Economic impacts of mitigation options to reduce suspended sediment loads and improve visual clarity in the Wairoa catchment, Hawke's Bay

Report prepared for the Wairoa Tripartite (Wairoa District Council, Tātau Tātau o Te Wairoa, Hawke's Bay Regional Council) and the Our Land and Water National Science Challenge

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1 Executive Summary

The Wairoa River is significant to the iwi and hapū of Te Rohe o Te Wairoa, and is valued ecologically as well as for recreation and mahinga kai. Excess sediment entering the water is an important threat to the health and mauri of the river.

The Wairoa Tripartite (Wairoa District Council, Tātau Tātau o Te Wairoa, Hawke's Bay Regional Council) and the Whitiwhiti Ora project (part of the Our Land and Water National Science Challenge) have formed a partnership to jointly guide the direction and delivery of a project focused on the river, particularly the impact of sediment on this taonga. As a part of the project the Tripartite created a land use scenario called the 'best efforts scenario' aims to investigate means of improving sediment loads in the river. The Tripartite has requested an economic evaluation of the consequences of implementing such a 'best efforts scenario' for the Wairoa district. The 'best efforts scenario' involves reverting all highly erosion prone land in Class 7 and 8 to scrub, space planting on all other erosion prone land, and riparian fencing on all streams REC Order 3 and above.

AgFirst were commissioned to estimate the stocking rate for different categories of land in the Wairoa catchment based on their LUC classification. When the best efforts mitigation were implemented the analysis assumed reductions in productive capacity of 100% from scrub reversion and 10% - 50% for space planting in Year 20 following planting. No reductions in productivity are assumed from riparian fencing. The Beef and Lamb NZ (B&LNZ) Economic Service North Island Hard Hill model was used to estimate revenue and expenses to quantify the impact on profitability. The cost of space planting was estimated at $2300 per ha for the 12m spacing based on information from HBRC[1] using their nursery data. The cost of fencing is based on data from Grinter and White (2016) and is estimated at $37.08/m.

Table 1 shows that there are 151,000 ha in exotic grassland in the catchment, which using the AgFirst estimates of stocking rate by LUC class gives a total of 1.3 million stock units. Using the North Island Hard Hill model, this results in total revenue of $135m per annum and operating profit (excluding capital items) of $40 million per annum. Within this there is 27,000 ha of Whenua Māori (land subject to Te Ture Whenua 1993) in the catchment, which proportionally results in 212,000 stock units, $22 million per annum in revenue, and $6.2 million per annum in operating profit (Table 8).

Table 1: Current productivity on farm indicators for all farmed land and whenua Māori, Wairoa catchment

Item	All land	Whenua Māori
Area (ha)	156135	27002
Stock units (su)	1,289,924	211,900
Revenue ($m/annum)	$135	$22.31
Operating profit ($m/annum)	$39	$6.17

Table 2 and Figure 1 shows the impact on farm outcomes for all land in the 'best efforts scenario' in Year 20. It shows a reduction of 30% - 60% of the current stock units, and

[1] Colin Stace, pers.comm. October 2023.

this results in a significant reduction in revenue. Operating profit is ranges from a small negative to about a third of current profit, and because the operating profit is before interest payments and tax, there are likely to be some farms experiencing significant negative cashflow.

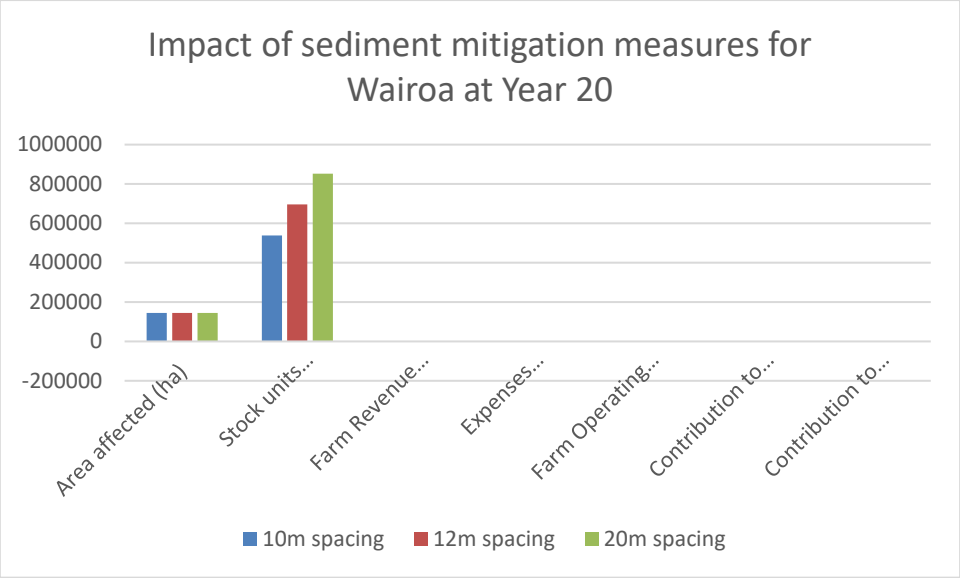

Figure 1: Impact of sediment mitigation scenario at Year 20 on farm revenue, operating profit and contribution to district GDP and HHI

Table 2: Impact on all land in Year 20 sediment mitigation measures on farm and community economic indicators, Wairoa catchment

All land	Spacing (m)			Proportion of current		
	10	12	20	10	12	20
Area affected (ha)	143977	143977	143977	92%	92%	92%
Stock units remaining (su)	539000	696000	853000	42%	54%	66%
Revenue ($m/annum)	$57	$73	$90	42%	54%	66%
Expenses ($m/annum)	$60	$67	$75	62%	70%	78%
Operating profit ($m/annum)	-$3	$6	$15	-8%	15%	37%
Total GDP ($m/annum)	$52	$73	$93	35%	49%	62%
Total HHI ($m/annum)	$21	$30	$39	32%	46%	60%
Employment (FTE)	413	538	662	41%	53%	66%

For Whenua Māori (Table 3) the mitigation measures affect 95% of land, and the stock units are reduced to between 39% and 65% of current stock units. Operating profit ranges from negative to 37% of current operating profit.

