nukuhou River	Pole kahikatea	WF8	Secondary		Aerial
8	Omuriwaka Marae	kahikatea, pukatea/ nikau forest	WF8, Kahikatea, pukatea forest	Secondary	N3; probably an error	Aerial
9	Matahi	Kahikatea, pukatea, tree fern	WF8	Secondary		Aerial
10	Whakarae Pa #1	Pole kahikatea	WF8, Kahikatea, pukatea forest?	Secondary		Aerial
11	Whakarae Pa #2	A few pole kahikatea		Secondary		No
12	Whakarae Pa #3	Pole kahikatea		Secondary		No
13	Waiiti Stream	Kahikatea (Pole). Totara on hillslope	MF4	Secondary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
14	Waiiti Stream	Kahikatea (Pole)	MF4	Secondary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
15	Omananui Stream	Alluvial kahikatea, rimu, pukatea, tawa	WF8 or MF7.3	Modified primary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
16	Omananui Stream	Alluvial kahikatea, rimu, pukatea, tawa	WF8 or MF7.3	Modified primary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial

Site id	Site Name	Vegetation Type	Potential Ecosystem unit	Vegetation Structure	Forest Type (Nicholls 1966-1969)	Surveyed
17	Pohatuatua Stream	Kahikatea (Pole stand)	MF4	Secondary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
18	Te Urewera Outdoor Centre	Kahikatea, matai, totara	MF4	Secondary		Aerial
19	Tauranga River loop	Kahikatea, totara, kanuka	MF4	Secondary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
20	Omutu Stream	Kahikatea (Pole stand)	MF4	Secondary		Aerial
21	Wharetoa Stream	Kahikatea (Pole stand)	MF4	Secondary		Aerial
22	Otapukawa Stream confluence	Kahikatea, matai, rimu forest	MF4	Modified secondary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
23	Orouahineuru Stream terrace	Totara (Pole stand)	WF2	Secondary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
24	Orouahineuru Stream terrace	Kahikatea, matai	MF4	Secondary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
25	Tuwharemanuka	Kahikatea (Pole stand)	MF4	Secondary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
26	Tuwharemanuka	Kahikatea, rimu, matai	MF4	Primary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
27	Otane	Totara, matai, kahikatea		Secondary		Aerial
28	Lower Whirinaki Gorge	Rewarewa, kanuka, totara forest	MF10	Secondary		Aerial
28	Upper Tauranga River	Kahikatea, matai, rimu, totara	MF4	Primary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
29	Upper Tauranga River	Kahikatea, matai, rimu, totara	MF4	Primary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
29	Lower Whirinaki Gorge	Kanuka, rewarewa	MF10	Secondary		Aerial

Site id	Site Name	Vegetation Type	Potential Ecosystem unit	Vegetation Structure	Forest Type (Nicholls 1966-1969)	Surveyed
30	Ariki Tuhoe cliffs	Kahikatea, rimu, matai, totara	MF11.4 Kahikatea, rimu forest	Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
30	Upper Tauranga River	Kahikatea, matai, rimu, totara?	MF4	Primary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
31	Maraetahia Stream	Kahikatea, rimu, matai, totara	MF11.4 Kahikatea, rimu forest	Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
32	Whakaruaki Stream	Kahikatea, rimu, matai, totara	MF11.4 Kahikatea, rimu forest	Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
33	Terrace north of Okui Hut	Pole kahikatea, totara	MF11.4 Kahikatea, rimu forest	Secondary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
34	Okui Hut Flat	Kahikatea, rimu, matai, totara	MF11.4 Kahikatea, rimu forest	Modified primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
35	Okui Hut Track	Pole kahikatea, minor totara	MF11.4	Secondary	N2	Aerial
36	Mangakino Stream	Kahikatea & some matai, rimu, totara	MF11.4 Kahikatea, rimu forest	Modified primary	N2	Aerial
37	Rorokuri Stream	Kahikatea & some matai, rimu, totara	MF11.4 Kahikatea, rimu forest	Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
38	Hukanui Stream	Kahikatea & some matai, rimu, totara	MF11.4 Kahikatea, rimu forest	Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
39	Pukerimu North	Kahikatea, rimu, matai	MF11.4 Kahikatea, rimu	Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial

