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Direct Economic Impact of the TANK

A report prepared for Hawke's Bay Regional Council

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Nimmo-Bell & COMPANY LTD

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Cover photo: Source – Google images

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1. Executive Summary

1. The objective of the study is to estimate the direct economic impacts of proposals for the TANK, the Hawke's Bay Regional Council's look at the best way to manage the waterways of the Tutaekuri, Ahuriri, Ngaruroro and Karamu catchments.

2. Our approach has been to work with Agfirst, Council officers, the TANK stakeholder group and science providers to define the scope and scale of analysis, provide input data for analysis and feedback on draft findings. This report provides the cashflows for the assessment of the wider indirect and induced economic impacts of the policy scenarios. We have relied on the farm budget information provided by Agfirst in emails and discussions, published material along with information provided by the Council to construct the cashflows.

3. Ten farm systems are modelled including five horticultural land uses (kiwi fruit, pip fruit, grapes, summerfruit and vegetables) and five pastoral land uses (summer moist hill, summer dry breeder finishing, summer dry intensive finishing, part time and dairy). Two policy scenarios assess the impact over time of irrigation restrictions plus sediment and nutrient mitigation on the Heretaunga Plains and sediment and nutrient mitigation on the Pastoral Hill Country within the TANK Catchment. These restrictions and activities have been converted into financial (revenue and expenditure) impacts at the representative farm level by Agfirst.

4. Three Horticulture scenarios are evaluated:
   Scenario 1 Base case: 79% of Horticulture irrigated area have no bans and 21% of Horticulture irrigated area are subject to current minimum flow restrictions related to Nga 2,400 l/s.
   Scenario 2 Future B: 74% of the irrigated area is subject to the 2013 reliability restriction and 20% of irrigators are subject to water restrictions related to Nga 3,600 l/s and 6% related to the Tutaekuri 2,500 l/sec restrictions. Expenditure is increased for agreed mitigations to reduce sediment and nutrients.
   Scenario 3 Future C: 74% of irrigators are subject to 9 in 10 year reliability restrictions and 20% of irrigators are subject to water restrictions related to Nga 3600l/s and 6% to Tutaekuri 2,500 l/sec. Expenditure is increased for agreed mitigations to reduce sediment and nutrients.

5. Mitigation for Pastoral farms are modelled with a 30% reduction in sediment for Scenario 2 (MS1) and a 30% reduction in sediment plus 10% reduction in nutrient loss (nitrogen) in Scenario 3 (MS2). Mitigations are phased in over ten years including land use change to forestry. Forestry cashflows are the same for both Scenarios 2 and 3 with planting aligned with the other mitigation changes. There is no forestry in Scenario 1.

6. Cashflows are in current dollars with product price based on the average of the last five years. The cash flow models cover a 30 year period and for Horticulture show three alternate pathways to the limits with the Fast start pathway starting in year 3; Medium in year 5 and Slow start in year 8. The output of the analysis is a series of cashflow sub-models over 30 years. The cashflow models contain two decision variables Net Present Value (NPV) and Benefit Cost Ratio (B/C) with the Treasury standard discount rate of 8% used as the default.

7. To set up the cashflows ready to estimate the indirect and induced effects of the policy options the horticulture budgets provided by Agfirst needed to be fleshed out in more detail.

The areas are as follows: Specifying the destination of produce into Export, Local and Process; Identifying the Recognised Seasonal Employer (RSE) Scheme component of wages; Developing the detailed budgets for the water allocation options from the No ban budgets for each crop; Specifying the details of livestock revenue for the Vegetable model; and Incorporating the mitigation activities into the Scenario 2 and 3 budgets

8. The Pastoral budgets provided by Agfirst covered all farm types and mitigation scenarios with more detail required as follows: Specifying the source and destination of livestock purchases and sales as inside and outside the Hawke's Bay Region; Irrigated land on pastoral farms; Translating model farm budgets into TANK totals and phasing in mitigations over 10 years; Compliance, monitoring and verification; and Modifying the forestry model to confirm with other components of the pastoral cashflows.

9. The results in PV terms for Horticulture at the default discount rate of 8% show a Base (Scenario 1) with total Revenue cashflow of $7,585.8 million. Expenses amount to $5,478.3 million leaving a net revenue of $2,107.5 million. Revenue is down by 2% and 5% for Future B (Scenario 2) and Future C (Scenario 3) respectively with Expenditure up 1% in both cases leaving Net Revenue down by 9% and 18% respectively.

10. Allowing Horticulture farmers more time before the policy is implemented has a significant effect in reducing the cost. Compared to a Fast start in year 3, a start in year 5 Net Revenue is improved by 2% for Future B and improved by 3% for Future C. Pushing the start date out to year 8, compared to a start in year 3, Net Revenue is improved by 3% and 8% respectively.

11. The results for the Base (Scenario 1) Pastoral total Revenue cashflow is a PV of $1,840.0 million. Expenditure amounts to $1,366.5 million leaving a Net Revenue of $473.5 million. For MS1 and MS2 Revenue decreases as does Expenditure leaving at Net Revenue at $452.5 million for MS1 and $437.4 million for MS2, down 4% and 8% respectively. Forestry adds a net $6.6 million so that the overall change to Net Revenue for Scenarios 2 and 3 is negative 3% and negative 6% respectively at $459.1 million and $444.0 million.

12. When Horticulture and Pastoral including Forestry cashflows are combined the PV of the Net Cashflow for the whole TANK is down 8% for Scenario 2 and down 15% for Scenario 3 compared with Scenario 1.

13. Changing the discount rate affects the magnitude of Present Values ($m) significantly, however, relativities between Net Revenue PVs ($m) change very little for mitigation scenarios (Sc2 and Sc3) compared to Base (Sc1). The exception is forestry where the NPV is $105.1m at 2%, $13.7 m at 6% and $6.6m at 8%.

14. Overall the Benefit Cost Ratios vary little between scenarios, although as expected from the PVs Scenario 1 is always higher than the mitigation scenarios.

15. Discussion at the EAWG noted the following points related to the economic analysis:
The economic analysis does not factor in behavioural change, which is likely to reduce the assessed negative impacts as farmers adjust to the new reality.
The analysis does, however, provide a set of baseline financials for individual farmers to assess their own situation and act as a catalyst for change. More importantly it provides a consistent

base of financial information that policy makers and the public can weigh up the economic costs to achieve environmental improvement.

The analysis also shows that reducing water allocation by the amounts assumed in Scenarios 2 and 3 have a far larger negative economic impact than the costs of reducing sediment and nutrient inflows into water ways.

As mitigation is expected to be more cost effective than reducing water allocation this should be the area of initial focus for change.

Recent flood events in other parts of New Zealand e.g. Tasman District have shown the vulnerability of land to major damage from forest slash ending up in water ways during the five year period from harvest until the new forest is established.

The size of the difference between Scenario 1 and Scenarios 2 and 3 provides an indication of the quantum that is available to introduce adaptive policies such as augmentation.

Vineyards on Gimblett gravels are potentially the biggest losers from the policy changes that are modelled.

Hawke's Bay is heavily reliant on primary production and the analysis of indirect and induced economic effects will highlight the even greater negative impacts beyond the horticulture and agriculture sectors.

16. Limitations and caveats discussed in the report include:

All models are simplifications of reality.

The past may not be a good guide to future uncertain outcomes.