Table 3: Impact on Whenua Māori in Year 20 sediment mitigation measures on farm and community economic indicators, Wairoa catchment

Whenuā Māori	Spacing (m)			Proportion of current		
	10	12	20	10	12	20
Area affected (ha)	25000	25000	25000	93%	93%	93%
Stock units remaining (su)	83000	110000	137000	39%	52%	65%
Revenue ($/annum)	$9	$12	$14	39%	52%	64%
Expenses ($/annum)	$10	$11	$12	61%	69%	77%
Operating profit ($/annum)	-$1	$0	$2	-18%	7%	31%

Including all these factors the total impact of the 'best efforts scenario' on the Wairoa district economy is shown in the last three rows of Table 2. It suggests that the contribution to GDP from the primary sector and meat works would be approximately 50% in year 10 and 35% in year 20 of its current level, and contribution to household income and employment would be about 30% - 40% of its current level. Indicatively the scale of the reduction is about 7 - 10% of the district economy. However the level of reduction in throughput at the meat processing plant would likely affect the viability of the works, so the impact would probably be higher than is indicated here.

The total cost of mitigations is estimated to be $120 - $360 million, the majority of which would arise from space planting ($80 - $310 million). For Māori land the total cost is estimated to be $25 - $66 million, of which $13 - $54 million would be in space planting. The analysis here assumes that the costs of mitigation are paid by farmers. When the capital cost is turned into a loan and repaid over 25 years, this adds an additional $9 - $27 million to farm costs for the whole catchment, and $2 -$5 million for Māori land

Meat Processing is the single largest employer of Māori, being approximately twice that of the next largest which is the ***sheep and beef farming sector and its support services***. Both of these two largest sectors will be directly affected by the reduction in productivity and profitability of farming in the catchment, with a likely one to one relationship for the meat sector of reduction in stock numbers to reduction in throughput at the meat works. In year 20 under the middle (12m) space planting scenario, the analysis predicts a reduction of about 50% in the stock units in the catchment, which is likely to lead to a loss of at least half of the jobs in these sectors. Importantly such a reduction in throughput for the meat works is likely to threaten its viability, and it is strong possibility that all of these jobs would be lost to the district, with processing moving to other parts of the region or elsewhere in the north island.

Some caution is required in interpreting these predicted effects. The estimates of carrying capacity may be in error, and there may not be a one to one reduction in productivity units with reductions in pasture growth or carrying capacity, and the results do not include any benefits from productive use of scrub reversion or carbon credits. The costings of the mitigations are also subject to considerable uncertainty. However the scale of change indicated in this study means that even if the impacts are overestimated, there will still be significant impacts for the district and for Māori if the "best efforts" scenario were to be implemented.

In terms of amelioration of these impacts, the following measures could be adopted:

- Assistance for farmers with the cost of implementing mitigation measures.

- Stimulation of greater intensification and land use change on the remaining unaffected area.
- Undertake smaller scale mitigation measures, particularly the potential for wider spacing or focusing on only the most vulnerable areas for the space planting which would have a significantly lower costs and reductions in productivity.

2 Introduction

The Wairoa River is significant to the iwi and hapū of Te Rohe o Te Wairoa, and is valued ecologically as well as for recreation and mahinga kai. Excess sediment entering the water is an important threat to the health and mauri of the river.

The Wairoa Tripartite (Wairoa District Council, Tātau Tātau o Te Wairoa, Hawke's Bay Regional Council) and the Whitiwhiti Ora project (part of the Our Land and Water National Science Challenge) have formed a partnership to jointly guide the direction and delivery of a project focused on the river, particularly the impact of sediment on this taonga. The Wairoa project aims to:

- understand the values of the local hapū with respect to the river, with a focus on mahinga kai and sites of cultural significance
- assess how sediment affects these values
- inform targeting of sediment sources via intervention scenarios to reduce the impacts of sediment on these values

As a part of the project the Tripartite created a land use scenario called the 'best efforts scenario' which was modelled through the SednetNZ model to estimate the impact on sediment loss. The 'best efforts scenario' involves full scrub reversion on Land Use Capability (LUC) 7e and 8e pastoral land, space planting of trees on LUC 4e, 5e, and 6e pastoral land, and fencing and woody-revegetation of riparian areas along streams of River Environment Classification version 2 (RECv2) order 3 and above. The MWLR estimates of the changes from implementing this scenario are (Vale et al, 2023):

- *Suspended sediment loads in the Wairoa catchment are significantly reduced under a best-efforts mitigation scenario. The widespread application of erosion mitigation measures is projected to more than offset potential future increases in suspended sediment loads due to climate change.*
- *Under baseline conditions, two SOE sites achieve band A attribute state while the remaining five sites are at band D and will require significant load reductions to achieve NBL.*
- *The best-efforts erosion mitigation scenario with contemporary climatic conditions results in five SOE sites achieving NBL, whereas under future climate change three sites are likely to achieve NBL at mid-century and late century across all RCPs.*

The Tripartite has requested an economic evaluation of the consequences of implementing such a strategy for the Wairoa district. This report describes an analysis undertaken to understand the economic implications of the 'best efforts scenario' at a farm and a community scale.

