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

Case Study 7: Mangaweka Asparagus

Report prepared by
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Executive Summary

- This case study explores how the integration of trees on steep hill slopes in the Rangitikei region can support landowner objectives of diversifying farm revenue streams, improving environmental performance, improving integration of farm enterprises and importantly addressing the issues associated with cattle occasionally breaching fences and accessing the river. Two tree planting scenarios were investigated to understand the physical, financial and environmental impact to the farm business.

- Mangaweka Asparagus, owned by George and Diana Turney and operated by General Manager Sam Rainey, is located at Mangaweka in the Rangitikei region. The farm business is 152 ha effective comprising 101.4 ha cropping (predominantly asparagus), 47.2 ha of cattle grazing and 3.4 ha of grazed trees. The farm has two distinct land classes; the flat cropping land and river flats and the steep hill slopes leading down to the river flats.

- The steep hill slopes are marginal for the carryover cows currently grazed, and, although the grazed area is fenced, the cattle occasionally breach the boundary fences on the river flats and access the river. Timber afforestation on these slopes has therefore been the focus of this case study. Given afforestation did not impact the area or performance of the asparagus operation, financial analyses focused on comparing the forestry returns with the returns from the same area of cattle grazing land to be replaced with tree plantings.

- Mangaweka Asparagus expressed an interest in evaluating alternative, non-radiata forestry species. The scenarios modelled illustrate what forestry options may be available for someone who does not want to plant radiata pine, or where radiata pine is not suitable. Three forestry systems were analysed including a structural timber system (may include species such as Douglas-fir, larch or fir), low productivity specialty timber (may include species such as black walnut, Tasmanian blackwood or oaks) and a high productivity eucalypt timber system.

- It has been a conscious decision to use generic cashflows for the forestry systems that are not specific to species on the basis that comparable data for alternative candidate species is limited and generally unavailable. Future demand and the development of specialty sawmilling and timber supply chains will have a significant bearing on future profitability. Sensitivity analyses should be used by landowners to understand the implications to financial returns, particularly when considering investment in risky and uncertain markets.

- Scenario 1 modelled a combination of 22.6 ha of structural timber and 6.9 ha of low-productivity specialty timber grown on a 55 year rotation. In contrast, Scenario 2 modelled the same areas of structural and specialty timber but, for the specialty timber system, modelled eucalypts on a 35 year rotation.

- Neither scenario could compete with the current cattle grazing operation on the same area of land, whether carbon was included or not. The high upfront capital costs of establishing the alternative forest scenario's (S1 = $10,850/ha; S2 = $9,237/ha) combined with the long-term investment of the slower rotation timber species (35 – 55 years) results in both scenarios generating negative NPVs. In comparison, the current cattle grazing operation generates an NPV of $8,037/ha and is highly profitable given the high revenue received from very little cash investment.

- Afforestation of alternative species on the steep hill slopes at Mangaweka Asparagus therefore fails to provide a diversified revenue stream that can provide a profitable investment at the assumed log and carbon prices and 6% discount rate. Afforestation does however remove the issue associated with stock access to the river and provides improvements in environmental performance. Nitrogen loss to water and biological greenhouse gas emissions was modelled to reduce by 40% and 77%, respectively, following the removal of the carryover cow grazing enterprise and replacement with forestry.

- Integrating trees within a farm business can be a complex process requiring careful planning. Landowners should consider the impacts to cashflow, the upfront capital cost of establishing and tending to forests, length of the investment period, market accessibility and impacts to the remaining farm system. Non-financial and personal considerations are also key parts of the planning process and may include environmental implications and ease of business integration. Planning to achieve right tree, right place is critical to meeting the objectives of tree planting.

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 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 landowners, iwi and rural professionals with the information they need to help landowners 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 will 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 online.

This case study, Mangaweka Asparagus, comprises a family-owned cropping business in the Rangitikei region. The case study was selected to explore knowledge gaps identified in the farmer interview phase of the project. The topics covered in this case study that align with the identified concerns and knowledge gaps include:

- Evaluating land classes and detailing the process for selecting the right tree for the right place and right purpose.
- Evaluating alternative structural and specialty forest species for timber potential.
- Illustrating how carbon sequestration and timber value contributes to financial outcomes and potential benefits.
- Providing robust financial and environmental analysis demonstrating potential returns, impact on environmental externalities, and the overall financial performance of the farm system. This is compared against the existing land use and clearly demonstrates the value proposition to the landowner.

Method

CASE STUDY SELECTION

To identify the Rangitikei case studies, the researcher worked with the local project steering group. The group, which comprised a Horizons Regional Council representative and local farmer, recognised the importance of having regional diversity in cases (geographic, enterprise type) to meet the brief to "provide results relevant to a range of farm situations nationally, with the alternatives contributing in different ways to the various benefits" as stated in the proposal. At the steering group meeting, the group identified a broad range of tree enterprise types relevant to the local area and a list of locals who could be interested in participating. Geographic, topographic and climatic diversity in the area, and diversity in farm situations and farmer objectives were all considered in identifying the options. The Horizons representative's knowledge of farmers initiating or considering tree enterprises was particularly helpful in identifying the list of potential case farms in the region. A shortlist was arrived at that captured diversity across all factors. Farm selection was crosschecked with findings of the interviews in Phase 1 and the diversity captured in the potential cases selected exceeded these requirements. Selected case study farmers were approached to see if they would be willing to participate. The Mangaweka Asparagus case discussed in this report is one of the four Rangitikei case studies selected.

DATA COLLECTION

The researcher visited Mangaweka Asparagus on 16 March 2020. Information on the interest and preferences for integrating forestry into their existing business was explored. The general manager has an interest in afforestation of the steep hill sides sloping down to river flats alongside the Kawhatau River. The block was inspected and information about the existing farm and forestry activities were captured. Data was collected using a template adapted from the DairyNZ Whole Farm Assessment (DairyNZ, 2016) to ensure consistency between case studies. Financial data was provided by the general manager and, where figures could not be separated from the cropping enterprise (not analysed in this case study), representative values from the Beef and Lamb NZ economic service were used. Further follow-up phone calls and emails with the general manager to clarify information were made as required.

The farm property was mapped and analysed in ArcGIS software to help identify the geo-physical variation of the areas identified for afforestation and was used to identify forest growth potential.

FARMING ANALYSIS

The financial and physical data provided for the business was analysed to develop a feasible status quo model of the cow grazing business (Status Quo scenario). Financial data pertaining to the business' cattle operation only was analysed given confidentiality requirements around the asparagus operation. OverseerFM software (OverseerFM, 2019) was used to estimate the nitrogen (N) and phosphorus (P) losses to water and biological greenhouse gas emissions (bGHGs) from the current land use activities using best practice data input standards. Assumptions made in developing the status quo model are provided in Appendix 1.

This status quo farm system was then re-modelled using spreadsheet analysis and OverseerFM, incorporating the impact of afforestation on the farm system.

TREE SCENARIO ANALYSIS

Appropriate afforestation scenarios for integration within the existing land activities were developed in association with Mangaweka Asparagus, ensuring scenarios aligned with their objectives and were of interest to them. They were then analysed for projected expenses, revenues and carbon sequestration over a 56 year timeframe. This timeframe was used for all scenarios for consistency and is based on two full typical 28-year *Pinus radiata* rotations. Where applicable, the impact of accessing regional or national grant schemes was included.

Mangaweka Asparagus are interested in alternative forestry species (i.e. non *Pinus radiata* species) to address issues with stock occasionally breaching fences and accessing the river, exclude stock from steep hill slopes to provide erosion control and deliver environmental and biodiversity benefits. Diversification of income streams (timber and carbon), and improving business integration in terms of balancing workload with cropping on the flat country are additional objectives. These scenarios and their drivers are discussed further in Section 2.

WHOLE FARM BUSINESS ANALYSIS

Changes to the financial performance of the steep hill slopes and environmental outcomes of the property were compared to the status quo scenario. An investment analysis, primarily using discounted cash flow analysis (NPV on pre-tax cash operating surplus at 6%; IRR) was undertaken to compare each of the forestry scenarios with the status quo farming scenario. Investment analysis is expanded on in the 'Note on investment analysis' section. Spreadsheets were used for the financial analysis comparisons. Aggregate impacts on the property's environmental footprint were calculated using OverseerFM. Assumptions are presented in Appendix 1.

A NOTE ON INVESTMENT ANALYSIS

The relative financial performance of the both the individual forestry, and aggregate land use, enterprises in each scenario is measured by both net present value (NPV) and internal rate of return (IRR). The forestry enterprises are also described using an annuity.

The net present value of an investment is the sum of the present value for each year's net cash flow less the initial cost of the investment. Investments with a positive NPV mean that the investment generates a return greater than the assumed discount rate (see below) and are acceptable investments; those with a negative NPV generate a lower return than the assumed discount rate and would be rejected.

The IRR is the actual rate of return on an investment with for the time value of money accounted for – essentially the discount rate at which the NPV of an investment would be zero.

An annuity is an annual cash flow that would deliver the same net present value over the lifetime of the investment at the assumed discount rate (in today's dollars) as the investment itself. This is useful in helping quantify the relative annual average profitability of forestry with land uses that generate revenue every year. However, the timing of cash flows is not directly apparent from this measure so this needs to be considered in conjunction with time series cash flow analysis.

A uniform discount rate of 6% has been used in analysing across both the forestry and farming aspects of the business model, including returns from ecosystems services such as nitrogen and carbon. A consistent discount rate is necessary when presenting NPVs to compare between scenarios but may not be appropriate where landowners prefer one revenue source over another. The use of a consistent discount rate here was a necessary practical assumption.

We note that while 6% is a common agricultural discount rate, 8% is a more common forestry discount rate. There are also other conventions which differ between standard practices for agricultural and forestry economic evaluations, such as the treatment of land opportunity costs and the length of time considered. These factors interact with the choice of discount rate. Additionally, it is useful to treat uncertain revenue streams such as the sale of carbon credits with a higher discount rate. While differing discount rates are useful to account for differences in risk profiles and other aspects of the revenue streams included, that additional level of analysis is considered out of scope for this report.

In this analysis, the investment in the land is deliberately excluded and case study results only reflect the investment in livestock, tree stock, plant and machinery and any additional rights to discharge nutrients to water. This assumption is made on the basis that the investment in the land is not discretionary between scenarios, but the choice of land use is.

Farm and business description

BACKGROUND

Mangaweka Asparagus is owned by George and Diana Turney who bought the property in 1989. The farm is located in the Kawhatau Valley, 10 km east of Mangaweka. General Manager, Sam Rainey, runs the day-to-day operations while George and Diana, along with their four children who sit on the company board, hold an advisory role in the business. Casual staff, including locals, backpackers and recognised seasonal employees from Vanuatu, are employed over the harvest season with up to 65 staff required over the late spring/early summer period.

The 164.9 ha property consists of two distinct land classes, the flat cropping country and river flats and the steep hill slopes leading down to the river flats. The flat ground is utilised primarily for asparagus cropping while pasture on the steep slopes is managed by grazing carryover cows.

The business is interested in planting trees on the steep slopes to provide better integration with the current cropping system and peak season labour demands, diversify the farm business and provide erosion control of steep slopes. The cattle grazing enterprise is secondary to the asparagus operation. However, a major concern for Sam is ensuring cattle do not get into the river. There has been an issue with cattle breaking through fences occasionally and accessing the river, often at inconvenient times with respect to asparagus management and requiring someone to immediately shift jobs and move the stock. Hence, trees provide a better alternative to cattle in terms of keeping stock out of the river and fit with other management activities.

FARM BUSINESS STRATEGY

Mangaweka Asparagus operates under a company structure with the owners and their children on the board. Their priorities are to ensure that the business remains financially viable to support the shareholders, while integrating alternative land uses to operate alongside the current asparagus operation to provide diversity in revenue and improve sustainability of the land.

The vision and goals for the farm business are to:

- Continue to operate a financially sustainable business to support the owners and their children.
- Improve and expand the asparagus operation.
- Integrate sustainable cropping practices.
- Protect the local environment including the Kawhatau River.
- Diversify income streams.

Figure 1: Mangaweka Asparagus aerial map identifying property boundary (orange line).

FARM DESCRIPTION

PHYSICAL CHARACTERISTICS

Mangaweka Asparagus is 164.9 ha in total consisting of 152 ha effective and 12.9 ha non-effective. Of the farmable area there is 88.8 ha of asparagus, 12.6 ha of winter wheat, 47.2 ha of cattle grazing (including 14.5 ha of river flats and 32.7 ha of steep country), and 3.4 ha of grazed trees. Areas of the river flats and winter wheat are currently being converted to asparagus.

The effective area consists entirely of acidic orthic brown soil. The climate is generally summer safe and has minimal winter water logging. The farm is in a moderate rainfall area receiving 1,150 mm per annum and has a mean annual temperature of 11.5^{o}c. Farm topography is characterised as 40% flat, 31% rolling, 10% easy hill and 19% steep. The asparagus land utilises the flat and rolling areas, while carryover cows are grazed primarily on the easy hill and steep land (Table 1). Mangaweka Asparagus are considering alternative land uses, such as trees, for this steep country to prevent stock access to water, provide erosion control, and reduce labour demands particular at the peak of the asparagus season.

Table 1: Slope description for each farm block.

