Integrating dairy and hill country farming with forestry for profitable and sustainable land use

Case Study 5: Ngāti Awa Farms Ltd

Report prepared by
Perrin Ag Consultants Ltd

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Executive Summary

- This report explores the process involved with making forestry planting decisions that are aligned with a landowner's objectives. Three scenarios were analysed showing:

i. The implications for a landowner deciding to replant existing *Pinus radiata* rotations with an alternative species.
ii. Replanting decisions for underutilised non forest land and their relevance to funding or grant programmes and the Emissions Trading Scheme (ETS).
iii. How riparian planting for landscape enhancement and sustainability can be planned to meet eligibility criteria similar to the recent One Billion Trees programme and the Emissions Trading Scheme.

- Te Rūnanga o Ngāti Awa, through their farming company Ngāti Awa Farms Ltd, own an 1,117 hectare drystock hill country sheep and beef breeding and finishing unit surrounding the Whakatāne Township in the Eastern Bay of Plenty. They are also majority shareholders in a partnership with other hapū trusts in a 204 hectare dairy unit near Te Teko on the Rangitāiki plains and a 340 hectare dairy unit near Rotomā.
- Ngāti Awa have stands of *Pinus radiata* on their drystock property that they have identified for replanting in alternative species. Some sites are unsuitable for pine and they do not see pine forestry as a core business for their farms as they already have significant pine forestry investments elsewhere.
- Ngāti Awa actively seek to reduce the environmental footprint of their farming operations and farm in a sustainable manner. Options for retiring land that enhances their properties from an environmental, financial, aesthetic and cultural viewpoint are actively considered.
- The visions, goals and values of Ngāti Awa Farms Ltd encompass that of the traditional Māori values of mana, mauri, whakapapa and tapu. They are central to Ngāti Awa's relationship with the natural environment and are also interconnected with the iwi's other social and cultural values. These values form the decision making framework for business strategy and policy decisions.
- The criteria for identifying and selecting potential planting sites referenced the strategy and values of Ngāti Awa. A total of 11 individual sites were identified across the three properties. Species selection was based on the mantra of "right tree, right place" with more weighting placed on species that could resonate with Ngāti Awa values and provide landscape enhancement, cultural value and ongoing employment for hapū through silviculture or alternative income streams.
- The species chosen were totara (*Podocarpus totara*) and coast redwood *(Sequoia sempervirens*) for timber production. Mānuka (*Leptospermum scoparium*) and kawakawa (*Piper exelsum*) were chosen as cover crops to colonise the bare land prior to planting timber species. Mānuka was also chosen as a single species on one site for mānuka oil production.
- Three scenarios were chosen from the site and species options to examine, at a high level, the process and implications for replanting current forest areas in alternative species (scenario 1), identifying and planting riparian areas (scenario 3) and planting options for underutilised land (scenario 2).
- Pōhutukawa *(Metrosideros excels)* and kahikatea *(Dacrycarpus dacrydioides)* were chosen as alternatives to the above mentioned timber species; their main attributes being aesthetics and cultural value. Modern cultivars of poplar (*Populus genus*) were selected for erosion control and a mixture of native species for riparian planting or landscape enhancement.

- Scenario 1 highlighted that the decision to replant *Pinus radiata* with alternative species has implications surrounding carbon liability and future carbon earning potential depending on the forest's age, species and definition within the ETS framework. A clear advantage was identified for native forests using the Field Measurement Approach (FMA) method for measuring carbon stock compared to the MPI default lookup tables. The potential premium of carbon credits from native forests were discussed as was the alternative income streams from honey and the medicinal value of mānuka and kawakawa cover crops.
- The outcome of scenario 2 was that despite meeting most of the criteria the same as the One Billion Trees programme and ETS criteria, mānuka planting for oil production was not eligible for inclusion in the ETS as the mānuka would be managed in a way, through the harvesting of foliage, that would limit forest height and canopy cover. There was potential to replace the barberry hedgerows on the Ngakauroa Dairy unit with mānuka; harvesting the foliage would allow the centre pivot irrigator to pass over and the mānuka trees would provide stock shelter and an aesthetic value.
- Scenario 3 examined potential riparian planting sites. Two examples from the Ngāti Awa drystock property were used to show that riparian planting for landscape enhancement and sustainability, if planned correctly, can meet the objectives of funding programmes and the ETS.
- This case study has shown that the decision to replant pine forest with alternative species can be complex with implications around carbon liability and future carbon earning potential depending on how the pine forest is defined within the ETS, the subsequent forest species rotation and the methodology used to measure carbon stock. Due to this complexity landowners are advised to seek the relevant professional advice when making replanting decisions.
- This is equally important when undertaking a financial analysis on planting options, it was considered beyond the scope of this report yet due to the expense of planting trees and long term nature of the investment, the need for a robust plan and financial analysis cannot be emphasised enough.
- Replanting pine with natives or coast redwood is an intergenerational investment due to the long rotation length (80 - 120 years for natives, 50 years or greater for redwood heartwood production). An investment analysis must account for other inherent benefits (including cultural, biodiversity and landscape enhancement benefits) when comparing the investment against shorter *Pinus radiata* term rotations.

CONTENTS

Introduction

The Integrated Farm Forestry Systems project is a multi-agency funded research and extension project, led by Te Uru Rākau and co-funded by DairyNZ, the Waikato, Bay of Plenty and Horizons Regional Councils, Living Water (DOC-Fonterra Partnership), Farmlands Co-operative and the Forest Growers Levy Trust.

The project is being delivered by Perrin Ag and PF Olsen researchers in collaboration with farmer (dairy and sheep & beef cattle) and industry groups. The project aims to address key issues associated with increasing adoption of forestry within farm business and provide land owners, iwi and rural professionals with the information they need to help land owners make well-informed forestry enterprise decisions and increase their confidence in implementing forestry as a land-use option.

One of four key phases of the project is completing a diverse range of farm case studies (including iwi-owned) to illustrate the impact of integration of various forestry options into existing pastoral farming systems. This follows on from a series of farmer interviews that were completed in 2019 to gain an in-depth insight into farm forestry practices, views and knowledge, and enablers and barriers to integrating forestry into pastoral farming businesses (Dooley et al. 2020).

For this component, a range of complementary, integrated farming and forestry enterprises have been evaluated with six Waikato/Bay of Plenty cases and four Rangitikei individual cases. Case studies cover a variety of primary land uses (e.g. dairy, sheep & beef cattle, deer). Forestry options include *Pinus radiata*, Douglas fir, mānuka and apiculture, PFSI (permanent forest sink initiative) forests for carbon and biodiversity, short rotation exotic species (including high stocking rate special purpose radiata pine for wood fibre supply) poplar space planting, and totara for timber. Case studies have been selected on their potential to demonstrate enhanced business and environmental performance and to ensure questions and knowledge gaps identified in Phase 1 of the project are explored. Once completed, the case studies will be publicly available on-line and the findings disseminated amongst farmers and rural professionals through a series of workshop and field days.

This case study, Ngāti Awa Farms Ltd, comprises a sheep and beef farm and two dairy units in the Eastern Bay of Plenty region. It explores the potential of forestry to offset environmental externalities, improve financial resilience and enhance productivity as well as meet Ngāti Awa's financial, cultural and social goals and visions.

Methodology

For this phase of the project, a long list of case studies were identified through the researcher's professional networks and local project steering groups. The final case studies were confirmed after evaluating the specific opportunities and challenges for each property against the key questions and knowledge gaps identified in Phase 1, as well as ensuring appropriate regional and sector diversity. Ngāti Awa Farms Ltd are one of the six Waikato/Bay of Plenty case studies analysed.

PROCESS

A property inspection was conducted at Ngāti Awa Farms Ltd on 18 June 2020, in which the landowners' interest and preferences for integrating forestry into their existing business was explored, the suitability of potential sites evaluated and information about the exiting farm and forestry activities was captured. A standardised data capture method adapted from the DairyNZ Whole Farm Assessment (Dairy NZ, 2016) process was used to ensure consistency in this process between case studies.

As part of this process the farm property was mapped and analysed in ARC GIS software. This was done in order to identify the geo-physical differences of areas of the property identified for afforestation. This is needed to both ascertain the impact on aggregated pasture production of changing land use and identify forest growth potential.

Appropriate afforestation scenarios for integration to the existing land activities were developed in association with Ngāti Awa Farms Ltd Species selection was guided by the overarching values of Te Rūnanga o Ngāti Awa with more weighting placed on options that connected with these values. This ensured that scenarios aligned with Ngāti Awa's objectives and were of interest to them.

A financial investment analysis was considered beyond the scope of this case study with scenario's instead focussed on high level analysis in regard to the process and outcomes of the decision making involved with afforestation. Potential implications in regard to ETS legislation and were also discussed including testing some scenarios for the eligibility of ETS and funding schemes.

Section 1: Farm and business description

INTRODUCTION

Ngāti Awa is a tribe comprised of 22 hapū or sub tribes that trace their ancestry back to an eponymous ancestor Awanuiārangi II, great grandson of Toroa the chief of the Mataatua waka that arrived at Kakahoroa (original name for Whakatāne) from Hawaiki.

The Ngāti Awa rohe or territory extends from Motiti Island and Maketu in the west to and then inland following the Pongakawa stream to Lake Rotoehu, the Rotoehu forest in the south before following the Rangitāiki River to Matahina, across the Whakatāne river catchment and Tāneatua and then finally following the Nukuhou River out to the Ohiwa harbour.

Figure 1: Ngāti Awa Rohe (source Te Puni Kōkiri)

Following a 2005 settlement with the Crown to recognise historical breaches of the Treaty of Waitangi, Te Rūnanga o Ngāti Awa was established as a post settlement governance entity to receive and administer the settlement redress for and on behalf of Ngāti Awa.

Ngāti Awa Farms Ltd is the landholding company for Ngāti Awa Group Holdings Ltd, the asset owning arm which manages the commercial and economic activities of Te Rūnanga o Ngāti Awa.

Ngāti Awa Farms Ltd own a 1,117 hectare drystock property that surrounds the Whakatāne Township and are majority shareholders in a partnership with other hapū trusts in two dairy farms, Ngakauroa, a 204 hectare effective property on the Rangitāiki plain near Te Teko and Tumurau, a 340 hectare effective property on Braemar Road, 2km north of Rotomā. Apart from farmland Ngāti Awa Group Holdings Ltd also has financial interests in managed funds investment, forestry, commercial property, fisheries, fishery quota and a tourism venture. These three farms are shown in Figure 2, Figure 3 and Figure 4 and in order to distinguish them for the purposes of the case study they will be referred to as “Ngāti Awa Drystock”, “Ngakauroa Dairy” and “Tumurau Dairy”.

BUSINESS STRATEGY

The visions, goals and values of Ngāti Awa Farms Ltd encompass the overarching values of Te Rūnanga o Ngāti Awa. The traditional Māori values of mana, mauri, whakapapa and tapu are central to Ngāti Awa's relationship with the natural environment; they are also interconnected with the following social and cultural values:

- Mauri ora (independence, resources and sustainability)
- Toi ora (health and wellbeing)
- Tūrangawaewae (culture and identity)
- Tū Pakari (leadership and hapū unity)

These values form the decision making framework for business strategy, policy, vision and goals for Ngāti Awa Farms Ltd In the context of Ngāti Awa Farms Ltd, apart from the economic benefits, the farms are also a gateway for bringing people to the land and giving a sense of ownership and belonging or tūrangawaewae.

VISION AND GOALS

- Have successful and sustainable businesses that are not only economic but follow the values of Ngāti Awa
- Establish initiatives that create employment for Ngāti Awa people
- High levels of health and education
- Environmental stewardship providing Kaitiakitanga
- Share innovative ideas with other iwi

Figure 2: Ngāti Awa drystock aerial map with property boundary (bold blue line)

Figure 3: Ngakauroa dairy unit aerial map with property boundary (bold blue line)

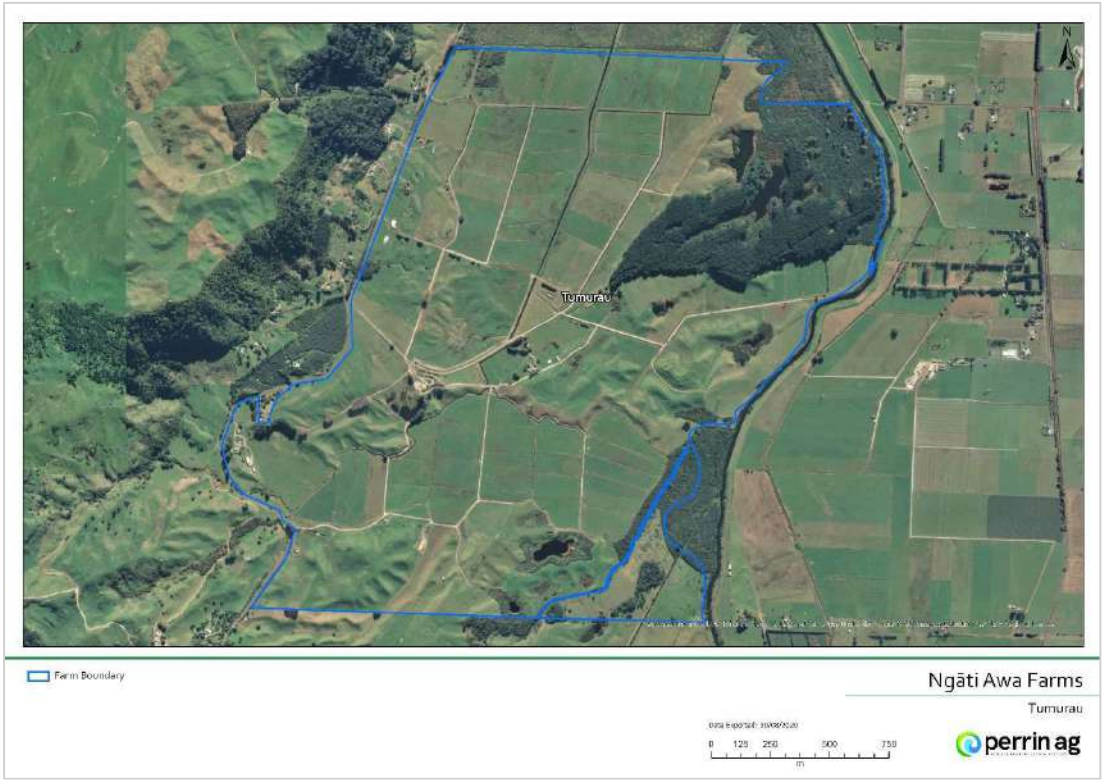

Figure 4: Tumurau dairy unit aerial map with property boundary (bold blue line)

FARM DESCRIPTION

Ngāti Awa Farms Ltd comprises of a drystock unit at Whakatāne, “Ngakauroa” a 600 cow dairy farm near Te Teko and “Tumurau” a 900 cow dairy farm near Rotomā.