3 Method

The data used by Manaaki Whenua Landcare Research (MWLR) to generate the estimates of sediment reduction contains estimate of the areas where mitigation in the form of reversion and space planting will occur. This data was provided to LWP in the form of a layer identifying where scrub reversion and space planting were included as mitigation, and a separate layer identifying the segments where riparian fencing was to occur. This data was used to estimate the area by LUC class affected by space planting and scrub reversion, and the length of riparian fencing required under the 'best efforts scenario'.

3.1 Productivity

AgFirst were engaged to estimate the stocking rate on land parcels within the Wairoa catchment, based on the LUC classification. They used in house data on productivity by LUC class, some of which could be applied directly to the LUC classes provided by MWLR, and some of which had to be interpolated. Their estimate of productivity (stocking rate) by class is shown in Appendix A Table 17.

Scrub reversion will result in complete loss of any productive capacity from pasture grown to support animal production although there may be opportunities for honey production or carbon credits. However space planting will still allow some production to occur. A Plant and Food Research (PFR) paper (Plant and Food Research, 2022) estimated the reduction in productivity for space planting, which is estimated at 10% at 10 years post planting and 50% for 20 years post planting at a 10m spacing. The authors of this paper cite a paper that indicates[2] a 20m spacing the reduction in productivity at 20 years would be in the order of only 10%.

A range of potential spacings is possible to include in the analysis of impact of space plantings. MWLR used a spacing of 10m for their estimate of mitigation impacts. HBRC[3] indicated that :

> *Based on the research, our general recommendation for spacing is 12 – 15 m for slip prone slopes, although in specific situations like rapidly eroding gullies this could go down to 10-12m, or as close as 8 – 10m for localised pair planting along small streams in some geologies.*

For this study we have used three potential spacings.

- The MWLR 10m spacing (100 stems/ha), for which the analysis uses a loss of productivity of 10% at 10 years and 50% at 20 years.
- An average 12m spacing (64 stems/ha), and have assumed a loss of productivity of 10% at 10 years and 30% at 20 years. The 30% is midway between the 10m (100 stems/ha) and 20m (25 stems/ha) spacing estimates made by PFR.

[2] A full reference for the paper was not provided.
[3] Colin Stace, pers.comm. October 2023

- An average 20m spacing (25 stems/ha), for which the analysis uses a loss of productivity of 5% at year 10 and 10% at year 20 from the PFR comments on wider spacing.

Note that the 20m spacing could involve either all the land in the managed landscape unit being planted at 20m, or 25% of the land planted at a 10m spacing.

3.2 Sheep and Beef Returns

The Beef and Lamb NZ (B&LNZ) Economic Service undertakes annual monitoring of sheep and beef farms nationally. Their North Island Hard Hill country is the most appropriate dataset for use in the Wairoa area, and the average of the last five years monitoring results was used to estimate the impact of reducing stocking rate. The study uses revenue and variable expenses per stock unit, and fixed expenses per ha to quantify the impact on profitability.

We note that AgFirst has indicated that for the lower producing areas of the farm, an average return per stock unit may overestimate the impact on profitability of taking those areas out of production, since the costs for maintaining those areas tend to be higher than more productive parts of the farm. However it should be noted that :

- Without detailed modelling of each farm it would be difficult to more precisely quantify the impact.
- The space planting, which is a large part of the impact, occurs on more productive parts of the farm.
- The areas involved in the mitigation comprise nearly 90% of the area in exotic grassland. In the data supplied by MWLR there is only 10,000 ha of the 156,000 ha in exotic grassland that has a LUC category 1 – 4, and the remainder is 6, 7 and 8, the majority of which is the “e” (erosion prone”) category. It is likely therefore that the mitigations will have a more than marginal impact on farm productivity, and that it would be very difficult to maintain total productivity by offsetting actions elsewhere on the farm.

The estimates of returns and expenses for sheep and beef operations in the Wairoa catchment are shown in Table 4.

Table 4: Estimates of financial returns from sheep and beef operation (Source: North Island Hard Hill model, B&LNZ, average 2020-21 to 2022-23)

Item	$
Revenue/su	$105.29
Variable expenses/su	$48.87
Fixed expenses/ha	$214.31

3.3 Costs of mitigations

The cost of space planting was sourced from HBRC[4] using their nursery data. These data are shown in Table 17, and indicate a cost of $825 - $3300 per ha for space planting depending on the density.

[4] Colin Stace, pers.comm. October 2023.

Table 5: Cost of space planting (Source: HBRC)

Item	Spacing		
	10m	12m	20m
Willow and poplar pole cost	$14.00	$14.00	$14.00
Sleeve	$8.00	$8.00	$8.00
Delivery	$1.50	$1.50	$1.50
Labour, layout	$2.50	$2.50	$2.50
Labour, planting	$7.00	$7.00	$7.00
Stems per ha	100.0	69.4	25.0
Cost per ha	$3,300	$2,292	$825

The cost of fencing is based on data from Grinter and White (2016) and updated using the Statistics NZ Business Price Index series. This data is shown in Table 6 below and the analysis uses the 0 m riparian planting width in Hill and High Country of $37.08/m.