	Area (ha)	Average slope (degrees)	Flat 0-7^{o}	Rolling 8-15^{o}	Easy Hill 16-25^{o}	Steep 26^{o}+
Asparagus	88.8	7.6	54%	37%	8%	1%
Winter wheat	12.6	9.5	40%	45%	13%	2%
Cattle country	32.7	38.0	4%	8%	12%	76%
River flats	14.5	10.4	40%	40%	15%	5%
Grazed trees	3.4	29.9	7%	17%	22%	54%
Total	152.0	15.1	40%	31%	10%	19%

FARM SYSTEM

The main income source for the farm is asparagus with 88.8 ha of land currently utilised for growing the crop. Additional areas of river flat and land currently used for winter wheat is planned to be developed for asparagus cropping. For the purposes of this case study, the area considered for conversion to asparagus has not been included in the analysis. A mustard crop is grown prior to planting asparagus and mulched in to suppress weeds and provide organic matter. The business is looking at ways to improve the sustainability of their system by integrating techniques such as strip tillage, inter-row cropping to create permanent soil cover, and non-chemical options of controlling weeds. Harvest occurs from October through to January. Labour over this time is critical with the farm employing approximately 65 staff. The business utilises locals, backpackers and 50 recognised seasonal employees (RSEs) to fulfil this labour requirement, providing accommodation for the RSEs over this time.

The remaining steep land and river flats (47.2 ha) are used to graze 90 Friesian x Jersey carryover cows from 1 May to 1 February. These cattle provide a way to manage pasture growth, suppress weeds and provide a regular cash flow for nine months of the year. Labour requirements are low which generally fits well with the business with just one full time equivalent (Sam Rainey) running the farm outside of the harvest period. The exception being a casual employee who comes in occasionally to help with stock work. However, during harvest, managing the stock can be a challenge with water issues often occurring during the peak period and requiring labour to address. Additionally, the steep land is marginal particularly for heavy stock and therefore other land uses are sought to minimise environmental impacts while still providing an alternate income source to supplement seasonal cropping revenue.

ENVIRONMENTAL FOOTPRINT AND LIMITS

Once agriculture enters the Emissions Trading Scheme (ETS), farmers may be required to make changes to reduce on-farm greenhouse gas (GHG) emissions to contribute to domestic and international GHG reduction targets.

Biological greenhouse gas emissions for Mangaweka Asparagus total 1.3 tonnes of carbon dioxide equivalents per hectare per year (t CO_2e/ha/yr) and comprise 52.4% methane (CH_4) and 47.6% nitrous oxide (N_2O). This is different to pastoral farms (typically 80% methane, 20% nitrous oxide) due to the significant cropping operation, which is the main contributor to emissions through N_2O from nitrogen fertiliser inputs. Reducing nitrous oxide emissions therefore relies on reducing nitrogen inputs, while reductions in methane emissions rely on reducing dry matter intake (21.6 g methane produced per kg of dry matter eaten) of livestock.

The current nitrogen leaching loss rate for Mangaweka Asparagus is 26 kilograms of nitrogen (N) per hectare per year (kg N/ha/yr) while phosphorus (P) losses equate to 0.3 kg P/ha/yr. Nitrogen losses are driven primarily by the cropping operation while phosphorus losses are driven from grazing cattle on the steep hill slopes.

The integration of trees on farm may provide a valuable tool to mitigate environmental externalities. Key opportunities relate to retiring marginal land to reduce methane emissions, sediment and P loss and providing income from log sales and carbon sequestration over time.

More information on the expected GHG requirements is provided in Appendix 2.

ESTABLISHED TREE PLANTING

Mangaweka Asparagus have existing plantings on the property including 3.4 ha of grazed trees and large areas of regenerating scrub on steeper areas of the hill slopes resulting from low grazing pressure. The owners are keen to plant trees on the hill slopes to better align labour demands with their asparagus system compared to the current cattle operation, mitigate issues with stock accessing the water, provide diversity in revenue streams and improve environmental performance.

STATUS QUO FARM SYSTEM PERFORMANCE

The physical, financial and environmental performance information for Mangaweka Asparagus' status quo operation are detailed below. The measures indicate the performance of the property in its current stage of development and management regime. Note, as the planned tree planting scenarios are only located on areas currently used for cattle grazing, the financial performance displayed below is for the cattle operation only. No changes to the cropping enterprise result from tree planting, and thus financial figures for the cropping enterprise have not been analysed.

PHYSICAL PERFORMANCE

Table 2: Summary of status quo farm system details.

Farm details		Current farm system	
Nearest town and catchment	Manawatu	**Asparagus area (ha)**	88.8
Season's rainfall (Overseer; mm)	1,150	**Winter wheat area (ha)**	12.6
Soil type(s)	Orthic brown soil	**Crop N fertiliser use (kg N/ha/yr)**	81
Topography	Flat (40%) Rolling (31%) Easy hill (10%) Steep (19%)	**Cattle area (ha)** **Cattle stocking rate (SU/ha)**	47.2 9.5
Total farm size (ha)	164.9	**Breed/Type**	FxJ carryover cows
Effective area (ha)	152.0	**Date on farm**	1 May to 1 Feb
Native and riparian trees (ha)	2.0	**Labour; Feb - Sept (FTE)**	1.1
Timber woodlots (ha)	0	**Labour; Oct - Jan (FTE)**	65.0

FINANCIAL PERFORMANCE

Table 3: Financial key performance indicators for the cattle operation.

Financial KPIs	Base System
Gross Farm Income ($/ha)	768
Farm Working Expenses ($/ha)	251
Operating Expenses ($/ha)	304
Operating Profit ($/ha)	465
Cash Operating Surplus ($/ha)	517

ENVIRONMENTAL PERFORMANCE

Table 4: Status quo environmental performance indicators.

Environmental Indicators	Status Quo
Total N loss (kg N)	4,214
N loss per hectare (kg N/ha)	26
N surplus (kg N/ha/yr)	36
N conversion efficiency	53%
P loss (kg P/ha/yr)	0.3
bGHG (t CO_2 eq./ha)	1.3
Greenhouse gas emissions (t CO_2 eq./ha)	1.9

**Contaminant loss KPIs were modelled through OverseerFM v6.3.4 and reported against the total farm area.*

Forestry options

This section describes the options for integrating trees on farm to meet the goals and values of Mangaweka Asparagus. The current physical, environmental and financial performance and limitations of the farm business discussed in Section 1 provide guidance for designing planting scenarios.

Scenario design considered Mangaweka Asparagus' tree planting objectives which included the following:

- Provide business integration with the current cropping system and peak season labour demands.
- A preference for non-radiata species.
- Provide diversity in revenue streams (timber and carbon).
- Reduce soil losses from erosion of steep slopes.

RIGHT TREE RIGHT PLACE: SUITABLE SPECIES SELECTION FOR THE FARM

Understanding a planting site and its effect on tree performance and future harvesting operations and growth potential is essential for selecting the right tree to achieve the desired outcomes. In this section, tree options for the steep hill slopes on the Mangaweka Asparagus property are explored.

STEEP HILL SLOPES

This area refers to 32.7 ha of steep slopes (38^{o}) leading down to the river flats adjoining the Kawhatau River at the northern end of the property (Figure 2 and Figure 3). The area receives good rainfall (1,145 mm) but is north-facing and susceptible to drying out over summer. Altitude at the base of the hill slopes is 365 m above sea level (asl) and climbs to 440 m asl at the top of the slopes. Pastures are undeveloped with low fertility and are composed of browntop. Carryover cows are utilised from 1 May through to 1 February to control pasture growth.

This area provides opportunity for diversifying marginal pastoral land into an alternative land use that can improve the physical and financial performance of the land, while achieving the objectives of the landowner. Planting of hill slopes for timber requires consideration around access and harvesting. Transporting logs from the harvest site to public roads requires good roading infrastructure and can be a costly exercise if tracks are not up to standard. If large upgrades are required, then landowners should consider increasing the scale of planned woodlots to dilute fixed roading costs (NZFFA, 2005a). Similarly, if slope and slope length of hill areas requires tracking for ground harvest or if haulers are required, then harvesting costs will be greater.

It is important to plan the design of woodlots to manage and reduce negative environmental outcomes at harvesting, particularly where waterways are close to the planting site. For Mangaweka Asparagus, this is a particularly important consideration given the proximity of the Kawhatau River at several points of the planting site. Key considerations will be around managing the post-harvest impacts of afforestation including containment of sediment and forestry slash and debris. Appropriate management of these woodlots and harvesting events will involve consideration of the National Environmental Standards for Plantation Forestry (NES-PF; 2018) which provides regulations on how the environmental effects of forestry should be managed.

In challenging situations where slope, access and/or nearby waterways are likely to increase harvesting costs landowners should consider whether the proposed woodlot has the scale and potential timber value necessary to justify extraction.

Figure 2: View of the steep hill slopes identified for tree planting.

Figure 3: Looking down a slope identified for tree planting. Kawhatau River in the background.

FORESTRY SCENARIO DESIGN

Mangaweka Asparagus expressed interest in alternative timber species (i.e. non-radiata species) for planting on their steep hill slopes. The objective of tree planting is to better align labour demands with their asparagus system compared to the current cattle operation, mitigate issues with water access, provide diversity in revenue streams and improve environmental performance.

Alternative timber species tend to be more site-specific and have longer rotation lengths than the mainstream *P. radiata* forests. The price received at harvest can be greater than that for radiata given the superior timber properties of many alternative species. However, the time to harvest is much longer which impacts on the return on investment. One of the key constraints with growing alternative species is that information for growers is limited. A good place to start for information is through local farm foresters and the New Zealand Farm Forestry Association (https://www.nzffa.org.nz/).

The scenarios modelled for Mangaweka Asparagus illustrate what forestry options may be available for someone who does not want to plant radiata pine, or where radiata pine is not suitable. The forestry areas chosen are those on the steep banks which run down to river flats and are away from the main production area. Two forest systems are included, neither of which use radiata pine. The main forest system produces structural timber, and the other produces pruned high value logs predominantly for furniture or flooring. It has been a conscious decision to use generic cashflows for the two systems not specific to species. There should be a process of reading up, and/or even site testing species to choose the most suitable species option. Within each forest system the cost assumptions, yields and revenues are within the margin of error of each other.

The first forest system for structural timber is intended to represent species such as Douglas-fir (*Pseudotsuga menziesii*), larch (*Larix*) or fir (*Abies*). It is assumed to be planted at 1,333 stems per hectare with no pruning and two thinning's. The aim is to keep branches small and trees slender by maintaining a high stocking through the younger ages, and then two thinning's to get down to an appropriate final crop stocking of 500 stems per hectare before harvest at 55 years.

The second forest system for appearance grade timber is intended for 'specialty timber' species such as black walnut (*Juglans nigra*), Tasmanian blackwood (*Acacia melanoxylon*), and oak (*Quercus*) among others. They are planted at 833 stems per hectare, include the cost of tree guards on every tree, and include three pruning's and two thinning's. The aim is to produce six metres of pruned timber with large butt logs. The final crop stocking after thinning is 250 stems per hectare. The forest is also assumed to be harvested at 55 years.

Considerations for the choice of species in each system are depth of soil, any known nutrient deficiencies, whether out of season frosts are likely, level of exposure to wind and occurrence of flooding on the river flats. There are excellent resources available which can be used to refine species choice based on these indicators. A short description of each of the above forest species is provided below.

SPECIES DESCRIPTION

STRUCTURAL REGIME SPECIES

Douglas-fir is known as a moist climate species requiring annual rainfall above 1,000 mm and should not be planted on drought-prone soils. The species prefers cool climates. Exposed northwest facing slopes should be avoided. Douglas-fir is particularly intolerant of wet soils and out-of-season frosts. As such, flat sites on valley bottoms should be avoided. Good weed and pest control is critical for successful establishment. Stocking is typically at a minimum of 1,000 stems per hectare (sph), with 1,200-1,600 sph common. Rotation length depends on silviculture regime and timing of thinning. Early thinned stands (initial thin to waste at age 10) can provide rotation lengths of 40 years, while late thinning (age 25) will push the harvest rotation to over 50 years. Unthinned stands will require a longer rotation of approximately 60 years before trees are large enough to harvest (NZFFA, 2005b).

Larch species are deciduous trees originating from the northern hemisphere. There are two main varieties of larch grown in New Zealand; European larch (*Larix decidua*) and Japanese larch (*Larix kaempferi*), with the latter showing greater performance in the lower North Island (Miller & Knowles, 1988), along with Hybrid larch (European x Japanese) which has faster growth rates. Japanese larch tolerates cold climates and shallow soils found on steeper slopes (NZFFA, n.d.). It can grow in altitudes up to 600 m and prefers moderate to high rainfall sites (approximately 750-1,250+ mm). The species is light demanding and grows only on well-drained soils. It is very frost hardy in winter but is susceptible to spring frost (Miller & Knowles, 1988). Weed and pest management in the first two years is critical to ensure successful establishment. Larch grown for timber should be thinned regularly to avoid overcrowding and, for a 40 year rotation, should be thinned to 400 sph. Pruning is necessary if quality clearwood is required (NZFFA, n.d.).

Fir (*Abies*) species are evergreen conifers originating from the northern hemisphere. They occupy relatively cool, moist sites at middle to high elevations in mountainous areas (Miller & Knowles, 1989). Fir species are wind tolerant and can cope on bony soils found in exposed erodible steeplands, although growth rates may be reduced if topsoil is both nutrient and moisture deficient. Fir requires free-draining soils and are not tolerant of excessive soil moisture (Satchell, 2018). Typical silvicultural regimes for New Zealand are based on an initial stocking of 1,667 sph thinned to 500 sph at age 17 to produce harvestable logs on a 40 year rotation (Miller & Knowles, 1989). Variation in this regime will exist between different fir species.

SPECIALTY APPEARANCE SPECIES

Black walnut is native to eastern North America and produces a timber used for the construction of high quality furniture (Nicholas et al., 1997). Black walnut is highly site-specific with the most important consideration being shelter, whether topographic or from neighbouring vegetation. Black walnut also requires free-draining soils with good fertility. Areas where late spring frost occurs should be avoided (Nicholas et al., 1997). Often, ideal sites for black walnut are small areas or pockets of land, rather than whole paddocks or hectares. Rotation lengths tend to be around 45-50 years (Knowles, 1978). Winter form pruning when necessary is required to improve stem form. Further pruning of branches up to six metres and subsequent thinning will promote production of clearwood (Haslett, 1986).