NGĀTI AWA DRYSTOCK FARM

A 1,117 hectare hill country breeding and finishing property surrounding the township of Whakatāne and Ōhope beach settlement. The farm consists of 770 hectares effective pasture and is split into three blocks separated by native bush or town boundary. A stock underpass and interconnecting laneways through reserve land allow for the blocks to be managed as a single unit. The property winters 1,500 Romney ewes and replacements with the majority of the lambs finished on summer crop. Approximately 235 Angus cows plus replacements are carried with all progeny retained as well as extra young cattle purchased to total 540 trade cattle wintered.

Figure 5: Ngāti Awa drystock property (*area 1 on farm map, figure 1*) overlooking Kohi point and Ōhope beach settlement in background

The topography includes numerous gully heads and stream catchments and, as a consequence, topography ranges from steep faces, easy and rolling hill to small areas of flat valley floors.

The majority (84%) of the land is north facing, nearly half of the property is classified by Overseer slope category as steep (>26°), 23% easy hill (16-25°) and the balance evenly split between flat (0-7°) to rolling (8-15°) country.

The soils on the valley floors, which form the productive flat land on the property, can be categorised as weathered fluvial recent soils (e.g. Galtymore_5a.2). These loam soils are characterised as being weakly developed with generally good drainage unless waterlogged when pugging can become an issue.

Traditionally the property is summer dry and experiences a wet winter and spring. This is managed by a flexible stock policy and managing wetter areas by grazing smaller stock classes (e.g. sheep and young cattle).

The soils on the easy to rolling country are mainly pumice soils (Orang_2a.2) formed from Taupō and Kaharoa ash, and are the most common soils on the property. The topsoil is typically sandy allowing good rooting depth, drainage, has good water holding capacity, but has a moderate risk of erosion if disturbed.

The steep areas contain steepland soils associated with allophanic pumice as well as tephric recent soils which consist of volcanic material overlying sandstone rock (Ngātiawa_3a.1). This rock often lies less than one metre below the weakly structured soil profile and impedes the rooting depth of plants and trees. The loamy topsoil has good drainage and water holding capacity until the soil profile reaches the impermeable rock. Once the soil becomes waterlogged there is a moderate risk of erosion.

Three streams flow through the property and out into the Whakatāne township and Ohiwa and Ōhope harbours. These sensitive areas and any wetlands have been riparian fenced with further tributaries identified for future fencing. Poplars have been planted on erodible land and there are existing pine woodlots on small steep areas that are ready for harvest. Regenerating native bush has been fenced off and an erodible gully head has been planted in mānuka.

Ngāti Awa Drystock is surrounded by the towns of Whakatāne and Ōhope, and parts of the farm are opened up to community groups for events as well as year-round access provided to a network of walking and cycling tracks. This public exposure reinforces the requirement for the property to do the right thing environmentally, not only by Te Rūnanga o Ngāti Awa's standards but also from the perception of the general public.

NGAKAUROA DAIRY

A 204 hectare (202 hectares effective) spring calving dairy unit peak milking 670 cows. The farm is stocked at 3 cows/ha and operates as a DairyNZ system 3, young stock are grazed off farm and approximately 340 cows are grazed off over winter. Supplements include 16T of Palm kernel expeller and 10 hectares of maize grown on farm as well as purchased hay and grass silage to fill autumn and spring feed deficits. Production for the 2019-20 season was 230,412 kg MS (344 kg MS/cow or 1,141 kg MS/ha).

The property is situated on the Rangitāiki plain and is flat in contour. Nearly all the effective area is used as dairy platform with the exception of 1.5 km of stop bank along the Rangitāiki River used for rough grazing. The majority of the property is a Perch Gley pumice soil (Awakeri_1a.1) characterised by poor drainage, in part due to the flat contour. Fenced open drains transect the farm to provide drainage.

Mean annual rainfall (Edgecumbe) is 1,527 mm. The property is also part irrigated, sourced from the Rangitāiki river, from November to late March with a 68 hectare centre pivot and 25 hectares of lateral irrigation.

TUMURAU DAIRY

A 340 hectare (315 hectares effective) spring calving, system 2, dairy farm peak milking 850 cows. The farm is stocked at 2.7 cows/ha with all young stock grazed off and approximately 300 cows off the platform over winter.

The contour is approximately 50% flat and 50% rolling pumice hillocks. In contrast to the well-drained pumice hillocks (Taupō_37a.1) the flat land is poorly drained peatland over pumice parent material (Pongokawa_2a.1). The flat land is a former wetland that was drained in the early 20th century, it

contains approximately 27.5 km of fenced drains and canals with 79 stock crossings. The drains and canals either flow directly into the Tarawera River on the eastern boundary or into the Tumurau wetland on the northern boundary. There are also numerous freshwater springs throughout the property that are all fenced and make up 20.6 hectares of riparian area. The farm has 5 pivots on the flats and some K line irrigation on the pumice hillocks; in total irrigation covers approximately 285 hectares.

Figure 6: Tumurau dairy unit

Figure 7: Tumurau dairy unit

CURRENT PLANTINGS

Current plantings mostly consist of radiata pine woodlots on Ngāti Awa drystock, ranging from smaller areas of 3.5–10 hectares on steeper faces and rock features unsuitable for grazing to larger 30–45 hectare plantings on areas that traditionally had a lot of scrub reversion. All but one area of pine is first rotation planting, either recently harvested or due for harvest in the next two years. The area of second rotation forestry is planted in six year old pines, however, poor establishment has led to many open areas that will require replanting.

Figure 8: Maraetotara Road pine plantation (area 4b) currently being harvested

Traditionally poplars have been planted along riparian areas and on erosion prone slopes, however these trees are estimated to be 35 - 40 years old and are becoming a nuisance and a hazard falling onto roads and fences. Recently a stand of poplars have been felled along the Wairere Stream catchment with the area being progressively fenced off and identified for riparian planting.

An area of 27 hectares featuring an erodible gully head and patches of regenerating bush has been planted in mānuka for honey production. Livestock were excluded from this six year old stand during establishment, it is now at a height where rough grazing can be provided for livestock without damaging plants.

The dairy units do not have as many plantings with most of the land utilised for productive grazing. On Ngakauroa there are established plantings around the houses and cowshed for aesthetics. The northern boundary of the farm contains a poplar shelterbelt and there are some barberry hedges which were traditionally planted for aesthetics and stock exclusion. Existing plantings have been limited to an extent by the centre pivot and lateral irrigation that cover a large area of the milking platform.

On Tumurau there are also established plantings around infrastructure such as the cowshed, staff accommodation and some laneways. All of the natural springs and many of the drains have been fenced off and planted in native species. These riparian plantings help reduce nutrient and sediment runoff but also enhance the aesthetic value of the property. Tumurau also has centre pivot and lateral K line irrigation covering much of the dairy platform limiting additional plantings. There are also 220 kVA pylon transmission lines running over part of the property which would limit the height and proximity of tree plantations.

Figure 9: Existing riparian plantings, Tumurau dairy unit

SITE SELECTION CRITERIA

Te Rūnanga o Ngāti Awa hold the perspective that the primary function of the land under Ngāti Awa Farms Ltd is farming and therefore, any areas retired from grazing must maintain or enhance productivity and new and existing plantations must be able to fit around current farming operations.

The site selection criteria can be grouped into three broad categories:

i. Replanting existing woodlots with alternative species
ii. Environmentally sensitive areas
iii. Land that is identified as currently underutilised and may have more value in being planted in trees

REPLANTING EXISTING WOODLOTS WITH ALTERNATIVE SPECIES

On the drystock property smaller pine woodlots were planted in the 1980's and 1990's on largely ungrazeable areas that contained steep terrain, rocky outcrops, or blocks with tracts of regenerating bush. Some of these areas contain archaeological sites which would restrict replanting as growth and future harvest events may cause damage.

Ngāti Awa Group Holdings has a forestry arm Ngāti Awa Forestry Ltd which has significant interest in 8,400 hectares of pine plantations. Therefore, the iwi does not see pine plantation on its farmland as a core interest and would rather look to plant alternative species. Consideration is given to species that not only have a timber value but may also provide an alternative income stream (e.g. carbon, floral honey), create biodiversity and/or have cultural significance.

Poplars, traditionally grown on the drystock farm for erosion control or in riparian areas, have now grown too large for their purpose, posing a hazard with trees and branches falling on roads and infrastructure. Ngāti Awa has identified theses areas of poplars for removal and replanting with an alternative species or modern variety of poplar that is fit for purpose.

ENVIRONMENTALLY SENSITIVE AREAS

Ngāti Awa seeks to reduce the environmental footprint of their farming operations and farm in a sustainable manner. Options of retiring land that enhances their properties from an environmental, financial, aesthetic and cultural viewpoint are actively considered.

Ngāti Awa drystock contains the catchment of three important streams that flow into the Whakatāne, Ōhope and the Ohiwa harbour. These streams (Wairere, Maraetotara, Wainuitewhara) are being progressively fenced off from livestock and riparian planted.

Some erosion prone areas have been retired and planted in mānuka and there is further scope for more plantings provided it doesn't negatively impact on farming operations.

On the dairy units the risk of sediment and microbial pathogen runoff from farm races into adjacent drains is an issue – as highlighted in recent farm environment plans commissioned for each property. This is exacerbated by some stock races having insufficient setbacks from drains. There is an opportunity to reduce runoff with the right plantings between the races and drains, acting as a filter.

UNDERUTILISED LAND

Any land that is underutilised in its current form of livestock farming would be considered for planting. On Ngāti Awa drystock this may include steeper terrain that cannot be grazed effectively or areas where there is already significant scrub reversion and the costs from ongoing weed control outweigh the benefits of keeping that land in pasture. On the dairy property this may include steeper, drier areas of the property that contribute little to annual pasture production (Tumurau) or in the case of Ngakauroa a long narrow area of stop bank currently used for occasional grazing of drystock.

OVERVIEW OF SITES

The sites selected for new plantings for this report include woodlots near harvest or recently harvested areas with regenerating native vegetation. The exception being the existing stand of plantation mānuka which was further utilised as a cover crop for native regeneration.

Table 1 in the appendices gives an overview of the chosen sites including details such as area, slope, aspect, previous cover, planting suggestions and subsequent eligibility for funding grants and ETS.

Figure 10: Ngāti Awa drystock farm showing selected planting areas 1-3

The local climate is characterised as temperate due to the proximity to the coast. Average long-term annual rainfall for Whakatāne and Edgecumbe is 1,189 and 1,376 mm, respectively. Mean annual average temperature is 14 degrees, with Whakatāne experiencing some of the highest sunshine hours nationally. Frosts are site specific to sheltered areas generally inland and winds are predominately of a Northwest – Southwest flow.

Overall, the sites are climatically suited to growing a wide range of species options with the main physical limitations being topographic (slope and aspect). The moderate risk of high rainfall events could pose an erosion risk to seedlings planted on sites with disturbed topsoil (e.g. cutover pine).

Figure 11: Ngāti Awa drystock farm showing selected planting sites 4a – 4c

Depending on the slope and aspect there will be microclimates which favour a particular species option over another. One example are the natural amphitheatre areas on Maraetotara Road recently harvested for pines (areas 4a, 4b, shown in Figure 11.) This area due to being sheltered and southerly facing, is often 3 degrees cooler than Ōhope beach which is only 600 m away.

The aspect of the sites is mainly to the south with the exception of the two larger pine blocks which are to the north and east. Topography of the sites consists of mainly steep faces, however, some areas can be categorised as gully heads while the riverbank area on the Ngakauroa Dairy unit is a gentle, westerly facing slope (area 10, Figure 13). Tumurau Dairy unit has some rolling to steep north facing banks and sidling's identified as possible replanting areas (areas 11a, b and c, Figure 14).