We assume technology change over time will affect all options similarly and is ignored.

The possibility of climate change over the next 30 years has not been explicitly modelled.

The results are relevant at the regional level and not to individual farm outcomes.

17. Next steps are for the wider TANK consultative group to see the results of this analysis and the analysis of indirect and induced effects. Once this is done there may be an opportunity to revisit the modelling of direct effects. If additional modelling is assessed as needed through an additional scenario, then the following steps are needed: Specify the policy option; Agree on assumptions; Construct model and present; and then Market Economics to assess indirect and induced effects.

2. Approach and methodology

The objective of the study is to estimate the direct economic impacts of proposals for the TANK: the Hawke's Bay Regional Council's look at the best way to manage the waterways of the Tutaekuri, Ahuriri, Ngaruroro and Karamu catchments. The methodology is similar to the economic analysis of other regional freshwater improvement policy initiatives undertaken by the authors for Lake Taupo (Thomas, Bell, McRae and Britton 2004), Waikato (Bell and Cudby 2010), Bay of Plenty (Bell 2011), Horizons (Bell, McDonald, Fairgray and Smith 2013), and Canterbury (Bell, McDonald, Fairgray and Muller 2014) Regional Councils.

Our approach has been to work with Agfirst, Council officers, the TANK stakeholder group which roughly representing the wider community, its Economic Assessment Working Group (EAWG) and science providers to define the scope and scale of analysis, provide input data for analysis and feedback on draft findings. The overall assessment is divided into three parts:

- Development of representative farm budgets of the current state and future alternative financial outcomes under different assumptions for Tank waterway improvement, undertaken by Agfirst
- Assessment of the direct economic benefits and costs over time of different policy scenarios compared with the status quo, undertaken by Nimmo-Bell, and
- Assessment of the wider indirect and induced economic impacts of the policy scenarios, under taken by Market Economics.

This report covers part b as outlined in paragraph 2. Nimmo-Bell has relied on the farm budget information provided by Agfirst in emails and discussions along with published material to construct the cashflows (MacGillvray 2017 and Archer and Brookes 2018) along with information provided by the Council (HBRC 2016a, 2016b and 2017 and Smith *et al* 2018) plus discussions and by email. We have attended two TANK meetings and one EAWG meeting in preparing this report.

Under the TANK, land managers (pastoral and horticultural farmers) are expected to be subjected to increased restrictions on water use for irrigation and required to reduce sediment and nutrient flows into waterways. Their management will have to change including coping with less water for irrigation, fencing off waterways, riparian stream planting, optimising fertiliser use, pole planting on steep land, and land use change (retiring steep land to revert to native bush and for production/carbon forests).

At this stage, the consultative groups have been working to understand the science underpinning the requirement for change and reach a consensus on what is required to achieve community goals on freshwater. The policies to achieve the desired outcomes and the method of implementation are future steps that will be built out of the consensus reached. The economic analysis will help inform the stakeholder group of the economic consequences of the possible policy changes and assist in balancing regional social, cultural, economic and environmental goals and outcomes.

The scope and nature of Nimmo-Bell's economic analysis is the development of a sub-regional economic model of direct costs and benefits of the TANK Catchments' agriculture and horticulture under different policy options to improve water quality and achieve efficient water allocation over time. This work aggregates representative farm system budgets developed by AgFirst to represent modelled changes over time under different policy scenarios starting from the current economic state. Cashflows of direct benefits

and costs are developed that highlight simplified transition pathways farmers may undertake analysed at the sub-regional level from the current situation to the community agreed standard of environmental outcome. These pathways are to demonstrate the potential economic implications of a staged implementation of increasingly costly water allocation, sediment and nutrient mitigation scenarios. The mitigation options modelled and the timing of adoption are subject to collaborative agreement by the TANK Stakeholder Group, Economic Assessment sub-group and the Council.

Ten farm systems are modelled including five horticultural land uses (kiwi fruit, pip fruit, grapes, summerfruit and vegetables) and five pastoral land uses (summer moist hill, summer dry breeder finishing, summer dry intensive finishing, part time and dairy). The vegetable model farm consists of onions, squash, peas/beans, sweetcorn and other. The other category has been determined by Agfirst from the balance of the vegetable crops and is intended to represent all other vegetable crops such as tomatoes and beetroot. Pasture is included as part of the vegetable rotation with livestock financials based on the parameters of the summer dry intensive finishing representative farm.

Two policy scenarios assess the impact over time of irrigation restrictions plus sediment and nutrient mitigation on the Heretaunga Plains and sediment and nutrient mitigation on the Pastoral Hill Country within the TANK Catchment. These restrictions and activities are converted into financial (revenue and expenditure) impacts at the representative farm level by Agfirst. Descriptions of the agreed scenarios for the first round of assessments for Horticulture are:

Scenario 1: Base case

79% of Horticulture irrigated area have no bans (Ground Water not connected to Surface Water and the Tutaekuri takes connected to surface water at the 2,000l/sec flow). There is no change to expenditure for mitigation.

21% of Horticulture irrigated area are subject to current minimum flow restrictions related to Nga 2,400 l/s which gives 44% Habitat Protection. For these irrigators Income is reduced from Base Case to reflect the water restriction (Nga 2,400 Revenue) with no change to Expenditure on sediment and nutrient mitigation.

Scenario 2: Future B

74% of the irrigated area is subject to the 2013 reliability restriction (similar to 19/20 reliability) with Expenditure increased for agreed mitigations to reduce sediment and nutrients.

20% of irrigators are subject to water restrictions related to Nga 3600l/s and 6% to 2,500 l/sec for the Tutaekuri which gives 70-75% Habitat Protection. For these irrigators Income is reduced from Base Case to reflect the combined effect of 4 in 5 year water reliability and water restrictions (Nga 3600 and Tut 2500 Revenue). Expenditure is increased for agreed mitigations to reduce sediment and nutrients.

Scenario 3: Future C

74% of irrigators are subject to 9 in 10 year reliability restrictions (GW 9/10 Revenue) with Expenditure increased for the same agreed mitigations as scenario 2

20% of irrigators are subject to water restrictions related to Nga 3600l/s and 6% to 2,500 l/sec for the Tutaekuri which gives 70-75% Habitat Protection. For these irrigators Income is reduced from Base Case to reflect the combined effect of 4 in 5 year water reliability and water restrictions (Nga 3600 and Tut 2500 Revenue) Expenditure is increased for the same agreed mitigations as scenario 2.

Pastoral models are less complicated in that all farm models are treated the same with a 30% reduction in sediment for Scenario 2 (MS1) and a 30% reduction in sediment plus 10% reduction in nutrient loss

(nitrogen) in Scenario 3 (MS2). Mitigations are phased in over ten years including land use change to forestry. Forestry cashflows are the same for both Scenarios 2 and 3 with planting aligned with the other mitigation changes. There is no forestry in Scenario 1.

Cashflows are in current dollars with product price based on the average of the last five years where data is available. There are two rounds of scenario testing with the number of policy options tested in each round having been agreed collaboratively by the TANK Stakeholder Group, Economic Assessment Sub group and the Council. The cash flow models cover a 30 year period and for Horticulture show three alternate pathways to the limits with the fast start pathway starting in year 3; medium in year 5 and slow start in year 8. Wherever practical, the cash flow models are designed to be as efficient and flexible as possible thereby facilitating the accommodation of potential additional scenarios with minimal cost. Provision is made for a possible third round of scenario testing after consideration of the first two rounds by the consultative group.