Tasmanian blackwood is a fast-growing evergreen species. It is tolerant of poor soil and exposure and is well suited for erosion control of steep slopes. However, deep moist soils and shelter is required for high quality timber production. Lower valley slopes and moist gullies are ideal for timber production, along with eroding gullies where shelter and plenty of soil moisture is available (Brown, 2005). Control of weeds and pests, particularly in the first two years, is critical for successful establishment. Form pruning and thinning is essential if growing for timber, otherwise blackwood left alone will grow a short stem and large, branched crown (Jackson, 2006). Form pruning annually to year eight is necessary to prevent malformation in the stem and crown. Thinning is also required to enable large crowns to form with large butt logs. Typically, blackwoods are planted at 700-800 sph and thinned to 400 sph at age 7-8. At age 10, they receive a final thin to a density of 200 sph. The average rotation length for blackwood is 35 years (Brown, 2006).

Oaks include a wide variety of trees native to the northern hemisphere. European oak (*Quercus robur*) is common in most parts of Britain and is present across Western and Central Europe. European oak has been grown in New Zealand since European settlers arrived. It is the best known timber of the oak species and has been used extensively because of its availability and timber properties (Haslett, 1984). Red oak (*Quercus rubra*) originates from North America and Canada and is considered to have a faster growth rate than the European oak. Oaks can grow on a range of soil conditions but will achieve better growth rates on fertile sites. Oaks have a tendency to grow large branches and spread if given space. Therefore, high stocking rates and timely pruning are essential to produce timber for high value uses such as joinery and flooring (Appletons Tree Nursery, n.d.). There are hybrid species available and produced at New Zealand nurseries. Different combinations can be trialled to get the right growth rates and crown shapes.

Eucalypts tend to grow best on low altitude, fertile and relatively sheltered sites with good drainage and regular rainfall, although tolerance to specific conditions will vary amongst species (NZDFI, 2019). Eucalypts grown for pulp have a short rotation length (<20 years) and can require form pruning to achieve a single straight stem, whereas eucalypts grown for clearwood are grown in 30 to 40 year rotations and will require both thinning and pruning lifts. Pulp wood tends only to be profitable where a mill is located within close proximity. As with all the alternative timber species described above, higher timber prices at harvest compared to radiata are possible given the superior timber properties of these species. Currently, however, finding a market outside of the local pulp mills can be difficult and often relies on a boutique sawmilling outfit with portable mills. The potential returns from growing these species will depend on future demand and the development of specialty sawmilling and timber supply chains.

SCENARIO DESIGN

For Mangaweka Asparagus, two scenarios were tested to assess the value of integrating alternative tree species on farm to support the key landowner objectives outlined previously. Farm woodlots were assessed for economic potential (including carbon) and compared against the current cattle operation.

Details of each scenario are provided below with a map of the planting design presented in Figure 4.

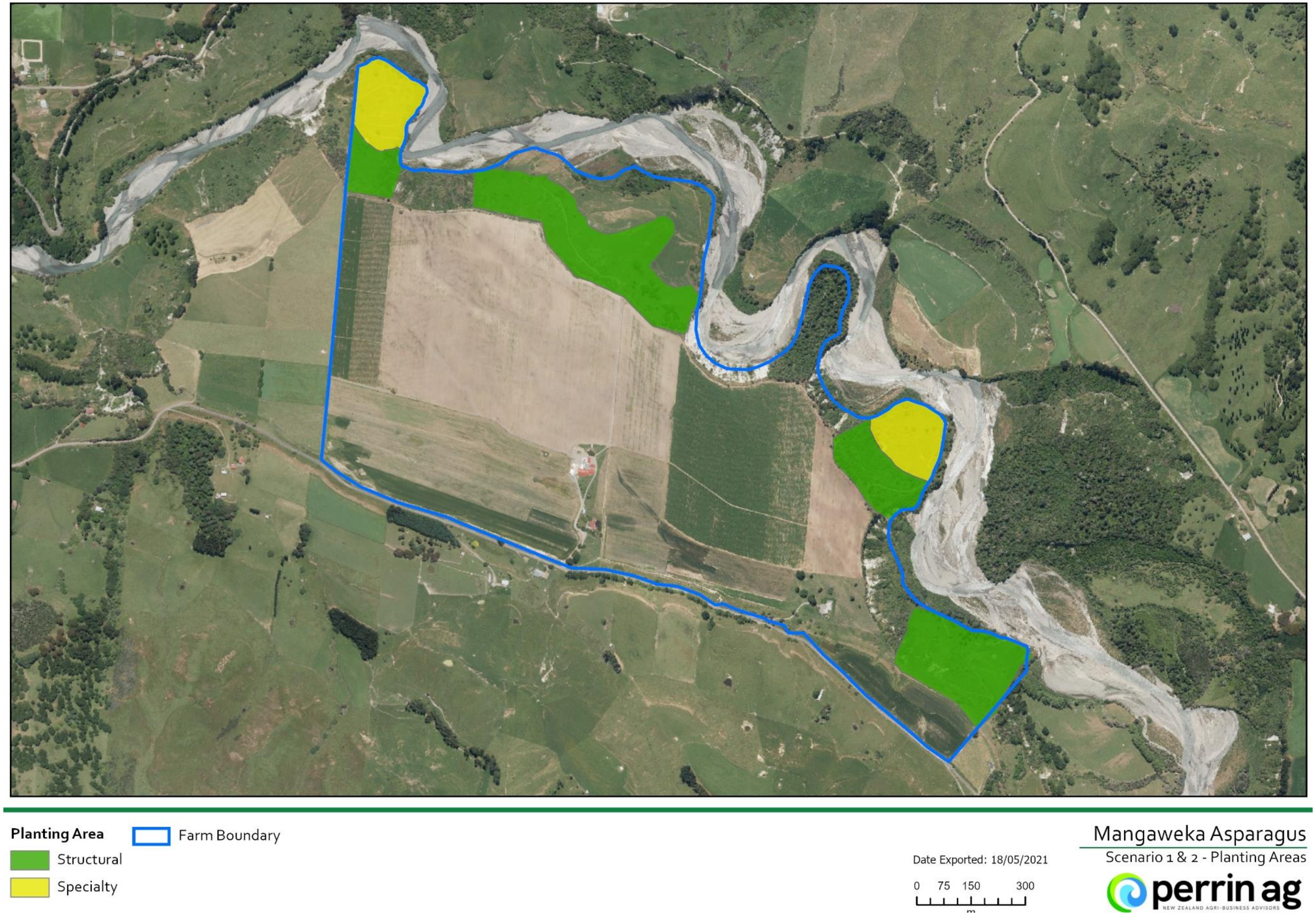

Figure 4: Scenario 1 and 2 planting areas.

SCENARIO 1 – STRUCTURAL + LOW PRODUCTIVITY SPECIALTY TIMBER

Scenario 1 modelled planting 22.6 ha of structural timber and 6.9 ha of low productivity specialty timber. The structural system includes timber species such as Douglas-fir, larch and fir and follows the steeper hill areas along the river bank. It makes up the majority of the planting area and is on the steeper zones where the requirement for management intervention is lower. The specialty system is on the flatter areas to make pruning easier, and for the potential for small numbers of trees to be harvested at a time if the need arises. It includes species such as black walnut, Tasmanian blackwood and oak. Specifics of this forestry scenario include:

- Total afforestation area is 29.4 ha including 22.6 ha of structural timber and 6.9 ha of specialty timber.
- The structural system was modelled on an initial stocking density of 1,333 stems per hectare, with no pruning's and thinned twice to a final stocking density of 250 stems per hectare.
- Structural timber harvest is based on a 55 year rotation length.
- The specialty system was modelled on an initial stocking density of 833 stems per hectare, pruned in three lifts to achieve six metre butt logs and thinned twice to a final stocking density of 250 stems per hectare. Tree guards were included on all trees.
- Specialty timber harvest is based on a 55 year rotation length.

The associated impact on the farm enterprise is:

- The effective grazing area is reduced by 29.4 ha.
- The remaining grazing area is planned for asparagus development (14.5 ha) or reversion to natives (3.2 ha) where topography limits both cattle grazing (although currently including within the cattle country) and forestry planting.
- Given not all of the cattle operation is being converted to forestry (37.5% of cattle area also being converted to asparagus), only 62.5% of the returns from the cattle operation were compared with the forestry scenarios on a per hectare basis.

SCENARIO 2 – STRUCTURAL + HIGH PRODUCTIVITY SPECIALTY EUCALYPT TIMBER

Scenario 2 modelled the same area of planting as for Scenario 1 but assumed *Eucalyptus fastigata* for the specialty timber system. This species is a higher productivity species than those assumed for Scenario 1 and can reach harvestable volume earlier. For this scenario, a harvest age for eucalypts was assumed at 35 years. To enable comparison with the 55 year specialty regime modelled in Scenario 1, revenue of eucalypts in the second rotation at age 20 (year 55) was assumed based on the value of the timber if it was harvested and sold at that point in the rotation. The silviculture regime for eucalypt was the same as for the specialty timber species outlined in Scenario 1 with the exception that no tree guards were required.

All other scenario design parameters were the same as for Scenario 1.

Forestry scenario analysis

This section describes the discrete performance of the forest investment for the two forest scenarios described. These results are analysed separately to the farm business. Table 5 summarises the investment outcomes over a 56 year period, both excluding and including carbon revenues from eligible woodlots. The full cash flow analyses are presented in Appendix 4.

Reductions of environmental externalities (N and P loss to water, reduced GHG emissions and carbon sequestration) are discussed in Section 5 (whole farm business analysis).

Table 5: Summary of individual investment performance of the forestry investments under each scenario.

	Scenario 1		**Scenario 2**	
	29.4		**29.4**	
Area in structural woodlot	22.6	ha	22.6	ha
Area in specialty woodlot	6.9	ha	6.9	ha
Returns over 56 years	**Total**	**/woodlot ha**	**Total**	**/woodlot ha**
NET PRE-TAX LOGS (undiscounted)	295,095	10,027	384,922	13,079
Net Present Value for whole term (WACC = 6%)	-$244,489	-$8,307	-$178,454	-$6,064
Internal Rate of Return (IRR)	1.2%		1.9%	
	Total	**/woodlot ha**	**Total**	**/woodlot ha**
NET PRE-TAX LOGS & CARBON (undiscounted)	696,003	23,649	746,321	25,359
Net Present Value of free cashflow (WACC = 6%)	-$71,400	-$2,426	-$7,655	-$260
Internal Rate of Return (IRR)	4.0%		5.7%	

SCENARIO 1

The net pre-tax undiscounted proceeds from Scenario 1 for timber only was $295,095 ($10,027/woodlot ha) over the 56 year period modelled. This includes revenue of $1,071,081 ($36,394/woodlot ha) and expenses of $683,296 ($23,218/woodlot ha) and is equivalent to an annuity (annual payment/loss) of -$15,253 (-$518/woodlot ha) in present value at a 6% discount rate (Appendix 4). In comparison, at the same discount rate, the existing cattle operation generates a return equivalent to an annuity of $500/ha. The net present value generated over the lifetime of the investment (56 years) is negative at -$244,489 (-$8,307/ha). The internal rate of return (IRR) is 1.2%.

If the safe tradeable carbon from the woodlots is included and sold, then the net present value improves but remains negative at -$71,400 (-$2,426/woodlot ha). The IRR generated from this investment also increases to 4%. The equivalent annuity improves also but is still negative at -$4,454 (-$151/woodlot ha).

SCENARIO 2

The net pre-tax undiscounted proceeds from Scenario 2 from timber only was $384,922 ($13,079/woodlot ha) over the 56 year period modelled. This includes revenue of $1,108,535 ($13,079/woodlot ha) and expenses of $673,780 ($22,894/woodlot ha) and is equivalent to an annuity of -$11,133 (-$378/woodlot ha). The higher returns in this scenario reflect the lower plant cost of eucalypts compared to the lower productivity specialty trees in Scenario 1 which are more costly to purchase per stem but also require tree guards at approximately $7/stem. In addition, the ability for eucalypt to be harvested on a shorter rotation length (35 years) and have a standing timber value included in the analysis at Year 56 (based on the value of the timber if it was harvested at that point in time) also enables Scenario 2 to perform better than Scenario 1. Applying a discount rate of 6% to the investment still provided a negative present value of -$178,454 (-$6,064/woodlot ha). The IRR for this investment over the 56 year term was 1.9%.

If the safe tradeable carbon was sold, then the present value improves but also remains negative at -$7,655 (-$260/woodlot ha). The IRR improves to 5.7%.

RISK ANALYSIS

This section analyses the sensitivity of each scenarios' internal rate of return pre-tax to log and carbon price ($/NZU). These are presented in Table 6 and Table 7.

Log price has been sensitised +/- 50% in 25% increments. This is to reflect the greater risk around marketing and selling alternative species that do not have a well-established supply chain. Log prices assumed in this analysis have been based on expert opinion given data on comparable markets for specialty log sales is very limited. On average, the eucalypt and specialty regimes were assumed to return $120 per cubic metre harvested while the structural regimes were assumed to return $96 per cubic metre. Given the uncertainties in the market and lack of comparable data, there is likely to be variation in the log revenue assumed in this analysis and what is received on the day, and it is likely that there will be considerable variation between woodlots. Future demands for alternative timbers and development of specialty sawmilling and timber supply chains will have a large bearing on future profitability of stands.