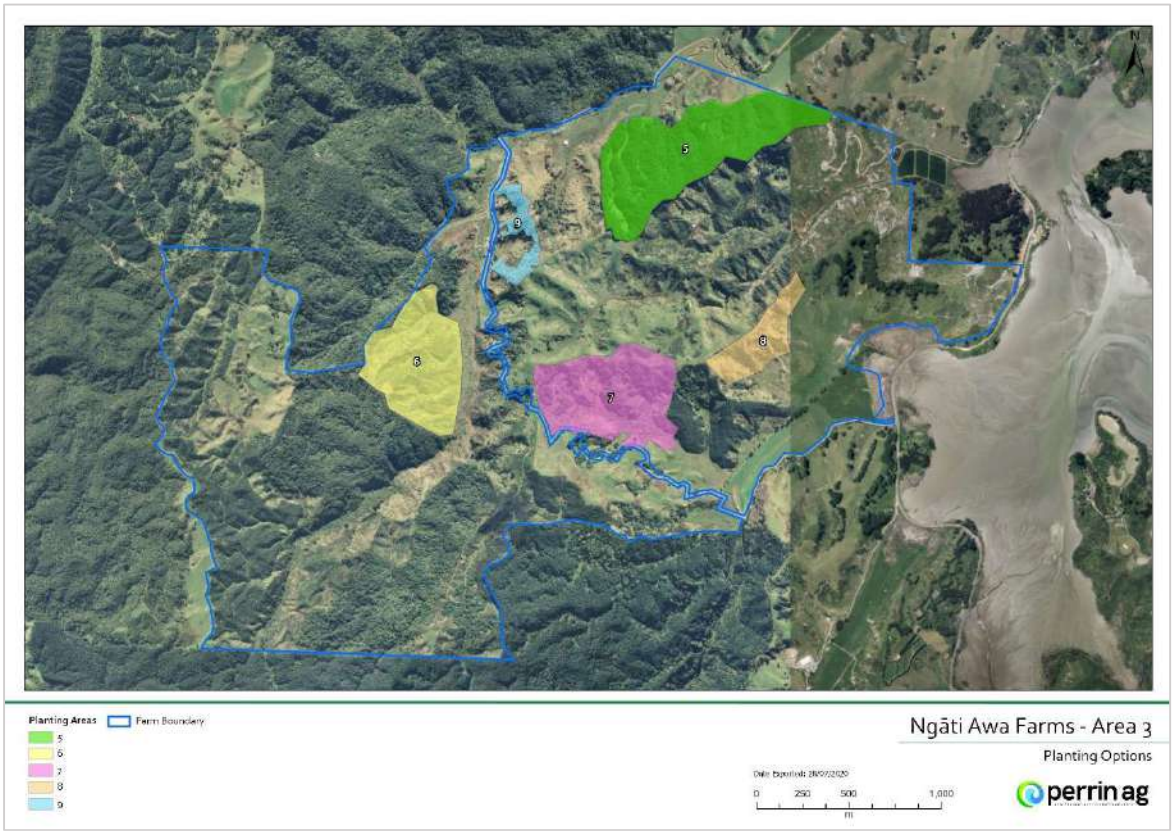

Figure 12: Ngāti Awa drystock farm showing selected planting sites 5-9

Figure 13: Ngakauroa dairy planting site 10

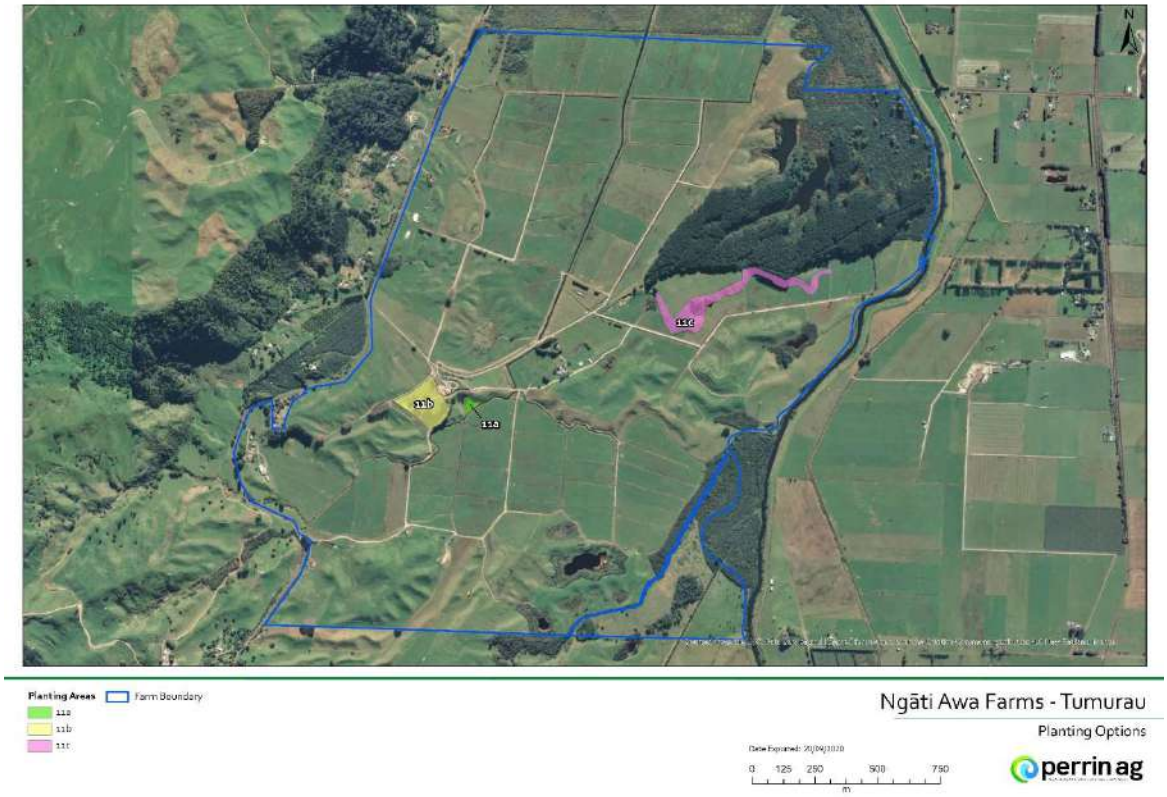

Figure 14: Tumurau dairy planting sites 11a -11c

Section 2: Forestry options

SPECIES SELECTION

Species options were selected based on the concept "right tree, right place, right purpose" and Ngāti Awa's desire to identify suitable alternative options, rather than *Pinus radiata*, for planting new and existing areas. Decisions on species selection are guided by the overarching values of Te Rūnanga o Ngāti Awa – meaning more weighting is placed on species options that interconnect with these values as well as the economic returns, social, cultural and environmental co-benefits. Examples of how a particular species may provide benefits that resonate with Te Rūnanga o Ngāti Awa include:

- Providing ongoing employment for hapū, e.g. silviculture and pest control
- Timber can be used for carving or species may have traditional medicinal properties (i.e. rongoā)
- Enhancing the landscape
- Specific cultural or spiritual significance to Ngāti Awa

THE SPECIES SELECTED

Tree species selected for timber were totara (*Podocarpus totara*) and coast redwood (*Sequoia sempervirens*). Radiata pine (*Pinus radiata*) was not selected as an option, however, was discussed in terms of a comparison species for scenario analysis. Mānuka (*Leptospermum scoparium*) and kawakawa (*Piper exelsum*) were chosen as cover crops to colonise the bare land prior to planting timber species.

Pōhutukawa (*Metrosideros excels*) and kahikatea (*Dacrycarpus dacrydioides*) were chosen as alternative timber species. Modern cultivars of poplar (*Populus genus*) were selected for erosion control and a mixture of native species for riparian planting or landscape enhancement.

TOTARA

Totara was selected as it is a native prevalent in the area, able to grow in a wide range of sites, suitable for timber production and carbon sequestration. Traditionally, totara was prized by Māori as its length, durability and ability to be easily worked made it valued for carvings (whakairo), instrument making, canoes and waka building amongst other uses. European settlers used totara timber for a wide variety of uses including bridges, fence posts, wharf piles and buildings, the heartwood was recognised for its durability in outdoor applications whilst the timber's natural resistance to borer made it popular for structural use in buildings.

Currently totara timber is sourced as 'old wood' from recycled timber for use in decorative interior joinery, or as 'farm totara' from regenerating totara or plantations on private land on a small commercial scale. The Northland Totara Industry Pilot Project (TIPP) is a two year collaborative programme that began in 2019 and is funded by Tanes Tree Trust, Scion, Northland Inc., Te Taitokerau Maori Forestry Inc. and Te Uru Rākau. It has started sustainably milling farm totara in larger commercial quantities and supplying the timber to the Auckland regional market in order to assess and test the entire supply chain with the aim of developing a domestic totara timber industry. A report by Satchell (2016) highlighted there are clear markets for higher grade heartwood and potential markets for sapwood in structural applications which would open up once the known qualities of totara were officially tested against the durability and structural requirements of the New Zealand Building Code.

COAST REDWOOD

Coast redwood has an ability to grow in a range of sites and its timber production and carbon sequestration potential is greater than that of native species. There is a strong traditional demand for redwood timber in California where the species originates from. As a result of dwindling timber supply in their homeland some American foresters, such as the New Zealand Redwood Company, have sought

to establish forests in New Zealand. A potential export market exists for good quality heartwood where redwood is used for a decorative timber due to its dark colour and natural durability for outdoor decking and cladding.

PŌHUTUKAWA AND KAHIKATEA

Pōhutukawa (*Metrosideros excels*) and kahikatea (*Dacrycarpus dacrydioides*) were chosen as further options but timber production is a secondary attribute with their main purpose being biodiversity and landscape enhancement. Pōhutukawa is already prevalent in the costal landscape, and grows well in rocky escarpments. Kahikatea was chosen for its ability to grow in riparian areas and at the base of gullies for erosion control.

MĀNUKA AND KAWAKAWA

A 'pioneer' or cover crop such as mānuka or kawakawa was chosen to be planted with the native timber species. These would colonise bare land, complement any regenerating native regrowth and provide shelter as the timber species grew. Another advantage is the cover crops allow for more rapid carbon sequestration until the slower growing timber species become established. In that time there is opportunity to create income from mānuka honey as well as utilising kawakawa commercially for its medicinal properties.

Ngāti Awa has a pure mānuka stand with hives placed on it by a third party. Annual mānuka honey yields can range from 20 – 40 kg honey/ha with a range of profit share contracts available to land owners. Income from mānuka honey would complement carbon revenue from the mānuka cover crop until seedling tree species eventually become established and form the forest canopy after 15 – 20 years.

Mānuka was also chosen as a single species plantation along the stop bank area of Ngakauroa Dairy unit. The gentle sloping, long narrow area would be ideal for mechanically harvesting mānuka foliage for oil production.

POPLAR

Modern poplar cultivars were chosen to replace the ageing poplar stand, smaller modern varieties such as "Kawa", "Toa" and "Tasman" have the following benefits:

- More upright growth characteristics and smaller crown compared to older varieties.
- Smaller mature height of 20-25 metres and improved disease tolerance.
- Able to be planted in a sleeve with little impact on area taken out of production.
- At 40 stems/ha there is potential to reach 30% canopy at 12 years for carbon income (Eyles, 2010). However, shading effect will reduce pasture production by 25% (Wall, 2006).
- Potential timber value providing form pruning and thinning of trees is carried out.

Certain areas would suit landscape enhancement planting, where aesthetic or cultural values would outweigh economic returns from timber production.

- The dairy units where tree height may become a problem – i.e. shading and irrigation.
- Mixture of species for aesthetics, trees that enable a five metre canopy height (for ETS eligibility), flowering trees to attract bird life/honey potential and endemic species.
- E.g. kōwhai, cabbage trees, pōhutukawa, flaxes, lemonwood, lancewood etc.
- Alternatively, species could be planted specifically for rongoā purposes or mahinga kai.

Section 3: Scenario analysis

There were 11 potential planting sites identified across the three farms and as a result it was considered beyond the scope of this report to examine each individual site in detail.

Instead, a selection of sites were chosen that were able to be grouped together into three different scenarios. These scenarios explored replanting radiata pine stands in alternative species, planting underutilised land in mānuka for oil production and identifying and planting riparian areas to be 1BT and ETS eligible.

The purpose of these scenarios is to examine in more detail:

- Eligibility for grants – the process, amount, timing, what is required.
- Carbon sequestration potential depending on forest species, forest area and methodology used to measure carbon stock.
- Possible liabilities that may arise from the forestry option in relation to ETS legislation.

Another factor when choosing the scenario options was the probability of other farmers also facing the same or similar scenarios on their own property, this would give the report relevance to the wider farming sector.

AN OVERVIEW OF FORESTRY IN THE EMISSIONS TRADING SCHEME (ETS)

The Emissions trading scheme is a way for New Zealand to meet its international obligations surrounding climate change. Essentially it puts a price on greenhouse gases to provide an incentive for emitters to reduce emissions and for landowners to establish and manage forests in such a way that more carbon storage is created.

The unit of trade within the ETS is known as a 'New Zealand Unit' or NZU, one unit represents one tonne of carbon dioxide. The Crown issues NZU's for increases in carbon stock for eligible forests that participate in the ETS, these may be held, bought or sold within NZ.

NZU's are held in the New Zealand Emission Unit Register (NZEUR), ETS participants must have a holding account in the NZEUR for unit transfers.

Forest owners can participate in the ETS in two ways – either by voluntarily registering their post 1989 forests in the ETS or becoming mandatory participants if they are owners of non-exempt pre 1990 forest that becomes deforested.

Definition of forest land

Forest land is defined as an area at least a hectare in size, with at least 30% of that hectare covered in forest species, capable of reaching at least 5 metres in height at maturity in the location they are growing. The forest species must also be capable of achieving a canopy closure of at least 30% at maturity and have an average width of at least 30 metres. "Forest species" is defined as a tree capable of reaching 5 metres in height but excludes trees grown primarily for fruit and nut production.

Pre 1990 forest

Pre 1990 forest land:

- Was forest land on 31 December 1989,
- Remained as forest land on 31 December 2007,
- And contained predominately exotic forest species on 31 December 2007

Land that was indigenous forest land (e.g. native bush) on 31 December 1989 and remained so on 31 December 2007 is not pre 1990 forest.

In recognition of the impact of ETS regulations on land use flexibility, owners of pre 1990 forest land were given up to November 2011 the option to apply one off allocation of 60 NZU's per hectare.

Pre 1990 forest owners can harvest and replant their land without any liability – that is they are not obliged to pay or surrender NZU's if their carbon stock decreases (e.g. due to harvesting) regardless of whether they received the one off allocation of NZU's or not.

