

Local Government New Zealand  
Regional Sector Water Subgroup

# Initial Economic Advisory Report on the Essential Freshwater Package

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**Cover photo:** Looking westwards to Otautau with the Aparima River in the foreground.

**Source:** Emma Moran

### **Acknowledgements**

This report has been compiled with the help and support of many people from different regions. Our thanks must go to Nicky Smith (Market Economics), Sandra Barns, Nicola Green and Santiago Bermeo (all from Bay of Plenty Regional Council), Femi Olubode and Mike Scarsbrook (both from Waikato Regional Council), Christina Robb (Happen Consulting Ltd.), Clare Wooding (LGNZ), Karl Erikson, Ewen Rodway, Vicky Collard, and Denise McKay (all from Environment Southland).

Everyone involved has worked hard to supply sufficient and accurate information for inclusion in this report within a very tight timeframe and limited context. Any errors and important omissions in the report should be considered with this in mind.

This report was produced for the LGNZ Regional Sector Water Subgroup by Emma Moran (Environment Southland) and Blair Keenan (Waikato Regional Council).

The purpose of this report was to give initial economic advice on specific draft proposals in the Government's Essential Freshwater Package (working draft – as it was at 21 June 2019) to inform discussions between the Regional Sector and the Ministry for the Environment. The Ministry for the Environment has refined the Package since this date but the specific proposals considered here have remained largely unchanged. Consequently, this report's findings are broadly applicable to the final proposals in the Essential Freshwater Package as released on 5 September for public consultation. The initial economic advice is currently being developed further to develop local government's understanding and inform their submissions.

For clarity, this report is not intended to be a policy document.

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## Executive Summary

The Essential Freshwater Package aims to do more to protect and restore the ecosystem health of waterbodies, and to do it more quickly, than is currently occurring. If successful then it is reasonable to expect that these reforms will avoid some of the longer term costs from the effects of human activities on fresh water, particularly with the impending threat of climate change. It is also reasonable to expect that the reforms will increase the short to medium term financial costs to those activities as they adjust to the new policy direction. The costs and benefits will ultimately flow through to the wellbeing of communities across New Zealand.

The purpose of local government is to meet the current and future needs of local communities, which includes maintaining and restoring healthy ecosystems. This report is an initial assessment of the shorter term financial costs to some regions of specific proposals in the Essential Freshwater Package. Its purpose is to provide a preliminary understanding of these impacts to the Regional Sector. The report focuses on the following draft proposals:

- A National Environmental Standard for Freshwater Management (NESFM) and section 360 regulations, including farm environment plans, stock exclusion, and a cap on nitrogen loss for some water bodies; and
- The inclusion of attribute tables in the National Policy Statement for Freshwater Management for Dissolved Inorganic Nitrogen (DIN) and Dissolved Reactive Phosphorus (DRP), especially in relation to national bottom lines for nutrients in rivers.

These elements were identified by the Regional Sector Water Subgroup (RSWS) as priorities. Analysis of other proposals may be included in the next phase. While the DIN and DRP proposal should also apply to urban activities, they are not considered in this report because it has been prepared ahead of pending changes to wastewater and stormwater management as a result of the Three Waters Review. A more complete economic evaluation is planned for the coming months. This work sits alongside other work considering the implications for regional councils of implementing the Essential Freshwater Package.

The basic approach taken here to assess the shorter term financial costs at a regional scale is to consider two basic questions:

1. What are the costs of changing the current direction of New Zealand's freshwater management policy?
2. What are the costs of changing the current timeframes for New Zealand's freshwater management policy?

There is considerable variation between and within regional New Zealand that will influence the costs of any national direction. This assessment has been delivered within a short timeframe and looks at specific regions but this picture will be quite different in other regions. The authors note that where an economic activity's use of water (either as a water take or to receive pollutants) is not accounted for in its production system, and this use impacts on other values, then all of the community is, in effect, subsidising that activity. This is the case regardless of the economic sector being considered (e.g. agriculture, forestry, manufacturing, tourism, local and central government).

## Main findings

The nature and extent of the full economic impacts of the Essential Freshwater Package (working draft) will depend on how people can and do respond to change. People's incentives are influenced not just by financial considerations but also other factors, including their level of engagement in, and understanding of, an issue. Farms are not only businesses; they are also family homes and, in some cases, have been so for many generations.

With these points in mind, the main findings of this report are:

1. **Proposed DIN and DRP attribute tables** – The use of national averages, without recognising the inherent complexity of natural systems, will likely impose unnecessary, and potentially very large, financial costs in many locations. Regulations based on these averages are likely to fail the cost-effectiveness and efficiency tests for policy because statistical evidence indicates nutrients only explain a small amount of the variation in ecological health of water bodies. When implemented, the financial costs may be significant in some localities, but the costs will depend on the targets that are set (i.e. limits and timeframes) and the spatial scale of any management approach. In other cases the costs will be more muted at a regional or national scale.
2. **Waikato case study Scenario 1 (no land use change)** – The DIN and DRP proposals were tested for the Waikato-Waipā catchment (pre-Plan Change 1) because of their particular relevance to soft-bottomed rivers and streams. There was also a pre-existing economic model developed for the Healthy Rivers/Wai Ora Plan Change 1 process. The impacts from these proposals can also be expected in many other catchments where soft-bottom streams are prevalent, such as the Bay of Plenty and Northland. The modelling for the Waikato-Waipā catchment was designed to find the “least cost” solution (i.e. a set of possible actions that fit the policy) but initial work, with land use held as fixed, showed the scenario may not have a feasible solution. Further analysis of this finding is recommended.
3. **Waikato case study Scenario 2 (with land use change)** – When the economic model allowed land use to change (i.e. it was not fixed), a least cost solution was found that involved large-scale afforestation. In the model's solution, drystock farming in the catchment contracts markedly, dairy and dairy support also contracts but to a lesser extent, while forestry increases to more than half of the catchment. The shift away from drystock land in this solution occurs because it is less profitable than dairy, so results in a lower opportunity cost when it converts to another land use. The model estimates an annualised cost of the DIN and DRP proposals for the Waikato-Waipā catchments of around \$100 million (or 11% of the total profits from land use each year). In reality, there will be other solutions and their impacts will depend on the allocation method and mitigations available, in addition to the targets and spatial scale for management highlighted above.
4. **Farm environment plans** – The Farm Environment Plan proposal generally aligns with the policy direction of many regions but not all. Their fast-tracking across New Zealand will substantially increase the skilled labour and financial capital needed. This circumstance is particularly relevant in regions where farm environment plans are not currently required such as in most of the Bay of Plenty. Improving the delivery of the farm environment plans required by regional councils will flow through to an uptake by farmers of mitigations and result in behavioural change – i.e. it will do more to improve water quality, more quickly.

5. **Southland case study (farm environment plans)** – A scenario similar to the farm environment plan proposal was modelled for Southland that assumed the region was at the start of the process (i.e. no existing plans). Although there are large gains to service industries, it was estimated that the accumulated change in value added by 2030 for Southland’s economy is around -\$17 million. There are not sufficient farm advisers with the necessary expertise, although investment in training will eventually resolve this labour constraint.
6. **Stock exclusion** – Many regions already have provisions for stock exclusion, or are moving to do so. This proposal may take a different direction from some regions’ current course, where it adds more stringent constraints for lowland areas and also for small streams. The omission of sheep and the risk-based approach for the hill and high country, mean further financial costs may occur at a later date in certain localities to achieve swimmability targets. If new or altered fencing occurs across New Zealand quickly then constraints around skilled labour and materials may inflate existing cost estimates in the short-run. A focus on a minimum setback may prove to be restrictive where larger widths are needed on some stream reaches for various issues (e.g. biodiversity, carbon emissions).
7. **Southland case study (stock exclusion)** – To a large extent, the cost-effectiveness of this proposal depends on how far the 5 metre average minimum setback across a farm encourages flexible solutions. A scenario similar to (but not the same as)<sup>1</sup> the proposal was modelled for the Maitua Freshwater Management Unit (Southland). By 2030, it was estimated that a 5 metre setback will decrease agriculture’s total effective area on lowlands by 1,785 hectares (or less than 1%). The corresponding annual change to value added for the pastoral industries is roughly -\$2 million (\$2015). By increasing a farm’s ineffective area, the setback may also act as a nutrient mitigation for the farm (assuming the remaining effective land is not intensified as a result).
8. **Nitrogen cap** – While this proposal is unlikely to go further than many regions’ current policy course for “highly nitrogen impacted waterbodies”, it may slow progress and shift its direction. The proposal’s complexity may bring with it extra costs, and take a community down a different nitrogen allocation path than they may have otherwise chosen to go<sup>2</sup>. It also risks sending incorrect investment signals about the long term viability of a farming activity, which can ultimately increase costs. The proposal’s intent is to target farms with poor environmental practices and its design targets those land uses that are most intensive (e.g. dairy or dairy support). While some farmers are able to achieve good environmental and financial performance, Southland research for 95 farms shows that the impacts of the proposal are as likely to be felt on the most profitable farms as the least profitable farms.
9. **Southland case study (nitrogen cap)** – The Nitrogen Cap proposal is complex and challenging to model. A range of scenarios were modelled to test various nitrogen caps in the Maitua Freshwater Management Unit (Southland) – some of which partially applied the concept used in the Nitrogen Cap proposal. If the concept was just applied to dairy land then by 2030, it

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<sup>1</sup> For ease of modelling and a lack of clarity at the time about the proposal, this scenario was applied to lowland on all farms (rather than just lowland farms), included sheep, but did not include all small streams. In some ways the results may overestimate the impact of a 5 metre setback and in other ways they may underestimate its impact. The first metre from a stream was not counted as effective area. With more time one or more of these assumptions may be able to be revisited.