Carbon price has also been sensitised at $0, $20, $35 and $50/NZU. These carbon values align with The Climate Change Response (Emissions Trading Reform) Amendment Act 2020. The Act establishes price controls on emissions sold through the Emissions Trading Scheme (ETS) including a price floor (the minimum price at which units may be sold) of $20/NZU, a temporary fixed price option of $35/NZU during the transition to auctioning and a price cap of $50/NZU. The $0/NZU gives an indication of the discrete IRR (from point of planting) generated from the scenarios in the second and future rotations when there is no safe tradeable carbon to sell from the woodlots.

Table 6: Impact of log price (%) and carbon price ($/NZU) on the pre-tax internal rate of return (IRR%) and net present value (NPV) per hectare for Scenario 1.

			Log revenue				
			-50%	-25%	0%	25%	50%
Carbon price ($/NZU)	0	IRR%	-0.23	0.75	1.43	1.94	2.36
		NPV/ha	-8,917	-8,620	-8,322	-8,024	-7,726
	20	IRR%	1.93	2.78	3.36	3.81	4.17
		NPV/ha	-4,201	-3,903	-3,605	-3,307	-3,010
	35	IRR%	5.44	5.86	6.18	6.45	6.67
		NPV/ha	-663	-366	-68	230	528
	50	IRR%	10.20	10.27	10.33	10.39	10.45
		NPV/ha	2,874	3,172	3,470	3,767	4,065

Table 7: Impact of log price (%) and carbon price ($/NZU) on the pre-tax internal rate of return (IRR%) and net present value (NPV) per hectare for Scenario 2.

			Log revenue				
			-50%	-25%	0%	25%	50%
Carbon price ($/NZU)	0	IRR%	-0.20	1.11	1.99	2.66	3.20
		NPV/ha	-7,149	-6,652	-6,156	-5,659	-5,163
	20	IRR%	2.90	4.05	4.81	5.38	5.84
		NPV/ha	-2,432	-1,936	-1,439	-943	-446
	35	IRR%	8.36	8.74	9.05	9.31	9.54
		NPV/ha	1,105	1,602	2,098	2,595	3,091
	50	IRR%	13.80	13.87	13.94	14.01	14.08
		NPV/ha	4,643	5,139	5,636	6,132	6,629

The internal rate of return is highly sensitised to carbon price. For every one dollar change in the price of New Zealand Units (NZUs), the IRR changes by an average of 0.20% and 0.26% for Scenario 1 and 2, respectively. The carbon price of $0/NZU reflects the potential returns from forestry after the first rotation when carbon can no longer be claimed under the averaging accounting scheme[1]. The IRR for Scenario 1 and 2 at $0/NZU ranges from -0.23% to 3.20% depending on log price variability. These reductions in IRR demonstrate the impact carbon has on the forestry investment and cash flow in the first rotation. For both Scenario 1 and 2 at all modelled log price sensitivities, carbon prices of $20/NZU and below are insufficient to achieve a positive net present value over the 56 year investment period. For Scenario 1 this is extended to $35/NZU when the log revenue remains at the status quo (0%) or drops below.

[1] Under the new averaging accounting scheme, carbon from harvestable forests can only be claimed in the first rotation up to the forests average age. This is the age at which the forest reaches the average level of carbon it is expected to store over the long-term. While no carbon can be claimed in second and future rotations, there is no requirement for credits to be surrendered at harvest provided replanting occurs (MPI, 2021a).

As expected, log price also has a major impact on the IRR, particularly when carbon prices are low. Given the uncertainties in the alternative timber market it is important to be aware of the impacts that the variation in log revenue can have on the investment. At $35/NZU the IRR in Scenario 1 and 2 changes by 0.3% for each +/- 25% movement in log revenue from the base model. After the first rotation when carbon can no longer be claimed (effectively $0/NZU), this increases to 0.65% for Scenario 1 and 0.85% for Scenario 2 and represents a significant risk to the business. As log revenue is received twice for Scenario 2 (on the basis that eucalypt is harvested once at Year 35 and also has a standing timber value in the second rotation at the end of 56 year analysis), the impact of log price on Scenario 2 is greater.

Impact on the farm system

IMPACTS OF LAND RETIREMENT

The impacts of the proposed land use change to forestry on the residual farming enterprise are summarised below.

PHYSICAL PERFORMANCE

The proposed land use change on 29.4 ha of steep hill slopes will require the removal of a portion of the dry cow grazing operation. Currently, 90 dry cows graze on 47.2 ha of hill slopes and river flats. Topography on areas of the hill slopes (3.4 ha) is extremely marginal for grazing (or timber afforestation), as is indicated by the level of regenerated scrub. This area will be retired and left to revert following tree planting. For the majority of the time cows are on farm (1 May to 1 February), the cows graze on the less steep areas, identified for tree planting, and the river flats. These river flats are intended to be developed for asparagus cropping, and therefore will also not be available for grazing. As a result, it is proposed that the entire dry cow grazing operation will be removed and replaced in part by forestry and asparagus. Development of additional asparagus area and subsequent impacts to the farm business were considered outside the scope of this project. Therefore, the impact of changing land use to forestry on the hill slopes will be compared with the portion of dry cow grazing (29.4 ha; approximately 62.5% of the cattle enterprise) that forestry would replace.

Figure 5: Marginal hill country not suited to grazing or timber afforestation.

PROFITABILITY

The conversion of 29.4 ha of cattle grazing land to forestry results in 62.5% of the cattle grazing enterprise being replaced. This is equivalent to $15,200 ($517/ha) in operating surplus.

IMPACTS OF INTEGRATED FORESTRY LAND USE

The impacts of the proposed land use change to forestry on the whole farm business enterprise are summarised below.

FINANCIAL PERFORMANCE

The forestry scenarios analysed for Mangaweka Asparagus focused on planting the steep hill slopes currently used for cattle grazing. As there was no change to the main farming enterprise – the cropping operation; financial analysis focuses on comparing the returns from the existing cattle operation with those from timber afforestation as modelled in Scenario 1 and 2.

The net pre-tax undiscounted returns from the portion of the cattle operation being converted to forestry was $851,389 ($28,959/ha) over the 56 year period analysed and is equivalent to a discounted annuity of $500/ha. Applying a discount rate of 6% to the investment period provides a present value of $236,294 ($8,037/ha). The IRR for this investment over the 56 year period is 198% reflecting the high returns from very little cash investment ($261/ha) as livestock are not owned and the minimal machinery used is shared with the asparagus enterprise. Note this cash investment deliberately excludes the investment in the land on the basis that land investment is not discretionary between scenarios but the choice of land use is.

Neither of the forestry scenarios were able to compete with the existing cattle operation given the high capital investment in planting, long investment period and relatively low returns from alternative species of which the hardwood timber is not currently well marketed in New Zealand. In addition, the high revenue of the carryover operation combined with very low inputs (both the asset and working capital) make it a difficult enterprise to compete with on a financial basis.

Table 8: Investment summary of the base cattle operation to be planted in forestry compared with forestry scenario's 1 and 2.

	Base Cattle Operation		**Forestry Scenario 1**		**Forestry Scenario 2**	
	29.4		**29.4**		**29.4**	
Area in structural woodlot	-	ha	22.6	ha	22.6	ha
Area in specialty woodlot	-	ha	6.9	ha	6.9	ha
Area in cattle grazing	29.4	ha	-	ha	-	ha
Returns over 56 years	**Total**	**/grazed ha**	**Total**	**/woodlot ha**	**Total**	**/woodlot ha**
NET PRE-TAX (undiscounted)	851,389	28,959	295,095	10,027	384,922	13,079
Present Value for whole term (WACC = 6%)	236,294	8,037	-$244,489	-$8,307	-$178,454	-$6,064
Internal Rate of Return (IRR)	197.6%		1.2%		1.9%	
	Total	**/grazed ha**	**Total**	**/woodlot ha**	**Total**	**/woodlot ha**
NET PRE-TAX INCLUDING CARBON (undiscounted)	851,389	28,959	696,003	23,649	746,321	25,359
Present Value of free cashflow (WACC = 6%)	236,294	8,037	-$71,400	-$2,426	-$7,655	-$260
Internal Rate of Return (IRR)	197.6%		4.0%		5.7%	

ENVIRONMENTAL PERFORMANCE: N AND P LOSS

The following environmental analysis for Scenario 1 and 2 models the planned farm system following development of 29.4 ha of timber afforestation and the remaining grazed land being converted to asparagus. Scenario 1 and 2 demonstrated significant reductions in contaminant loss (Table 9) as a result of replacing a higher N loss land use (grazing carryover cattle at 19 kg N/ha) with a low N loss land use (forestry at 3 kg N/ha). The removal of the cattle enterprise resulted in N loss to water reducing by 40% to 15 kg N/ha over the total property area. Asparagus is not a recognised crop in OverseerFM. As such, modelling decisions were required to be made to create an output similar to regional council expectations of nitrogen loss from asparagus. Low N fertiliser inputs combined with the long-term perennial cropping system (approximately 10 years between cultivations) results in high uptake of applied N and low losses of N to the environment.

A significant reduction (-57%) in P loss was also modelled in Scenario 1 and 2 with the addition of forestry. Topography is one of the key factors that influences P losses with steeper slopes losing more P during runoff events than flat or gently rolling slopes. The removal of cattle grazing from the steep hill country therefore reduced P losses to just 0.1 kg P/ha.

Table 9: Summary of nitrogen and phosphorus loss for Scenario 1 and 2 compared to the base system.

Nitrogen and phosphorus*	Base system	Scenario 1 & 2
Total farm N loss (kg N)	4,214	2,542
N loss/ha (kg N/ha)	26	15
N surplus (kg N/ha)	36	8
N conversion efficiency	53%	83%
Total farm P loss (kgP)	51	22
P loss/ha (kgP/ha)	0.3	0.1

**Contaminant KPIs modelled in OverseerFM v6.3.4 and reported against the total farm area.*

ENVIRONMENTAL PERFORMANCE: BIOLOGICAL GHG PROFILE

Biological greenhouse gas emissions (methane and nitrous oxide) at the whole property level also showed significant reductions reducing by 1 t CO_2 eq./ha/yr (-77%) as a result of removing the cattle operation (Table 10). With no stock on farm, methane is no longer emitted and nitrous oxide emissions associated with the urine patch no longer occur. The biological greenhouse gas profile for the farm operation under Scenario 1 and 2 therefore becomes 100% nitrous oxide (0.3 t CO_2 eq./ha/yr).

Overall, total biological emissions reduced by 167 t CO_2 eq./yr to 47 t CO_2 eq./yr with the removal of cattle from the farm. If farm enterprises were to become exposed to a potential future liability from biological emissions not able to be offset by sequestered carbon, this reduction in emissions would represent an annual saving of $4,175 assuming a carbon price of $25/NZU. The reduction in GHG emissions highlights the potential of land use change to forestry (or other lower emitting land uses) as a tool to support farm level contribution to national greenhouse gas reduction targets (refer to Appendix 2).

Table 10: Summary of biological emissions for Scenario 1 and 2 compared to the base system.

Greenhouse gases*	Base system	Scenario 1 & 2
Total biological GHG (t CO2 eq./ha/yr)	1.3	0.3
Methane (t CO2 eq./ha/yr)	0.7	0
Nitrous oxide (t CO2 eq./ha/yr)	0.6	0.3

**Contaminant KPIs modelled in OverseerFM v6.3.4 and reported against the total farm area.*

The safe carbon claims and accumulated emissions over the 56 year period for Scenario 1 and 2 compared to the base system were analysed and are displayed in Figure 7 and Figure 8. Safe carbon claims of 13,436 t are available for both Scenario 1 and 2 from carbon stored over 16 years. The carbon sequestration of forests under 100 ha is estimated using the Ministry for Primary Industries Carbon Look-up Tables (MPI, 2017). All exotic species in the look-up tables (with the exception of radiata and Douglas-fir) are currently classified as either hardwood or softwood with an average carbon sequestration rate assumed for each of the categories regardless of species. The finer details for averaging carbon accounting are still being finalised and are expected to be set by the time averaging comes into play on 1 January 2023 (MPI, 2021b). Uncertain policy is a risk for new forest plantings. In particular, the treatment by species for the rotation length is of relevance for this analysis. Given the policy is not finalised and the policy direction for exotic hardwoods is unclear, differentiation between the long and short rotations has not been included in this analysis. Both the 55 year and 35 year rotations for the pruned regimes modelled in Scenario 1 and 2, respectively, are therefore assumed to earn the same carbon credits to Year 16.