Table 6: Unit costs for stock exclusion fencing (Source:Grinter and White, 2016 updated using CGPI, StatsNZ)

Riparian planting width	Simple land use	Flat and Flat (high country) ($/m)	Hill and High Country ($/m)
0m	S&B, arable	$7.65	$37.08
	Dairy	$4.73	$5.43
5m	S&B, arable	$14.99	$44.42
	Dairy	$12.07	$12.77
15m	S&B, arable	$32.12	$61.55
	Dairy	$29.20	$49.09

The estimate of stock exclusion for land that is retired is based on a nominal square block of 50ha, with only one side fenced. This results in 223m of fencing per 50ha block, which results in a cost of $165/ha. This approach provides a nominal indication of the potential costs of retirement, which will in some cases be higher than are actually experienced where the existing fencing of a property matches closely with the LUC outlines, and in other cases could be low where new fencing in irregularly shaped blocks is required.

3.4 District economic model

An Input – Output (IO) model of the Wairoa district was sourced (Butcher Partners) based on the 2019/20 Statistics NZ national IO model. This involved disaggregation of the national model based on employment and proprietary data of industries' activities and distribution. An IO model is considered appropriate for the scale of changes likely to occur in the Wairoa district, given that alternative models are unlikely to resolve changes at this small scale. However it should be noted that at the scale of a smaller district like Wairoa errors in the data used to compile the IO model can become more significant.

The IO model was applied to the revenue changes from the reduction in productivity to provide estimates of the flow on impacts to the region in terms of value added (GDP), household income (HHI) and employment (Full Time Equivalents FTE). Because of its importance in the local economy, the impact on the local meat works was separately included in this analysis, using an IO model that excluded the linkages between the meat works and sheep and beef farming (because the sheep and beef farming impacts were calculated separately).

The analysis also includes the increase in economic activity associated with the capital costs of mitigation, assuming that these costs were spread over 10 years. Thus the estimate of impact at year 10 uses the reduction in productivity at year 10 and the increase in activity associated with space planting and fencing. The estimate of impact at year 20 has only the reduced productivity from the space planting as the expenditure on the mitigation activities is assumed to already have occurred.

3.5 Impact on Māori

The impact for Māori uses two approaches.

- The direct impact on Whenua Māori (land subject to Te Ture Whenua 1993) is derived from a map of Māori Land Court land from 2016. A map of this land in the context of the Wairoa catchment is shown in Figure 2 below.
- The major sectors in the district economy in which Māori are employed was derived from an Infometrics product Te Matapae[5]. This information was used in conjunction with the IO table to identify the likely impact on these sectors, and associated employment impact. The local meat works is the largest employer of Māori in the district, and the impact on this business has been calculated separately.

[5] Lewis Ratapu, pers.comm. Downloaded December 2020.

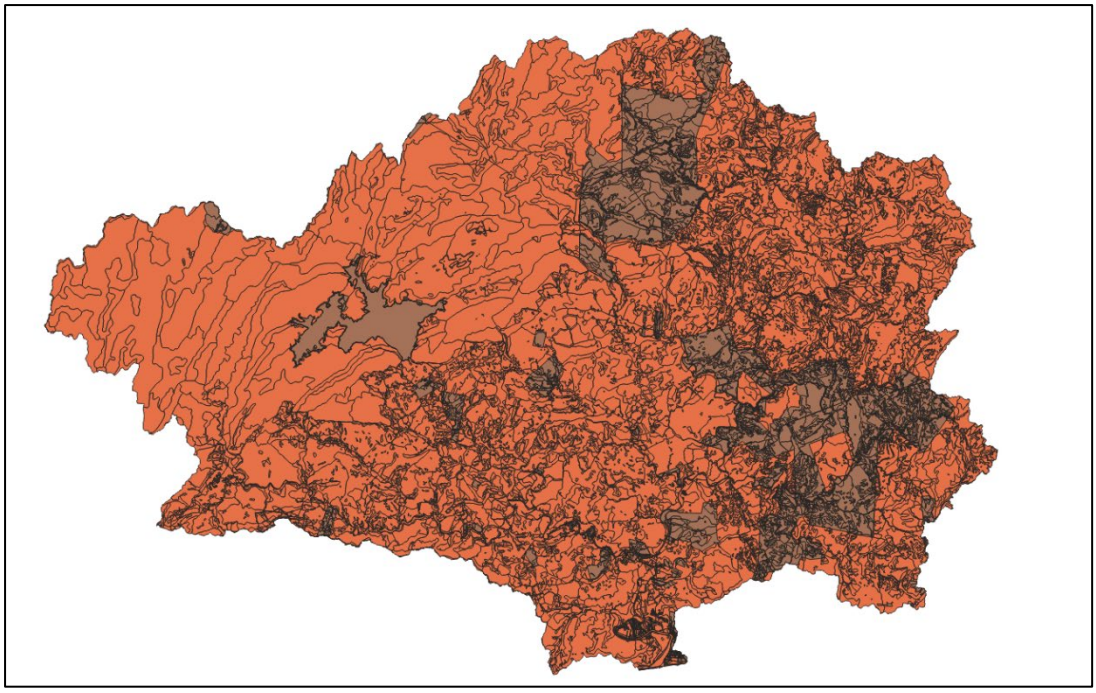

Figure 2: Whenua Maori (brown) in the Wairoa catchment (orange)

4 Results

4.1 Current economic output

The current economic output is based on the total of all stock units in the Wairoa catchment. Table 7 shows that there are 151,000 ha in exotic grassland in the catchment, which using the AgFirst estimates of stocking rate by LUC class gives a total of 1.3 million stock units. Using the NI Hard Hill model from B&LNZ, this results in total revenue of $135m per annum and operating profit (excluding capital items) of $40 million per annum. Within this there is 27,000 ha of Whenua Māori in the catchment, which results in 212,000 stock units, $22 million per annum in revenue, and $6.2 million per annum in operating profit (Table 8). Including the flow on impacts and the impacts on the meat processing sector these changes result in direct (in the farm and processing businesses) GDP of $104 million, HHI of $47 million, and 710 FTEs. Including the flow on impacts of these two sectors into the wider economy, there is $150 million in GDP, $65 million in HHI and 1000 FTEs.