The output of the analysis is a series of cashflow sub-models over 30 years that detail changes in revenue and expenditure for the 10 modelled farm systems grouped into two mitigation scenarios. The cashflow models contain two decision variables NPV; B/C with the Treasury standard discount rate of 8% used as the default supported by a sensitivity analysis at 2% (the assumed Social Time Preference Rate) and 6% (rate used by Agfirst in its forestry cashflows analysis).

Draft copies of spreadsheets and report are provided for the Council/Economic Assessment Sub-Group to review. Deliverables include a report that details the methodology, results, assumptions and limitations/uncertainties relating to the analysis (together with supporting spreadsheet calculations). Copies of all models and calculations are provided to the Council. Attendance by Nimmo-Bell at selected TANK Stakeholder and Economic Assessment Group Meetings including discussions relating to the methodology, development of scenarios and presentation of preliminary and final results at these forums is included as an essential part of the methodology.

3. Developing the detailed Horticulture Budgets

To set up the cashflows ready to estimate the indirect and induced effects of the policy options the horticulture budgets provided by Agfirst need to be fleshed out in more detail. The areas are as follows:

- Specifying the destination of produce into Export, Local and Process
- Identifying the Recognised Seasonal Employer (RSE) Scheme component of wages
- Developing the detailed budgets for the water allocation options from the No ban budgets for each crop
- Specifying the details of livestock revenue for the Vegetable model
- Incorporating the mitigation activities into the Scenario 2 and 3 budgets

3.1 Destination of Produce

The Agfirst base case budgets which provide gross revenue by crop need to be expanded to show the destination whether Export, Local or Process. This is done by taking the percentage volume of each crop together with the price per tonne and applying these to the revenue per hectare of the No ban model. *Table 1* and *Table 2* below demonstrate the process for the Vegetable model to produce the revenue per hectare by destination.

Table 1 Vegetable crop destination by volume and price

	Export		Local		Process		weighted
	Vol %	Price $/t	Vol %	Price $/t	Vol %	Price $/t	av price
Peas&Beans					100%	$285	$285
Sweetcorn					100%	$285	$285
Squash	95%	$600.00	5%	$128			$506
Onions	79%	$470.00	17%	$500	4%	$150	$462
TANK Other					100%	$189	$189

Source: Agfirst

Table 2 Vegetable No ban model crop destination

No ban breakdown of revenue*							
Crop	$/ha	area (Ha)	$/model	Xpt	Local	Process	Total
Peas&Beans	$6,992	31.5	220,256	-	-	220,256	220,256
Sweetcorn	$4,062	31.5	127,941	-	-	127,941	127,941
Squash	$13,447	63	847,154	804,796	42,358	-	847,154
Onions	$28,282	31.5	890,892	703,805	151,452	35,636	890,892
TANK Other	$12,852	52.5	674,730	-	-	674,730	674,730
Total Cropping Revenue		210	2,760,973	1,508,601	193,809	1,058,563	2,760,973
Rev $/ha			13,147	7,184	923	5,041	13,147
*Source Agfirst: Vegetable model worksheets clean 2 BB 180425							

3.2 RSE component of wages

RSE workers from overseas are an important source of labour on horticulture properties in the TANK. As they remit a significant proportion of their wages back to the families in the Pacific this needs to be considered in assessing the indirect and induced impacts of the TANK policy options. Unfortunately, there are no official statistics of RSE worker numbers by crop type in the TANK. We have used the local knowledge of HorticultureNZ to make the estimates of the proportion of wages that apply to RSE workers (see *Table 3*) and split out wages in the per hectare models on this basis

Table 3 Estimated proportion of wages that are RSE

	Kiwifruit	Pipfruit	Grapes	Summerfruit	Vegetables
RSE	0.16	0.28	0.23	0.21	0.17
Other wages	0.84	0.72	0.77	0.79	0.83

Source: HorticultureNZ

3.3 Development of detailed budgets for the water allocation options

Agfirst provided detailed revenue budgets for the No ban situation, but only gross revenue for the water allocation policy options (see Table 4 below).

Table 4 Income $ per hectare by crop type and policy option

Crop/Option	No Ban	Nga 2,400	GW 2013	GW 9/10	Tut 2,500	Nga 3,600	Nga 4,000
Kiwifruit	101,364	100,198	99,191	98,251	96,874	96,854	96,633
Pipfruit	79,597	77,701	78,019	74,959	74,415	74,647	72,987
Grapes	16,064	15,999	15,984	15,844	15,810	15,854	15,809
Summerfruit	54,704	52,862	53,437	51,340	50,987	51,287	48,744
Vegetables	13,147	12,466	12,996	11,844	11,836	11,832	11,271

Source: Agfirst

The method used to expand out the water allocation options is to relate the revenue for each option to No ban which has a detailed breakdown of revenue. The revenue per hectare for each option is divided by the revenue for No ban, as shown in Table 5 Crop income relative to No ban

below, and each proportion of No ban is applied to the No ban detailed breakdown of revenue to obtain an estimate of the detailed revenue for that option. For example, No ban revenue for Kiwifruit is $101,364/ha and revenue for Nga 2,400 Kiwifruit is $100,198/ha. The resulting proportion of revenue for Nga 2,400 for Kiwifruit is 0.988. This figure is applied to each component of No ban revenue for Kiwifruit to get the detailed breakdown of Nga 2,400 revenue for Kiwifruit. Expenditure does not change, an assumption tested by Agfirst with small changes under mitigation deemed to be immaterial to the analysis.

Table 5 Crop income relative to No ban

Crop Income relative to No ban						
Crop	No Ban	Nga 2,400	GW 2013	GW 9/10	Tut 2,500	Nga 3,600
Kiwifruit	1.000	0.988	0.979	0.969	0.956	0.956
Pipfruit	1.000	0.976	0.980	0.942	0.935	0.938
Grapes	1.000	0.996	0.995	0.986	0.984	0.987
Summerfruit	1.000	0.966	0.977	0.938	0.932	0.938
Vegetables	1.000	0.948	0.988	0.901	0.900	0.900

3.4 Breakdown of livestock revenue for Vegetables

Sheep revenue is a significant source of total revenue for the Vegetable model farm of 210 ha effective. This model farm is totally in pasture for sheep from April until July and then a proportion of the farm is in pasture until the end of October. The remainder of the year the land is in crop. The farm type specified for sheep on the Vegetable model farm is the same as the Intensive pastoral model farm. The breakdown of revenue into Inside and Outside the Region is derived from the Intensive pastoral model, which is specified below under the sub-head Specifying livestock purchases and sales, see Table 8.

3.5 Incorporating mitigation activities

Agfirst have estimated the cost of mitigation and maintenance activities required to meet the policy objectives for Horticulture which are identical for both Scenarios 2 and 3. In the cashflow spreadsheets the mitigation activities are assumed to occur over the first year of adoption of the policy followed by a maintenance level for subsequent years.

The specific crop risk assessment, mitigation options and other management factors carried out are as follows:

- Pipfruit, Grapes, Summerfruit and Kiwifruit - Site specific sediment risk assessment carried out. As these are a permanent crops minimal sediment loss is expected
- Vegetables - Site specific sediment loss risk assessment carried out. Vegetable crops have generally moderate / high sediment loss risk. Best practice guidelines used: develop management strategy, potential solutions, sediment traps, grass filter strips etc. with an ongoing sediment loss monitoring program.