<sup>2</sup> This may also be the case for other provisions not considered in this report, such as those relating to hydro-electricity.

was estimated that the annual net change in value added for the dairy industry is around -\$17 million (\$2015) for a 9% reduction in the industry's nitrogen loss. Across these scenarios, it appears that focusing on the higher nutrient loss farms within groups of similar biophysical characteristics is less cost-effective than focusing on farms with higher nutrient losses overall. A more cost-effective alternative could be to require farmers to implement the nitrogen-relevant mitigations in their farm environment plans, which are tailored to their farm.

10. **Farm debt** – Indebtedness in the agricultural sector has been increasing rapidly over recent years, leaving farmers in a more vulnerable position to change at a time when change is happening at a rapid pace. Some farms will have low sustainability across several components (human, social and financial, and environmental). Economic analysis is needed across all agricultural industries (i.e. not just dairy), especially in relation to land values.
11. **Policy connections** – the overall financial costs of the Government's reforms will depend on how the proposals fit together as a coherent process (i.e. as series of sequential and interconnected steps) and within the wider work programme (e.g. water quantity). The in-depth farm environment plans required by regional councils gives both the starting point and the transition path for a farmer's riparian and nitrogen management, as well as reducing the effects of activities identified as high risk. For example, farm environment plans can be used successfully to manage intensive winter grazing. There will also be connections with the nitrogen cap and the DIN proposals.
12. **Regional variability in costs** – The human and financial resources needed to achieve the requirements at a national scale within the timeframes proposed are vast, and there will be considerable variability in their regional distribution. The costs will be felt most in regions with large agricultural or horticultural sectors, regions where there is relatively recent intensification (i.e. higher debt levels), and regions where the reforms represent a significant change in direction from their current course.
13. **Overseer** – The efficiency of a proposal that relies on Overseer is partly driven by the mitigations able to be modelled in Overseer, which will always be a subset of the relevant mitigations available. Beyond reducing excess fertiliser use, there are still limited mitigations in Overseer that make a difference to a farm's nutrient loss without also reducing its profitability. In reality, there are many cost-effective technologies, such as peak flow control structures, but their usefulness in policy can depend on how well they are represented in Overseer (if at all). Where a proposal incentivises the use of a subset of the mitigations available then it is likely to achieve a sub-optimal solution.

There are many past and recent examples relevant to freshwater management of where a Government's policy direction has had unintended but foreseeable consequences (e.g. the loss of undeveloped land of ecological value resulting from the 1950 Marginal Lands Act). Such examples highlight the importance of both understanding and recognising the possible impacts of any new policy direction. The authors strongly recommend that the Government undertake a holistic evaluation across the proposals of the draft Essential Freshwater Package at an industry and regional scale for the Regulatory Impact Statement. The authors also strongly recommend that connections with the wider work programme, particularly with allocation methods and water quantity, are considered within this evaluation.

## Contents

Executive Summary.....	3
Main findings .....	4
1 Introduction .....	9
2 Regional variability in agriculture .....	12
3 Proposal for DIN and DRP attribute tables .....	18
3.1 DIN and DRP bottom-lines – Waikato.....	19
Nutrient attributes.....	19
Modelling - Waikato.....	20
4 Agriculture proposals – The Southland Economic Model.....	24
4.1 The counterfactual scenario .....	24
5 Farm Environment Plans.....	26
5.1 Introduction .....	26
5.2 Modelling – Southland.....	29
6 Stock exclusion.....	32
6.1 Introduction .....	32
6.2 Modelling – Mataura (Southland).....	35
7 On-farm nitrogen cap.....	38
7.1 Introduction .....	38
7.2 Modelling – Mataura (Southland).....	40
The Mataura Freshwater Management Unit .....	41
Southland dairy farms.....	43
Nitrogen Cap scenarios .....	46
7.3 Trends in farm debt .....	50
Appendix 1 RSWs Advice Note – The DIN “bottom line” .....	52
Appendix 2 Farm environment plans.....	56
Appendix 3 Farm nutrient loss and profitability .....	57
Appendix 4 The 75 <sup>th</sup> percentile .....	59
Appendix 5 Agriculture and Forestry Report Key Findings .....	60





# 1 Introduction

The Essential Freshwater Package aims to do more to protect and restore the ecosystem health of waterbodies, and to do it more quickly, than is currently occurring. The draft proposals include investment in at risk catchments, amendments to the National Policy Statement for Freshwater Management, and a package of regulations applying to agriculture (to be delivered via a National Environmental Standard and regulations under s.360 of the RMA). If successful then it is reasonable to expect that these reforms will avoid some of the longer term costs from the effects of human activities on fresh water, particularly with the impending threat of climate change. It is also reasonable to expect that the reforms will increase the shorter term financial costs to those activities. The costs and benefits will flow through to the wellbeing of communities across regional New Zealand.

This report is an initial assessment of the financial costs to the regions of elements of the Essential Freshwater Package. It focuses on draft provisions in the proposed National Environmental Standard for Freshwater Management (NESFM) and the Science and Technical Advisory Group (STAG) proposal for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) attribute tables to protect ecosystem health within the National Objectives Framework<sup>3</sup>. These proposals were identified by the Regional Sector Water Subgroup as priorities on behalf of the Regional Sector. A more complete economic evaluation will occur in the coming months and it sits alongside other work that is considering the implications for regional councils of implementing the Essential Freshwater Package.

The draft provisions are expected to have financial costs for economic activities in rural areas. Farming is a balancing act between inputs and outputs to produce food efficiently and profitably, and fresh water is a vital component across the whole farm production system. Farmers use water as an input in production, for things like stock drinking and irrigation. Water also takes away substances (e.g. nutrients, sediment and microbes) that are created alongside outputs such as meat, crops, and milk. Although less obvious than on the input-side of a production system, the loss of these substances are a 'use' of water and can contribute to declining water quality.

Most farm production systems were not set up on the basis of having to account for these effects, but many farmers now adopt good management practices (e.g. rates and timing of fertiliser applications, alternative harvest techniques, and riparian fencing) to reduce them. These good management practices are one type of a wider set of actions or 'mitigations' available for managing a farm's environmental effects. Fewer farmers go beyond this point because of the impacts of using these mitigations on farm profitability. The existence of environmental issues indicates a basic problem with the structure of the economy – the symptoms may show up first as environmental effects but they are likely to eventually affect the economy as well.

To date, operating in ways that create environmental effects has had a benefit in the short-term to farmers and all others in their value chains, including people who are the final consumers of their products in both domestic and export markets. Despite this wider short-term benefit, farmers generally have to absorb changes in profitability because they compete in commodity export markets

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<sup>3</sup> The National Objectives Framework is a central part of the National Policy Statement for Freshwater Management 2014 (2017).

and have little ability to influence prices for their products. As awareness of the damage caused by the economy grows, there is more pressure from society for activities, such as farming, to be more environmentally sustainable.

*Where an economic activity's use of water (either as a water take or to receive pollutants) is not accounted for in a production system, and its use impacts on other values, then all of the community is, in effect, subsidising that activity. This is the case regardless of the economic sector being considered (e.g. agriculture, forestry, manufacturing, tourism or local or central government).*

### **Moran et al. (2017) The Southland Economic Project: Agriculture and Forestry Report**

Yet, sustainability (i.e. being able to continue or sustain something) has multiple components to it (e.g. human, social, financial, and environmental), and improving one component (i.e. environmental performance) is likely to see complex outcomes. For example, it may increase a farmer's knowledge and skills and it may also see a rise in health and safety issues, including mental illness, especially where there is high debt and market values for land are yet to adjust. One in four New Zealanders live in rural areas or small towns, and these communities have a greater share of children, old people, and Maori<sup>4</sup>. In some regions more than half the population has either no formal qualification or their highest qualification is NCEA Level One. In these circumstances achieving change and managing the effects of change for the wellbeing of communities is challenging.

As well as rural areas, the Essential Freshwater Package is also expected to have financial costs for urban areas. This report does not consider these costs because it has occurred ahead of pending changes to wastewater and stormwater management as a result of the Three Waters Review.

People and communities in both rural and urban areas are continually adapting their economic activities to new policy direction from central and local government. In the past, different policies have had unintended consequences, that may have been foreseeable, even without the benefit of hindsight. There are many examples that are relevant to freshwater management, including the loss of land with ecological value as result of the Marginal Lands Act in 1950<sup>5</sup>, and the land use change resulting from the market reforms of the 1980s. Such examples highlight the importance of understanding, and responding to, the possible impacts of any new policy direction.

The current version of this report is the output from Phase 1 of the economic evaluation. It focuses on the RSWS' priorities that were possible to consider within a tight timeframe, and is largely based on evidence available for Waikato and Southland.