While the contribution of the farming and meat processing sectors to GDP are similar, the meat processing sector contributes approximately double the employment and household income impacts.

Table 7: Current Productivity on farm indicators for all farms, Wairoa catchment

Item	Number
Area (ha)	156135
Stock units (su)	1,289,924
Revenue ($m/annum)	$135
Variable expenses ($/annum)	$63
Fixed expenses ($m/annum)	$33
Operating profit ($m/annum)	$39

Table 8: Current Productivity on farm indicators for Whenua Māori, Wairoa Catchment

Item	Number
Area (ha)	27002
Stock units (su)	211,900
Revenue ($m/annum)	$22.31
Variable expenses ($m/annum)	$10.36
Fixed expenses ($m/annum)	$5.79
Operating profit ($m/annum)	$6.17

Table 9: Flow on impacts under Current productivity

Sector	Item	Direct	Total
Sheep and beef farming	**GDP ($m)**	$58.36	$83.15
	HHI ($m)	$13.04	$21.92
	Employment (FTE)	241	382
Meat works	**GDP ($m)**	$45.63	$66.36
	HHI ($m)	$33.88	$42.94
	Employment (FTE)	469	629
Total	**GDP ($m)**	$104.00	$149.50
	HHI ($m)	$46.92	$64.86
	Employment (FTE)	710	1,010

4.2 Impacts of reduced productivity from sediment mitigation

Table 10 shows the impact for all land from the sediment mitigation measures on productivity and other farm indicators at year 10, and Table 11 and Figure 3 shows the impact on farm outcomes in Year 20. Table 12 and Table 13 show the on-farm outcomes for Whenua Māori. The results for all land show that at Year 20 the total reduction in stock units is between 30% and 60% of the current stock units depending on the density of planting, and this results in a significant reduction in revenue. About 20% - 50% of the reduction in stock units comes from scrub reversion, and the rest from space planting. Riparian fencing is assumed to not have an impact on production in this analysis.

While variable expenses scale with the reduction in stocking rate, there are a number of expenses which do not, and with reduced scale on each farm these ongoing costs will result in significantly lower operating profit in Year 10 of about 30% - 40% of current, with the operating profit being -8% to 37% of current in Year 20. Because the operating profit is before interest payments and tax, there are likely to be some farms experiencing significant negative cashflow. It is likely that under these conditions there will be an amalgamation of farms and attempts to recapture sufficient scale so that the fixed costs associated with running a farming business are able to be adequately covered by returns.

The estimation of the total impacts includes the flow on impacts throughout the community, but particularly that of the meat processing works in the Wairoa township. The meat works is a significant employer, estimated at 469 FTEs directly and with further contributions from suppliers in town. The results from the analysis suggest that the current output from meat sales from farms in the Wairoa catchment (based on the calculation of stocking rate by land parcel), is slightly larger than the purchases the meat works from farms in the IO table. Although both of these figures are likely to have a reasonable error margin, it does suggest that there is an approximately direct relationship between change in output from farms and the processing through the meat works. Thus a 20% - 50% reduction in stock units on farm will likely lead to an approximately 20% - 50% reduction in meat processing throughput. The calculations here use that one-to-one relationship to estimate the reduction in throughput for the meat processing works.

The estimation of total impacts in Year 10 also includes the employment and GDP effects of the capital works involved in establishing the fencing and space planting required to implement the mitigation measures. The analysis assumes that this capital expenditure is spread over 10 years, and the spending occurs through the “Agriculture, forestry, and fishing support services” sector in the IO table. The cost of these mitigations and the impact of supporting the capital spending on operating profit is shown in Section 4.3.

Including all these factors the total impact of the ‘best efforts scenario’ on the Wairoa district economy is shown in the last three rows of Table 10 and Table 11. It suggests that the contribution to GDP and HHI from the primary sector and meat works would be approximately 40% – 60% in year 10 and 30% - 60% in year 20 of its current level. Employment in Year 20 would be 40% to 70% of its current level. Indicatively the scale of the reduction is ~5% - 10% of the district economy. However the level of reduction in throughput at the meat processing plant would likely affect the viability of the works, so the impact would probably be higher than is indicated here. The implications of the impacts on the meat processing works are discussed further below in Section 4.4.