They are liable however, (with some exceptions) if the land is converted to another land use other than forestry, or replanting or regeneration has not occurred within specified timeframes – by definition where "deforestation" occurs. In this situation the landowner is liable to surrender sufficient NZU's to the Crown based on the pre 1990 deforestation lookup tables.

The post-harvest area to be replanted (classified as "temporarily unstocked" forest land) must meet the following replanting and regeneration criteria in order not to be deemed "deforested"

- Four years after clearing must be replanted with 500 stems per hectare of forest species or 100 stems per hectare of willows or poplars consistent with managing soil erosion.
- Alternatively regenerated with at least 500 stems per hectare of exotic or native forest species in such a manner that 10 years after clearing the hectare is likely to be forest land.

- 10 years after clearing the hectare must be predominately exotic forest species growing and have a crown cover of 30% from trees that have reached 5 metres in height. Or be predominately indigenous forest species growing and the hectare is forest land.
- 20 years after clearing the hectare must be predominately indigenous forest species with a tree crown cover of at least 30% from trees that have reached 5 metres height.

Post 1989 forest

- Was not forest land on 31 December 1989
- Was forest land on 31 December 1989, but was deforested between 1 January 1990 and 31 December 2007, or
- Was pre-1990 forest land that was deforested on or after 1 January 2008, and any ETS liability.

Participants must file an emissions return once in every mandatory emissions return period (MERP) to account for changes in their forest's carbon stock. A voluntary return can be made once a year in order to claim NZU's as a result of an increase in a forests carbon stock.

However, participants must also repay units if a forests carbon stock decreases (e.g. fire, windthrow) and even if the decrease in only temporary (e.g. harvesting).

Participants are also required to notify the government if some or all of the registered post-1989 forest land is transferred to another person or entity (e.g. forest is sold).

If the land is withdrawn from the ETS then the total number of units received for the forest since ETS registration must be surrendered (regardless of who received the units).

**Note: Carbon averaging accounting is a new method of measuring carbon stock of forests participating in the ETS, it was introduced as part of amendments to the Climate Change Response Act and will become mandatory for all new forests by 2023. This new method is discussed with more detail on pages 29 and 38.*

MPI Default Carbon tables and Field Measurement Approach for calculating forest carbon storage

Under current ETS rules, participants are required to use one of two methods to measure forest carbon stocks depending on the size of their forest. A forest is defined as a Carbon Accounting Area (CAA) from which carbon stocks are measured and can be made up of either a single land parcel or multiple land parcels greater than one hectare in size.

For forests less than 100 hectares in size participants are required to use default MPI carbon look-up tables to calculate carbon stocks.

Forests greater than 100 hectares or greater in size are required to use participant specific carbon tables generated from the "Field Measurement Approach" (FMA). The FMA is a site specific measurement based method for determining forest carbon stock change based on collecting data from individual sample plots within a participant's forest. The forest inventory and growth modelling techniques used are recognised professionally within the NZ forestry sector.

MPI determines the number of sub plots required to collect information based on the forest size, for example 30 sample plots for 100 hectares and 200 sample plots for 10,000 hectares or more.

Current accounting method for measuring carbon change and proposed carbon average accounting method

The current carbon stock change accounting approach requires ETS participants to account for any loss of carbon in their forests, even if that loss is temporary. This means surrendering NZU's earned during forest growth at harvest and being liable for any carbon loss associated with adverse events (e.g. fire, windthrow).

Carbon averaging accounting is a new method of measuring carbon stock of forests participating in the ETS, it was introduced as part of amendments to the Climate Change Response Act and will become mandatory for all new forests by 2023.

Currently new forests joining the ETS have the option of either scheme, forests registered between 1 January 2019 and 31 December 2022 have the option of transitioning to average accounting.

With carbon averaging ETS participants with first rotation post 1989 forests will be able to earn NZU's up to a forests "average" age. This average age is based on the long term carbon storage of a forest over several rotations of growth and harvest at an assumed commercial harvest age typical to their forest type e.g. (28 years for *Pinus radiata*). They will not be liable to repay credits for the temporary carbon loss through harvesting or adverse events such as fire or windthrow.

For a comprehensive overview of forestry in the ETS visit the Te Uru Rākau website:

https://www.mpi.govt.nz/growing-and-harvesting/forestry/forestry-in-the-emissions-trading-scheme/

SCENARIO 1: REPLANTING RADIATA PINE STANDS WITH NATIVE OR EXOTIC SPECIES

The following scenario uses the option of replanting pine forests in native totara using a cover crop of mānuka or kawakawa, or replanting in coast redwood with no cover crop.

Various radiata pine stands on Ngāti Awa Drystock were identified as sites for replanting and used to examine the following:

- Eligibility for funding for replanting pine forests in native species
- ETS liability associated with replanting forests depending on whether they were classified as a "pre 1990 forest" or "post 1989 forest" and the potential to earn carbon from the subsequent forest rotation.
- A comparison of using the current MPI default carbon look-up tables and FMA method for measuring carbon accumulation in native and exotic softwood forests.
- Registering a post 1989 forest in the ETS for its second or subsequent rotation.
- A comparison of the current "stock change" accounting method for measuring carbon and the soon to be introduced "carbon average accounting" method available for new ETS participants.

ELIGIBILITY FOR FUNDING WITH THE SAME CRITERIA AS 1BT

As discussed in the site selection criteria, Ngāti Awa drystock contains many areas of first rotation pine that either have been harvested or are ready to harvest. These areas have been identified to replant in an alternative species.

In order to be eligible for the same criteria as 1BT funding, land must not be 'forest land' at the time of application nor must it have been forest land for 5 years prior. As the sites in this scenario have been, or are currently planted in, first rotation pine they come under the definition of 'forest land' and are not eligible under the same criteria as 1BT funding.

There are two sites however, that may be an exception to the general ruling around 1BT funding; these are the 16.1 hectare Maraetotara Road natural amphitheatre areas (4a and 4b), comprising of two recently harvested pine stands covering archaeological sites.

MPI does state that under "exceptional circumstances" they will consider funding native and reversion projects on land that does not meet the previously mentioned criteria (Te Uru Rākau, MPI website 2020). Under this notion it may be beneficial for Ngāti Awa to investigate whether replanting around archaeological sites previously in pine with more suitable native species would qualify as 'exceptional circumstances'.

PRE 1990 FOREST

Ngāti Awa have two stands of pre 1990 pine forest that have been selected for replanting.

- Pre 1990 forests have no ETS liability for harvesting and replanting providing the forest is replanted within a pre-specified timeframe or sufficient regeneration of forest species occurs (see notes in "an overview of forestry in the ETS" section).
- If replanting or regeneration does not happen then "deforestation" is considered to have occurred. There is an allowance of up to two hectares of pre 1990 forest deforestation in a five year period, beyond which NZU's would have to be surrendered to the Crown to match the loss of area to deforestation.

The first stand is a 3.4 hectare area (Figure 10, area 1) harvested two years ago and is now regenerating in native species. This area could be left to regenerate if the vegetation is deemed "forest land" in 10 years and by 20 years have tree crown cover of 30% and a height of at least 5 metres.

Alternatively, the regenerating native bush would provide a suitable cover crop for native tree seedlings such as totara or pōhutukawa. Plantings could then link up with the 9.8 hectare Wairere Stream riparian area that has also been identified for replanting.

The second stand is 29.1 hectares of second rotation radiata pine (Figure 12, area 6), this stand is 6 years old, however, it has had poor seedling establishment and if it were to continue as pine then some areas would need to be replanted.

Figure 15: Poor establishment of second rotation pines in area 6

If these areas were not replanted then in order to avoid a deforestation liability, it would have to be proven that the areas of poor establishment are two hectares or less or, there is sufficient regeneration of forest species to achieve 30% canopy cover and 5 metre mature height.

Alternatively, the current stand of young pines could be sprayed out and re-planted in a more desirable species (e.g. totara, pōhutukawa or coast redwood). The higher establishment costs of replanting compared to clear felled forest and the opportunity cost of the six year old pines would have to be taken into consideration.

POST 1989 ETS REGISTERED FORESTS

If the 29.1 hectare stand previously mentioned hypothetically were a post 1989 forest registered in the ETS and had NZU previously allocated then, it would be liable to surrender those NZU's back at the next five year mandatory emissions reporting period (MERP) if, over that period, then there were a net loss in carbon stocks'.

This is under the current carbon accounting 'stock change' approach whereby a participant in the ETS is required to account for any loss in carbon in their forests even if that loss is temporary (e.g. through harvesting and replanting).

This net loss of carbon would be greater in the example of replanting the stand with a native seedling understory of totara or pōhutukawa than if it were replanted pine again. The carbon accumulation from the native forestry plantation (shown as the green line in Figure 16) would not be able to match the rate of carbon loss from decay of the 6 year old pines and decaying residual underground root mass from the first rotation pines.

This example is best illustrated in the following graph which depicts the carbon accumulation and decay from each rotation as well as the total accumulation of carbon stocks over time.

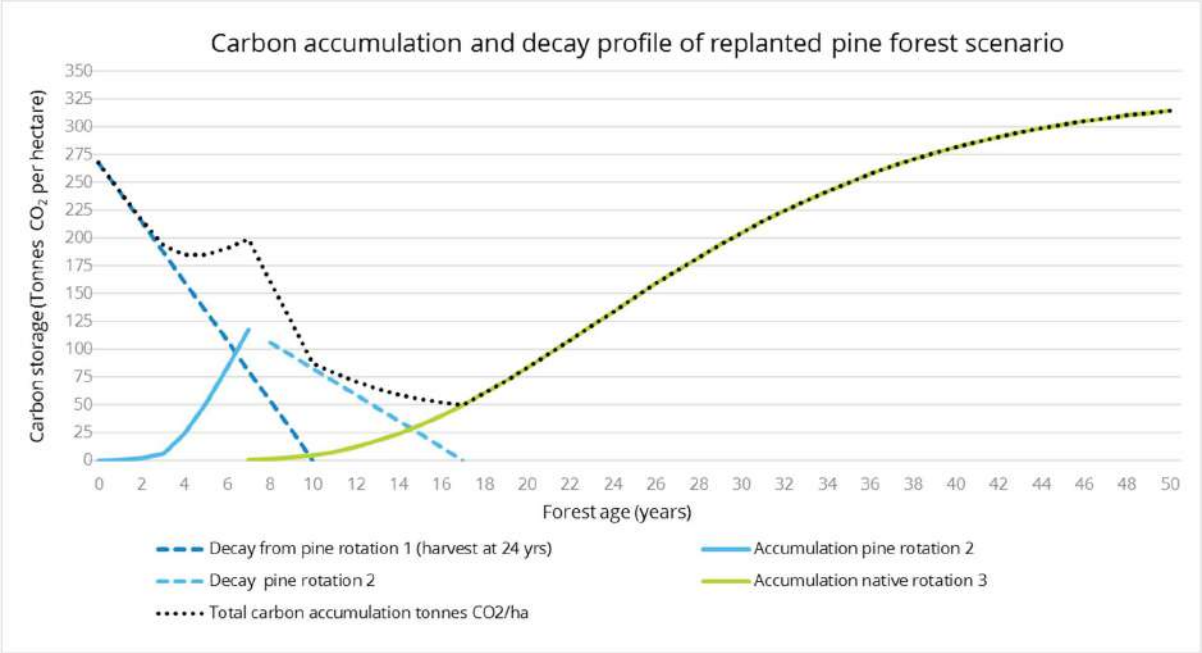

Figure 16 : Carbon accumulation and decay of replanted pine forest scenario

- Assume first rotation planted 1990 in order to use this example as if it were a post 1989 forest.
- Actual harvest date of 2014 used as well as replanting of second rotation within same year.
- Assume second rotation pines sprayed out in 2021 at 7 years and understory replanted with seedling natives that winter.
- As the plantation is less than 100 hectares carbon stock figures were used from the MPI lookup tables for the relevant forest species.

The date the first rotation pines were harvested (2014) is depicted as year zero on the horizontal axis. The vertical axis shows the carbon storage per hectare expressed in tonnes of carbon dioxide (CO_2). The decay of the above ground waste (slash and stumps) and below ground biomass (root system) is shown as the dark blue dotted line. As this rots carbon is released and hence total carbon accumulation decreases (black dotted line). For ETS purposes MPI assume a liner rate of decay over a 10 year period from harvest (MPI, 2017).

The carbon accumulation from the second rotation pines is shown as the light blue line before being sprayed off in 2021 and then decaying as shown in the light blue dotted line. The green line is the carbon accumulation of the native trees that form the third rotation of forest.

Total carbon accumulation initially decreases until year four when the rate of carbon sequestration from the second rotation pines surpasses the rate of decay from the first rotation, and therefore, total carbon accumulation increases.

Once the second rotation pines are sprayed out in year seven they then begin to decay and therefore total carbon accumulation starts to decrease again. The carbon sequestered from the native tree plantings is considerably less than that of *Pinus radiata* and therefore total accumulation does not begin to increase again until year 17. After that period total accumulation then matches the sequestration rate of the native tree plantings in rotation three.

IMPLICATIONS FOR NZU ALLOCATION AND LIABILITIES, MANDATORY EMISSIONS RETURN PERIODS

- Assume that the forest was registered with the ETS as a single carbon accounting area (CAA) in December 2012 and then eligible to file a return for the 2008 – 2012 mandatory emissions reporting period (MERP).
- Participants in the ETS are required to file a return within six months of the end of each MERP in order to calculate changes to the carbon stocks of their forest. The most recent period being 2013-2017.
- Under the current carbon accounting 'stock change' rules any net loss in carbon stocks must be accounted for – i.e. a participant must surrender equivalent earned NZU's or buy NZU's and repay back to the Crown.