- The report first considers the changes to attribute tables for DIN and DRP, particularly those in relation to the Science and Technical Advisory Group (STAG) proposal for national bottom lines for nutrients in rivers. [The modelling work uses an economic model developed for Waikato Regional Council's Plan Change 1.](#)

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<sup>4</sup> <https://www.health.govt.nz/our-work/populations/rural-health> (9/07/2019)

<sup>5</sup> The intent of the Marginal Lands Act 1950 was to increase the production of any land that, in the opinion of the Marginal Lands Board, was not developed to its full productive capacity or was declining in productivity.

- The report then turns to the draft agricultural provisions (as at 21 June) that are proposed to be included in the NESFM and considers requirements for farm environment planning, stock exclusion, and reducing excessive nitrogen leaching caused by poor practice. The modelling work uses the Southland Economic Model for Fresh Water.

Analysis of other provisions in the NESFM (i.e. requirements for High Risk Land Use activities and land use intensification) may follow. The RSWS is planning to more fully develop the economic evaluation in Phase 2, when there is more certainty about the Essential Freshwater Package.

## 2 Regional variability in agriculture

The financial costs of the draft provisions relating to agriculture will clearly vary across New Zealand. In New Zealand 13% of the population is rural but there is large variability between regions, and in regions such as Southland roughly 30% of the population live in rural areas, with most living in areas that are 'highly rural/remote' or 'rural with low urban influence'. A good starting point for understanding distributional impacts is the relative share of agriculture within a regional economy. A sector's share of a regional economy changes over time, depending on both the size of the sector and the size of the economy.

Figure 1 (on the next page) shows agriculture's share of regional economies (as measured by Gross Domestic Product), and New Zealand as a whole, from 2000 to 2016 – it does not include services to agriculture or related processing or manufacturing. The amount of fluctuation from one year to the next is indicative of a sector's resilience to change, although there are usually many factors at play. The impact of the global financial crisis from 2008 to 2009 can clearly be seen on the graph, with the most resilient regional agricultural sector being Hawke's Bay, and for a shorter time, Marlborough.

Regions such as Waikato and Canterbury have large agricultural sectors in absolute terms but they also have large economies so agriculture's share of their economy is smaller than some other regions. Regions such as Southland, Tasman and the West Coast have large agricultural sectors relative to the size of their economy, and are more exposed to its changing fortunes. These regions will have high levels of connectedness within local communities (i.e. how much towns exist to service surrounding rural areas and how reliant rural areas are on services in specific towns).

GDP is a partial measure of economic activity and, while it indicates a regional economy's size, it does not gauge its quality. Interest payments on debt contribute to GDP but usually represent a flow of income out of a region. Similar issues exist if business ownership is located outside of a region. GDP also does not capture an economy's non-market transactions (e.g. volunteerism) or changes in natural resource, such as the loss of soil from the land. A more relevant measure at a regional scale is employment but multiple measures are needed to understand the economy's resilience to changing conditions, its sustainability in terms of resource use, and its contribution to people's standards of living and community outcomes across a region.

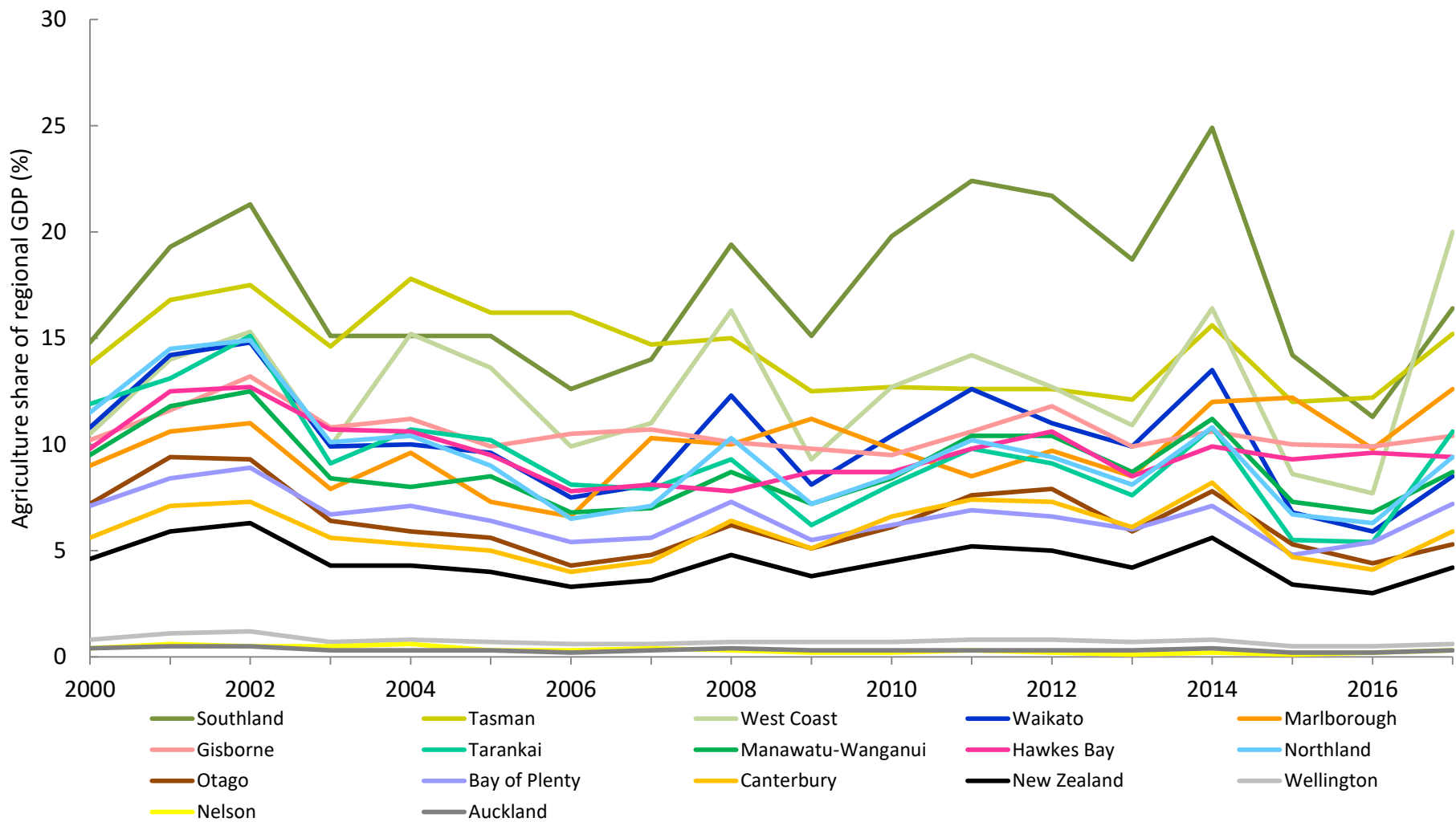


Figure 1: Agriculture by region (2000 to 2016)  
 Source – Statistics New Zealand Regional GDP and MBIE Modelled Territorial Authority Gross Domestic Product (MTAGDP)

Another indicator of the draft provisions' distributional impacts is how the mix of industries within the agricultural sector varies by region. There are two perspectives - the importance of an agricultural industry to a region, and the importance of a region to an industry. To understand both perspectives, a range of basic measures are relevant and they include: land area (in absolute and relative terms), the number of farm businesses, and employment, including self-employment and in-direct employment (e.g. services to farming and farm product processing and manufacturing). In general, dairy farming tends to generate a considerable on-farm employment while drystock farming often generates a large amount of employment in processing industries.

The agricultural industries in some regions are predominantly pastoral while other regions, such as Marlborough, are strongly influenced by arable or horticulture industries. Overall, there has been a decline in total stock in the North Island and an increase in total stock in the South Island. Regional variability also needs to consider differences within each industry. For example, there is a strong north-south gradient in the sheep and beef industry between beef cattle and sheep; and similarly there is a north-south gradient in the dairy industry in herd size. Table 1 shows that in 2017/18, almost 70% of dairying in New Zealand occurred in five regions: Waikato, Taranaki, Canterbury, Southland and Northland (New Zealand Dairy Statistics). Canterbury has the highest average number of cows per hectare, followed by Waikato and Otago, while the West Coast and Northland have the lower average number of cows per hectare.

**Table 1: Dairy herds and dairy cows by region**

Region	Number of dairy herds	Share of dairy herds	Number of dairy cows	Cows per effective hectare	Share of national dairy herd
Waikato	3,322	28.7%	1,135,822	2.95	22.7%
Taranaki	1,620	14.0%	477,311	2.80	9.6%
Canterbury	1,191	10.2%	952,363	3.43	19.0%
Southland	982	8.5%	583,240	2.64	11.7%
Northland	853	7.4%	271,945	2.28	5.4%
Total	7,968	68.8%	3,420,681		68.4%

Source – New Zealand Dairy Statistics 2017-18

In many regions various agricultural industries are also highly connected. Almost all commercial sheep and beef farms have some other form of revenue (e.g. from deer, arable crops<sup>6</sup>, grazing other livestock, and farm forestry). These multiple revenue streams, and the way that different livestock classes interact with each other, mean sheep and beef farms are complex businesses. Figure 2 shows the estimated distribution of commercial sheep and beef farms across New Zealand by farm class<sup>7</sup>

<sup>6</sup> Arable crops, particularly forage and fodder crops, are not only grown on arable farms. In 2014, an estimated 68,280 hectares in Southland was used for winter forage crop – although just 2,290 hectares of this area was grown on arable farms (Pearson, Couldrey, & Rodway, 2016).