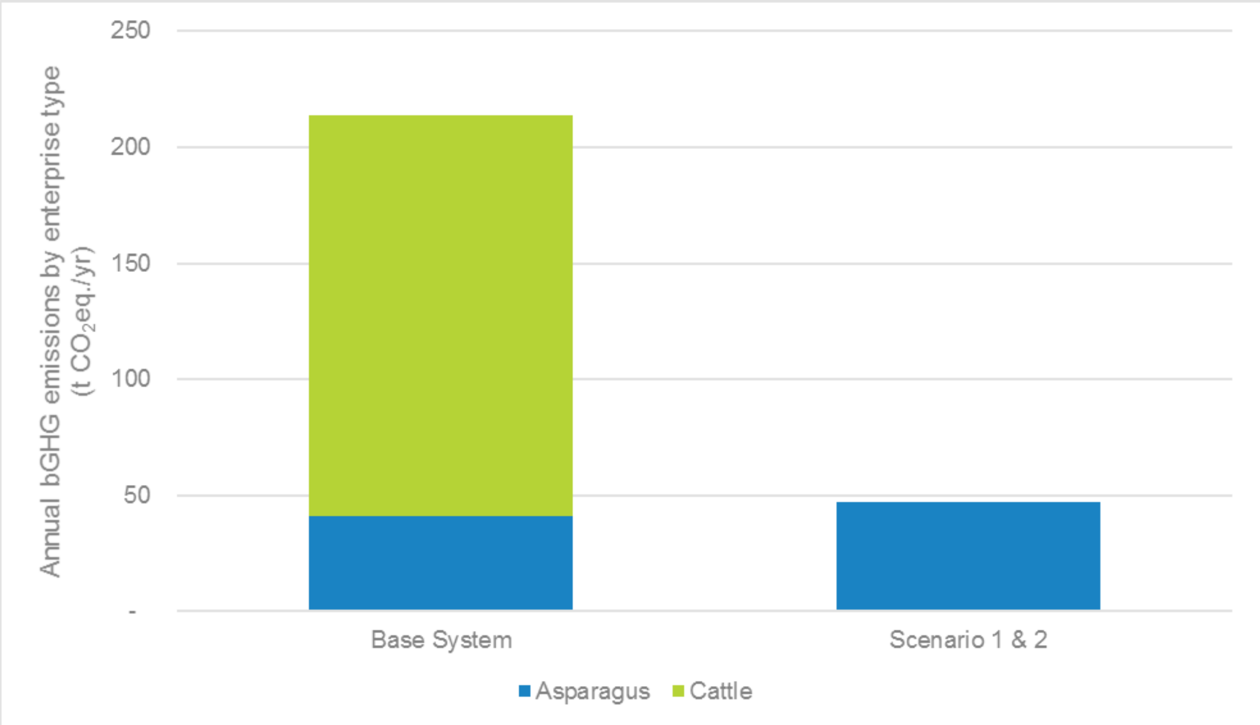

Figure 6: Annual biological greenhouse gas (bGHG) emissions by enterprise type for Scenario 1 and 2 compared to the base system.

The largest source of whole property emissions under the base system is from the cattle enterprise (81% of total emissions; 173 t CO_2 eq/yr). With cattle removed under Scenario 1 and 2, total biological emissions are just 0.46 t CO_2 eq./ha/yr (47 t CO_2/yr) and is attributed to the asparagus operation only (Figure 6). Over the 56 year period, total accumulated emissions under the forestry scenarios are therefore only a fraction (22%; 2,679 t CO_2 eq) of what the base system would otherwise emit over the same period (12,198 t CO_2 eq.). If on-farm biological emissions were to face a liability in the future, the farm would be exposed to a tax of $66,975 (assuming a carbon price of $25/NZU) over the 56 year period ($1,196/yr) if operating under Scenario 1 or 2. This compares to $304,950 ($5,446/yr) if the farm continued to operate under the current base system.

In addition, 13,436 t of carbon is also sequestered under the forestry scenarios. The farm has three options in terms of using this carbon; offsetting, selling immediately or selling at a future date. Given the forestry area modelled is far larger than that required to offset the residual farming enterprise, if the business chose to use the forestry as an offset there would be sufficient carbon sequestered to offset the farm's emissions (and potential liability if on-farm emissions are to become exposed to a carbon tax) for the next 285 years.

Alternatively, the owners could elect to sell the carbon immediately upon claiming at the market price on the day (as was modelled in the forestry analysis). If a carbon tax was to be imposed on on-farm emissions with the liability at the farm level, then a portion of this revenue could be used to pay the liability ($1,196/yr). Depending on business liquidity, the farm could otherwise pay the liability with cash reserves and retain the carbon claimed on the balance sheet as a liquid asset (rather than selling) and sell at a future date in expectation that the price of carbon will go up. There is risk to the latter option if the carbon price goes down. For the scenarios modelled, if carbon price is $20/NZU or less then at all log price variabilities measured in the sensitivities in Table 6 and Table 7, the return on investment would be negative.

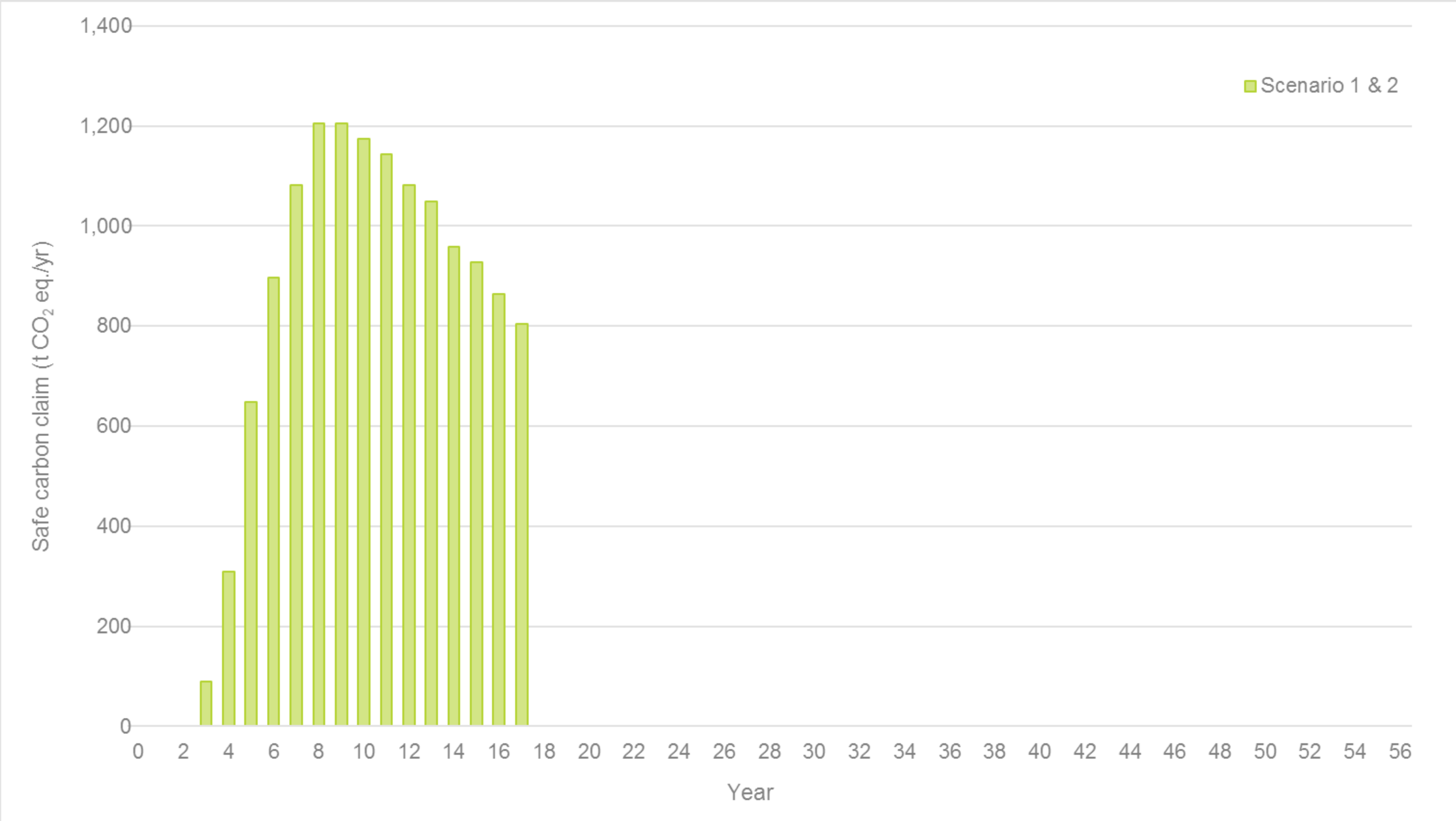

Figure 7: Safe carbon claims for Scenario 1 and 2. Note carbon claims refer to carbon stored in the year prior.

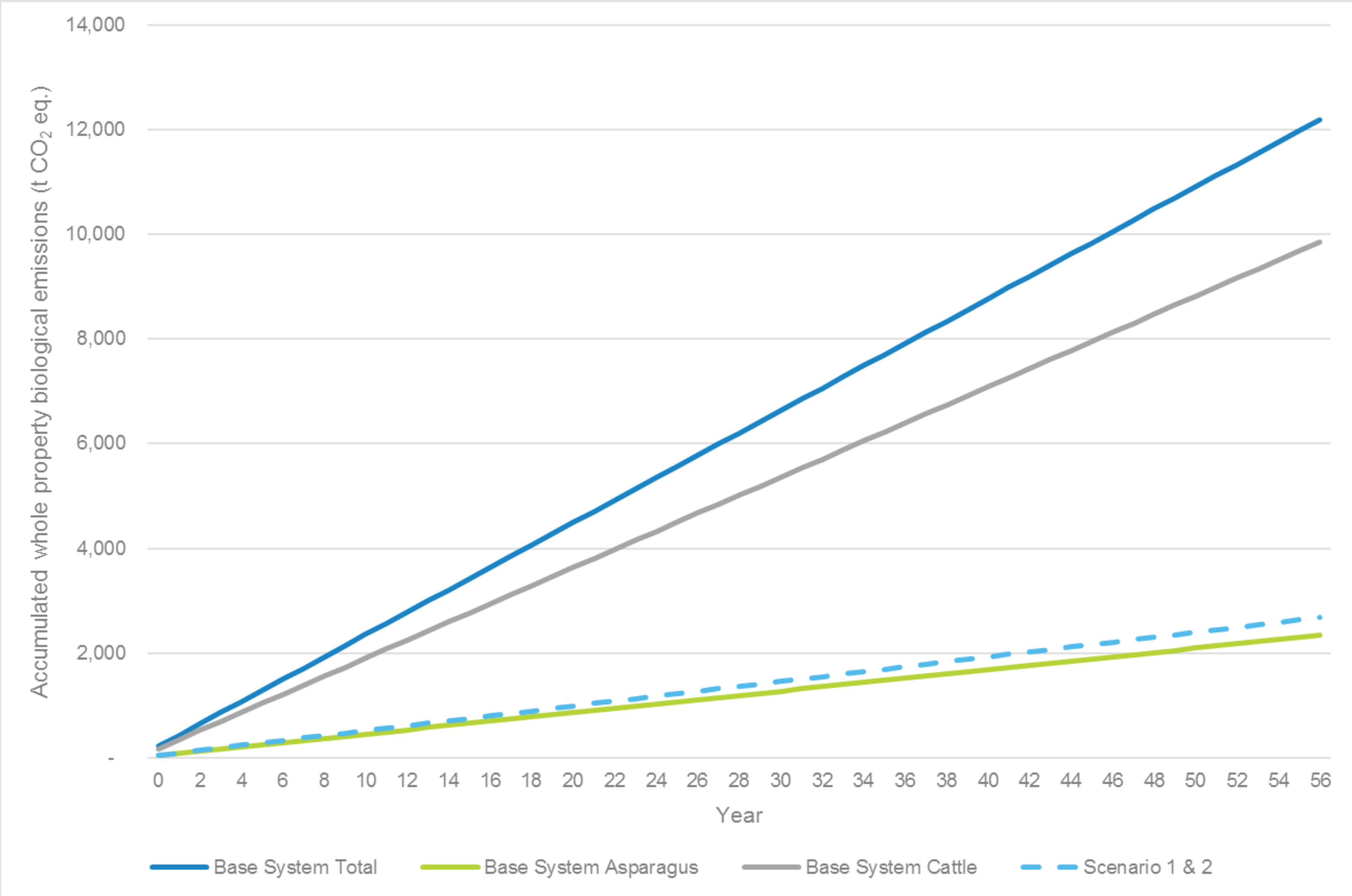

Figure 8: Accumulated whole property emissions in Scenario 1 and 2 compared to the base system.

Summary and Conclusions

- Neither Scenario 1 nor Scenario 2 could compete with the current cattle grazing operation on the same area of land, whether carbon was included or not. The high upfront capital costs of establishing the forest scenario's (S1 = $10,850/ha; S2 = $9,237/ha) combined with the long-term investment of the slower rotation timber species (35 – 55 years) results in both of the alternative timber scenarios modelled on Mangaweka Asparagus generating negative NPVs.

- Log revenue from the alternative timber scenario's (S1 = $27,728/ha; S2 = $30,323/ha) modelled in this analysis are based on expert opinion given the lack of comparable data available. Given there is not a well-established timber market for alternative species in New Zealand, it is difficult to predict what the price of logs will be at harvest in 35 – 55 years' time. It is therefore prudent that landowners conduct sensitivity analyses on investments where future prices are highly uncertain to understand where the price would need to be to return a sufficient profit. The profitability of alternative timber stands planted today is likely to be dependent on future demand and the development of specialty sawmilling and timber supply chains.

- Establishment of alternative species on Mangaweka Asparagus is likely to be on the basis of improved business integration with the current labour demands of the asparagus cropping enterprise and increased environmental performance as opposed to financial benefits. The integration of forestry plantings on farm provides a 40% reduction in nitrogen leaching losses, 57% reduction in P loss and a 77% reduction in biological greenhouse gas emissions.

- Carbon sequestered under the forestry plantings can provide the opportunity for the business to offset the limited nitrous oxide emissions from the asparagus system, provide immediate revenue and cashflow to the business, or be retained on the balance sheet as a liquid asset in the expectation that carbon values will rise. Each of these options has risks that should be considered before implementing. A forestry consultant with expertise in carbon should be utilised to ensure the implications of carbon decisions are well understood.

- Integrating trees within a farm business can be a complex process requiring careful planning. Landowners should consider the impacts to cashflow, the upfront capital cost of establishing and tending to forests, length of the investment period, market accessibility and impacts to the remaining farm system. Non-financial and personal considerations are also key parts of the planning process and may include environmental implications and ease of business integration. Planning to achieve right tree, right place is critical to meeting the objectives of tree planting.