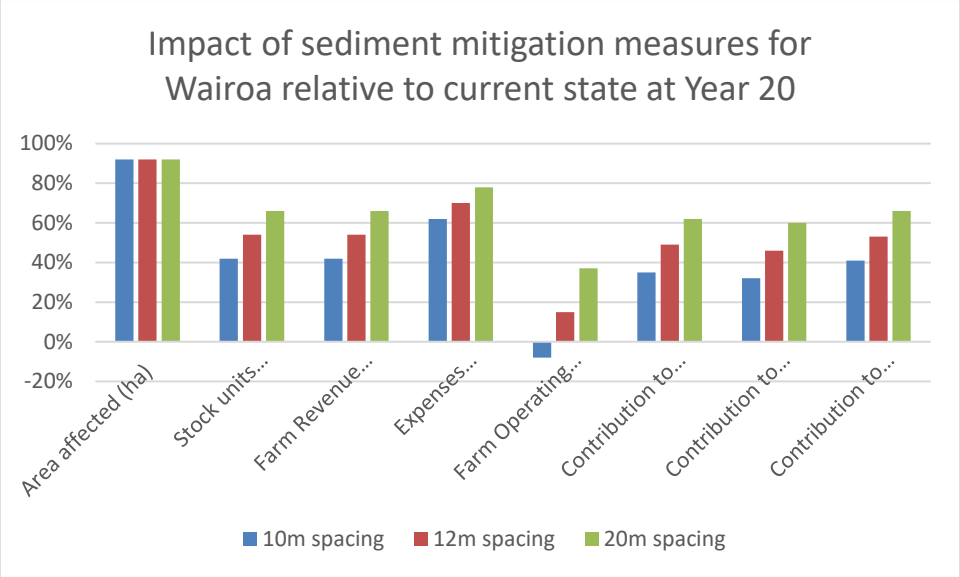

Figure 3: Impact of sediment mitigation measures in Year 20 relative to current state

Table 10: Impact for all land in Year 10 of sediment mitigation measures on farm and community economic indicators, Wairoa catchment

	Spacing (m)			Proportion of current		
All land	**10**	**12**	**20**	**10**	**12**	**20**
Area affected (ha)	143977	143977	143977	92%	92%	92%
Stock units remaining (su)	853000	853000	892000	66%	66%	69%
Revenue ($/annum)	$90	$90	$94	66%	66%	69%
Expenses ($/annum)	$75	$75	$77	78%	78%	80%
Operating profit ($/annum)	$15	$15	$17	37%	37%	43%
Total GDP	$69	$75	$90	46%	50%	60%
Total HHI	$25	$29	$36	38%	44%	56%
Employment	433	494	615	43%	49%	61%

Table 11: Impact for all land in Year 20 of sediment mitigation measures on farm and community economic indicators, Wairoa catchment

	Spacing (m)			Proportion of current		
All land	**10**	**12**	**20**	**10**	**12**	**20**
Area affected (ha)	143977	143977	143977	92%	92%	92%
Stock units remaining (su)	539000	696000	853000	42%	54%	66%
Revenue ($/annum)	$57	$73	$90	42%	54%	66%
Expenses ($/annum)	$60	$67	$75	62%	70%	78%
Operating profit ($/annum)	-$3	$6	$15	-8%	15%	37%
Total GDP	$52	$73	$93	35%	49%	62%
Total HHI	$21	$30	$39	32%	46%	60%
Employment	413	538	662	41%	53%	66%

Table 12: Impact for Whenua Māori in Year 10 of sediment mitigation measures on farm and community economic indicators, Wairoa catchment

Whenua Māori	Spacing (m)			Proportion of current		
	10	**12**	**20**	**10**	**12**	**20**
Area affected (ha)	25000	25000	25000	93%	93%	93%
Stock units remaining (su)	137000	137000	143000	65%	65%	67%
Revenue ($/annum)	$14	$14	$15	64%	64%	68%
Expenses ($/annum)	$12	$12	$13	77%	77%	79%
Operating profit ($/annum)	$2	$2	$2	31%	31%	37%

Table 13: Impact for Whenua Māori in Year 20 of sediment mitigation measures on farm and community economic indicators, Wairoa catchment

	Spacing (m)			Proportion of current		
Whenua Māori	**10**	**12**	**20**	**10**	**12**	**20**
Area affected (ha)	25000	25000	25000	93%	93%	93%
Stock units remaining (su)	83000	110000	137000	39%	52%	65%
Revenue ($/annum)	$9	$12	$14	39%	52%	64%
Expenses ($/annum)	$10	$11	$12	61%	69%	77%
Operating profit ($/annum)	-$1	$0	$2	-18%	7%	31%

4.3 Cost of mitigations

The total cost of mitigations (Table 14) is estimated to be $120 - $360 million, the majority (60% - 90%) of which would arise from space planting. For Whenua Māori the total cost is estimated to be $25 - $66 million, of which a similar majority would be in space planting.

The analysis here assumes that the costs of mitigation are paid by farmers. When the capital cost is turned into a loan and repaid over 25 years, this adds an additional $8 - $20 million to farm costs for the whole catchment, and $0.4 - $4 million for Whenua Māori. When this equivalent annual cost of the mitigations is deducted from the operating profit, allowing for decreased productivity, the catchment as a whole generates a loss under the two more dense planting scenarios for both Whenua Māori and all land.

However in the implementation of these measures also adds spending into the economy for the period over which it occurs (assumed as 10 years in this analysis), which generates its own impacts on economic activity and employment. In Year 10 there would be an additional contribution of $8 - $24 million in GDP, $5 - $14 million in HHI, and 80 – 230 FTE generated by the mitigation works.

Table 14: Impacts of mitigations on all land for sediment control, Wairoa catchment

Mitigation costs	10m	12m	20m
Retirement fencing ($m total)	-$8.1	-$8.1	-$8.1
Space planting ($m total)	-$313.1	-$217.4	-$78.3
Riparian fencing ($m total)	-$37.0	-$37.0	-$37.0
Total ($m total)	**-$358.3**	**-$262.6**	**-$123.4**
Annualised ($m/year)	$27.0	$19.8	$9.3
Operating cost after annualised costs Year 10 ($m/year)	**-$12.3**	**-$5.1**	**$7.6**
Operating cost after annualised costs Year 20 ($m/year)	**-$30.0**	**-$14.0**	**$5.4**
Contribution to GDP first 10 years($m/year)	$24.0	$17.6	$8.3
Contribution to HHI first 10 years ($m/year)	$14.4	$10.6	$5.0
Contribution to Employment first 10 years (FTE)	230	168	79