Table 1: Carbon stock change difference between opening and closing stocks for mandatory emissions reporting periods (MERP)

MERP	Years in period	Opening total carbon stock (tonnes CO2)	Closing total carbon stock (tonnes CO2)	Net carbon stock change (tonnes CO2)	Net carbon stock change (tonnes CO2/ha)
MERP 1	2008-12	11,669	16,412	4,743	96
MERP 2	2013-17	16,412	5,378	-11,035	-54
MERP 3	2018-22	5,378	3,600	-1,778	-61
MERP 4	2023-27	3,600	1,729	-1,871	-64
MERP 5	2028-32	1,729	2,081	352	12

If a return was filed for the 2008-2012 MERP period then the forest would be eligible for an allocation of 4,743 NZU's based on the net accumulation of carbon over that period. As the forest was harvested in 2014, total carbon stocks decrease with the removal of the trees. This is represented as a net loss of 11,035 tonnes CO_2 at the end of the second emissions period (MERP 2).

NZU's have to be surrendered under current rules to account for the loss of carbon; under the ETS there is a "liabilities cap" which is a rule stating that the participant is not liable to surrender more units than the unit balance for the CAA. In this particular example, the maximum amount of units that would ever have to be surrounded then is 4,743 despite there being a net carbon loss of 11,305 units for the 2013-17 period.

As a result of the slower sequestration rate of the native tree species compared to that of the previous *Pinus radiata* rotations the plantation does not accumulate net carbon until the 2028-32 emissions period when 352 units are able to be claimed.

POST 1989 FORESTS REGISTERED IN ETS EXAMPLE 2: EFFECT OF SPECIES ON TRADEABLE CARBON.

Ngāti Awa Drystock has a 44.5 hectare block of first rotation pines planted in 1992 (Figure 12, Area 5), this stand is due for harvest in the next 12 months and the site would be suitable for replanting in either a native or exotic species for timber production.

The graph in Figure 17 on the following page shows the options of replanting in either totara (native forest) or coast redwood, assuming harvest of the current stand and replanting of the second rotation occurs in 2021. For comparison, the carbon accumulation of *Pinus radiata* has been included as two successive rotations harvested at 29 years.

The graph shows that the rate of carbon sequestration from the shorter rotation *Pinus radiata* is far greater than that of the coast redwood and totara species.

If this forest was registered in the ETS and NZU's claimed from the carbon sequestration of the initial pine rotation, then replanting in an alternative species would create a greater carbon liability issue. This is due to slower carbon sequestration rates compared to replanting again with pine (as discussed in the previous example).

With a greater carbon liability there is a corresponding decrease in the quantity of NZU's that can be effectively traded with no liability – this is known as "safe carbon". Safe carbon is essentially the carbon storage in the forest remaining at the point at which the rate of carbon decay is overtaken by the carbon sequestration of the subsequent forest rotation. This is shown in the graph in Figure 17 as the volume of carbon below which the line depicting total carbon accumulation for each species reaches its lowest point.

Under a second rotation of pine the volume of safe carbon able to be traded is 169 tonnes CO_2 per hectare (169 NZU's/ha), with coast redwoods 95 NZU's/ha and totara or other indigenous plantings 40 NZU's/ha.

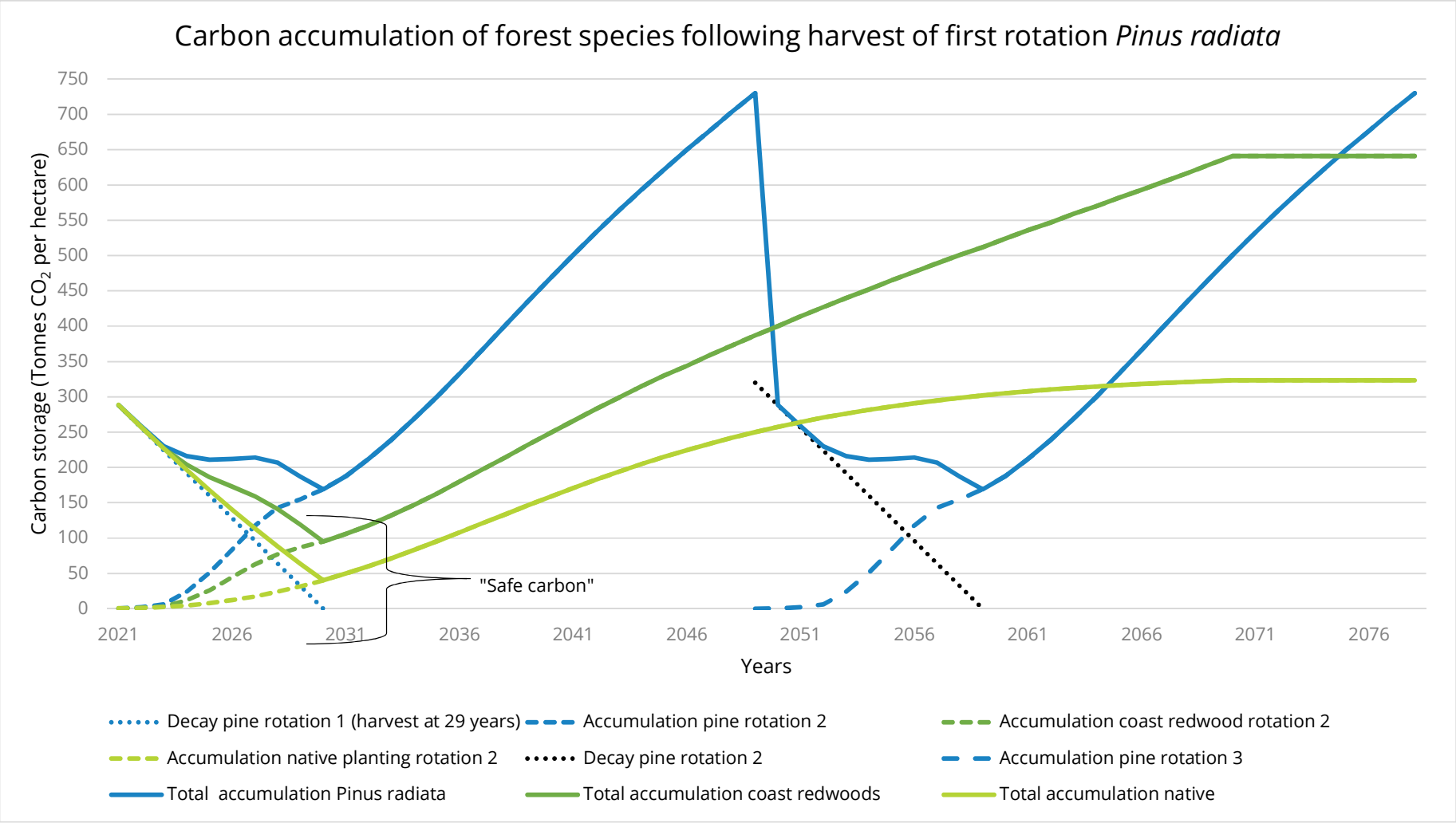

Figure 17: Carbon of various forest species following harvest of first rotation *Pinus radiata*

MPI DEFAULT CARBON LOOK-UP TABLES VERSUS FIELD MEASUREMENT APPROACH

Under current ETS rules, participants are required to use one of two methods to measure forest carbon stocks depending on the size of their forest. A forest is defined as a CAA from which carbon stocks are measured and can be made up of either a single land parcel or multiple land parcels greater than one hectare in size.

For forests less than 100 hectares in size participants are required to use default MPI carbon look-up tables to calculate carbon stocks. These look-up tables are a series of pre calculated values of forest carbon stocks, by age, for a given forest type. *Pinus radiata* and Douglas fir (*Psudotsuga menziesii*) are included as separate species in the tables as good quality industry data exists for these species due to their long history of being grown in New Zealand on a wide variety of sites. All other species are defined as either exotic softwoods, exotic hardwoods, or indigenous forest.

For less commonly grown exotic species there is little growth data available, hence modelling in the MPI default tables has been based on what robust data there is available for other species and adjusted to account for different growth rates etc. Exotic hardwoods have been based on the growth model of Eucalyptus *nitens* and exotic softwoods based on the *Pinus radiata* growth model.

Indigenous forest default carbon stock values are based on measurements taken from regenerating shrub lands typically dominated by mānuka/kānuka forest species as native regeneration is the most common method for indigenous forest to enter the ETS.

Individual forests of 100 hectares or greater in size are required to use participant specific carbon tables generated from forest sample plot data known as the "Field measurement approach" (FMA). The field work associated with measuring sample plots comes at a significant cost, hence why forest areas under 100 hectares have been excluded. Work by Tuahine (2018) estimates a cost of $350 - $550 for each sample plot, 30 plots are required for a 100 hectare forest and 200 plots for 10,000 hectares. Sample plots must be measured at least once every mandatory emissions reporting period.

Unlike the default MPI tables, the FMA method reflects the growing conditions for an individual participant's forest land; particular species can be nominated for measuring (e.g. initial regenerating shrub species such mānuka/kānuka) and other species added as they appear (e.g. dominant tree species such as totara).

Almost invariably using the FMA method will give a more accurate estimate of carbon stock in an ETS participant's forest. This is most relevant in the case of indigenous forest where the default look-up tables stop at 50 years of growth and beyond that point under that scenario carbon stock will level out at 323.4 tonnes CO_2/ha. In reality, most growth cycles and rotation periods of native forest timber species are generally in the range of 60-80 years, therefore the default tables underestimate the true total carbon stocks of native forestry.

Research by Tane's Trees Trust (Kimberly et al. 2014) has developed a model to predict the average carbon sequestration rates for native tree species based on measurement data collected from native plantations throughout the country.

Table 2: Predicted carbon sequestration stocks (tonnes CO_2/ha) for native tree species on average sites at 20, 40, 60 and 80 years. (Kimberly et al. 2014)

Species	20 years	40 years	60 years	80 years
Puriri	67	348	920	1,165
Kauri	101	508	757	929
Totara	93	437	577	712
Black Beech	120	670		
Red Beech	113	624	631	
Rimu	68	329		
Mixed shrub species	228			

The table shows that, with the exception of rimu and native shrubs, all species have greater carbon stocks at 40 years than in the MPI default tables at 50 years. The carbon stocks of native shrubs at 20 years are still greater than that of the default look-up tables (228 t CO_2/ha vs. 158.7 t CO_2/ha).

Therefore, ETS participants who have native plantation forest 100 hectares or greater could expect to earn a significantly higher number of NZU's than those with a smaller forest area who rely on default look-up tables. Participants growing a native crop of shrubs prior to planting tree seedlings could also yield more units in the first 20 years depending on the species grown.

POST 1989 FOREST NOT REGISTERED IN THE ETS

Unregistered post 1989 forests have no ETS obligations unlike pre 1990 forests which were automatically entered into the ETS by default, and therefore, have liabilities associated with deforestation. An unregistered post 1989 forest has no liability for harvesting and replanting ("no entitlement – no obligation").

ENTERING SECOND ROTATION FOREST IN THE ETS

Ngāti Awa has multiple blocks of post 1989 forest less than 100 hectares, some recently harvested and others awaiting harvest.

If some of these blocks were not ETS registered and it was decided to enter some of the blocks (once replanted) into the ETS, then under the current stock change accounting approach, voluntary emissions returns can be filed immediately. However, there will not be a net allocation of credits until the carbon sequestration of the second rotation exceeds the residual decay of the original first rotation crop (M. Duckett, personal communication 25 August 2020). This sequestration rate of the subsequent rotation species will then have an impact on when net carbon can be allocated as shown in Figure 18 (shown by where the decay line intersects the various accumulation lines).

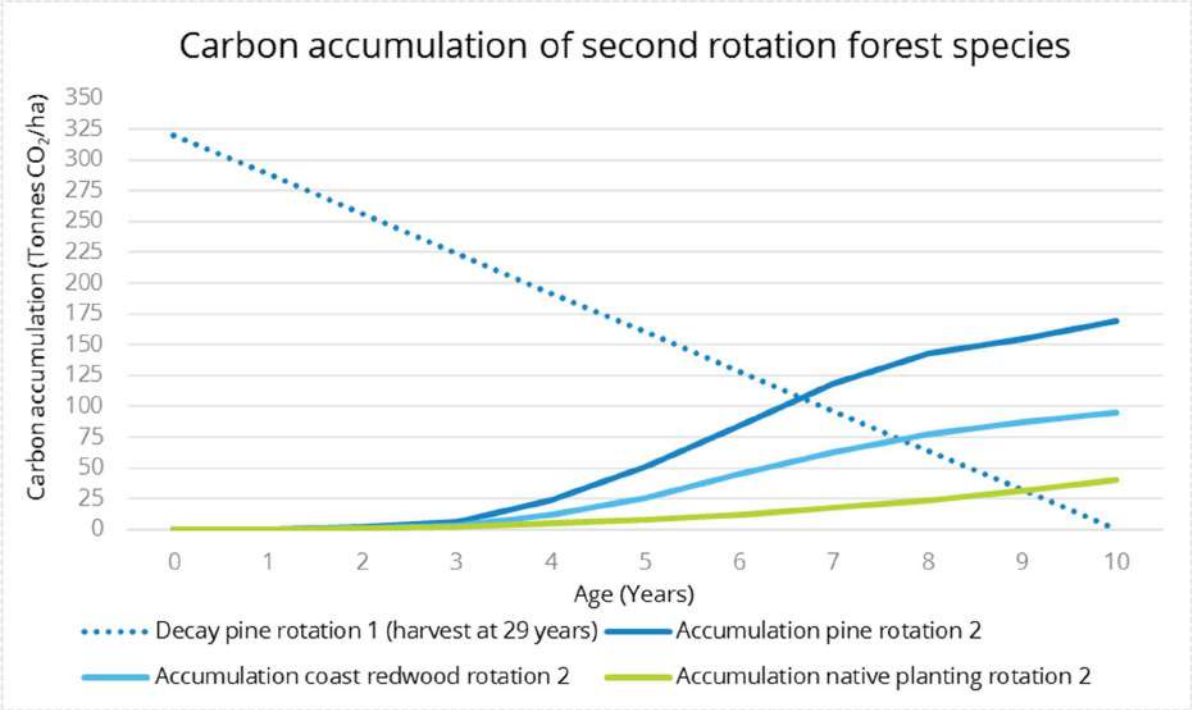

Figure 18: Carbon accumulation of second rotation forest species (MPI default tables)

The point at which carbon accumulation for a species exceeds the carbon loss from decay is approximately 7 years if replanted in pines, 8 years if in coast redwood and 9 years if in native forest species. From these points onwards sequestered carbon can be claimed and sold as NZU's. However, at harvest depending on the timing of the MERP it is likely that all of the NZU's earned will have to be surrendered back as unlike first rotation forests accumulation did not begin at Year 1, therefore, there is not enough carbon accumulation to allow for "safe carbon" with no liability.