<sup>7</sup> The B+LNZ Sheep and Beef Farm Survey<sup>7</sup> classifies commercial sheep and beef cattle farms into eight farm classes – that are divided across the South Island and North Island and by relative intensity. 'Intensity' is defined using a combination of land type and appropriate farm management and it is a relative term within the sheep and beef industry (i.e. it does not necessarily imply that a particular farm class is an intensive land use). Farm

(Beef + Lamb New Zealand Economic Service). Canterbury stands out as having mixed cropping / finishing farms, most Northland farms are hill country, most Southland farms are intensive finishing, more than half of Gisborne farms are hard hill country, while in Nelson and the West Coast there are many finishing/breeding farms. However, this distribution does not indicate the geographic extent of each farm class by region. The South Island high country stations, which are mainly located in Marlborough, Canterbury and Otago, make up a relatively small number of farms but are at least 5,000 effective hectares and have tens of thousands of stock units.

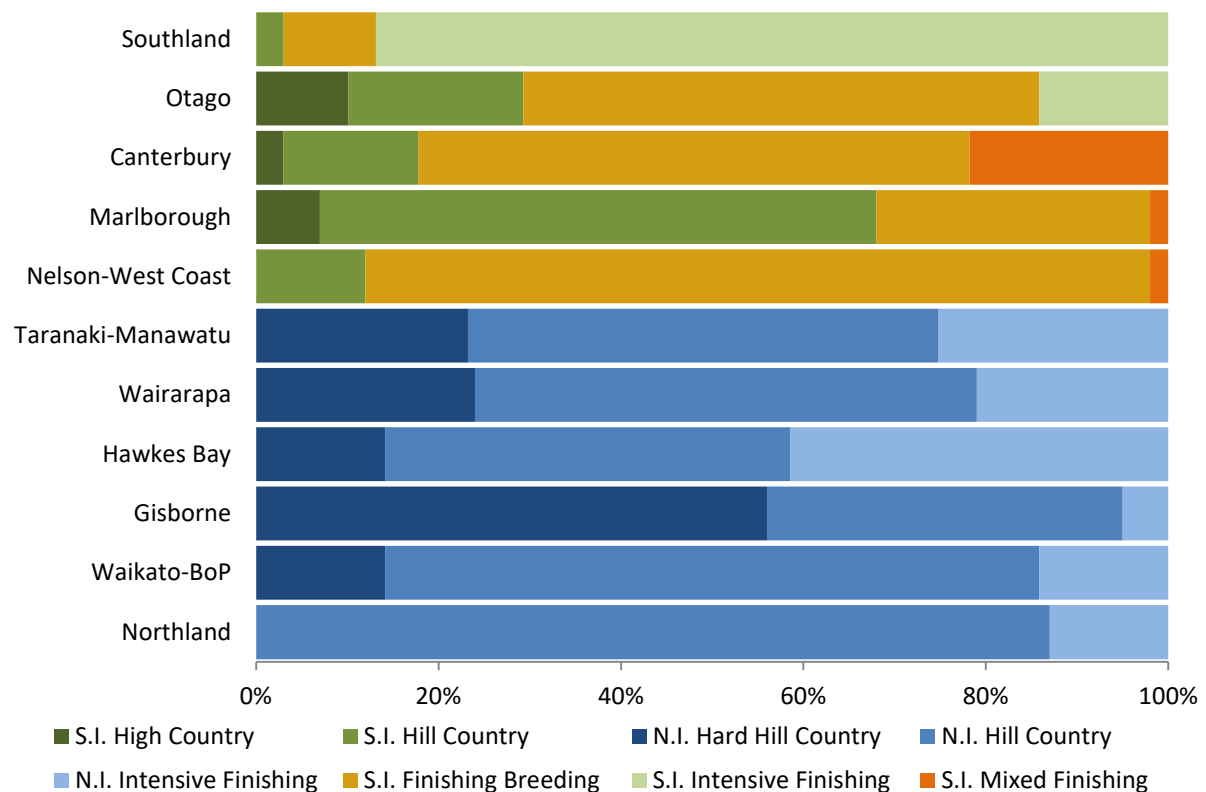


Figure 2: Percentage of sheep and beef farms by farm class and region 2013-14  
Source – Beef + Lamb New Zealand Economic Service

The sheep and beef farm classes can be used to highlight some of the regional variability. Figure 3 shows the proportion of farms with different winter feed area percentages in the Sheep and Beef Farm Survey for 2013-14. The farms are identified by farm class to indicate how the proportion of a farm's effective areas used for winter feed varies across New Zealand. In the South Island, the hill and high country farms have smaller proportions but larger areas than the intensive finishing farms, while other South Island farm types tend to have the full range. The proportion of winter feed area appears to be less important in the North Island, where pasture growth during winter is less limited. The pattern of winter feed areas has probably changed little since 2013-14.

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class is a broad classification of a farm business that takes into account its business type in addition to physical attributes such as those in the Land Use Classification Index.

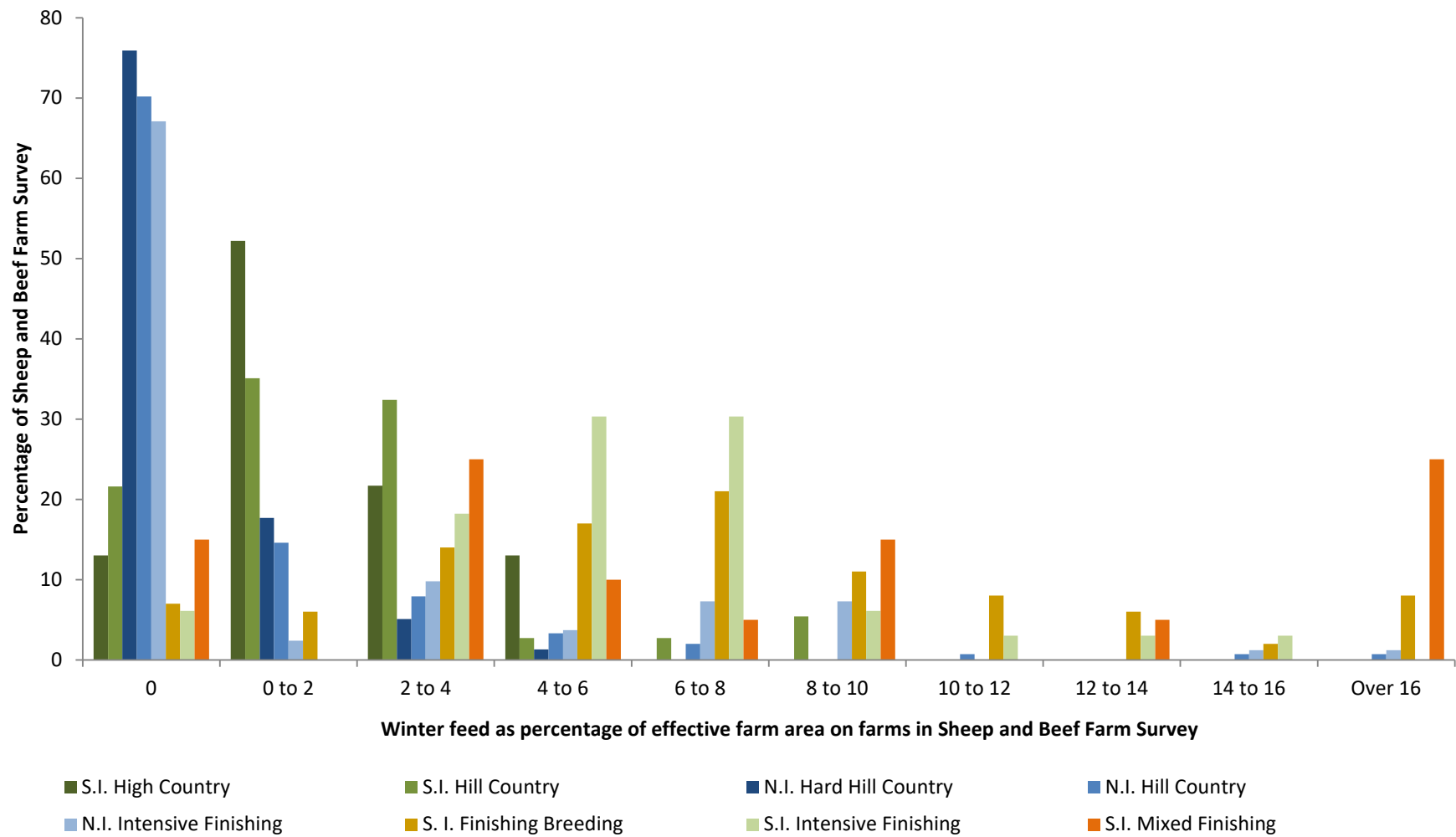


Figure 3: Percentage distribution of winter feed area in Sheep and Beef Farm Survey 2013-2014  
 Source – Beef + Lamb New Zealand Economic Service



Variability also occurs over time. An important consideration in the financial costs of policy reform is how the impacts of policy can change markedly from one year to the next, particularly for the agricultural sector where profitability can be highly variable over time. Some industries have a better ability to buffer themselves against downturns in commodity markets than others, although there are many factors at play. Figure 4 shows the financial performance of sheep and beef farming for New Zealand as a whole on a per effective hectare basis (using inflation-adjusted Earnings before Interest Tax and Rent (EBITR)). While profitability has generally been increasing over time, it can be variable from one year to the next.