Table 15: Impacts of mitigations on Whenua Māori for sediment control, Wairoa catchment

Mitigation costs	10m	12m	20m
Retirement fencing ($m total)	-$1.4	-$1.4	-$1.4
Space planting ($m total)	-$54.1	-$37.5	-$13.5
Riparian fencing ($m total)	-$10.5	-$10.5	-$10.5
Total ($m total)	**-$66.0**	**-$49.5**	**-$25.5**
Annualised ($m/year)	$5.0	$3.7	$1.9
Operating cost after annualised costs Year 10 ($m/year)	**-$3.0**	**-$1.8**	**$0.4**
Operating cost after annualised costs Year 20 ($m/year)	**-$6.1**	**-$3.3**	**$0.0**

4.4 Employment for Māori

Table 16 shows the major sectors of employment for Māori in the Wairoa district and their likely primary drivers. As noted above ***Meat Processing*** is the single largest employer of Māori, being approximately twice that of the next largest which is the ***sheep and beef farming sector and its support services***. Both of these two largest sectors will be directly affected by the reduction in productivity and profitability of farming in the catchment, with a likely one to one relationship for the meat sector of reduction in stock numbers to reduction in throughput at the meat works. In year 20 under the middle (12m) space planting scenario, the analysis predicts a reduction of about 50% in the stock units in the catchment, which is likely to lead to a loss of at least half of the jobs in these sectors. Even under a 20m spacing scenario there is a decline in stock units of about a third. Such a reduction in throughput for the meat works is likely to threaten its viability, and it is a reasonable possibility that all of these jobs would be lost to the district, with processing moving to other parts of the region or elsewhere in the north island.

Table 16: Major sectors of employment for Māori, Wairoa district

Sector	Māori employment	Proportion of Māori employees in Wairoa district	Drivers
Meat processing	403	26%	Stock numbers
Sheep and beef farming + support services	198	13%	Stock numbers
Education	164	11%	Population (employment)
Health	76	5%	Population (employment)
Road and Bridge Construction	51	3%	Central government
Supermarket and Grocery Stores	48	3%	HHI

Education and health are major employers for Māori, and these together are actually larger than the sheep and beef farming plus support services. These sectors will be driven primarily by population in the district, which in turn tends to be strongly influenced by employment. In the 12m space planting scenario, at year 20 the analysis predicts about half of the contribution to employment provided by farming would be lost, equivalent to ~500 jobs. The total employment for the Wairoa district is ~3000 FTEs, so we would expect a decline of ~15% in employment if there were no alternative new sources of employment found, and we would expect that this would lead to at least some population decline as workers move elsewhere to seek employment. However because of family and cultural ties we would not expect all these workers to leave the district, and so it is likely that there would be an impact in the order of 5% - 15% on employment for Māori in these education and health sectors.

Road and bridge construction has a large transfer component from central government, with all of the state highway and 50% of other roading works funded centrally. The mitigation works are not expected to greatly alter employment in that sector, although there may be some pressure on local government finances that reduce the expenditure on local roading. It is also possible that the mitigation works reduce the requirement for repair of roading through reduced sediment build up in rivers in the district.

Supermarket and grocery stores employment will be largely driven by household income in the district. The reduction in HHI associated with the farming sector in the 12m space planting scenario at year 20 is ~$30 million, which is 15% of the district consumption expenditure. We would therefore expect some reduction in employment in this sector, although it will be muted by central government welfare support for unemployed workers and their families who remain in the district.

5 Discussion

The results from this study indicate that there are likely to be significant impacts for the farms and communities from the implementation of the sediment mitigation scenario, with approximately 30% to 60% of the output from farming potentially lost. This loss in production would cause low profitability before capital items and tax, and reductions in employment and activity in the wider community. After interest and tax it is likely that many farms with significant areas of erosion prone land would be in a negative cashflow state.

In addition the mitigations themselves would have significant costs, and if these costs fell on farmers, their profitability before capital and tax would likely be negative while these costs were repaid. However there would be some offsetting flow on effects in the community from expenditure on the mitigation activities while they were being implemented.

Some caution is required in interpreting these predicted effects. While the analysis attempts to make reasonably neutral assumptions, there are a number of areas where it may overestimate the impacts. As noted by AgFirst in making their assessment of the carrying capacity of the different LUC classes, they have undertaken studies which showed that farms could retire some of the less productive areas of their farms for very little impact on profitability. This arises because the less productive areas take more cost and higher management input in order to keep them productive, and their removal may enable greater focus on the more productive parts of the farm. There is also the

possibility of analytical errors in the assignment of carrying capacity leading to overestimation of the productivity of these areas.

The impact of space planting on productivity has been assumed to be linear with the reduction in pasture production. The PFR study on the reductions in pasture growth with space planting seems reasonably robust, however the assumption of linear productivity change assumes that stock utilisation of pasture does not change with the introduction of space planting. It may be that this assumption of invariant utilisation is not valid, and there is some compensation for falling pasture production by increased utilization. This would mean that the analysis here overestimates the impact of space planting.

The costings of the mitigations are also subject to considerable uncertainty.