Forests registering with the ETS between 1 January 2019 and 31 December 2022 will have the option of either entering the current 'stock change' model or the new 'carbon average approach'.

Carbon averaging accounting is a new method of measuring carbon stock of forests participating in the ETS, it was introduced as part of amendments to the Climate Change Response Act and will become mandatory for all new forests by 2023.

Under the carbon averaging approach, forests joining the ETS after their first rotation will have been considered to have already reached their average age; as NZ can only count the first rotation of a forest towards its international climate change obligations. Therefore, under the averaging approach "subsequent" rotations can only claim NZU's if more carbon can be sequestered than the average produced from the previous rotation. This can be done by increasing the rotation length of future rotations or replanting in a species that has a greater potential to sequester more carbon.

The concept of carbon average accounting and how it differs with the current 'stock change' approach is discussed further in the next section.

CARBON STOCK CHANGE VS. CARBON AVERAGE ACCOUNTING

The current carbon stock change accounting approach requires ETS participants to account for any loss of carbon in their forests, even if that loss is temporary. This means surrendering NZU's earned during forest growth at harvest and being liable for any carbon loss associated with adverse events (e.g. fire, windthrow).

With carbon averaging, ETS participants with first rotation post 1989 forests will be able to earn NZU's up to a forests "average" age. This average age is based on the long term carbon storage of a forest over several rotations of growth and harvest at an assumed commercial harvest age typical to their forest type e.g. (28 years for *Pinus radiata).*

Participants will be able to earn NZU's up until a forest reaches its average age, beyond that point they will not earn anymore NZU's. However, unlike the current stock change method they will not have to repay any units back at harvest nor will they be liable for repaying units during adverse events.

Assuming the same species is replanted and rotation length kept, this effectively increases the volume of "safe units" that are able to be traded and is predicted to incentivise new plantings.

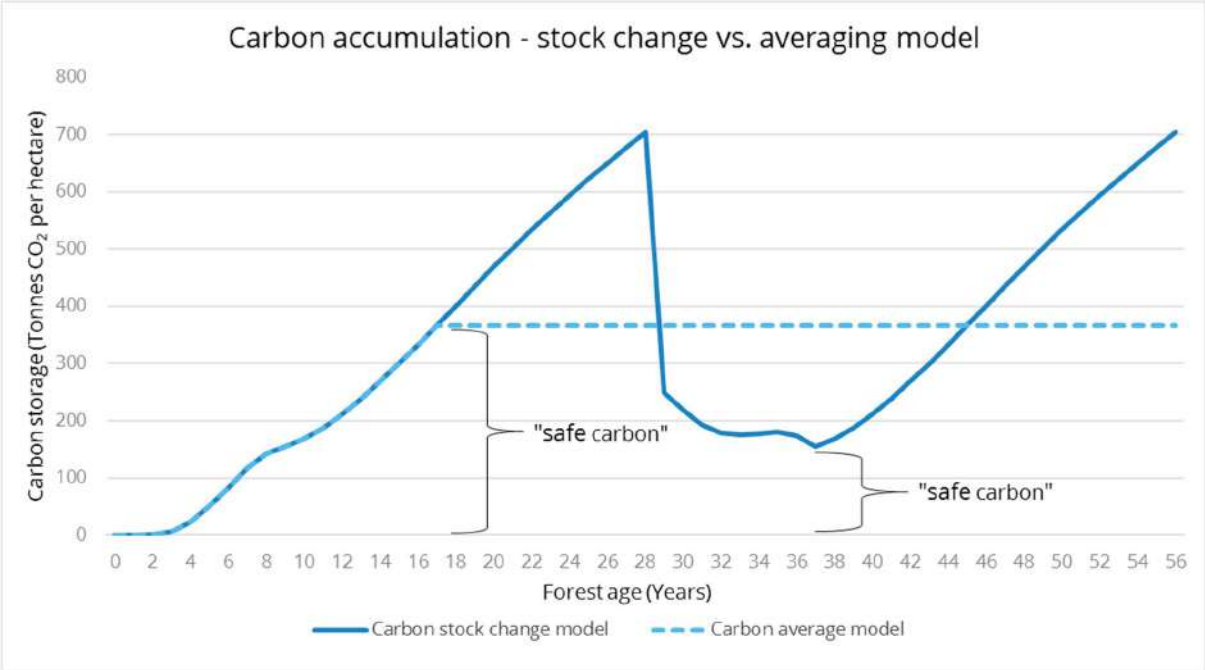

Figure 19: Carbon accumulation, comparison of accounting methods on *Pinus radiata* harvested at 28 years (Bay of Plenty region).

The Government is currently seeking feedback on proposed methodology for calculating average age and other rules affecting average accounting, decisions expected to be made by 2021. Industry experts are predicting the average age will be approximately 60% of the age at harvest, for example, a pine forest harvested at 28 years will have an average age of 17 years, therefore, NZU's can be earned up to the point the forest reaches its average age.

A "rotation band" is allocated to each average age to allow for variations in harvest age without the liability to repay credits if the forest is harvested a couple of years earlier than normal, or for the government to owe credits if the forest is harvested later.

For example, a forest with an assumed harvest age of 28 years will have a rotation band of 25 – 31 years and an average age of 17 years for carbon sequestration. A harvest age of 30 years will have a rotation band of 27 – 33 years and an average age of 18 years for carbon sequestration.

Participants will earn more credits by increasing the average age of their forest by having longer harvest rotations. In second and subsequent rotations a liability will occur if a forest is harvested prior to its average age and NZU's will be earned if harvested later.

If a participant decides to plant a second or subsequent forest rotation in a different species that has the potential to store more carbon (based on species and rotation length) then the forest will not be eligible to earn NZU's until the forest has reached the default average age of the original forest species.

Conversely, if a participant decides to replace a second or subsequent rotation with a lower average carbon stock (e.g. from hardwoods to radiata pine), they will have to surrender NZU's to compensate for the reduced average carbon stock.

SCENARIO 2: PLANTING MĀNUKA FOR OIL PRODUCTION

Ngakauroa Dairy unit contains a 5.2 hectare area of stop bank adjacent to the Rangitāiki River (Figure 13, area 10). This area is currently used for rough grazing. At 1.4 kilometres long, this narrow, gentle sloping strip is suitable for planting mānuka in rows and able to be mechanically harvested for oil production.

This scenario gives a broad overview of growing mānuka for oil production and tests the Ngakauroa example for funding eligibility.

Figure 20: Stop bank area on Ngakauroa dairy unit

Mānuka (*Leptospermum scopiu/ericoides*) is commonly used by Māori for rongoā purposes. The bark, seed pods and foliage have a wide variety of uses including treating wounds and inflammation, gastrointestinal complaints, respiratory complaints and as a mild sedative. By utilising knowledge of traditional uses (matauranga Māori) East Cape iwi worked with scientists in the 1990's to discover the antibiotic properties of mānuka leaf extracts. This is due to a high level of natural chemical called leptospermone present in distilled mānuka oil; other chemical compounds called triketones present in the oil also have therapeutic qualities.

Scientists discovered leptospermone acts against certain strains of Staphylococcus aureus or "Superbug" bacteria which is resistant to most penicillin. This initial finding was the catalyst for further research around the health benefits of mānuka oil products. Increasing studies into potential medicinal uses and the resulting potential economic value have created strong interest into developing the mānuka oil industry from its current fledgling status to something more akin to that of the success of mānuka honey.

PLANTING

Seedlings can be planted in 2.4 m rows which is the width used by the viticulture industry to allow machinery to get down the rows, thereby enabling mechanical harvesting and other aspects of plantation management (weed control, fertiliser etc.).

Seedlings could be spaced at 1-1.5 metres which, when combined with the row width would allow sufficient space and sunlight encourage the plant to grow plenty of foliage which is the main source of oil extract.

Under ideal growing conditions, plant growth rates of 435 mm (millimetres) a year can be expected for the first 10 years, 300 mm at 30 years and 210 mm at 40 years. With irrigation, seedlings planted at 0.5 metres in height have grown to between 1.5–1.8 metres in their first year (Mānuka Bioactives, 2014). For oil production, tree height is targeted at 2.5 m.

There is also the possibility of replacing the current barberry hedgerows on the Ngakauroa dairy unit with mānuka plantings. It would be easily accessible for annual harvesting of foliage, would grow into an attractive hedgerow and as a native plant have biodiversity benefits. Foliage harvesting would also enable tree height to be managed for a centre pivot irrigator to pass over.

HARVESTING

Harvesting normally occurs once a year in spring and summer when oil levels are at their highest in the foliage. Small quantities are able to be harvested from years 1-3 while also allowing for plant establishment. From year 4 onwards the foliage can be fully harvested.

Green leaves and branches less than 10 mm in diameter are harvested then left to wilt in order to reduce moisture content improve the efficiency of distillation, this is also improved by cutting all the foliage into uniform 100 mm lengths.

There is little information on foliage yields from plantation mānuka but available information ranges from two tonnes of foliage per hectare from natural stands planted at 1,100 plants per hectare to 5 tonnes per hectare foliage from stands in purpose grown rows planted at a density of 2,000 -2,500 plants per hectare (Wearmouth, 2015).

DISTILLING

Foliage is steam distilled on site using portable distillation equipment in order to reduce the need for transporting bulky foliage – especially relevant for remote sites. Alternatively, it can be effective to transport foliage to a distillation plant if it is nearby.

Steam distillation produces 2-3 litres of oil per tonne of foliage, the floral infused steam vapour can also be sold as a hydrosol product. Mānuka oil sells for $500 per litre.

Distillation equipment is expensive and also requires specialist equipment associated with processing and bottling the oil. A reasonable level of skill is required as poor distillation can result in the loss of valuable essential oils during the distillation process.

For this reason, some people choose to sell foliage direct to distillers with $500-$600 per tonne paid for good quality foliage.

MARKETS

Currently there are a few companies looking to partner with landowners for mānuka plantations for oil production, the New Zealand Mānuka Company, Mānuka Bioactives and Mānuka Rx being examples.

These companies have their own distillation facilities and are actively marketing products derived from mānuka oil. Given the interest in mānuka oil products a 2017 report from Boffa Miskell Ltd highlighted a strong case for landowners with mānuka plantations to form distillation cooperatives to invest in the necessary equipment to achieve scale and consistency of product. The branding and marketing of oil products could then be based on appellation depending on the active ingredients or region thus creating a niche product.

ELIGIBILITY FOR FUNDING WITH SAME CRITERIS AS 1BT

i. The land is not currently "forested" (being actively farmed land it does not meet the definition of a forest).
ii. The area is greater than five hectares in size so meets the threshold for both native and exotic plantations (one and five hectares respectively).
iii. The area is wide enough to allow for an average tree canopy cover of at least 30 metres when mature.
iv. The tree species grown on the site must be capable of reaching at least five metres and be actively managed in such a way to allow it to reach five metres and 30% canopy closure at maturity.

The mānuka plantation would meet all of the above criteria except for the last point where annual harvesting would effectively fail to allow the plant to reach a height of five metres and ultimately 30% canopy closure.

Therefore, it would be highly unlikely the mānuka plantation would be eligible for the same funding as 1BT, nor would it be eligible for the ETS.

If the stand was left unharvested (therefore oil production discontinued), 30% canopy closure would be achieved in 4-5 years and 5 metre height in 11–12 years, thus meeting criteria for the same as 1BT and ETS.

On Ngakauroa dairy apart from the stop bank area identified for mānuka oil production, there is little scope for planting without taking out areas of productive pasture.

There would be potential however, in exploring the merits of replanting existing hedgerows with mānuka. This could then be harvested for mānuka oil as well as having the benefits of aesthetics, shelter and a low enough height for centre pivot irrigators to pass over. Although it would not be eligible for similar to 1BT funding or the ETS.

There are numerous pockets of mānuka plantings on the Ngāti Awa drystock farm that have been planted as areas have been retired from grazing. The spacing of these plantings indicates the plants are unlikely to meet ETS criteria for canopy cover, however, they could be suited for harvesting foliage for mānuka oil production.

SCENARIO 3: RIPARIAN PLANTING FOR SAME AS 1BT FUNDING, AND ETS ELIGIBILITY

Ngāti Awa has riparian areas on both the drystock and dairy units that have been identified in this report for riparian planting.

DRYSTOCK PROPERTY

- A 1.5 hectare area of the Wairere Stream adjacent to Burma Road (Figure 10, area 3), this area according to aerial photography, has been planted with poplars since 1987. They have recently been removed as they posed a hazard frequently toppling over onto Burma Road. This section of stream may be prone to sedimentation build up as a result of low natural stream gradient and the moderate erosion vulnerability of the surrounding soil type (Orang_2a.2, allophanic orthic pumice soils).
- A 9.8 hectare area of the Wairere Stream adjacent to the Pacific Coast Highway (Figure 10, area 2). The stream flows to the farm boundary and then through native vegetation to Whakatāne. This area was also planted with poplars at the same time as the area discussed above and the majority is fenced for stock exclusion. The poplars were removed 18 months ago with the remaining native vegetation left to regenerate. This section of the Wairere Stream has good natural gradient and therefore, streambed build-up should not be an issue.