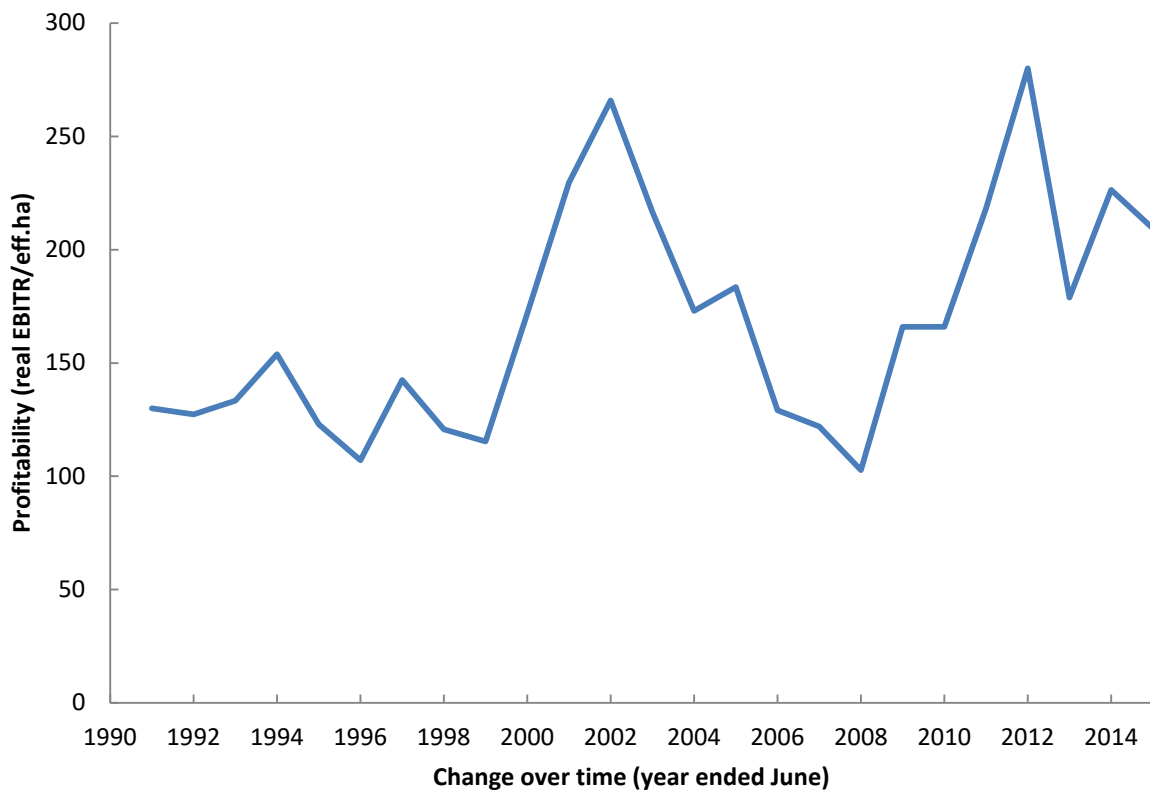


Figure 4: Sheep and beef farm profitability for New Zealand (1991-2014)  
Source – Beef + Lamb New Zealand Economic Service

### 3 Proposal for DIN and DRP attribute tables

The Regional Sector Water Subgroup requested an economic analysis of the Science and Technical Advisory Group (STAG)'s attribute tables for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP), and specifically, the proposed national bottom-lines. These new attribute tables are intended to replace nitrate and ammonia toxicity attribute tables in the National Policy Statement for Freshwater Management 2014 (2017). They are designed to "capture ecosystem effects in soft-bottomed waterways not captured by the periphyton attribute". It is understood that the periphyton attribute tables are to be retained.

The initial approach was to develop case studies for the Maitai and the Selwyn – Te Waihora catchments, starting with the Maitai and a focus on DIN. The first step was to consider the baseline scenario (i.e. current NPSFM requirements) for the existing situation and an alternative scenario for the STAG's proposed DIN bottom line. After gathering baseline monitoring data in the Maitai, it was concluded that the proposal for a DIN bottom line is likely to mean little or no change over the existing requirements in the NPSFM for ecosystem health when and where a National Objectives Framework process has been completed.

The existing ecosystem health requirements relate to where rivers and streams are affected by, or could be affected by, conspicuous periphyton or are upstream of nutrient sensitive receiving environments like lakes or estuaries. Initial estimates by Dr. Ton Snelder indicate that current nitrogen loads for New Zealand are 27% higher than those that would achieve the periphyton bottom line with respect to DIN, with nitrogen loads for some regions (including Southland) of up to around 40% higher. The impact of the periphyton bottom line on a broad range of economic activities has existed since the NOF was introduced in 2014 – the STAG's DIN proposal is generally less stringent so at a regional or national scale may have little further impact.

In the Maitai Catchment most (but not all) rivers and streams that are affected by, or could be affected by periphyton flow into the Fortrose Estuary. This estuary is currently showing signs of eutrophication that are unlikely to be considered acceptable in the National Objectives Framework process, despite it being more resilient to catchment nutrient loads than other nutrient sensitive receiving environments, such as Lake Ellesmere/Te Waihora and Waituna.

The new tables will be more stringent in localities where rivers and streams do not support, or could not support, conspicuous periphyton, OR do not have a downstream receiving environment that is sensitive to nutrients (e.g. a hard-bed river or stream or a lake or an estuary). These localities are broadly associated with fine bed substrates (i.e. soft bottomed reaches) and are where nitrate toxicity is the existing constraint. As many as 26% of New Zealand's waterbodies are soft-bottomed but many have nutrient sensitive receiving environments downstream. The DIN and DRP attribute tables will have economic impacts in these localities, at least during the period when activities must reduce their nutrient losses to meet the national bottom-lines.

The economic impacts of situations where a river or stream is beyond any bottom line (whether for periphyton or DIN) will be influenced by the target(s) (i.e. limits and timeframes) and the scale of the management approach. Thinking of economic analysis that already exists, the Hinds catchment in Canterbury may be a useful alternative case study to the Maitai.

The STAG’s proposal may lead to a focus on a national bottom line that may be misplaced if it does not sufficiently allow for variation in how local circumstances influence ecological health, which are driven by factors including climate and flow regimes. Consequently, it may lead to further financial costs at a later date, especially when consideration of water quantity issues is brought into the mix.

For these reasons, the following approach was taken in this report:

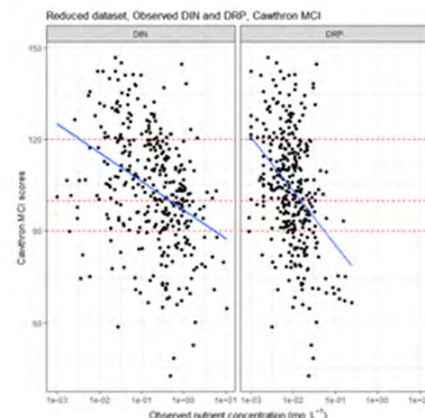
1. Catchments where the proposal would actually apply (i.e. soft-substrate streams and rivers, not upstream of sensitive receiving environments) are identified throughout the country, to enable a more thorough assessment of implications.
2. Recommend a similar analysis to that of Ton Snelder’s is completed of the proposal for DRP that includes existing knowledge for DIN.
3. A meta-analysis was completed (using the Waikato as a case study) for the regions, such as the Waikato, where there are appreciable numbers of rivers and streams that are
  - a. not susceptible to periphyton blooms and
  - b. not upstream of nutrient sensitive receiving environments.
4. The Maitai and Selwyn – Te Waihora case study work for the DIN bottom line was not pursued. An alternative is to consider for further work is the Hinds Catchment.

More information is included in Appendix 1 – RSWS Advice Note – The DIN “bottom line”.

### 3.1 DIN and DRP bottom-lines – Waikato

#### Nutrient attributes

It is understood that the numerical values for DIN and DRP targets have been derived on the basis of a statistical analysis of the relationship between nutrient concentrations and various measures of ecosystem health (such as fish, periphyton, macroinvertebrates and ecosystem metabolism). As illustrated in the image to the right, nutrients appear to explain little of the variation in Macroinvertebrate Community Index (MCI) scores. To the extent that the DIN and DRP targets are derived from a statistical relationship between nutrients and the MCI, the apparently low explanatory power of the independent variables (nitrogen and phosphorus) gives rise to important implications for policy.



If the MCI is considered to be a useful indicator of ecosystem health then the weak statistical relationship suggests that nitrogen and phosphorus may be ineffective policy targets. Not only is there little evidence of a causal link, there is little evidence of a strong correlation between nutrients and the MCI. Other factors may be more important in determinants of environmental quality. For example, at least in some places, riparian shading, reducing sedimentation, and habitat restoration are also important for ecological health. While these actions may also reduce nutrient discharges, this

would not justify the use of less important attributes (nutrients) as a policy target to achieve water quality objectives.

Consequently, the cost-effectiveness of policies targeting nutrients is likely to be questionable. A dollar spent on reducing nutrients may be expected to achieve less improvement in MCI scores than a dollar spent on other actions (such as riparian shade, sediment reduction, or stream habitat restoration). Assuming the available budgets to address these issues are limited, choosing policies that are not cost-effective will potentially achieve less improvement in water quality than other methods.