References

Appletons Tree Nursery. (n.d.). *Oak for timber production*. Available from https://www.appletons.co.nz/articles?field_article_terms_tid=All&field_article_category_tid=66

Brown, I. (2005). *Where blackwoods go wrong.* New Zealand Tree Grower, February 2005.

Brown, I. (2006). Blackwood – an overview. New Zealand Tree Grower, August 2006.

DairyNZ. (2016). Whole Farm Assessment Guide and Questionnaire. Available from DairyNZ

Dooley, L., Parker, L., Durie, R. (2020). Farmer Interviews on Practice, Perceptions and Knowledge of Trees on Farm, Report provided to Te Uru Rakau.

Haslett, A.N. (1984). *Utilisation properties of New Zealand-grown European Oak (Quercus robur).* FRI Bulletin No. 58, Ministry of Forestry, Forest Research Institute. Rotorua.

Haslett, A.N. (1986). *Properties and utilisation of exotic specialty timbers grown in New Zeeland, part IV: Black walnut Juglans nigra L.* FRI Bulletin No. 119, Ministry of Forestry, Forest Research Institute, Rotorua.

Knowles, R. L. (1978). Black walnut: what can New Zealand learn from the United States? *NZ Journal of Forestry 23*(2): 224-239.

Miller, J., & Knowles, K. (1988). *Introduced forest trees in New Zealand: recognition, role and seed source 3. The Larches*. FRI Bulletin No. 124, Ministry of Forestry, Forest Research Institute, Rotorua.

Miller, J., & Knowles, K. (1989). *Introduced forest trees in New Zealand: Recognition, role and seed source 7. The Silver Firs – Abies spp.* FRI Bulletin No. 124, Ministry of Forestry, Forest Research Institute, Rotorua.

MPI. (2017). *Carbon look-up tables for forestry in the Emissions Trading Scheme*. Retrieved from https://www.mpi.govt.nz/dmsdocument/4762/direct

MPI. (2021a). *Consultations: Introduction to averaging carbon accounting for forests in the Emissions Trading Scheme*. Retrieved from https://www.mpi.govt.nz/consultations/additional-proposed-amendments-to-the-climate-change-forestry-sector-regulations-2008/introduction-to-averaging-carbon-accounting-for-forests-in-the-emissions-trading-scheme/

MPI. (2021b). *Updates and changes to the ETS.* Retrieved from https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/updates-and-changes-to-the-ets/

Nicholas, I.D, Gifford, H.H., & Kimberley, M.O. (1997). *Siting black walnut.* FRI Bulleting No. 188, New Zealand Forest Research Institute, Rotorua.

NZFFA. (2005a). Choosing land for planting for profit. *NZFFA Information leaflet No. 1*. Retrieved from https://www.nzffa.org.nz/farm-forestry-model/resource-centre/information-leaflets/farm-forestry-association-leaflet-series/no-1-choosing-land-for-planting-for-profit/

NZFFA. (2005b). Growing Douglas fir. *NZFFA Information Leaflet No. 19.* Retrieved from https://www.nzffa.org.nz/farm-forestry-model/resource-centre/information-leaflets/farm-forestry-association-leaflet-series/growing-douglas-fir/

NZFFA. (n.d.). *Larch – Japenese arch, Larix kaempferi*. Retrieved from https://www.nzffa.org.nz/farm-forestry-model/species-selection-tool/species/larch/japanese-larch/

O'Loughlin, C. (2005). The protective role of trees in soil conservation. *NZ Journal of Forestry 49*(4): 9-15

OverseerFM. (2019). OverseerFM User Guide. Available from http://www.docs.overseer.org.nz/fm/OverseerUserGuide.pdf

Resource Management (National Environmental Standards for Plantation Forestry) Regulations 2017. Available from http://www.legislation.govt.nz

Satchell, D. (2018). *Trees for steep slopes.* Available from https://www.nzffa.org.nz/farm-forestry-model/why-farm-forestry/trees-for-erosion-controlsoil-conservation/report-trees-for-steep-slopes/

Appendices

APPENDIX 1: KEY MODELLING ASSUMPTIONS

For the Mangaweka Asparagus case study, the following key assumptions have been used in the analysis:

FARMING ENTERPRISES

- Market rates for grazing carryover cows were assumed at $10 per head per week.
- Input expense data was sourced from the case study business and Beef and Lamb NZ economic service where costs for the cattle enterprise were amalgamated with the cropping enterprise.
- The financial performance of the cattle enterprise has been described both in terms of operating profit (earnings before interest, tax and rent - EBITR) and cash operating surplus.
- Reported bGHGs comprise methane (CH_4) and nitrous oxide (N_2O) and are expressed as t CO_2 equivalent per hectare over the entire property area.

TREE ENTERPRISES

- Tree growth productivity and log revenue was based on expert opinion given the lack of comparable industry data available for alternative species. Eucalypt and specialty regimes were assumed to return $120 per cubic metre harvested, while the structural regime was assumed to return $96 per cubic metre.
- Rates of carbon sequestration from ETS eligible forests are referenced against the MPI lookup tables (MPI, 2017).
- A carbon price of $25 per New Zealand Unit (NZU) was assumed.
- Only "safe" carbon is considered tradeable. Under changes to the ETS, forestry planted from 2019 is able to earn NZUs up to the forest's "average age". The "average age" for a forest is the age at which it reaches the average level of carbon it is expected to store over the long-term (several rotations). The "average age" is based on the typical age at which the forest is commercially harvested (MPI, 2021a).
- Forest industry representative values were used for seedlings and associated royalties, fencing, track upgrades and maintenance, and annual costs such as operations management, property maintenance and public liability insurance.
- The applicable forest operations included planting and form pruning.

WHOLE BUSINESS

- We have assumed a requirement to repay loan principal equivalent to the average amount of debt as per the B+LNZ Economic Survey for Class 4 farms in the Western North Island amortised over 20 years at an interest rate of 5.3%.

- A provision for annual capital reinvestment in the farming enterprise, equivalent to the assumed level of plant and equipment depreciated, has been made in the discounted cash flow analysis.

- To provide a "like with like" analysis the cattle operating assets (excluding land) were purchased and sold at the start and end of the cash flow analysis.

APPENDIX 2: BACKGROUND TO ENVIRONMENTAL LIMITS

GREENHOUSE GASES (GHG)

New Zealand has signed up to international conventions and protocols to reduce GHGs including:

- Reduce emissions to 5% below 1990 levels by 2020

- Reduce emissions to 30% below 2005 levels by 2030 (Paris Agreement).

- Reduce emissions to 50% below 1990 levels by 2050. This was notified in the New Zealand Gazette in March 2011.

- The Zero Carbon Bill introduced in 2019 requires carbon dioxide (CO_2) and nitrous oxide (N_2O) to reduce to net zero by 2050 and methane (CH_4) to reduce to 10% below 2017 by 2030 and 24-47% below 2017 by 2050.

Reducing agriculture emission will be essential for achieving these targets as the sector contributes 48% of New Zealand's total emissions and 85% of the sector's emissions are generated on farm. Other than for biogenic methane and nitrous oxide (through the Zero Carbon Act) and indirectly for fuel and electricity, GHG reduction targets have not yet been set for the sector and agriculture is not yet explicitly in the Emissions Trading Scheme (ETS). However, farmers can expect to be required to make changes to reduce on-farm GHGs and contribute to the above targets being met. The ETS is being updated, including with respect to the settings for forestry, to support the attainment of these reduction targets. Including forestry in farm business enterprises, particularly on land less suited to intensive agriculture, can provide a practical multi-purpose solution to the above challenges.

APPENDIX 3: CATTLE ENTERPRISE FINANCIAL ANALYSIS

Annual Cattle Budget	Total	per Hectare
Income		
Cattle	22,592	768
Total income	**22,592**	**768**
Expenses		
Wages	2,429	83
Yard use	311	11
Weed and pest	548	19
R&M	3,317	113
Rates	783	27
Total farm expenses	**7,389**	**251**
Cash operating surplus	**15,203**	**517**
Depreciation/capital	1,539	52
Operating profit	**13,665**	**465**
Interest	3,724	127
Tax	2,783	95
Debt repayment	3,487	119
Cash surplus/deficit	**3,670**	**125**

APPENDIX 4: TREE SCENARIO FULL CASH FLOWS

SCENARIO 1 – STRUCTURAL TIMBER + LOW PRODUCTIVITY SPECIALTY TIIMBER

			Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	Year:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Dates:	30/06/20	30/06/21	30/06/22	30/06/23	30/06/24	30/06/25	30/06/26	30/06/27	30/06/28	30/06/29	30/06/30	30/06/31	30/06/32	30/06/33	30/06/34	30/06/35	30/06/36	30/06/37	30/06/38	30/06/39	30/06/40	30/06/41	30/06/42	30/06/43	30/06/44	30/06/45	30/06/46	30/06/47
Year ending 30 Jun		**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**
Area																													
Stocked area (ha)				29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
Clearfell area (ha)																													
Planted area (ha)			29.4																										
Forestry Costs																													
Track/Fence Upgrade																													
Land Preparation	9,075	7,358																											
Planting	361,846		179,871	1,913																									
Release	63,894		27,053	9,754																									
Animal Control	10,891		1,619	1,619	1,619	883	883	883	883	294	294	294																	
Pruning/Form pruning	24,214									9,687			6,643		6,643														
Waste thin/Fertiliser	58,860											22,560			6,870		22,560			6,870									
Inventory, Mapping	5,592		294								1,015			309		1,015			309										
Annual Costs																													
Property Maintenance & Protection	36,485		883	883	883	883	883	883	883	883	883	883	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589
Fire, Wind & Public Liability Insurance	38,286		26	51	77	103	129	154	180	206	232	257	283	309	335	360	386	412	437	463	489	515	540	566	592	618	643	669	695
Forest & Operations Management	24,715		441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441
Administration/Acctng/Audit	16,477		294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294
Rates	32,962		589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589
Notional land rent																													
Total Expenditures (Logs)	**683,296**	7,358	211,070	15,544	3,903	3,193	3,219	3,245	3,270	12,394	3,748	25,319	8,839	2,531	15,761	3,288	24,859	2,325	2,660	9,246	2,402	2,428	2,453	2,479	2,505	2,531	2,556	2,582	2,608
Revenue																													
Log Revenue	815,208																												
Land sale																													
Other - 1BT	44,145		13,244		30,902																								
Tree crop sale	211,728																												
Total Revenue (Logs)	**1,071,081**	0	13,244	0	30,902	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET PRE-TAX LOGS	**295,095**	-7,358	-197,948	-15,640	26,855	-4,267	-3,458	-4,415	-3,605	-13,660	-4,179	-26,680	-9,366	-4,282	-16,383	-3,958	-25,577	-3,090	-3,473	-10,107	-3,311	-3,384	-3,458	-3,532	-3,605	-3,679	-4,047	-4,120	-4,194
Discount rate (WACC) 6%	**6%**	**1.00**	**0.94**	**0.89**	**0.84**	**0.79**	**0.75**	**0.70**	**0.67**	**0.63**	**0.59**	**0.56**	**0.53**	**0.50**	**0.47**	**0.44**	**0.42**	**0.39**	**0.37**	**0.35**	**0.33**	**0.31**	**0.29**	**0.28**	**0.26**	**0.25**	**0.23**	**0.22**	**0.21**
Present value for whole term	**-244,489**	**-7,358**	**-186,743**	**-13,919**	**22,548**	**-3,380**	**-2,584**	**-3,112**	**-2,398**	**-8,570**	**-2,473**	**-14,898**	**-4,934**	**-2,128**	**-7,681**	**-1,751**	**-10,672**	**-1,216**	**-1,290**	**-3,541**	**-1,094**	**-1,055**	**-1,017**	**-980**	**-944**	**-909**	**-943**	**-906**	**-870**
PV/ha	**-8,307**																												
Internal Rate of Return (IRR)	**1.2%**																												
Annuity	**-15,253**																												
Annuity/ha	**-518**																												
Taxation analysis																													
Tax credits on capitalised costs																													
Land prep (dimin. @ 6%p.a.)																													
New tracking (dimin. @ 24%p.a.)																													
Fencing (dimin. @ 12%p.a.)																													
Tax credits on forestry/annual costs	**220,651**	2,060	59,134	4,379	1,133	1,195	968	1,236	1,009	3,825	1,170	7,470	2,622	1,199	4,587	1,108	7,161	865	972	2,830	927	948	968	989	1,009	1,030	1,133	1,154	1,174
Tax liabilities	**290,917**																												
Total tax credit/liability	-70,266	2,060	59,134	4,379	1,133	1,195	968	1,236	1,009	3,825	1,170	7,470	2,622	1,199	4,587	1,108	7,161	865	972	2,830	927	948	968	989	1,009	1,030	1,133	1,154	1,174
NET POST-TAX LOGS	**224,829**	**-5,297**	**-138,814**	**-11,261**	**27,988**	**-3,072**	**-2,490**	**-3,178**	**-2,596**	**-9,835**	**-3,009**	**-19,210**	**-6,743**	**-3,083**	**-11,796**	**-2,850**	**-18,415**	**-2,225**	**-2,500**	**-7,277**	**-2,384**	**-2,437**	**-2,490**	**-2,543**	**-2,596**	**-2,649**	**-2,914**	**-2,967**	**-3,020**
CARBON																													
Safe Carbon Claims (NZU)	**13,436**				90	309	648	896	1,081	1,205	1,205	1,174	1,143	1,081	1,050	958	927	865	804										
Expenditures																													
Registration	**3,347**						3,347																						
Inventory	**2,117**						529			529					529				529										
ETS administration	**12,176**						529	529	529	529	529	529	529	529	529	529	529	529	529	529	529	529	529	529	529	529	529	529	529
Revenue																													
NZU Price ($/unit)			25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
NZU revenue ($)	**335,900**						9,975	16,200	22,400	27,025	30,125	30,125	29,350	28,575	27,025	26,250	23,950	23,175	21,625	20,100									
NZU purchase cost ($)																													
NET PRE-TAX CARBON	**314,913**	0	0	0	0	0	5,570	15,671	21,871	22,619	29,596	29,596	28,821	28,046	25,966	25,721	23,421	22,646	20,566	19,571	-529	-529	-529	-529	-529	-529	-529	-529	-529
Total Expenditures (Logs+Carbon)	**710,978**	7,358	211,070	15,544	7,250	6,540	7,624	3,774	3,799	16,800	4,278	25,848	9,369	3,060	16,820	3,818	25,388	2,854	3,718	9,776	2,931	2,957	2,983	3,009	3,034	3,060	3,086	3,111	3,137
Total Revenue (Logs+Carbon)	**1,406,981**		13,244		30,902		9,975	16,200	22,400	27,025	30,125	30,125	29,350	28,575	27,025	26,250	23,950	23,175	21,625	20,100									
NET PRE-TAX (LOGS & CARBON)	**696,003**	-7,358	-197,826	-15,544	23,651	-6,540	2,351	12,426	18,601	10,225	25,847	4,277	19,981	25,515	10,205	22,432	-1,438	20,321	17,907	10,324	-2,931	-2,957	-2,983	-3,009	-3,034	-3,060	-3,086	-3,111	-3,137
Discount rate (WACC) 6%	**6%**	**1.00**	**0.94**	**0.89**	**0.84**	**0.79**	**0.75**	**0.70**	**0.67**	**0.63**	**0.59**	**0.56**	**0.53**	**0.50**	**0.47**	**0.44**	**0.42**	**0.39**	**0.37**	**0.35**	**0.33**	**0.31**	**0.29**	**0.28**	**0.26**	**0.25**	**0.23**	**0.22**	**0.21**
Present value for whole term	**-71,400**	**-7,358**	**-186,629**	**-13,834**	**19,858**	**-5,180**	**1,757**	**8,760**	**12,371**	**6,415**	**15,299**	**2,388**	**10,526**	**12,680**	**4,785**	**9,922**	**-600**	**7,999**	**6,650**	**3,617**	**-969**	**-922**	**-877**	**-835**	**-794**	**-756**	**-719**	**-684**	**-651**
PV/ha	**-2,426**																												
Internal Rate of Return (IRR)	**4.0%**																												
Annuity	**-4,454**																												
Annuity/ha	**-151**																												
Taxation analysis																													
Tax credits on forestry/annual costs	199,074	2,060	59,100	4,352	2,030	1,831	2,135	1,057	1,064	4,704	1,198	7,238	2,623	857	4,709	1,069	7,109	799	1,041	2,737	821	828	835	842	850	857	864	871	878
Tax liabilities	393,955		3,708		8,652		2,793	4,536	6,272	7,567	8,435	8,435	8,218	8,001	7,567	7,350	6,706	6,489	6,055	5,628									
Total tax credit/liability	-194,881	2,060	55,391	4,352	-6,622	1,831	-658	-3,479	-5,208	-2,863	-7,237	-1,197	-5,595	-7,144	-2,858	-6,281	403	-5,690	-5,014	-2,891	821	828	835	842	850	857	864	871	878
NET POST-TAX (LOGS & CARBON)	**501,122**	-5,297	-142,435	-11,192	17,029	-4,709	1,693	8,947	13,393	7,362	18,610	3,079	14,387	18,371	7,348	16,151	-1,036	14,631	12,893	7,434	-2,111	-2,129	-2,148	-2,166	-2,185	-2,203	-2,222	-2,240	-2,259