Maintenance of Model Farm Ongoing mitigation management is assumed to be zero for all crops except Vegetables where best practice is kept up, maintaining the risk management strategy and monitoring outputs.

For nutrient management Model Farm specific crop risk assessment, mitigation options and other management factors are implemented as follows:

- Pipfruit, Grapes, Summerfruit and Kiwifruit - Site specific nutrient risk assessment carried out. Low expected loss due to low levels of applied nutrients. There is the potential for follow up monitoring of drainage water in "at risk" blocks
- Vegetables - site and crop specific nutrient risk assessment (include winter grazing) carried out. Application and loss varies. Management planning based on best practice guidelines. Potential

mitigation includes grass or riparian buffer strips, fertiliser application technique and product choices. There is potential for monitoring drainage water in "at risk" blocks.

For all crops nutrient maintenance requires best practice nutrient management guidelines to be carried out with fertiliser application based around plant and soil testing. Vegetable also require ongoing drainage water monitoring.

For water shading/riparian planting Model Farm Specific Crop risk assessment, mitigation options and other management factors are implemented

- Pipfruit, Grapes, Summerfruit and Kiwifruit - site assessment needed based on meters of water way edge, type and shade optimisation. A strategy develop based on evaluation of needs and best fit options.
- Vegetables - site assessed with need based on meters of water way edge, type and shade optimisation. A strategy developed based on evaluation of needs and best fit options including fencing where there is winter grazing.

Maintenance of ongoing water shading management centres mainly around weeding riparian strips.

Table 6 Horticulture mitigation and maintenance costs $/ha

below shows the estimated costs per hectare for each crop and each activity.

Table 6 Horticulture mitigation and maintenance costs $/ha

	Kiwifruit	Pipfruit	Grapes	Summerfruit	Vegetables
Mitigation					
Sediment	9	5	3	6	123
Nutrients	273	75	69	111	73
Water Shading / Riparian Planting	565	253	147	312	219
Total	847	333	220	429	415
Maintenance					
Sediment	-	-	-	-	41
Nutrients	182	75	56	83	78
Water Shading / Riparian Planting	169	76	44	94	59
Total	351	151	100	177	177

Source: Agfirst

4. Developing the detailed Pastoral budgets

As with Horticulture, to set up the cashflows ready to estimate the indirect and induced effects of the policy options the Pastoral budgets provided by Agfirst need to be fleshed out in more detail. However, in the case of the pastoral sector detailed budgets were provided for all farm types and mitigation scenarios. Additional areas are as follows:

- Specifying the source and destination of livestock purchases and sales as inside and outside the Hawke's Bay Region
- Irrigated land on pastoral farms
- Translating model farm budgets into TANK totals and phasing in mitigations over 10 years
- Compliance monitoring and verification
- Modifying the forestry model to confirm with other components of the pastoral cashflows

4.1 Specifying source and destination of livestock purchases and sales

Agfirst provided detailed budgets for five farm types for Scenarios 1, 2 and 3 with a breakdown of livestock Revenue as Sales – Purchases as shown in Table 7.

Table 7 Agfirst Budget: Livestock Sales - Purchases

Forecast Profit and Loss for TANK Intensive				
			$ Total	$/ha
Revenue	Sheep	Sales - Purchases	328,536	727
		Wool	46,544	103
		Capital Value Change	0	-
		Total	375,080	830
	Beef	Sales - Purchases	318,395	704
		Total	318,395	704

Source: Agfirst

In order to assess the regional indirect and induced effects of the policy changes these high level figures need to be disaggregated to show the destination of sales and source of purchases as to whether they are Inside or Outside the Hawke's Bay Region. Agfirst estimated the proportion of livestock sales and purchases Inside Hawke's Bay as shown in Table 8. An example of the resulting detailed breakdown of livestock sales and purchases either Inside or Outside the region is shown in Table 9.

Table 8 Proportion of Livestock sales and purchases Inside Hawke's Bay by stock type

Livestock		Inside HB
Sales	Store sheep	100%
	Works ewes	88%
	Wks lbs+hgts	88%
	Store cattle	100%
	Prime beef	55%
	Cow beef	25%
	Bull beef	30%
	Bobby calves	100%
Purchases	Bulls	20%
	Steers	60%
	Br bulls	66%
	Rams	33%
	Lambs	66%
	Br ewes	70%

Source: Agfirst

Table 9 Example of detailed breakdown of Livestock Sales and Purchases

				Pastoral: Base				
Average Per ha			**Farm Expenditure**	**Summer moist**	**Summer dry**	**Intensive**	**Part-time**	**Dairy**
Total Effective ha				45,938	48,043	27,572	8,342	4,800
No Ban %		*79%*						
Nga2400 %		*21%*						
Revenue	Produce sales		Export fresh	-	-	-	-	-
			Local	-	-	-	-	-
			Process	-	-	-	-	
	Livestock sales		Live sheep 100% Inside HB	163	96	2	48	-
			Works sheep Inside HB	343	290	1,740	681	-
			Works sheep Outside HB	47	40	237	93	-
			Total Sh Rev	552	426	1,979	822	-
			Live cattle 100% inside HB	43	43	-	890	101
			Works cattle Inside HB	144	277	543	-	146
			Works cattle Outside HB	154	261	999	-	311
			Total C Rev	341	581	1,542	890	559
	Less Livestock Purchases		Sheep Inside HB	5	4	827	235	-
			Sheep Outside HB	11	8	418	112	-
			Total Sh pur	16	12	1,245	347	-
			Cattle Inside HB	75	188	265	53	45
			Cattle Outside HB	48	124	572	212	23
			All C pur	123	311	837	265	68

4.2 Irrigated land on pastoral farms

Approximately 4,700 ha of pasture is currently irrigated. Of this, about half is irrigated from stored (dam) water. This water will not be affected by low flow restrictions as it is reliant on high flows. The stored water means a different security of supply applies to these takes with the security of supply enabled for any one dam addressed through a resource consent. The triggers and limits for taking water at times of high

flow are a different consideration and beyond the scope of this exercise, which is looking at impacts of minimum flow restrictions.

The representative farms for summer moist/dry/intensive have on average 32ha of irrigated pasture. AgFirst estimate that, on average, if pasture irrigation is restricted during Jan/March this would have a 0.7% impact on Gross Farm Income. If there is a total ban Mid Nov to March the impact would be 2.4% of GFI. Given this small impact, irrigation restrictions on pastoral farms are not modelled, however, supporting data and general analysis of impacts are included in Agfirst reporting.

4.3 Phasing mitigations over ten years

Phasing the introduction of the policy mitigations over ten years is accomplished by taking the costs per hectare, multiplying these by the total effective area for each farm type and then dividing the resulting number by 10 and applying in the cashflows annually over ten years. The per hectare expenditure by pastoral farm type for the four types of mitigation: Stream and sediment mitigation fencing; Water reticulation; Riparian and non-production forestry establishment; and Additional pole planting are shown in Table 10.