Since cost-effectiveness is a necessary condition for efficiency, the choice of DIN and DRP as policy targets would be expected to fail the efficiency test for policy if nutrient reducing actions are not cost-effective. It may also be that the observed relationship between nutrients and MCI score is so poor because it varies so much across the country. This would imply that even if the targets for DIN and DRP may be suitable in some locations, they will not be in others – again implying a policy that is neither cost effective nor efficient.

### **Modelling - Waikato**

To assess the implications of the proposed bottom-lines for nutrients (DIN and DRP), the Waikato Regional Council developed a scenario using the model designed for the Healthy Rivers/Wai Ora (Plan Change 1) process. The model was developed by the Technical Leaders' Group<sup>8</sup> that provided technical input into the development of Plan Change 1<sup>9</sup>.

The Waikato-Waipā catchment covered by this model was considered to be a useful catchment to examine, since it is generally not subject to concerns related to periphyton or sensitive downstream receiving environments (and hence, represents the type of catchment where the proposed DIN and DRP attributes are more likely to have a significant effect). The model was developed to estimate the change in land use profitability subject to constraints on discharges of nutrients, sediment and bacteria to the Waikato-Waipā river catchment. That is, it would provide an estimate of the change in profitability that would be expected in order to meet proposed environmental targets.

As a 'first pass' estimate of the effects of the proposed nutrient bottom-lines, the model was rerun using the proposed DIN and DRP attributes as constraints. The modelling scenario used the same baseline as Plan Change 1, but none of the Plan Change 1 policy package was assumed – hence this represents a hypothetical assessment of the costs of implementing the proposed DIN and DRP requirements.

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<sup>8</sup> Membership of the group included: Dr Bryce Cooper, General Manager - Strategy, NIWA; Dr Liz Wedderburn, Portfolio Leader Agriculture Policy and Maori Agribusiness Principal Scientist, AgResearch; Mr Antoine Coffin, Director, Te Onewa Consultants; Dr Graeme Doole, Professor of Environmental Economics, University of Waikato; Dr Mike Scarsbrook, Environment Policy Manager, DairyNZ; Dr John Quinn, Chief Scientist - Freshwater and Estuaries, NIWA; and Dr Tony Petch, Director, Tony Petch Consulting Ltd.

<sup>9</sup> The model is described in this report: <https://www.waikatoregion.govt.nz/services/publications/technical-reports/2018-technical-reports/tr201852/>.

Where sub-catchments already have water quality that is *better* than the proposed attributes, land uses were constrained to not allow any increases in nutrient concentrations; where they are *worse* than the proposed attributes, the model seeks the lowest cost way of achieving the water quality objective. In the first attempt to model the implications of the proposed DIN and DRP attributes, land use was kept fixed. This meant that the required abatement had to come from the mitigations defined within the model<sup>10</sup> *other than land use change*. However, using this approach, the model was unable to find a solution. Investigating why this was the case is not straightforward, and will need more time, but the possibility that there are simply not enough mitigation options to achieve the objective cannot be ruled out.

A second modelling run was then carried out with constraints on land use change removed. This time, the model was able to find a solution whereby the DIN and DRP attributes were able to be achieved across the catchment. The solution required considerable changes in land use for the Waikato-Waipā catchment. In particular, it found large-scale afforestation, particularly of drystock land would be required.

According to the modelling results, drystock farming would fall from 43% of modelled land use in the catchment to 14 percent, while forestry would increase from about one-fifth of the catchment to more than one half. The area allocated to dairy farming would also fall by 13%, drystock farming would fall by 68% and forestry land use would increase by 160%. The switch away from drystock farming is an artefact of the optimisation approach of the model: because drystock has a lower profit per hectare than dairy farming, the opportunity cost of planting a drystock farm is lower than planting a dairy farm. Figure 5 and Figure 6 (next page) show the baseline and the results of the second modelling run (i.e. when there is no constraint in the model on land use change).

The implications for land use profitability are driven by these land use changes. The total profit estimated to be obtained from land use declines only by around \$7 million per year, but this is because the falls in profits for the dairy sector (of around 7%) and drystock sector (around 40%) are offset by very large increases in forestry profits (190%). Note that the model uses EBIT as an indicator of profit, so debt servicing costs do not feature in the results.

These changes in profits do not include the costs of land use transition, which the model estimates at an annualised rate of \$84 million. These costs represent the costs of converting land and additional mitigation strategies that are less embedded within the management of farm systems. They include, for example, additional stream fencing, effluent management, erosion control and 'edge of field' mitigations. Combining the change in land use profitability and transition costs gives an estimated annual cost of meeting the DIN and DRP attributes in the Waikato-Waipā catchment of around \$100 million (or around 11% of the total profits derived from land use in the catchment<sup>11</sup>).

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<sup>10</sup> These are described in full in this Waikato Regional Council Technical Report: <https://www.waikatoregion.govt.nz/services/publications/technical-reports/2018-technical-reports/tr201847/>.

<sup>11</sup> For reference, this compares with an estimated 4% reduction in total profits from Waikato Regional Council's Plan Change 1.

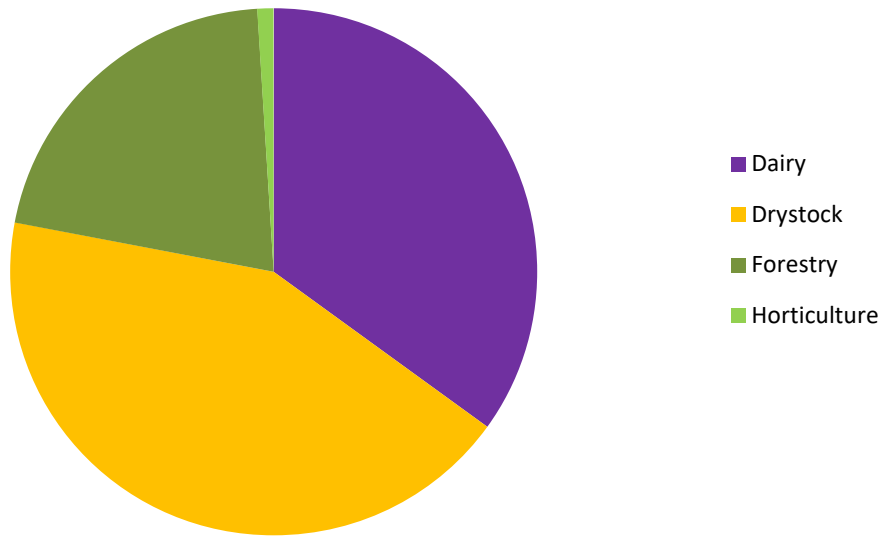


Figure 5 Baseline land use in the Waikato-Waipā Catchment

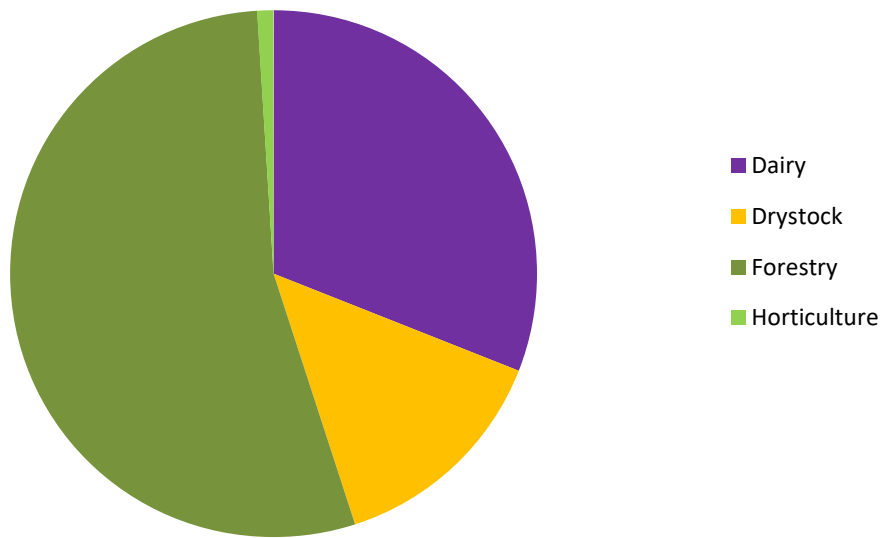


Figure 6: Modelled land use in Waikato-Waipā Catchment under the DIN proposal

As noted above, however, policies targeting DIN and DRP are not expected to be cost-effective or efficient. Therefore, these estimates may overstate the cost of improving water quality if a more cost-effective set of policies (not solely driven by DIN and DRP) were considered.

The Waikato-Waipā model is highly complex, and characterises multiple non-linear systems. This means that care is required in interpreting results, and further analysis should be done. For instance, further work is required to understand how the various systems in the model are interacting and whether the model is finding a global optimal solution (rather than local maxima).

While the land use change and financial costs suggested by the Waikato model are notable in themselves, it is worth considering the implications that will have on communities within the catchment. Various parties to recent policy proposals have noted the potential effects of large-scale afforestation on local communities.

The soft-bottomed waterways that characterise the Waikato-Waipā catchment means it is likely to be particularly affected if the proposed DIN and DRP attributes have to be implemented. It is noted that other parts of New Zealand – including Northland, Bay of Plenty and the Hauraki plains part of the Waikato region – can be expected to be similarly affected. At a regional or national level, these effects are significant, but at a local level they could be particularly severe.