27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	0	1
28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
30/06/48	30/06/49	30/06/50	30/06/51	30/06/52	30/06/53	30/06/54	30/06/55	30/06/56	30/06/57	30/06/58	30/06/59	30/06/60	30/06/61	30/06/62	30/06/63	30/06/64	30/06/65	30/06/66	30/06/67	30/06/68	30/06/69	30/06/70	30/06/71	30/06/72	30/06/73	30/06/74	30/06/75	30/06/76
2048	**2049**	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**	**2069**	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**
29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.3	6.8	22.6
																										22.5	6.8	
																									-0.1	-0.1	22.6	6.8
																											1,718	
																											180,062	
																											27,087	
																											1,621	
																											1,241	
																									2,649			
589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	584	881	881
721	746	772	798	823	849	875	901	926	952	978	1,004	1,029	1,055	1,081	1,107	1,132	1,158	1,184	1,209	1,235	1,261	1,287	1,312	1,338	1,364	1,385	26	51
441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	440	438	441	441
294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	293	292	294	294
589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589
2,633	2,659	2,685	2,711	2,736	2,762	2,788	2,814	2,839	2,865	2,891	2,917	2,942	2,968	2,994	3,019	3,045	3,071	3,097	3,122	3,148	3,174	3,200	3,225	3,251	5,923	3,288	213,958	2,255
																										815,208		
																												211,728
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	815,208	0	211,728
-4,267	**-4,341**	**-4,415**	**-4,488**	**-4,562**	**-4,635**	**-4,709**	**-4,782**	**-4,856**	**-4,930**	**-5,003**	**-5,077**	**-5,150**	**-5,224**	**-5,297**	**-5,371**	**-5,445**	**-5,518**	**-5,592**	**-5,665**	**-5,739**	**-5,812**	**-5,886**	**-5,960**	**-6,033**	**-8,737**	**807,348**	**-215,013**	**204,172**
0.20	**0.18**	**0.17**	**0.16**	**0.15**	**0.15**	**0.14**	**0.13**	**0.12**	**0.12**	**0.11**	**0.10**	**0.10**	**0.09**	**0.09**	**0.08**	**0.08**	**0.07**	**0.07**	**0.06**	**0.06**	**0.06**	**0.05**	**0.05**	**0.05**	**0.05**	**0.04**	**0.04**	**0.04**
-835	**-801**	**-769**	**-737**	**-707**	**-678**	**-649**	**-622**	**-596**	**-571**	**-547**	**-523**	**-501**	**-479**	**-458**	**-438**	**-419**	**-401**	**-383**	**-366**	**-350**	**-334**	**-320**	**-305**	**-292**	**-398**	**34,717**	**-8,723**	**7,814**
1,195	1,215	1,236	1,257	1,277	1,298	1,318	1,339	1,360	1,380	1,401	1,421	1,442	1,463	1,483	1,504	1,524	1,545	1,566	1,586	1,607	1,627	1,648	1,669	1,689	2,446	2,201	60,204	5,491
																										228,258		62,659
1,195	1,215	1,236	1,257	1,277	1,298	1,318	1,339	1,360	1,380	1,401	1,421	1,442	1,463	1,483	1,504	1,524	1,545	1,566	1,586	1,607	1,627	1,648	1,669	1,689	2,446	-226,057	60,204	-57,168
-3,072	**-3,125**	**-3,178**	**-3,231**	**-3,284**	**-3,337**	**-3,390**	**-3,443**	**-3,496**	**-3,549**	**-3,602**	**-3,655**	**-3,708**	**-3,761**	**-3,814**	**-3,867**	**-3,920**	**-3,973**	**-4,026**	**-4,079**	**-4,132**	**-4,185**	**-4,238**	**-4,291**	**-4,344**	**-6,290**	**581,291**	**-154,809**	**147,004**
25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,633	2,659	2,685	2,711	2,736	2,762	2,788	2,814	2,839	2,865	2,891	2,917	2,942	2,968	2,994	3,019	3,045	3,071	3,097	3,122	3,148	3,174	3,200	3,225	3,251	5,923	3,288	213,958	2,255
																										815,208		211,728
-2,633	-2,659	-2,685	-2,711	-2,736	-2,762	-2,788	-2,814	-2,839	-2,865	-2,891	-2,917	-2,942	-2,968	-2,994	-3,019	-3,045	-3,071	-3,097	-3,122	-3,148	-3,174	-3,200	-3,225	-3,251	-5,923	811,919	-213,958	209,473
0.20	**0.18**	**0.17**	**0.16**	**0.15**	**0.15**	**0.14**	**0.13**	**0.12**	**0.12**	**0.11**	**0.10**	**0.10**	**0.09**	**0.09**	**0.08**	**0.08**	**0.07**	**0.07**	**0.06**	**0.06**	**0.06**	**0.05**	**0.05**	**0.05**	**0.05**	**0.04**	**0.04**	**0.04**
-515	**-491**	**-467**	**-445**	**-424**	**-404**	**-384**	**-366**	**-349**	**-332**	**-316**	**-301**	**-286**	**-272**	**-259**	**-246**	**-235**	**-223**	**-212**	**-202**	**-192**	**-183**	**-174**	**-165**	**-157**	**-270**	**34,914**	**-8,680**	**8,017**
737	745	752	759	766	773	781	788	795	802	809	817	824	831	838	845	853	860	867	874	881	889	896	903	910	1,658	921	59,908	631
																										228,258		59,284
737	745	752	759	766	773	781	788	795	802	809	817	824	831	838	845	853	860	867	874	881	889	896	903	910	1,658	-227,337	59,908	-58,652
-1,896	-1,915	-1,933	-1,952	-1,970	-1,989	-2,007	-2,026	-2,044	-2,063	-2,081	-2,100	-2,118	-2,137	-2,155	-2,174	-2,193	-2,211	-2,230	-2,248	-2,267	-2,285	-2,304	-2,322	-2,341	-4,265	584,582	-154,050	150,820

SCENARIO 2 – STRUCTURAL TIMBER + LOW PRODUCTIVITY SPECIALTY EUCALYPT TIMBER

			Age	1	2	3	4	5	6	7	8	9	10	11	12
	Year:	0	1	2	3	4	5	6	7	8	9	10	11	12	13
	Dates:	30/06/20	30/06/21	30/06/22	30/06/23	30/06/24	30/06/25	30/06/26	30/06/27	30/06/28	30/06/29	30/06/30	30/06/31	30/06/32	30/06/33
Year ending 30 Jun		**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Area															
Stocked area (ha)				29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
Clearfell area (ha)															
Planted area (ha)			29.4												
Forestry Costs															
Track/Fence Upgrade															
Land Preparation	**10,793**	7,358													
Planting	**292,081**		132,372	1,913											
Release	**87,389**		27,053	9,754											
Animal Control	**13,433**		1,619	1,619	1,619	883	883	883	883	294	294	294			
Pruning/Form pruning	**47,187**									9,687			6,643		6,643
Waste thin/Fertiliser	**72,600**											22,560			6,870
Inventory, Mapping	**5,729**		294								1,015			309	
Annual Costs															
Property Maintenance & Protection	**36,902**		883	883	883	883	883	883	883	883	814	814	589	589	589
Fire, Wind & Public Liability Insurance	**33,515**		26	51	77	103	129	154	180	206	232	257	283	309	335
Forest & Operations Management	**24,713**		441	441	441	441	441	441	441	441	441	441	441	441	441
Administration/Acctng/Audit	**16,476**		294	294	294	294	294	294	294	294	294	294	294	294	294
Rates	**32,962**		589	589	589	589	589	589	589	589	589	589	589	589	589
Notional land rent															
Total Expenditures (Logs)	**673,780**	7,358	163,571	15,544	3,903	3,193	3,219	3,245	3,270	12,394	3,680	25,250	8,839	2,531	15,761
Revenue															
Log Revenue	**891,505**														
Land sale															
Other - 1BT	**44,145**		13,244		30,902										
Tree crop sale	**172,886**														
Total Revenue (Logs)	**1,108,535**	0	13,244	0	30,902	0	0	0	0	0	0	0	0	0	0
NET PRE-TAX LOGS	**384,922**	**-7,358**	**-150,421**	**-15,620**	**26,885**	**-4,021**	**-3,408**	**-4,148**	**-3,535**	**-13,374**	**-4,020**	**-26,305**	**-9,255**	**-3,887**	**-16,253**
Discount rate (WACC) 6%	**6%**	**1.00**	**0.94**	**0.89**	**0.84**	**0.79**	**0.75**	**0.70**	**0.67**	**0.63**	**0.59**	**0.56**	**0.53**	**0.50**	**0.47**
Present value for whole term	**-178,454**	**-7,358**	**-141,907**	**-13,902**	**22,573**	**-3,185**	**-2,547**	**-2,924**	**-2,351**	**-8,391**	**-2,380**	**-14,689**	**-4,876**	**-1,932**	**-7,620**
PV/ha	**-6,064**														
Internal Rate of Return (IRR)	**1.9%**														
Annuity	**-11,133**														
Annuity/ha	**-378**														
Taxation analysis															
Tax credits on capitalised costs															
Land prep (dimin. @ 6%p.a.)															
New tracking (dimin. @ 24%p.a.)															
Fencing (dimin. @ 12%p.a.)															
Tax credits on forestry/annual costs	**203,563**	2,060	45,826	4,374	1,125	1,126	954	1,162	990	3,745	1,126	7,365	2,592	1,088	4,551
Tax liabilities	**363,616**														
Total tax credit/liability	**-160,054**	2,060	45,826	4,374	1,125	1,126	954	1,162	990	3,745	1,126	7,365	2,592	1,088	4,551
NET POST-TAX LOGS	**224,868**	**-5,297**	**-104,595**	**-11,246**	**28,010**	**-2,895**	**-2,454**	**-2,987**	**-2,545**	**-9,629**	**-2,895**	**-18,940**	**-6,664**	**-2,799**	**-11,702**
CARBON															
Safe Carbon Claims (NZU)	**13,436**				90	309	648	896	1,081	1,205	1,205	1,174	1,143	1,081	1,050
Expenditures															
Registration	**3,347**						3,347								
Inventory	**2,117**						529			529					529
ETS administration	**12,176**						529	529	529	529	529	529	529	529	529
Revenue															
NZU Price ($/unit)			25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
NZU revenue ($)	**335,900**						9,975	16,200	22,400	27,025	30,125	30,125	29,350	28,575	27,025
NZU purchase cost ($)															
NET PRE-TAX CARBON	**314,913**	0	0	0	0	0	5,570	15,671	21,871	22,619	29,596	29,596	28,821	28,046	25,966
Total Expenditures (Logs+Carbon)	**698,114**	7,358	163,571	15,544	3,903	6,540	7,624	3,774	3,799	16,800	4,209	25,780	9,369	3,060	16,820
Total Revenue (Logs+Carbon)	**1,444,435**		13,244		30,902		9,975	16,200	22,400	27,025	30,125	30,125	29,350	28,575	27,025
NET PRE-TAX (LOGS & CARBON)	**746,321**	-7,358	-150,327	-15,544	26,998	-6,540	2,351	12,426	18,601	10,225	25,916	4,345	19,981	25,515	10,205
Discount rate (WACC) 6%	**6%**	**1.00**	**0.94**	**0.89**	**0.84**	**0.79**	**0.75**	**0.70**	**0.67**	**0.63**	**0.59**	**0.56**	**0.53**	**0.50**	**0.47**
Present value for whole term	**-7,655**	**-7,358**	**-141,818**	**-13,834**	**22,668**	**-5,180**	**1,757**	**8,760**	**12,371**	**6,415**	**15,340**	**2,426**	**10,526**	**12,680**	**4,785**
PV/ha	**-260**														
Internal Rate of Return (IRR)	**5.7%**														
Annuity	**-478**														
Annuity/ha	**-16**														
Taxation analysis															
Tax credits on forestry/annual costs	195,472	2,060	45,800	4,352	1,093	1,831	2,135	1,057	1,064	4,704	1,179	7,218	2,623	857	4,709
Tax liabilities	404,442		3,708		8,652		2,793	4,536	6,272	7,567	8,435	8,435	8,218	8,001	7,567
Total tax credit/liability	-208,970	2,060	42,092	4,352	-7,560	1,831	-658	-3,479	-5,208	-2,863	-7,256	-1,217	-5,595	-7,144	-2,858
NET POST-TAX (LOGS & CARBON)	**537,351**	-5,297	-108,235	-11,192	19,439	-4,709	1,693	8,947	13,393	7,362	18,659	3,129	14,387	18,371	7,348