Table 10 Expenditure ($/ha) by mitigation by Pastoral farm type for MS1 and MS2

	Pastoral: MS1				
Farm Expenditure	**Summer moist**	**Summer dry**	**Intensive**	**Part-time**	**Dairy**
Stream and sediment mitigation fencing	4	4	18	10	4
Water reticulation	1	1	6	2	1
Riparian and non-production forestry establishment	3	3	14	8	2
Additional pole planting	3	4	-	3	2
Total mitigation expenses	**11**	**12**	**38**	**23**	**9**

Source: Agfirst

The mitigations in Table 10 apply to both MS1 and MS2 for Scenarios 2 and 3. In addition, for Scenario 3, fertiliser policies in MS2 budgets are optimised to reduce nutrient inflow into waterways by 10%. Table 11 shows the change in fertiliser expenditure by Pastoral farm type in moving from MS1 to MS2. This applies for fertiliser excluding nitrogen and lime to Summer moist (a reduction of $40/ha), Summer dry (a reduction of $12/ha) and Intensive (a reduction of $15/ha). In addition, there is a reduction in nitrogen use on Intensive farms of $15/ha. Fertiliser policies do not change on Part time and Dairy farms.

4.4 Compliance, monitoring and verification

It is expected that pastoral farmers will be required to prepare and action a Farm Environmental Management Plan (FEMP). The assumption is made that FEMPs would be prepared on the same time scale as implementation of mitigation i.e. a 10-year phase in period. This timing would ensure there are enough rural professionals to assist farmers prepare their plans (approximately 37 initial plans per year). Once the Council has approved each FEMP then farmers would get on with the changes in the approved plan. Based on 369 farmers at $3,500/farm to prepare the initial plan the cost would be $1.3 million, spread over 10 years. Added to this is a three-yearly update at a cost of $1,500/farm, budgeted as an annual costs of $500/farm. On Intensive farms an extra $500/year/farm is allowed for nutrient budgeting. For dairy farms it is assumed that Fonterra will pick up the annual costs of FEMPs and the annual cost of nutrient budgeting. Taken together the PV of monitoring and verification for pastoral farmers is a total of $2.4 million (at 8%

discount rate) over the 30 years of the project life. This adds 0.2% to the PV of pastoral farm expenditure. The PV of the costs picked up by Fonterra is $90,000 (at 8% discount rate).

Table 11 Optimising fertiliser policies in MS2 ($/ha)

	Pastoral				
	Summer moist	**Summer dry**	**Intensive**	**Part-time**	**Dairy**
MS1					
Fertiliser (Excl. N & Lime)	94	70	101	87	200
Nitrogen	9	7	70	26	180
Lime	9	7	12	9	-
MS2					
Fertiliser (Excl. N & Lime)	54	58	86	87	200
Nitrogen	9	7	55	26	180
Lime	9	7	12	9	-
Reduction in fertiliser MS1 to MS2					
Fertiliser (Excl. N & Lime)	40	12	15	-	-
Nitrogen	-	-	15	-	-
Lime	-	-	-	-	-

Source: Agfirst

4.5 Forestry

4.5.1 Wood Production

The expenditure and revenue of land use change from pasture to production forestry are handled separately from other mitigation activities in the cashflows. A total of 5,099 hectares is assumed to be converted from pasture to production forestry equally over ten years. This translates to approximately 1.4 hectares per year per pastoral farm over ten years with a total of 14 hectares per farm at the regional level. The area planted varies by farm type and at an individual property level there will be an even greater variation, which is not modelled in this analysis.

Wood production expenditure and revenue per hectares have been provided by Agfirst as shown in Table 12 and Table 13.

Table 12 Forest establishment expenditure ($/ha)

Project years				0	1	5	6	7	8
Year beginning 1 July				2021	2022	2026	2027	2028	2029
			Total						
Costs/ha	No.	$							
Seedlings	900		360		360				
Spot spraying			244		244				
Hand planting			311		311				
Fencing (m@$/m)	50	15	750		750				
Site maintenance ($/ha/yr)		100	300			100	100	-	100
Pruning			1,940			600	540	-	800
Thining (stems/ha)	350	1	800			450	-	-	350
Insurance (Fire, Stat & Public Liability)			290	5	5	5	5	5	10
Total costs			35,897	5	1,670	1,155	645	5	1,260

Source: Agfirst

Table 13 forest harvest expenditure and revenue ($/ha)

Project years				27	28
Year beginning 1 July				2048	2049
			Total		
Costs/ha	No.	$			
Road Project management ($/t/yr)		2	1,140	1,140	-
Forest roading ($/tonne removed)		2	1,140	1,140	-
Harvest Project management ($/t/yr)		2	1,140		1,140
Skid site construction/ha		100	100		100
Harvest (avg $/tonne)		26	14,820		14,820
Log loading (avg /tonne)		2.5	1,425		1,425
Transport (Logs km, $/km/t0	75	0.22	7,838		7,838
Transport (Chip km $/km/t)	110	0.22	2,299		2,299
Insurance (Fire, Stat & Public Liability)			290	15	
Site clean up for replant		1000	1,000		1,000
Total costs			35,897	2,295	28,622
Revenue (t/ha, $/t)			-		
Pruned log	207	170	35,190		35,190
Sawlog	268	110	29,480		29,480
Chipwood	95	45	4,275		4,275
	570		-		
Total wood revenue			68,945		68,945
Net cashflow from wood			33,049	(2,295)	40,324

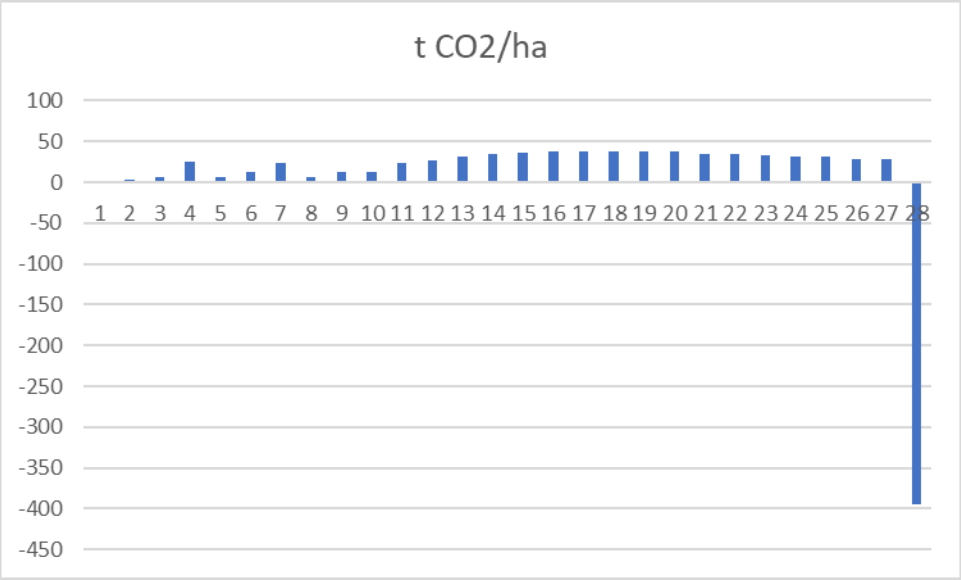
Source: Agfirst

4.5.2 Carbon

Carbon credits are claimed throughout the 28 year rotation at an assumed value of $20/t CO_2 with a proportion paid back at harvest using the same value. The data for this analysis is provided by Agfirst and sourced from Massey University. Figure 1 below shows the annual increment of CO_2 t/ha over the 28 years of the rotation. Note that in the early years of the rotation, CO2 laid down varies as pruning and thinning removes actively growing wood. A total of 665 t CO_2 is accumulated over the rotation of which 394 t must be paid back at harvest leaving a net 271 t, which at $20/t is $5,420/ha accumulated over 27 years.