NGAKAUROA AND TUMURAU DAIRY UNITS

- Both properties are intersected with numerous drains and waterways, all of them fenced for stock exclusion. The largest drains have been riparian planted while smaller drains have only long rank grass on their banks to act as a natural buffer. Many of these smaller drains have low natural fall to carry water or are dry during summer; as a result there can be a build-up of weed and grass. The centre of these drains needs spraying or clearing with a digger annually to maintain good flow.
- Many of these smaller drains on both properties run adjacent to stock races; Fonterra farm environment plans commissioned in 2019 have identified a high risk of contamination into these waterways from sediment and nutrient runoff. A sward of vegetation and a 1 metre setback as recommended by DairyNZ would act as a filter to most of this runoff.
- The potential height of plantings would have to be limited to enable access to the drains for spraying and cleaning (e.g. digger access). Species height would also be limited on the areas of both dairy units that centre pivot irrigators pass over to approximately 3.5 metres.

Riparian plantings on the dairy units would be limited by height (centre pivot irrigator needs to pass over) and by width (1 metre setback either side of the drains without further encroachment on productive dairy land). Therefore, they would not meet ETS criteria nor the same criteria as the recent 1BT funding.

The proposed riparian planting areas on the Ngāti Awa drystock farm have no height limitations for species nor limitations on planting width, therefore, it is possible they are able to meet the criteria for some funding programmes and ETS. Two riparian areas are used as examples below to test the eligibility criteria.

Figure 21: Wairere Stream upper catchment adjacent to Burma Road (area 3)

Figure 22: Wairere Stream lower catchment, note riparian fencing in place and felled poplars

ELIGIBILITY CRITERIA FOR DIRECT GRANTS THE SAME AS 1BT SCHEME

i. You must have the right to plant on the land.

- Ngāti Awa are owners of the property and therefore have the right to plant the land.

ii. The land must not be by definition 'forest land' at the time of application, nor 5 years prior to planting.

- The definition of forest land is at least 1 hectare of tree species capable of reaching 5 metres in height at maturity with a collective canopy of at least 30% and a width of at least 30 metres of that hectare.
- The steeper side of the stream bank was fenced for stock exclusion, however, regenerating species are limited to shrubs unlikely to reach 5 metre in height when mature e.g. ponga (*Cyathea dealbata*).
- The gully floor side of the stream bank was planted with poplars, this area was not fenced and stock had access to graze underneath the poplars and the stream bank, therefore it was 'actively farmed'.
- Despite the poplars being greater than 5 metres in height themselves, they were not planted wide enough to have a canopy cover at least 30 metres wide. Therefore, they do not meet the definition of a 'forest'.

iii. The land must not already be in another government scheme. For example, erosion control funding program, regional council hill country erosion control funding schemes, afforestation schemes or ETS.

- The riparian areas in the report are not currently in a scheme.

iv. The area to be planted must be a minimum of 1 hectare for the native planting grant category and 5 hectares for all other categories (this can be made up of 1 hectare blocks of the same or multiple categories). The area to be planted must also be wide enough to allow an average canopy cover of at least 30 metres. Riparian areas are allowed to be 10 metre wide if a management plan is provided, endorsed by regional council or relevant professionals.

- Both areas are greater than 1 hectare in size (1.5 and 9.8 hectares), they can also be planted 30 metres in width therefore making them eligible for the ETS in the future as well as the same as 1BT grants.

v. Plantings must include tree species which can reach 5 metres in height at the intended planting location. Tree species not eligible include those grown primarily for fruit or nut crops and trees that are recognised as a weed species by regional councils.

- Kahikatea has been included as a tree species, pōhutukawa could also be used on the rocky banks; both these species are endemic to the area and are capable of reaching the targeted height and canopy cover.
- Smaller tree species such as cabbage tree (Ti Kouka), kowhai, five finger (Whauwhaupaku) and lemonwood (Tarata) all grow over 5 metres in height.

vi. Seedling density should be reflective of best practice for the type of planting being undertaken. For example, 2,500 – 10,000 stems per hectare for native planting projects (including smaller trees and shrubs), 1,000 – 2,500 stems per hectare for most native and exotic plantation forests.

ELIGIBILITY FOR THE EMISSIONS TRADING SCHEME

The criteria for the ETS differs slightly from that of the recent 1BT direct grant criteria; however, it is possible to receive direct grant funding and also be eligible to enter the plantation into the ETS. In this case the riparian plantings would qualify for Post 1989 forest land as the area was made up of regenerating parts that were unlikely to reach the definition of a forest and parts that were actively farmed. The new planting contains species that will grow to reach the definition of a forest and the riparian area meets the ETS threshold of one hectare in size and at least 30 metres in width.

FUNDING CATEGORIES

Table 3: Same criteria as One Billion Tree Fund basic grant categories (Sourced from MPI website)

1BT Grant funding summary:			**Top-up ($ /ha)**		
Category	**Area ***	**Base rate/ha**	**Erosion prone land or land with high preparation costs**	**Fencing**	**Ecological restoration ** **
Native planting	1-300 ha	$ 4,000	Up to $500	$ 500	$ 2,000
Native reversion	5-300 ha	$ 1,000	Up to $500	$ 500	N/A
Mānuka / kanuka planting	5-300 ha	$ 1,800	Up to $500	N / A	N/A
Exotic planting	5-300 ha	$ 1,500	Up to $500	N /A	N/A
* Minimum application size is 1ha for native planting and 5 ha for exotics (can be made up of 1 ha plots and / or a combination of categories)					
** This top-up cannot be used in conjunction with any others.					

Table 3 indicates the two riparian areas, subject to meeting the previously mentioned eligibility criteria, could be eligible for up to $4,500 per hectare in grants including the native planting and top up fencing grant. The two proposed riparian areas combined would fence off approximately 1.9 kilometres of stream bank; this would be almost the entire length of the Wairere Stream that is not already in native vegetation. On this basis it would be worth Ngāti Awa investigating eligibility for an ecological restoration top up grant which is for projects that aim to restore native ecosystems at a catchment scale. If successful, total grant funding of $6,000 per hectare for the riparian plantings could be achieved.

PAYMENT OF FUNDING GRANTS

A 10 year grant agreement is signed between the landowner and the Crown. Various milestones have to be met in order to receive funding. Payment is usually made over two or three milestones.

MILESTONE 1

Typically, 30% of the total grant is paid once there is evidence the project is underway or has been committed to, i.e. an invoice from a seedling order.

MILESTONE 2

Normally 50% or 70% of the grant is paid once there is evidence of successful seedling establishment of at least 750 stems per hectare. Depending on the establishment time this can be two months to four years from planting.

MILESTONE 3

Following a successful establishment post planting maintenance is the key to the long term success of a project such as riparian plantings or ecological projects. The remaining 20% of grant funding is paid once there is evidence that seedlings are at a sufficient stocking rate (e.g. 600 stems per hectare for native and 400 stems per hectare for exotics) and that plants are also growing free from weed and pest competition. Payment usually occurs up to year eight from planting.

Section 4: Discussion and Conclusion

Many of the areas identified as possible planting sites on the Ngāti Awa properties are ineligible for funding from programmes such as the recent 1BT as they are already defined as "forest areas" under the direct grant funding criteria.

Despite the proposed site for mānuka oil production at Ngakauroa being non-forested, it does not meet all of the criteria as the stand will be managed in such a way, through regular harvest of foliage, that will prevent forest height and canopy cover requirements being met.

There is potential on Ngakauroa in exploring the merits of replanting existing hedgerows with mānuka; this could then be harvested for mānuka oil as well as having the benefits of aesthetics, shelter and a low enough height for centre pivot irrigators to pass over.

There are areas of steep pumice hillocks and banks on Tumurau Dairy that were identified as possible areas for planting (areas within 11a-11c). As these areas are in grassland they could be eligible for grants providing species and forest size criteria were met. These areas have lighter soil and grow less pasture than the flatter areas of the farm which feature heavier, wetter soils. However, the impact of removing these areas from the current farming system would have to be further investigated (e.g. they are possibly drier areas of the farm used to minimise pasture damage to the remainder of the farm during wetter periods).

A large portion of Tumurau is irrigated either by centre pivot or k line irrigation, in order to manage plantings around this there may be a height restriction on possible tree species or an impact on the size and width of any planned plantations, this may affect eligibility for grants or inclusion into the ETS. For these sites, if aesthetic or cultural values would rank higher than economic returns from timber or carbon production, then planting a range of species for landscape enhancement and biodiversity would be recommended.

Riparian planting along fenced drains on the dairy units will also not be eligible for direct grants as achieving the required planting width of 10 metre will require current fencing setbacks to be increased. To do this will involve taking pasture out of production. Where drains are adjacent to races there is often a setback of less than a metre, therefore, to meet the 10 metre requirement either the race or drain will have to be shifted at considerable cost.

Planting grasses, sedges and flax along current setbacks would help achieve environmental goals by greatly reducing the risk of nutrients and sediment entering drains. Centre pivot irrigators would also be able to pass over without plant height becoming an issue. However, this is not eligible for many grants or ETS inclusion.

Sites selected as riparian areas on the Ngāti Awa drystock, provided adequate planting width and species mix to attain height and canopy requirements is undertaken, will meet direct grant requirements. ETS eligibility can be satisfied also. There is also a case to investigate an extra grant for ecological restoration worth an extra $2,000 per hectare as the proposed riparian planting will effectively exclude livestock from the remainder of the Wairere Stream catchment.

Scenario 1 examined replanting forest areas currently in radiata pine in alternative species of either coast redwood, or totara, planted with a mānuka cover crop. Examples of such areas on Ngāti Awa Drystock were discussed in further detail to show:

i. Potential liabilities depending on how the forest is classified under the ETS.
ii. Implications of the difference in carbon sequestration rate of different forest species in subsequent rotations.

iii. How methods used to calculate the carbon stock of a forest can impact on carbon sequestration potential.

Pre 1990 forests (e.g. areas 1 and 6) have no ETS liability at harvest providing the land is replanted within four years or sufficient regeneration of forest species occurs.

In the case of area 6 on the drystock farm, the areas of poor seedling establishment will need to be regenerating in vegetation that will meet "forest species" definition or, the area will need to be less than 2 hectares in order to qualify for a 'deforestation exemption' in order to avoid an ETS liability.

Post 1989 forests not registered in the ETS also have no carbon liability at replanting; however, if they were then registered with the ETS for their second rotation under current rules, carbon could not be earned until the sequestration of the second rotation had exceeded the rate of decay of the previous rotation. In effect there would be no "safe carbon" and it is likely all credits earned would have to be surrendered at harvest.

Another option is to register under the soon to be mandatory "carbon average accounting" rules (currently optional until 31 December 2022). Under average accounting all new forests entering the ETS after their first rotation will be deemed to have already reached their 'average age'. In order to earn credits, the carbon storage of the new species must be more than that of the previous species, this can be done by planting a species that sequesters more carbon and/or increasing rotation length.

Currently owners of second rotation forest have the option of either accounting method when registering in the ETS. The decision will be based around a trade-off between the ability to earn more NZU's and earlier under the current stock change model or receiving a lesser amount of NZU's much later but with no liability at harvesting nor for adverse events.

If the forest was already post 1989 ETS registered, then replanting pine with slower sequestering species such as totara or redwood would have an impact on carbon liability. Depending on the species, carbon potential and the timing of the MERP, the level of "safe carbon" able to be traded without liability will be reduced (Figure 18).

Any first rotation post 1989 forests that enter the ETS using the average accounting concept will effectively have a greater amount of "safe carbon" that can be traded, as the liability for temporary deforestation has been removed (Figure 19).

Currently post 1989 forests 100 hectares and under in the ETS use default carbon look-up tables to measure carbon stock while larger forests use the FMA method from which participant specific tables are derived, there is a significant cost to this but ultimately it gives more accurate information.

Native forest species and some exotics often have rotation lengths of 60 – 120 years, greater than the default table limit of 50 years, naturally regenerating forests have the ability to sequester carbon for several hundred years.

As a result, there is a benefit for forests of 100 hectares or more (made up of a single stand or multiple stands) with mixed species and longer rotations to measure their carbon stock using the FMA method. This could result in a forest having greater sequestration rates and carbon stock than a forest using the MPI default look-up tables.

There is evidence to suggest that NZU's from native forests could attract a premium from companies seeking to invest in offsetting their emissions against forestry projects that are aligned to their values. A recent report (Aoteoroa circle, 2020) indicated that many NZ corporates would prefer to support the planting of native forest species through their offsetting efforts.

However, the limited supply of these "biodiversity credits" lead to spending decisions that either result in sourcing internationally recognised "gold standard credits" offshore or support domestic exotic

forest credits. An example is Fonterra's certified carbon zero milk brand "Simply milk" (Fonterra, 2020); only half of the required credits to offset production are sourced from NZ native forest with the remainder international "gold standard" credits from overseas.

This case study has shown that the decision to replant pine forest with alternative species can be complex with implications around carbon liability and future carbon earning potential depending on how the pine forest is defined within the ETS, the subsequent forest species rotation and the methodology used to measure carbon stock. Therefore, it is important to seek the relevant professional advice when making replanting decisions.

Replanting pine with natives or coast redwood is an intergenerational investment due to the long rotation length (80 – 120 years). Therefore, an investment analysis must account for other inherent benefits when comparing the investment against shorter term *Pinus radiata* term. Cultural, biodiversity and landscape enhancement benefits must also be recognised.

Ngāti Awa Farms Ltd are able to identify these benefits by the application of traditional Māori values to their business strategy as well as their long term view of investment in the land i.e. "the whenua is a gift passed down from our ancestors."