- The retirement fencing is based on a nominal fencing requirement per retired block, and should be considered as indicative only.
- The space planting costs per stem are reasonably solidly established, being based on data from HBRC and confirmed by a separate source. However the spacing that will achieve the sediment reduction is subject to considerable uncertainty. MWLR have used 10m spacing (100 stems/ha) as the basis for their analysis, while HBRC indicate that ~12m spacing (69 stems/ha) is appropriate. PFR in their report on the pasture growth reductions associated with space planting cite a paper indicating that 20m planting (25 stems/ha) would achieve effectively the same sediment reductions as denser plantings as considerable lower cost and smaller loss of pasture growth. Furthermore stakeholders have indicated that 100% of every erosion prone landscape unit may not be planted, and there may be higher density plantings in the most erosion prone parts of the landscape unit, with lower density or no plantings over the rest. We tested the impacts of this, and the scenario impacts from planting 25% of each unit at 10m spacings is approximately equivalent to the impact of 20m space plantings over the whole of each erosion prone unit. The density of space planting has considerable implications for the cost and impact of the mitigation measures, and further consideration should be given to incorporating the least dense planting that is consistent with achieving the sediment reduction targets.
- The riparian fencing is based on national level data, and while material costs can be reasonably ascertained, the labour cost of fencing in rough and difficult farmland are very difficult to establish. These costings are better than indicative, but the actual costs could be considerably higher than is indicated here.

These caveats should all be kept in mind when considering the conclusions reached here. However the scale of change indicated in this study means that even if the impacts are overestimated, there will still be significant impacts for the district and for Māori if the “best efforts” scenario were to be implemented. Furthermore it is considered possible that at this scale of impact on the farming sector, the meat processing works would no longer be viable, and it may lead to the complete loss of those jobs. Given that in the order of 80% - 90% of employment at the works appears to be Māori, the closure of the works would be a serious matter for the district.

In terms of amelioration of these impacts, the following measures could be adopted:

- ***Assistance with the cost of implementing mitigation measures***. Given the large impact on the farming community in terms of reduction in productivity, it may be that cost sharing would be appropriate and this would ameliorate at least some of the direct impact for farming operations.

- ***Stimulation of greater intensification and land use change on the remaining area***. Intensification of sheep and beef farming on remaining available land would offset some of the losses in terms of stock throughput at the meat works, while land use change to intensive horticulture may offset the direct employment impacts in the sheep and beef sector. Horticultural operations, with their associated need to post harvest processing and packing, may also offset the loss of jobs from meat works.

- ***Undertake smaller scale mitigation measures***. Reducing the scope of the mitigations would also reduce the costs and associated impacts. Indicatively for space planting mitigations the combination of costs of planting and the impacts on productivity suggest that moving to wider spacing over the same area, and/or focusing efforts on the most erosion prone parts of each landscape unit, would be lower impact on productivity and costs than maintaining the more intensive spacing over a lesser area. The wider spacing has a significantly lower cost and lower impact on productivity than does the denser spacing, such that it would require a larger reduction in the mitigated area under a dense planting scenario to achieve the same savings in costs and productivity that could occur with a less dense spacing over the 'best efforts scenario' area.

6 References

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Appendix A AgFirst Estimate of Stocking Rate by LUC

Table 17: AgFirst estimate of stocking rate by LUC class, Wairoa catchment. (green columns are LUC classes for which AgFirst data had in house data, yellow rows required interpolation from their available information)

LUC class	Limitation reason (e = erodibility limitation, w = wetness limitation, s = soil limitation, c = climate limitation)	LUC Unit	Area in Exotic Grassland	AgFirst estimate of stocking rate for exotic grassland
1	c	1	366	17.9
1	w	1	447	16.7
2	w	1	1300	17.0
3	e	2		16.9
3	e	22	917	12.4
3	c	6	62	12.9
3	sl			13.3
3	s	3		12.2
3	s	9	3936	10.7
3	s	9*	1015	11.4
3	w	1	257	12.2
3	w	1*	2012	12.2
3	w	3*	264	12.0
3	w	9	674	11.7
4	e	2		14.4
4	e	3		14.0
4	e	21	3034	11.0
4	c	4+	29	10.0
4	s	2		11.9
4	s	5	21	11.0
4	w	2	142	11.0
6	e	1		10.0
6	e	2		10.7
6	e	4		10.6
6	e	6		9.9
6	e	8		10.0
6	e	7		9.4
6	e	10		8.9
6	e	11		8.5
6	e	14		8.9
6	e	28	4825	8.1
6	e	32	26514	8.0
6	e	35	14186	8.1
6	e	62	134	7.8
6	e	64	1561	7.7
6	e	66	3289	7.6
6	e	78	836	7.5
6	e	87	19	7.4
6	c	3		7.6
6	c	4+	351	9.2
6	c	9*	2675	8.5
6	el	s		10.0
6	e	22*	3203	8.4
6	e	62*	1729	8.4
6	e	84*	14702	8.4
6	e	87*	325	8.4
6	s	3	17505	8.4
6	s	15	108	8.4
6	sl			8.9
7	0		4581	7.2
7	0		4486	7.2
7	e	2		8.5
7	e	3		8.2
7	e	4		8.0
7	e	5		9.0
7	e	7		7.2
7	e	8		7.8

LUC class	Limitation reason (e = erodibility limitation, w = wetness limitation, s = soil limitation, c = climate limitation)	LUC Unit	Area in Exotic Grassland	AgFirst estimate of stocking rate for exotic grassland
7	e	14		5.3
7	e	16		10.0
7	e	24	2187	7.2
7	e	27	40	7.2
7	e	36	7126	7.2
7	e	42	1145	7.2
7	e	53	6	7.2
7	e	57	2102	7.2
7	e	63	4520	7.2
7	e	2*	2729	7.2
7	e	4	9789	7.2
7	e	4*	8797	7.2
7	e	36+	509	7.2
7	e	43+	452	7.2
7	s	2	248	6.8
8	e	1	23	4.3
8	e	2	595	4.3
8	e	4		3.5
8	e	6	3	4.3
8	s	1	364	4.3