	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Year:	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Dates:	30/06/34	30/06/35	30/06/36	30/06/37	30/06/38	30/06/39	30/06/40	30/06/41	30/06/42	30/06/43	30/06/44	30/06/45	30/06/46	30/06/47
Year ending 30 Jun	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**
Area														
Stocked area (ha)	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
Clearfell area (ha)														
Planted area (ha)														
Forestry Costs														
Track/Fence Upgrade														
Land Preparation														
Planting														
Release														
Animal Control														
Pruning/Form pruning														
Waste thin/Fertiliser		22,560			6,870									
Inventory, Mapping	1,015			309										
Annual Costs														
Property Maintenance & Protection	589	589	589	589	589	589	589	589	589	589	589	589	589	589
Fire, Wind & Public Liability Insurance	360	386	412	437	463	489	515	540	566	592	618	643	669	695
Forest & Operations Management	441	441	441	441	441	441	441	441	441	441	441	441	441	441
Administration/Acctng/Audit	294	294	294	294	294	294	294	294	294	294	294	294	294	294
Rates	589	589	589	589	589	589	589	589	589	589	589	589	589	589
Notional land rent														
Total Expenditures (Logs)	3,288	24,859	2,325	2,660	9,246	2,402	2,428	2,453	2,479	2,505	2,531	2,556	2,582	2,608
Revenue														
Log Revenue														
Land sale														
Other - 1BT														
Tree crop sale														
Total Revenue (Logs)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET PRE-TAX LOGS	**-3,818**	**-25,426**	**-2,930**	**-3,303**	**-9,927**	**-3,121**	**-3,184**	**-3,248**	**-3,311**	**-3,375**	**-3,439**	**-3,728**	**-3,791**	**-3,855**
Discount rate (WACC) 6%	**0.44**	**0.42**	**0.39**	**0.37**	**0.35**	**0.33**	**0.31**	**0.29**	**0.28**	**0.26**	**0.25**	**0.23**	**0.22**	**0.21**
Present value for whole term	**-1,689**	**-10,610**	**-1,153**	**-1,227**	**-3,478**	**-1,031**	**-993**	**-955**	**-919**	**-884**	**-849**	**-869**	**-833**	**-799**
Taxation analysis														
Tax credits on forestry/annual costs	1,069	7,119	820	925	2,780	874	892	909	927	945	963	1,044	1,062	1,079
Tax liabilities														
Total tax credit/liability	1,069	7,119	820	925	2,780	874	892	909	927	945	963	1,044	1,062	1,079
NET POST-TAX LOGS	**-2,749**	**-18,307**	**-2,110**	**-2,378**	**-7,148**	**-2,247**	**-2,293**	**-2,338**	**-2,384**	**-2,430**	**-2,476**	**-2,684**	**-2,730**	**-2,775**
CARBON														
Safe Carbon Claims (NZU)	958	927	865	804										
Expenditures														
Registration														
Inventory				529										
ETS administration	529	529	529	529	529	529	529	529	529	529	529	529	529	529
Revenue														
NZU Price ($/unit)	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
NZU revenue ($)	26,250	23,950	23,175	21,625	20,100									
NZU purchase cost ($)														
NET PRE-TAX CARBON	25,721	23,421	22,646	20,566	19,571	-529	-529	-529	-529	-529	-529	-529	-529	-529
Total Expenditures (Logs+Carbon)	3,818	25,388	2,854	3,718	9,776	2,931	2,957	2,983	3,009	3,034	3,060	3,086	3,111	3,137
Total Revenue (Logs+Carbon)	26,250	23,950	23,175	21,625	20,100									
NET PRE-TAX (LOGS & CARBON)	22,432	-1,438	20,321	17,907	10,324	-2,931	-2,957	-2,983	-3,009	-3,034	-3,060	-3,086	-3,111	-3,137
Discount rate (WACC) 6%	**0.44**	**0.42**	**0.39**	**0.37**	**0.35**	**0.33**	**0.31**	**0.29**	**0.28**	**0.26**	**0.25**	**0.23**	**0.22**	**0.21**
Present value for whole term	**9,922**	**-600**	**7,999**	**6,650**	**3,617**	**-969**	**-922**	**-877**	**-835**	**-794**	**-756**	**-719**	**-684**	**-651**
Taxation analysis														
Tax credits on forestry/annual costs	1,069	7,109	799	1,041	2,737	821	828	835	842	850	857	864	871	878
Tax liabilities	7,350	6,706	6,489	6,055	5,628									
Total tax credit/liability	-6,281	403	-5,690	-5,014	-2,891	821	828	835	842	850	857	864	871	878
NET POST-TAX (LOGS & CARBON)	16,151	-1,036	14,631	12,893	7,434	-2,111	-2,129	-2,148	-2,166	-2,185	-2,203	-2,222	-2,240	-2,259

27	**28**	**29**	**30**	**31**	**32**	**33**																						
28	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**
30/06/48	30/06/49	30/06/50	30/06/51	30/06/52	30/06/53	30/06/54	30/06/55	30/06/56	30/06/57	30/06/58	30/06/59	30/06/60	30/06/61	30/06/62	30/06/63	30/06/64	30/06/65	30/06/66	30/06/67	30/06/68	30/06/69	30/06/70	30/06/71	30/06/72	30/06/73	30/06/74	30/06/75	30/06/76
2048	**2049**	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**	**2069**	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**
29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.3	22.6	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.2		29.5
							6.8																			29.2		
						-0.1		6.9																	-0.2		29.5	
							1,718																			1,718		
								24,340	447																		132,563	447
								7,832	7,832																		27,087	7,832
								378	378	378	206	206	206	206	69	69	69										1,621	378
															9,687			6,643		6,643							1,241	
																				6,870					6,870			
								69											309					309	2,030		69	
589	589	589	589	589	589	589	587	657	657	657	657	657	657	657	657	589	589	589	589	589	589	589	589	589	589	584	884	884
721	746	772	798	823	849	875	897	676	701	727	753	778	804	830	856	881	907	933	959	984	1,010	1,036	1,062	1,087	1,113	1,132	26	52
441	441	441	441	441	441	440	440	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441	438	438	442	442
294	294	294	294	294	294	293	293	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	292	292	295	295
589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589	589
2,633	2,659	2,685	2,711	2,736	2,762	2,785	4,523	35,276	11,339	3,087	2,941	2,966	2,992	3,018	12,593	2,863	2,889	9,489	3,181	16,410	2,923	2,949	2,975	3,309	11,921	4,754	164,816	10,917
							230,843																			660,661		
																												172,886
0	0	0	0	0	0	0	230,843	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	660,661	0	172,886
-3,918	**-3,982**	**-4,046**	**-4,109**	**-4,173**	**-4,236**	**-4,297**	**224,771**	**-36,864**	**-12,965**	**-4,750**	**-4,642**	**-4,705**	**-4,769**	**-4,832**	**-4,758**	**-4,753**	**-4,817**	**-4,812**	**-5,184**	**-11,809**	**-5,002**	**-5,066**	**-5,130**	**-5,502**	**-14,136**	**653,649**	**-166,664**	**157,601**
0.20	**0.18**	**0.17**	**0.16**	**0.15**	**0.15**	**0.14**	**0.13**	**0.12**	**0.12**	**0.11**	**0.10**	**0.10**	**0.09**	**0.09**	**0.08**	**0.08**	**0.07**	**0.07**	**0.06**	**0.06**	**0.06**	**0.05**	**0.05**	**0.05**	**0.05**	**0.04**	**0.04**	**0.04**
-767	**-735**	**-704**	**-675**	**-647**	**-619**	**-593**	**29,244**	**-4,525**	**-1,501**	**-519**	**-478**	**-457**	**-437**	**-418**	**-388**	**-366**	**-350**	**-330**	**-335**	**-720**	**-288**	**-275**	**-263**	**-266**	**-644**	**28,108**	**-6,761**	**6,032**
1,097	1,115	1,133	1,151	1,168	1,186	1,203	1,700	10,322	3,630	1,330	1,300	1,317	1,335	1,353	1,332	1,331	1,349	1,347	1,452	3,306	1,401	1,418	1,436	1,541	3,958	1,963	46,666	5,231
							64,636																			184,985	64,636	49,359
1,097	1,115	1,133	1,151	1,168	1,186	1,203	-62,936	10,322	3,630	1,330	1,300	1,317	1,335	1,353	1,332	1,331	1,349	1,347	1,452	3,306	1,401	1,418	1,436	1,541	3,958	-183,022	-17,970	-44,128
-2,821	**-2,867**	**-2,913**	**-2,959**	**-3,004**	**-3,050**	**-3,094**	**161,835**	**-26,542**	**-9,334**	**-3,420**	**-3,342**	**-3,388**	**-3,433**	**-3,479**	**-3,426**	**-3,422**	**-3,468**	**-3,464**	**-3,733**	**-8,502**	**-3,602**	**-3,648**	**-3,693**	**-3,962**	**-10,178**	**470,627**	**-184,634**	**113,473**
25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,633	2,659	2,685	2,711	2,736	2,762	2,785	4,523	35,276	11,339	3,087	2,941	2,966	2,992	3,018	12,593	2,863	2,889	9,489	3,181	16,410	2,923	2,949	2,975	3,309	11,921	4,754	164,816	10,917
							230,843																			660,661		172,886
-2,633	-2,659	-2,685	-2,711	-2,736	-2,762	-2,785	226,321	-35,276	-11,339	-3,087	-2,941	-2,966	-2,992	-3,018	-12,593	-2,863	-2,889	-9,489	-3,181	-16,410	-2,923	-2,949	-2,975	-3,309	-11,921	655,907	-164,816	161,969
0.20	**0.18**	**0.17**	**0.16**	**0.15**	**0.15**	**0.14**	**0.13**	**0.12**	**0.12**	**0.11**	**0.10**	**0.10**	**0.09**	**0.09**	**0.08**	**0.08**	**0.07**	**0.07**	**0.06**	**0.06**	**0.06**	**0.05**	**0.05**	**0.05**	**0.05**	**0.04**	**0.04**	**0.04**
-515	**-491**	**-467**	**-445**	**-424**	**-404**	**-384**	**29,445**	**-4,330**	**-1,313**	**-337**	**-303**	**-288**	**-274**	**-261**	**-1,028**	**-220**	**-210**	**-650**	**-206**	**-1,001**	**-168**	**-160**	**-152**	**-160**	**-543**	**28,205**	**-6,686**	**6,199**
737	745	752	759	766	773	780	1,266	9,877	3,175	864	823	831	838	845	3,526	802	809	2,657	891	4,595	818	826	833	927	3,338	1,331	46,149	3,057
							64,636																			184,985		48,408
737	745	752	759	766	773	780	-63,370	9,877	3,175	864	823	831	838	845	3,526	802	809	2,657	891	4,595	818	826	833	927	3,338	-183,654	46,149	-45,351
-1,896	-1,915	-1,933	-1,952	-1,970	-1,989	-2,005	162,951	-25,399	-8,164	-2,222	-2,117	-2,136	-2,154	-2,173	-9,067	-2,061	-2,080	-6,832	-2,290	-11,815	-2,105	-2,123	-2,142	-2,383	-8,583	472,253	-118,668	116,617