It is important that the actual tonnes of CO_2 that have to be paid back are banked along the way to offset the risk that the payback price is higher than the price received over the rotation. If this is done on a proportionate basis then only 41% of the annual carbon should be cashed in leaving the other 59% banked in tonnes of CO_2 to pay back at harvest. At an 8% discount rate cashing only 41% of the carbon credits each year reduces the PV of carbon from $4,098/ha over 28 years (and the risk that the price will be higher when paying back at the end) to $1,680/ha, which is 52% and with the benefit of no risk from price change. At 2% discount rate cashing 41% each year results in 77% of the PV and at 6% discount rate it is 57%.

Figure 1 Annual increment of carbon over the rotation in t CO_2/ha



5. Implementation

How the policy changes are implemented has a major influence on outcomes. If land managers are given reasonable time to implement the changes there is likely to be a high degree of adoption and thus less resources will need to be expended on compliance, monitoring and verification.

In this analysis Horticulture and Pastoral farming are treated differently according to the specific characteristics of each sector and the nature of the changes that need to be implemented.

For Horticulture, three implementation starting years are analysed for Scenarios 2 (Future B) and 3 (Future C). These are referred to as Fast - starting in year 3, Medium - starting in year 5 and Slow - starting in year 8, see Table 14. The change from Base, the current situation, to Future B or Future C takes place in one year and this is followed by ongoing maintenance in the new situation. The one year change over reflects the change in water allocation arrangements with an intermediate position (Scenario 2) and full adoption (Scenario 3) to achieve the policy goal. Scenario 1, the Base is unchanged over the 30 years of the project life.

Implementation of the Pastoral policy involves farmers making changes to management that involve significant fencing of streams, retiring vulnerable land and planting for stream protection, production forestry and land retirement. On some farms this will involve significant outlay and time to achieve. Given this, Scenarios 2 (MS1) and 3 (MS3) including forestry are implemented in equal steps over ten years starting from year 1. In the cashflows forest harvesting starts in year 28, this means that there is a run over to year 37 in order to include the harvesting of forests planted in year 10. Due to discounting the revenue from this period has only a marginal affect on the overall results of the analysis, effectively reducing the cost of change relative to Horticulture, where the cashflows are truncated in year 30.

Table 14 TANK Implementation profiles

TANK economic modelling: Implementation profiles																
Year ending 30 June		1 Jul'21	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2048	2049	2051
Year		0	1	2	3	4	5	6	7	8	9	10	11	27	28	30
Horticulture																
Scenario 1. Base																
		Base	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Scenarios 2 (Future B) and 3 (Future C)																
Crop Mitigations (Sediment, nutrients and water shading/riparian planting																
	Fast	B	B	B	1	M	M	M	M	M	M	M	M	M	M	M
	Medium	B	B	B	B	B	1	M	M	M	M	M	M	M	M	M
	Slow	B	B	B	B	B	B	B	B	1	M	M	M	M	M	M
Pastoral																
Scenario 1. Base																
		Base	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Scenarios 2 (MS1) and 3 (MS2)																
Pasture mitigations (stream and sediment mitigation fencing, water reticulation, riparian and non-production forestry establishment, additional pole planting)																
		B	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	M	M	M	M
Production Forestry																
Scenarios 2 (MS1) and 3 (MS2)																
Establishment		B	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10				
Harvest															0.1	0.1

6. Results

6.1 Horticulture

At the default discount rate of 8% the Present Value (PV) of the Base for Horticulture the total Revenue cashflow is $7,585.8 million. Expenses amount to $5,478.3 million leaving a net revenue of $2,107.5 million (see Table 15). Revenue is down by 2% and 5% for Future B and Future C respectively with Expenditure up 1% in both cases leaving Net Revenue down by 9% and 18% respectively.

Table 15 Present Value ($m) of high level results for Horticulture

Discount rate 8%	Sc 1 Base	Sc 2 Future B	Sc 3 Future C
Revenue	7,585.8	7,431.3	7,242.6
% change to base		**-2%**	**-5%**
Expenditure	5,478.3	5,504.8	5,504.8
% change to base		**1%**	**1%**
Net Revenue	2,107.5	1,926.5	1,737.8
% change to base		**-9%**	**-18%**

Allowing farmers more time before the policy is implemented has a significant effect in reducing the cost. Compared to a Fast start in year 3, a start in year 5 Net Revenue is improved by 2% for Future B and improved by 3% for Future C. Pushing the start date out to year 8, compared to a start in year 3, Net Revenue is improved by 3% and 8% respectively (see Table 16).

Table 16 Horticulture PV ($m) sensitivity to starting date

Discount rate 8%	Sc 1 Base	Sc 2 Future B	Sc 3 Future C
Net Revenue			
Medium start - year 5	2,107.5	1,955.6	1,797.4
% change cf fast		**2%**	**3%**
% change cf Base		**-7%**	**-15%**
Slow start - year 8	2,107.5	1,991.8	1,871.3
% change cf fast		**3%**	**8%**
% change cf Base		**-5%**	**-11%**

Whereas the Net Revenue for Fast start Future B was 9% less than Base, with the Medium start it is 7% less and 5% less for a Slow start. The comparable figures for Future C are 18%, 15% and 11% less than base.

6.2. Pastoral

At the default discount rate of 8% the Present Value (PV) of the Base for Pastoral total Revenue cashflow is $1,840.0 million. Expenditure amounts to $1,366.5 million leaving a net revenue of $473.5 million (see Table 17). For MS1 and MS2 Revenue decreases as does Expenditure leaving at Net Revenue at $452.5 million for MS1 and $437.4 million for MS2, down 4% and 8% respectively. Forestry adds a net $6.6 million so that the overall change to Net Revenue is negative 3% and negative 6% respectively at $459.1 million and $444.0 million.

Table 17 PV ($m) of high level results for Pastoral

	Sc 1	**Sc 2**	**Sc 3**
Discount rate 8%	Base	MS1	MS2
Pastoral: start yr 1, 10 yr spread			
Revenue	1,840.0	1,809.2	1,776.2
Total Expenditure	1,366.5	1,356.7	1,338.9
Net Revenue	473.5	452.5	437.4
NR % change to Base		-4%	-8%
Forestry: start yr 1, 10yr spread			
Wood Revenue	-	11.3	11.3
Carbon Revenue	-	13.2	13.2
Total Forestry Revenue	-	24.6	24.6
Expenditure	-	17.9	17.9
Net Revenue	-	6.6	6.6
TANK Net Cashflow	473.5	459.1	444.0
% change to Base		**-3%**	**-6%**

6.3 Combined

When Horticulture and Pastoral including Forestry cashflows are combined the PV of the Net Cashflow for the whole TANK is down 8% for Scenario 2 and down 15% for Scenario 3 compared with Scenario 1 (see Table 18).