Moreover, the financial costs produced by the Waikato model do not take into account the financial position of individual farm businesses. Recent reports by AgFirst and Macfarlane Rural Business Ltd commissioned by the Ministry for the Environment suggest that many farms would struggle to remain solvent once debt servicing and depreciation are accounted for, and this problem would be exacerbated by the costs of meeting the STAG's recommendations. Understanding the implications of these financial effects will be crucial in avoiding unintended consequences for local communities. Trends in debt levels and their implications are discussed in section 7.3 of this report.

## 4 Agriculture proposals – The Southland Economic Model

The agriculture proposals were modelled in the following sections using The Southland Economic Model for Freshwater.

This model was developed as part of The Southland Economic Project, which was a joint venture between DairyNZ, Beef + Lamb New Zealand Ltd., Department of Conservation, Ministry for Primary Industries, Ministry for the Environment, Southland Chamber of Commerce, Te Ao Marama, and Environment Southland. The Project also closely involved Deer Industry New Zealand and New Zealand Deer Farmers Association (Southland Branch), the three territorial authorities in Southland (Invercargill City Council, Southland District Council and Gore District Council). As well, the Project has had strong support from Foundation for Arable Research, and Horticulture New Zealand, and forestry companies: Southwood and Rayonier.

The Southland Economic Model is a dynamic computable general equilibrium (CGE) model of Southland's economy based on systems thinking. It contains two "regions": Southland and the rest of New Zealand and 19 economic sectors. It also contains two important datasets: one is for 95 Southland farms across all agricultural land uses, and the other is for eight municipal wastewater schemes in the region. Each of these datasets contains information on the costs and effectiveness of actions designed to reduce the effects of these activities on water.

The farm dataset was used for the other farms in Southland. In the Southland Economic Model all farms in each agricultural land use (e.g. drystock, dairy, arable, horticulture) are classified as:

- Either "large" (>1,000 effective hectares) or "small" (<1,000 effective hectares), and
- The small farms are further classified as either "flat" or "mixed slope", and
- The small farms are further classified by soil drainage ("poorly drained" or "well drained") and rainfall ("wet" or "dry").

In some cases not all classifications are relevant to each agricultural land use.

To provide some perspective for other regions, Southland as a whole contains a total land area of 3.2 million hectares (or 12% of New Zealand). Around 59% of the Southland is in indigenous vegetation, much of which is in Fiordland or Stewart Island. Agriculture and forestry occurs on 38% of land in the region, mostly at lower altitudes. The remaining 3% of "land" is either surface water, or other land uses, such as urban.

### 4.1 The counterfactual scenario

For the economic modelling using The Southland Economic Model, alternative scenario(s) representing each proposal were compared to a baseline or 'counterfactual' scenario. In the context of this report, the counterfactual scenario assumes current land uses stay constant into the future.

While in reality land uses are continually changing, this assumption reflects that the proposed Southland Water and Land Plan (decisions version) is quite restrictive in terms of land use change



where that would involve an increase in nutrient losses. The plan is currently under appeal in the Environment Court and may change. For the purposes of this analysis, it is considered that holding land use constant is the most pragmatic approach.

There are some fencing and cultivation / setback requirements already in the proposed Southland Water and Land and these are also included in the counterfactual or baseline scenario, so that only changes in the scenario modelling that *go beyond* these requirements need to be considered. The current assumptions relating to fencing / setbacks are as follows:

- *Cultivation* – no cultivation occurs within 5 metre of a watercourse. The length of streams under different land uses is calculated using GIS – and a setback of 2 metres either side of the stream is applied (5 metres was not applied because there was already an existing rule in baseline of 3 metres). In the counterfactual, 26% of this land is retired from production (it was not assumed 100% as the land could be used for purposes other than cultivation).
- *Stock Exclusion* – applies to stream lengths of order 3 and above on agriculture land calculated in GIS and estimates have been made as to existing fencing. The region is divided into three land slope categories (classified by the NZLRI slope dataset): plains, undulating/rolling, and steeper land. There are variations in timeframes by stock classes and in some situations stock exclusion is required for streams less than 1 metre. All stock on plains must be excluded from all waterbodies on plains by 2025. Beef cattle and deer must be excluded from undulating/rolling land by 2030, unless stocking rate is less than 6 stock units per hectare. Sheep are excluded from this rule.
- *Stock Exclusion (land retirement)* - As the fencing rules did not have setbacks, and land immediately next to streams is not normally used for production, no land retirement implications of fencing are considered in the counterfactual.

## 5 Farm Environment Plans

### Farm Environment Plans – draft proposals as of 21 June 2019 (as understood by the RSWS)

Farm Environment Plans are to be risk-based and mandatory where risks to water quality are high. Minimum content defined and existing and new regimes enabled.

Approved by certified practitioner, independent auditing and reporting, and regional councils to monitor the sign-off.

Phase roll out over 10 years: Tranche 1 by 2022 (current), Tranche 2 by 2025 (target vulnerable catchments and catchments with high water quality risks), and Tranche 3 by 2030.

Three options being considered:

1. Requiring consents for high risk land use activities above certain thresholds, section 360 regulations for exclusion of stock from waterways; and mandatory farm environment plans, phased in over time.
2. High risk land use activities managed by the compulsory use of Farm Environment Plans, not resource consents. Discretion sits with a suitably qualified and experienced practitioner who could approve alternative solutions. Non-compliance referred the case to the council.
3. Greater role for independent expert in setting the requirements for good practice at farm scale, based on council rules, national regulation, and guidance/standards for that farm system in that area. Practices would be set out in a Farm Environment Plan. Councils would take enforcement action based on evidence/intelligence received from independent experts/auditors.

### 5.1 Introduction

There has been considerable progress in environmental planning at a property scale over recent years, and a variety of approaches have been developed. To illustrate the point, Table 2 identifies the range of terms used in the different regions and industries – currently, not all regions require farm environment plans. The resources (i.e. skilled labour, financial capital, time) required to deliver and implement these plans in a meaningful way (i.e. translate into actions on the ground) can be significantly underestimated. At present, the timeframes in the draft farm environment plan proposal, and those that some regions have set, appear to be aspirational, given the practicalities of achieving the targets.

**Table 2 Summary of rural environmental planning by region and industry**

<b>Plan</b>	<b>Region or Industry Group</b>
Whole Farm Plan	Horizons
Farm Environment Plan	Waikato, Greater Wellington, Gisborne, Canterbury, Foundation for Arable Research
Comprehensive Farm Plans	Taranaki
Farm Environment Management Plan	Hawkes Bay, Southland
Land & Environment Plan	Marlborough, Tasman, Otago, West Coast
Focus Activity Farm Plan	Southland
Farm Water Quality Improvement Plan	Northland
Land Environment Plan	Beef + Lamb New Zealand, Deer Industry New Zealand
New Zealand Good Management Practice (an add on)	Horticulture New Zealand
Nutrient Management Plan	Lake Rotorua Catchment - Bay of Plenty

A national approach to farm environment plans that builds on existing work and encourages consistency while allowing for local circumstances is likely to improve their effectiveness and efficiency in managing the environmental effects of farming activities. The financial costs of farm environment plans fall into the following areas:

- Preparing and reviewing farm environment plans;
- Independent auditing and reporting of activities;
- Training farm advisors;
- Putting in place the actions;
- Consenting, monitoring and auditing; and
- Information and data management

In most cases these are on-going costs that will fall on farmers and growers, in one way or another, although some costs may be shared by ratepayers. If farm environment plans are fast-tracked across New Zealand then the amount of skilled labour and financial capital required will increase substantially. Based on their experience with Lake Rotorua Nutrient Management – Plan Change 10 (which requires nutrient management plans for nitrogen), Bay of Plenty Regional Council staff estimated that about 7 full-time equivalent farm advisers are required to deliver 300 farm environmental plans in one year.

In general, preparing an initial farm environment plan is likely to take three to four days' work for the farmers and further work for a farm adviser, although it can be more depending on the size and complexity of the farm business. At present, there are not sufficient farm advisers in most regions to undertake this work within proposed timeframes. The process of becoming a farm adviser certified in nutrient management takes time: a person needs a degree in agriculture or related field, additional papers in sustainable nutrient management, have at least two years' work experience, meet other

competencies, and pass a final exam. The skills needed to produce a nutrient management plan are slightly different to those for a farm environment plan, although some people can fulfil both roles. Appendix 2 summarises the skills and information needed to develop farm environment plans.

The implication is that there will be a time lag before New Zealand has reached a point where there are enough qualified advisers to meet the needs of each region, especially as all regions will be requiring their services at the same time. Subsidising the cost of farm environment plans is unlikely to overcome this critical skilled labour constraint in the short-run and there is a risk that financial assistance may inflate the price of farm environment plans, rather than improve or hasten their delivery. A similar situation exists for the reviewing, consenting, monitoring and auditing of farm environment plans.

In the Waikato region, about 6,500 farm environment plans are already required under proposed Plan Change 1 for the Waikato and Waipā river catchments, and the total across the whole region is estimated to be around 10,000. Plan Change 1 proposes prioritising farm plans by catchment: in Priority 1 catchments the farm environment plans are needed by 1 March 2022; in Priority 2 catchments by 1 March 2025; and in Priority 3 catchments by 1 July 2026. The farm environment plan proposal in the Essential Freshwater Package also uses a catchment risk-based approach, with similar timeframes for Tranche 1 and Tranche 2, but a longer timeframe for Tranche 3.