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Appendices

APPENDIX 1: AREAS IDENTIFIED FOR PLANTING

Planting Areas
- 4a
- 4b
- 4c

Farm Boundary

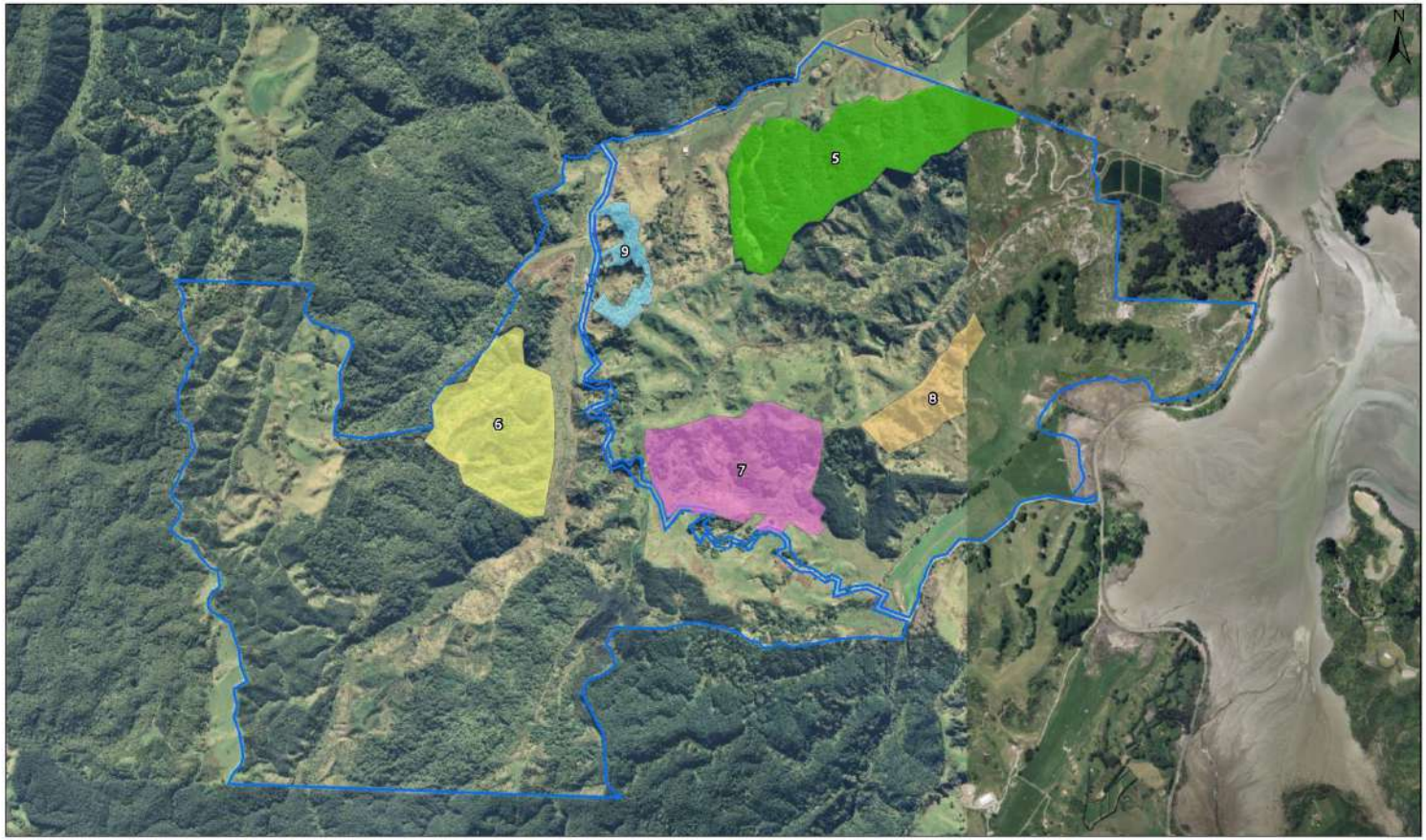
Date Exported: 26/07/2020

0 100 200 400
m

Ngāti Awa Farms - Area 2

Planting Options

perrin ag



Planting Areas
Farm Boundary
5
6
7
8
9

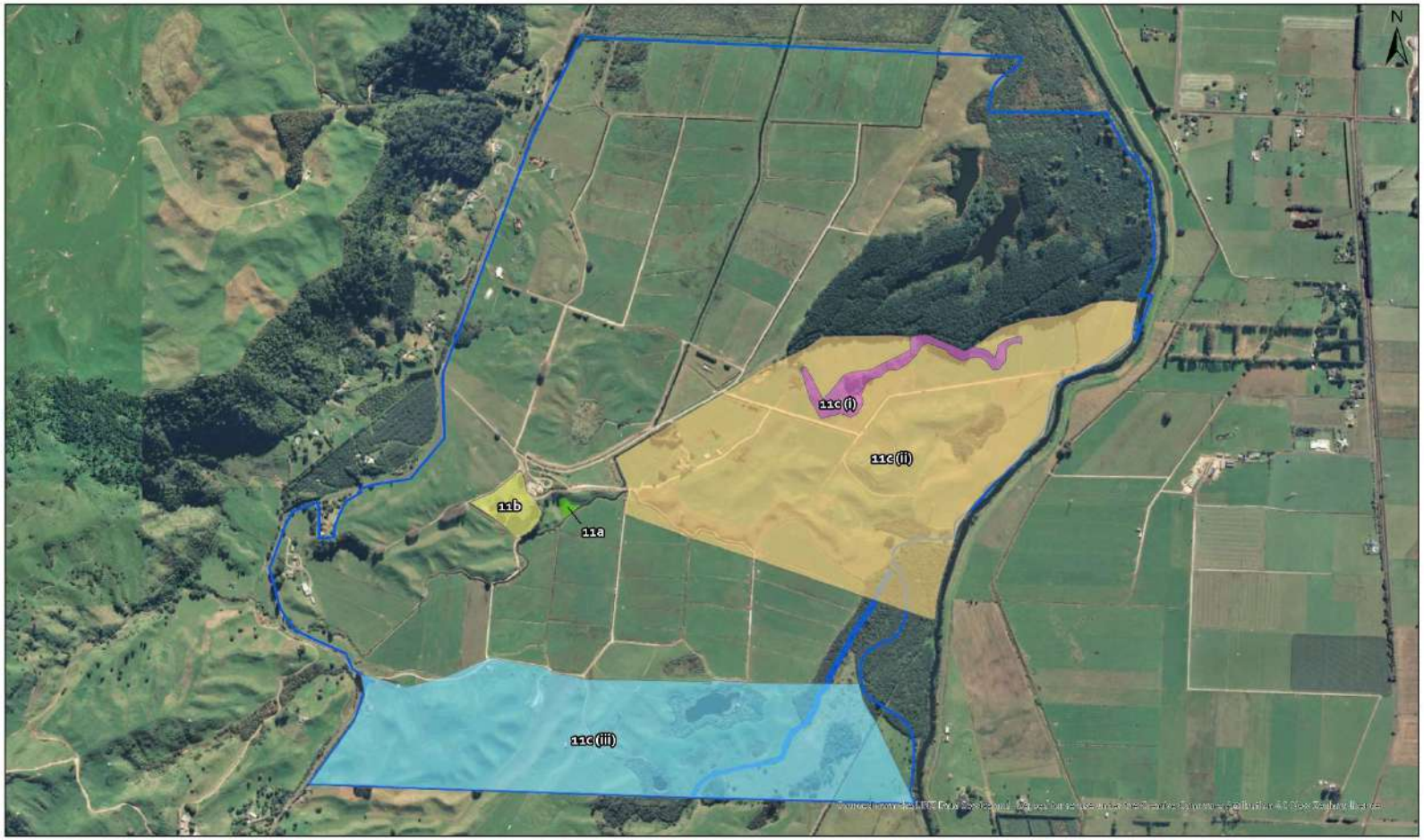
Ngāti Awa Farms - Area 3

Planting Options

Date Exported: 28/07/2020

0 250 500 1,000
m

perrin ag



Planting Areas
- 11a
- 11b
- 11c (i)
- 11c (ii)
- 11c (iii)

Farm Boundary

Ngāti Awa Farms - Tumurau

Planting Options

Date Exported: 26/07/2020

0 125 250 500 750
m

perrin ag

Planting Areas

- 10
- Farm Boundary

Ngāti Awa Farms - Ngakauroa

Planting Options

Date Exported: 26/07/2020

0 125 250 500 750
m

perrin ag

Table 4: Ngāti Awa land parcels with geographical and physical descriptions, including species options, grant and ETS eligibility

Farm	Parcel No	Site	Area (ha)	Contour	Aspect	Cover	Previous cover	Pre 1990	Post 1989	Eligibility	Same as 1BT eligibility	Carbon liability	Possible species options	Notes
Ngati Awa drystock	1	Former pine woodlot	3.4	very steep	south	regenerating native	pine	yes		pre 1990	no	yes would need to match carbon sequestation from pine area (3 ha)	Totara/Pohutukawa with native cover crop	in pines 1987
	2	Wairere Stream (in process of fencing and replanting)	10.1	steep	south west	regenerating native, cutover poplar	poplar, native	yes		Polar + some pre 1990, indegenious forest (need to check canopy height)	no	yes?	native riparian	fenced off and in poplars with regen 1987 (retrolens) >30 m wide
	3	Wairere Stream by dump - proposed riparian	1.47	slight slope	west	cutover poplar	poplar , pasture	n/a	n/a	yes post 1989 if planted >30 m wide	yes	no	native riparian or kahikatea	Poplar plantings <30 m wide 1987
	4a	Maraetotara Rd natural amphitheatre	5.38	steep, some cliffs	south, south west	cutover pine with regen	regen, pasture		yes	post 1989	no	yes would need to match carbon sequestation from pine area	Totara with native medicinal cover crop	pasture and regen on steeper areas 1987 - farmed
	4b	Maraetotara Rd natural amphitheatre	10.8	steep, some cliffs	south, south west	cutover pine with regen	regen, pasture		yes	post 1989	no	yes would need to match carbon sequestation from pine area	Totara with native medicinal cover crop	pasture and regen on steeper areas 1987 - farmed. Includes 1.5 ha currently farmed - no carbon liability
	4c	Maraetotara Rd pines due for harvest 2021	12.1	steep	south east	mature pine	regen, pasture		yes	post 1989	no	yes would need to match carbon sequestation from pine area	Totara with native medicinal cover crop	pasture in 1987
	5	Pines, first rotation	44.5	steep, rolling	north	mature pine	pasture		yes	post 1990	no	yes would need to match carbon sequestation from pine area	Ttotara/Pohutukawa with manuka cover crop or coast redwood	pasture in 1988
	6	Second rotation forest, 6 yrs poor establishment	29	steep	east	6 yr pines, scattered scru, pampas grassb	pines (1st rotation)	yes		pre 1991	no	yes would need to match carbon sequestation from pine area	Ttotara/Pohutukawa with manuka cover crop	in pines 1987
	7	Existing manuka plantation 7 yrs	32.7	gully, north south slopes	predominately south	plantation manuka 7 yrs, broken scrub	pasture	n/a	n/a	post 1989	yes (if not capable of meeting 5 m canopy)	no, not eligible to enter ETS until 5 m and >30% canopy closure	plant totara use existing manuka as cover crop	in pasture 2013
	8	Generic gully head	11.5	steep	south east	pasture, scattered broken scrub	pasture	n/a	n/a	yes, post 1989 if planted	yes	no	Ttotara/Pohutukawa with manuka cover crop	in pasture and scattered scrub - farmed
Ngakauroa dairy	10	Riverbank, Rangitaiki River	4.72	gentle slope	west	pasture	pasture	n/a	n/a	unknown	yes	no	plantation manuka in rows	flood prone and less than 30 m wide in places, not eligible for credits, limited honey production
Tumurau dairy	11a	Natural spring area	0.23	flat	south	pasture	pasture	n/a	n/a	no	no , <1 ha	no	riparian	not eligible as less than 1 ha
	11b	Effluent pond gully	2.34	rolling	south	pasture	pasture	n/a	n/a	no	yes	no	asthetic planting	ponds still in use, pylons overhead, limited planting to achieve >5 m
	11c (i)	Example of sand country sidling (more land suitable)	3.59	steep	south	pasture	pasture	n/a	n/a	yes, post 1989 if planted	yes	no	Totara/White pine with native cover crop or exotic plantation	low DM production but need to know how removing area impacts on farm system, economics of fencing parcels

APPENDIX 2: ANCILLARY NOTE TO NGĀTI AWA FARM STOCK POLICY

Cropping is carried out on the cultivatable parts of the farm in order to improve pasture species and reduce the reversion of poorer quality kikuyu dominant pasture. Around 25 hectares of chicory is grown as a summer crop for lamb finishing and the re-sown in a ryegrass and white clover permanent mix in the autumn. Approximately 250 bales of baleage are made annually and fed to young cattle and calving cows over the winter and spring period.

The sheep policy consists of 1,500 mixed aged ewes wintered and 500 ewe hogget replacements. Approximately 800 ewes are mated to a maternal sire and lamb from in mid-august with the remainder put to a terminal and lamb a month earlier. Scanning percentages are around 168% and docking 142%. Weaning occurs from late November / early December with the lambs going onto summer crop, typically 85% of lambs are finished at 19-20 kg CW (carcass weights) of 19-20 kg CW with the remainder sold store in late autumn.

The cattle policy consists of 235 predominately Angus cows with 45 heifers retained as replacements. First calving heifers are calved behind a wire from 1 August with the mixed aged cows a month later in September. Weaning occurs from late- March/early- April with all progeny retained and carried through the winter to be sold store as yearling cattle in the spring/autumn. A small proportion are taken through a second winter and finished depending on the season and the markets. Some store cattle are bought in addition to what is reared on farm.

At the time of visit in mid-June trade cattle consisted of 240 mixed sex weaners, 140 rising two year old heifers and 160 rising two year old steers.