Table 18 PV ($m) of the combined Horticulture and Pastoral cashflows

	Sc1	Sc 2	Sc 3
Discount rate 8%			
Fast start: Horticulture yr 3 + Pastoral yr 1, 10 yr spread			
Revenue	9,425.8	9,240.5	9,018.8
Total Expenditure	6,844.8	6,861.5	6,843.7
Net Revenue	2,581.0	2,379.0	2,175.2
% change to Base	-	**-8%**	**-16%**
Forestry 10yr spread			
Net Revenue	-	6.6	6.6
TANK Net Cashflow	2,581.0	2,385.6	2,181.8
% change to Base	-	**-8%**	**-15%**

6.4 Sensitivity to Discount rate

Changing the discount rate affects the magnitude of Present Values ($m) significantly (see Table 19), however, relativities between Net Revenue PVs ($m) change very little for mitigation scenarios (Sc2 and Sc3) compared to Base (Sc1), see Table 20. The exception is forestry where the NPV is $105.1m at 2%, $13.7 m at 6% and $6.6m at 8%. The reason for this is the long wait before revenue is generated under forestry – 28 years for wood. The higher the discount rate the lower the weighting on future cashflows.

Table 19 Net Revenue PVs ($m) under different discount rate assumptions

Discount rate	2%	6%	8%
NR Hort yr 3 Sc1	4,192.6	2,576.8	2,107.5
Sc2	3,804.4	2,349.4	1,926.5
Sc3	3,397.1	2,111.8	1,737.8
NR Past + For Sc1	942.0	578.9	473.5
Sc2	907.2	554.6	452.5
Sc3	977.6	548.8	444.0
NR Combined Sc1	5,134.6	3,155.7	2,580.9
Sc2	4,816.6	2,917.6	2,385.6
Sc3	4,374.6	2,660.6	2,181.8

Table 20 relative Net Revenue (%) for Sc 2 and 3 compared with Sc 1 under different discount rates

Discount rate	2%		6%		8%	
Scenario	Sc2	Sc3	Sc2	Sc3	Sc2	Sc3
Horticulture start yr 3 (fast start)	-9%	-19%	-9%	-18%	-9%	-18%
Pasture + forestry	-4%	4%	-4%	-5%	-4%	-6%
Combined	-6%	-15%	-8%	-16%	-8%	-15%

6.4 Benefit Cost Ratios

Overall the Benefit Cost Ratios vary little between scenarios, although as expected from the PVs Scenario 1 is always higher than the mitigation scenarios (see Table 21). The difference is greater for Horticulture compared with Pastoral with 0.03 compared with 0.02 in moving from Scenario 1 to Scenario 2. In moving from Scenario 1 to Scenario 3 Horticulture compared with Pastoral the change is 0.06 and 0.02. Given that Horticulture mitigation cost in total across the TANK is significantly greater than that faced by Pastoral farmers the difference between Scenarios 2 and 3 compared with Scenario 1 is closer to Horticulture than pastoral at 0.03 and 0.06.

Table 21 Benefit Cost ratios at 8% discount rate

Scenario	Sc1	Sc2	Sc3
Horticulture start yr 3 (fast start)	1.38	1.35	1.32
Pasture + forestry	1.35	1.33	1.33
Combined	1.38	1.35	1.32

6.5 Discussion

The EAWG noted that the economic analysis does not factor in behavioural change. When farmers are confronted with the implications of policy change it is likely they will adapt their management to the new environment. Thus, the economic consequences set out here are likely to be more negative than the actual outcome. Where a farmer is unable to adapt it is likely they will sell out and the new managers of the resources will take the new operating environment into account in the purchase price. If profitability is reduced, the value of the asset is reduced with the buy/sell price lower than before the policy change. The outgoing farmer will receive less for the property than before the policy change. These considerations are not taken into account in the analysis. Over the long term the return on capital from pastoral farming have remained relatively stable at around 3%. When returns rise so does the price farmers pay for farmland and vice versa when returns fall thus maintaining the long run return on capital.

The analysis does provide a set of baseline financials for individual farmers to assess their own situation and act as a catalyst for change. More importantly it provides a consistent base of financial information that policy makers and the public can weigh up the economic costs to achieve environmental improvement.

The analysis shows that reducing water allocation by the amounts assumed in Scenarios 2 and 3 have a far larger negative economic impact than the costs of reducing sediment and nutrient inflows into water ways. As mitigation is expected to be more cost effective than reducing water allocation this should be the area of initial focus for change.

Recent flood events in other parts of New Zealand e.g. Tasman District have shown the vulnerability of land to major damage from forest slash ending up in water ways during the five year period from harvest until the new forest is established. There will need to be increased efforts to ensure a change in land use from pasture to production forestry does not result in increased sediment and forest slash getting into water ways during high rainfall events.

The size of the difference between Scenario 1 and Scenarios 2 and 3 provide an indication of the quantum that is available to introduce adaptive policies such as augmentation. If the cost of augmentation is less than the difference in net benefit between options then augmentation becomes an option worth considering.

Vineyards on Gimblett gravels are potentially the biggest losers from the policy changes that are modelled. The alternative land use if irrigation water on these stony soils is insufficient to meet the needs of grapes is dry stock farming or perhaps life style blocks. Either way, the infrastructure on these properties would be redundant and a liability to new owners who would most likely heavily discount the land value in grapes with a major capital loss to the outgoing owners.

Hawke's Bay is heavily reliant on primary production and the analysis of indirect and induced economic effects will highlight the even greater negative impacts beyond the agriculture sector to the rest of the business community and to households.

7. Limitations and caveats

All models are simplifications of reality. In this case the models provide a static analysis and thus do not allow for dynamic adjustment which is likely as land mangers assess their options to remain viable in the new operating environment.

The past may not be a good guide to future uncertain outcomes. Changes to many factors are likely to affect the actual economic outcomes including the international supply demand for the primary products produced in the TANK catchments through changes to global politics, trade agreements and the like.

We assume technology change over time will affect all options similarly and is ignored. Technology change is speeding up over time especially information technology which appears to be changing the operating environment at an exponential rate. Farmers are major users of technology and we can expect that the way farms are operated in the future will be quite different to that of today, but the form this will take is not known.

The possibility of climate change over the next 30 years has not been explicitly modelled. The evidence that climate is changing is expressed through significant increases in disaster events such as floods and droughts. More long term effects such as temperature and sea level rising are more likely to impact significantly on the TANK beyond the next 30 years.

The results are relevant at the regional level and not to individual farm outcomes. There is a natural tendency for individual farmers to relate the outcomes of this analysis to their own specific situation and to see that it does not relate. This is because the regional impacts are based on averages and representative model farms, which are unlikely to match the specific situation of any individual farmer.

8. Next steps

While initial feedback has been provided on the direct economic analysis of the 3 scenarios by the Council and the EAWG the wider TANK consultative group has yet to see them.

Once the EAWG has seen the results of the analysis of indirect and induced effects there may be an opportunity to revisit the modelling of direct effects before presenting to the wider TANK consultative group.

If additional modelling is assessed as needed through an additional scenario, then the following steps are needed: Specify the policy option; Agree on assumptions; Construct model and present; and Market Economics to assess indirect and induced effects.

References

Archer, Leander and Jonathan Brookes 2018. Modelling water restrictions and nutrient losses for Horticulture in the TANK catchment – an economic analysis. Agfirst, 16 March 2018

Bell BA and Cudby C., 2010. Economic analysis of options to clean up the Waikato River. A NIWA led project reporting to MfE and the Guardians Establishment Committee.