Site id	Site Name	Vegetation Type	Potential Ecosystem unit	Vegetation Structure	Forest Type (Nicholls 1966-1969)	Surveyed
			forest			
40	Pukerimu South	Kahikatea, rimu, matai	MF11.4 Kahikatea, rimu forest	Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
41	Oruatewhehi Forest	Relict large kahikatea in gully, tawa	MF7	Modified primary	M2; Rimu, matai, kahikatea, tawa, kamahi	Aerial
42	Whaeo Power house	Kahikatea, matai (minor totara, rimu)	MF10	Logged Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
43	Wheao	Kahikatea, matai, rimu (minor totara)	MF10	Logged Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
44	Wheao	Kahikatea, matai (minor totara, rimu)	MF10	Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
45	Wheao	Kahikatea, matai (minor totara, rimu)	MF10	Primary	L2, Rimu, kahikatea/miro, matai, totara	Aerial
45	Wheao	Tawa forest	MF7	Primary		Aerial
46	Kereru River #1	Probably secondary kahikatea & pukatea	WF8?	Modified primary		No
47	Ponuiahine	Treeland inc. kahikatea, pukatea, tawa?	WF8?	Secondary		No
48	Kereru River #2	Pole kahikatea	WF8?	Secondary		No
49	Raukokore River #1	Kahikatea, pukatea and secondary spp.?	WF8?	Modified primary		No
50	Raukokore River #2	Kanuka, manuka and secondary kahikatea?	WF8?	Secondary & modified primary		No
51	Raukokore Oxbow	Emergent kahikatea, pukatea	WF8	Primary		No

Site id	Site Name	Vegetation Type	Potential Ecosystem unit	Vegetation Structure	Forest Type (Nicholls 1966-1969)	Surveyed
52	Mangawhiri Basin North	Matai, rimu and tawa	MF10-MF11 transition	Primary	L2, Rimu, kahikatea/miro, matai, totara	No, type map & plot data
52	Mangawhiri Basin North	Matai, totara, kahikatea, rimu	MF10	Primary	L2, Rimu, kahikatea/miro, matai, totara	No, type map & plot data
53	Mangawhiri Basin South	Matai, totara, rimu	MF10	Primary	L2, Rimu, kahikatea/miro, matai, totara	No, type map & plot data
54	Tauranga Stream	Matai, rimu, totara, kahikatea, miro)	MF10	Primary	L1; Rimu, miro, matai, totara, kahikatea	No, type map & plot data
55	Tauranga Stream	Matai, rimu, kahikatea, tawa	MF11	Primary	L2, Rimu, kahikatea/miro, matai, totara	No, type map & plot data
56	Waiparera Stream	Matai, rimu, kahikatea, tawa	MF11	Primary	L2, Rimu, kahikatea/miro, matai, totara	No, type map & plot data
57	Waiparera Stream	Matai, rimu, totara, kahikatea, miro)	MF10	Modified primary	L1; Rimu, miro, matai, totara, kahikatea	No, type map & plot data
58	Waiparera Stream	Secondary mixed broadleaved	MF10	Secondary		No
59	Waiparera Stream	Secondary kamahi	MF11	Secondary	P, General hardwoods	No, type map
60	Whirinaki River Terrace	Broadleaved secondary podocarp mosaic	MF10	Secondary	P3	No

Site id	Site Name	Vegetation Type	Potential Ecosystem unit	Vegetation Structure	Forest Type (Nicholls 1966-1969)	Surveyed
61	Middle Whirinaki River	Weedy, inc. hawthorn, willow, blackberry	WF2			No
62	Wahaoteana & Pareanui Streams	Matai, kahikatea, rimu riparian margin	MF11 poss. 11.4	Modified primary	L2, Rimu, kahikatea/miro, matai, totara	No
63	Lower Okahu Stream	Matai, kahikatea, rimu	MF11 poss. 11.4	Modified primary	L2, Rimu, kahikatea/miro, matai, totara	No
64	Troutbeck Rd. Murupara East	Secondary podocarps	MF10	Secondary		Aerial
65	Fort Galatea	A few pole kahikatea on wetland edge	MF4	Secondary		From road
66	Ngatamawahine Stream	Relict pole totara in pine	WF2	Secondary		From road
67	Tapuaeharuru Stream Terrace	Unknown, kahikatea apparent from image	?	Secondary	D3, Rimu, tawa	No
68	Lower Galatea faces	Kanuka, bracken, potential podocarp site	MF10			Aerial
69	Rangitaiki River Flats	Pine, treefern, broadleaved. Potential	MF10	Secondary		No