Bell, BA 2011. Land use change economics. Contribution to a Beca led project "Intervention packages for Lake Rotorua", prepared by Beca in association with NIWA, Nimmo-Bell, AgResearch, GNS Science and Market Economics

Bell, BA, B Brook, G McDonald, D Fairgray and N Smith 2013. Cost Benefit and Economic Impact Analysis of the Horizons One Plan. A report prepared for DairyNZ and Horizons Regional Council, by Nimmo-Bell and Market Economics 31, October 2013

Bell, BA, G McDonald, D Fairgray and C Muller 2014. Cost Benefit and Economic Impact Analysis for the Dairy Sector and Region of Environment Canterbury's Variation 1 Selwyn Te Waihora, A report prepared by Nimmo-Bell, Market Economics and DairyNZ for DairyNZ, September 2014.

HBRC 2016a. Greater Heretaunga and Ahuriri land and water management collaborative stakeholder (TANK) group, Meeting 25: 13 December 2016

HBRC 2016b. TANK modelled catchments: landuse, soil, slope, VCN analysis. 14 December 2016

HBRC 2017. Tutaekuri River and Ngaruroro River reliability of supply for irrigation .ppt presentation TANK Meeting 2 November 2017

Lochie MacGillvray 2017. Part 2 of the TANK catchment Economic, Social and Ecological Impact Assessment: Water management and land management policy options. Agfirst 2nd Interim Report for the Hawkes Bay Regional Council, 14 November 2017

Smith Jeff, Mary-Anne Baker, Rob Waldron and Thomas Wilding 2018. Discussion document and options, Part 1 Lowland stream flow enhancement scheme – further policy development; Part 2 High flow allocation regime – policy and rules; Part 3 River flow management regimes and water abstraction. Report for meeting 38 of the TANK group, 22 March 2018

Thomas, A, BA Bell, A McRae and R Britton 2004. A sustainable environmental land management system for Lake Taupo. A report prepared by Nimmo-Bell for Taupo Lake Care, funded by the Sustainable Farming Fund, December 2004.

Appendix 1 More detail on sensitivity to discount rate

Table 22 Horticulture Fast start, Scenario 1 Base at 3 discount rates (PV $m)

	Scenario 1. Base		
Discount rate	2%	6%	8%
Fast start: Horticulture yr 3			
Revenue	15,091.3	9,275.1	7,585.8
Expenditure			
Post harvest	3,808.2	2,340.5	1,914.2
Labour	3,864.6	2,375.2	1,942.6
Working Expenses	2,424.4	1,490.0	1,218.6
Overhead Expenses	377.4	232.0	189.7
Mitigation Expences	-	-	-
Depreciation	424.1	260.6	213.2
Total Expenditure	10,898.7	6,698.3	5,478.3
Net Revenue	4,192.6	2,576.8	2,107.5

Table 23 Horticulture Fast start, Scenario 2 Future B at 3 discount rates (PV $m)

	Sc 2. Future B Fast		
Discount rate	2%	6%	8%
Fast start: Horticulture yr 3			
Revenue	14,757.7	9,080.5	7,431.3
Expenditure			
Post harvest	3,808.2	2,340.5	1,914.2
Labour	3,864.6	2,375.2	1,942.6
Working Expenses	2,424.4	1,490.0	1,218.6
Overhead Expenses	377.4	232.0	189.7
Mitigation Expences	54.6	32.8	26.5
Depreciation	424.1	260.6	213.2
Total Expenditure	10,953.3	6,731.1	5,504.8
Net Revenue	3,804.4	2,349.4	1,926.5

Table 24 Horticulture Fast start, Scenario 3 Future C at 3 discount rates (PV $m)

	Sc 3. Future C Fast		
Discount rate	2%	6%	8%
Fast start: Horticulture yr 3			
Revenue	14,350.4	8,842.9	7,242.6
Expenditure			
Post harvest	3,808.2	2,340.5	1,914.2
Labour	3,864.6	2,375.2	1,942.6
Working Expenses	2,424.4	1,490.0	1,218.6
Overhead Expenses	377.4	232.0	189.7
Mitigation Expences	54.6	32.8	26.5
Depreciation	424.1	260.6	213.2
Total Expenditure	10,953.3	6,731.1	5,504.8
Net Revenue	3,397.1	2,111.8	1,737.8

Table 25 Pastoral, Scenario 1 Base at 3 discount rates (PV $m)

	Scenario 1. Base		
Discount rate	2%	6%	8%
Pastoral: start yr 1, 10 yr spread			
Revenue	3,660.5	2,249.7	1,840.0
Expenditure			
Post harvest	-	-	-
Labour	728.0	447.4	365.9
Working Expenses	1,611.8	990.6	810.2
Overhead Expenses	253.7	155.9	127.5
Mitigation Expences	-	-	-
Depreciation	125.1	76.9	62.9
Total Expenditure	2,718.5	1,670.8	1,366.5
Net Revenue	942.0	578.9	473.5
Forestry: start yr 1, 10yr spread			
Wood Revenue	-	-	-
Carbon Revenue	-	-	-
Total Forestry Revenue	-	-	-
Expenditure	-	-	-
Net Revenue	-	-	-
TANK Net Cashflow	942.0	578.9	473.5

Table 26 Pastoral including Forestry, Scenario 2 MS1 at 3 discount rates (PV $m)

	Sc 2. MS1		
Discount rate	2%	6%	8%
Pastoral: start yr 1, 10 yr spread			
Revenue	3,588.9	2,210.0	1,809.2
Expenditure			
Post harvest	-	-	-
Labour	722.2	444.2	363.5
Working Expenses	1,564.4	964.3	789.8
Overhead Expenses	252.8	155.4	127.1
Mitigation Expences	19.9	16.3	14.9
Depreciation	122.3	75.2	61.5
Total Expenditure	2,681.7	1,655.4	1,356.7
Net Revenue	907.2	554.6	452.5
Forestry: start yr 1, 10yr spread			
Wood Revenue	185.0	19.5	11.3
Carbon Revenue	23.6	17.9	13.2
Total Forestry Revenue	208.6	37.4	24.6
Expenditure	103.5	23.7	17.9
Net Revenue	105.1	13.7	6.6
TANK Net Cashflow	1,012.2	568.3	459.1

Table 27 Pastoral including Forestry, Scenario 3 MS2 at 3 discount rates (PV $m)

	Sc 3. MS2		
Discount rate	2%	6%	8%
Pastoral: start yr 1, 10 yr spread			
Revenue	3,512.0	2,167.3	1,776.2
Expenditure			
Post harvest	-	-	-
Labour	722.2	444.2	363.5
Working Expenses	1,519.0	939.2	770.4
Overhead Expenses	253.0	155.5	127.2
Mitigation Expences	19.9	16.3	14.9
Depreciation	125.3	77.0	63.0
Total Expenditure	2,639.5	1,632.2	1,338.9
Net Revenue	872.5	535.1	437.4
Forestry: start yr 1, 10yr spread			
Wood Revenue	185.0	19.5	11.3
Carbon Revenue	23.6	17.9	13.2
Total Forestry Revenue	208.6	37.4	24.6
Expenditure	103.5	23.7	17.9
Net Revenue	105.1	13.7	6.6
TANK Net Cashflow	977.6	548.8	444.0