In the Bay of Plenty region, the farm environment plan proposal will affect 23 to 56 properties feeding forage crops over winter on slopes greater than 20 degrees, 25 to 35 stock holding areas, and 25 to 30 commercial vegetable growers, plus those activities requiring resource consents under other proposals. It is unclear which catchments in the region the Nitrogen Cap proposal and related farm environment plans might apply to but at least the Kaituna and Waihi estuary catchments are likely candidates. In these two catchments alone, about 175 dairy farms and 40 drystock farms would require farm environment plans, as well as around 1,000 horticulture blocks (average 8 ha) if farm environment plans are required for these. There are no intensive feedlots, and no farms are known to be intensively grazing forage crops on areas of greater than 50 hectares (or 10% of the property).

In the Southland region, farmers must prepare and implement a farm environment plan (including a nutrient budget) for their farming activity to be permitted under the proposed Southland Water and Land Plan (decisions version). The timeframes for achieving this condition are risk-based by activity: 1 May 2019 for dairy farming or intensive winter grazing practices, and 1 May 2020 for all other farming practices. The proposed Southland Water and Land Plan is currently under appeal but when it becomes operative it is likely that the timeframes will reflect those in the Essential Freshwater Package: Tranche 1 by 2022 (current), Tranche 2 by 2025 (target vulnerable catchments and catchments with high water quality risks), and Tranche 3 by 2030. Most of Southland's catchments and farming activities are likely to fall into Tranches 1 and 2.

It is understood that, in the draft proposal, each "management unit" will need a farm environment plan (and each management unit may have multiple properties). The definition of management unit will be critical to the number of plans that are required. In Southland, the relevant rule (Rule 20 – Farming) applies to landholdings that are 20 hectares or more. It is estimated that there are roughly 4,500 agricultural and horticultural properties. An additional 4,000 properties are livestock support, small landholdings (5 – 40 ha) or lifestyle blocks (< 5ha). Each region has a unique set of land uses and policy context, so the financial costs will differ considerably between regions.

## 5.2 Modelling – Southland

To test the financial costs of the new draft proposal for farm environment plans, a Farm Environment Plan scenario was developed and modelled for all of Southland. The proposal for farm environment plans does not yet clarify which farms or situations are included in each of the three tranches, so scenario modelling is based on assumptions described below.

In this scenario farm environment plans are required by 2022 for higher risk activities (Tranche 1 – assumed to be dairy + drystock over 20kg), by 2025 for other farming activities in the Maitai, Oreti, and Aparima Freshwater Management Units (Tranche 2), and by 2030 for other farming activities in the Waiau Freshwater Management Unit (Tranche 3). This Farm Environment Plan scenario was compared to the Counterfactual scenario detailed in Section 4. **It was assumed in the Counterfactual that no farm environment plans have already been completed.**

In the Farm Environment Plan scenario it was assumed that farm environment plans are not a one-off; rather they must be updated on an on-going basis to ensure continuing compliance with regulations. It was also assumed that the first time a plan is created it will cost the most at \$5,200 per farm, and that it must be reviewed and updated every three years at around a cost of around \$3,700 per farm. There is also an annual software subscription estimated at \$200 per farm. Table 3 gives the numeric assumptions used in the modelling.

Considering the whole of the Southland region, plus the need to continue to update plans over time, there are sizeable labour resources needed for creation of farm environment plans. Table 3 estimates the number of plans required each year, and the number of full time employees required to create these plans. To make it possible to add together first-year plans and other plans requiring different levels of effort, all plans have been ‘normalised’ to the level of effort required for a first-year plan. Applying the Bay of Plenty’s estimates from Plan Change 10 (i.e. 7 employees can complete around 300 plans in one year) to Southland, at the most intensive period (i.e. around 2025), nearly 35 additional people would be needed for the preparation of farm environment plans.

**This estimate may change depending on the Ministry for the Environment’s definition of ‘management unit’.**

Table 3: Estimated number of farm environment plans required and number of employees by year

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Estimated number of plans	741	936	1,131	1,147	1,295	1,442	1,028	1,028	1,112	1,134	1,157
Estimated number of employees	19	22	26	27	30	34	24	24	26	26	27

Table 4: Assumed costs for the Farm Environment Plan scenario

FARM ENVIRONMENTAL PLAN COSTS					
<b>First plan costs</b>					
Year required					
Cost per farm (\$2017)	Sheep,Beef	Deer	Dairy	Hort	Arable
Nutrient budget	2000	2000	2000	2000	2000
Auditor fees	1000	1000	1000	1000	1000
Council fees	2000	2000	2000	2000	2000
Overseer sub	200	200	200	200	200
<b>Total</b>	<b>5200</b>	<b>5200</b>	<b>5200</b>	<b>5200</b>	<b>5200</b>
<b>Audit plan costs</b>					
Frequency (years between plans)	3	3	3	3	3
Cost per farm (\$2017)	Sheep,Beef	Deer	Dairy	Hort	Arable
Nutrient budget	1500	1500	1500	1500	1500
Auditor fees	500	500	500	500	500
Council fees	1500	1500	1500	1500	1500
Overseer sub	200	200	200	200	200
<b>Total</b>	<b>3700</b>	<b>3700</b>	<b>3700</b>	<b>3700</b>	<b>3700</b>
<b>In between costs (annual costs for years when full plan not required)</b>					
Cost per farm (\$2017)	Sheep,Beef	Deer	Dairy	Hort	Arable
Nutrient budget	0	0	0	0	0
Auditor fees	0	0	0	0	0
Council fees	0	0	0	0	0
Overseer sub	200	200	200	200	200
<b>Total</b>	<b>200</b>	<b>200</b>	<b>200</b>	<b>200</b>	<b>200</b>

The regional economic modelling for Southland suggests that the number of additional advisors required under the Farm Environment Plan scenario is higher than the numbers in Table 4. The model predicts a maximum of around 60 additional employees across the whole of Southland in the two industries related to farm environment plans: 'Finance, Insurance, Real Estate and Business Services' (includes farm consultants) and 'Other Services' (includes council services).

The main reason for the higher estimate in the modelling is that economic transactions are considered principally in monetary terms, and the number of employees is calculated as a step at the end of each time period based on its monetary transactions. The model also uses average ratios of employees required per dollar of output or factor input costs in industries. The industry responsible for creating farm plans is a relatively aggregated industry that includes a range of business services (e.g. finance, insurance, rental, real estate services, business services and agricultural support services). In this case, the average output per employee across the whole industry may not accurately represent the output per employee in the quite specific activity of creating farm environmental plans.

An important consideration will be how to resource the labour demand for farm plan creation. Although 35 employees may not be a large number when considered at a regional scale, these employees must have very specialist knowledge and skills and so cannot necessarily be sourced from the general labour resource. As well, with the proposal coming into place across New Zealand, it seems unlikely these people can be simply sourced from other regions.

The labour market has some internal self-regulating dynamics that will help to address shortages – i.e. shortages in occupations create higher salaries and opportunities, which attract more people into the occupation and training for the necessary skills. However, it can take time for these dynamics to play out. In the short term, because farmers have no ability to decline purchase of these services regardless of the price, and there is unlikely to be the necessary skill sets readily available, there is risk of very high price hikes in the services of farm plan creation. While being of benefit to those already involved in farm plan creation, this could also become quite a burden for farming communities.

The value added impacts are quite differentiated across the regional economy, with losses accruing to the pastoral sector and gains in the two service sectors associated with supplying plans. Table 5 gives the most notable impacts by industry and the accumulating totals for Southland’s economy as a whole (i.e. the change in each year plus the change in previous years).

**Table 5: Accumulated change in value added in Southland under the Farm Environment Plan scenario (\$2017 million)**

<b>Industry</b>	<b>2020</b>	<b>2022</b>	<b>2024</b>	<b>2026</b>	<b>2028</b>	<b>2030</b>
<b>Sheep, beef, deer, other livestock, grain farming, horticulture</b>	0	-4	-11	-20	-27	-34
<b>Dairy cattle farming</b>	-1	-7	-11	-15	-19	-22
<b>Other food manufacturing</b>	0	0	1	1	2	3
<b>Dairy product manufacturing</b>	0	0	0	0	1	1
<b>Utilities, construction and transport</b>	0	0	0	1	1	2
<b>Trade and hospitality</b>	0	0	0	1	1	1
<b>Business services</b>	0	3	7	11	14	17
<b>Other services</b>	0	3	6	9	11	14
<b>Total</b>	0	-4	-8	-12	-14	-17

By 2030 the accumulated total change in value added for the Farm Environment Plan scenario compared to the Counterfactual scenario is -\$17 million. It may be helpful to think of value added as a measure of the *income* generated by each economic activity, as its principal components are (1) industry profits and (2) wages and salaries.

This scenario modelling is very much a “first cut”, and further work can be done if required to test variations around the different tranches and timing.

## 6 Stock exclusion

### NESFM and RMA section 360 Regulations – Stock exclusion

NZ will be divided into lowland areas and other areas.

In lowland areas:

- All lakes and intermittent rivers (but not ephemeral) >1 metre wide, stock is excluded within 12 months for all dairy and dairy support; and within 3 years for other pastoral systems;
- All permanent and intermittent rivers < 1 metre, stock is excluded within 3 years for all dairy and dairy support; and within 5 years for other pastoral systems;
- All wetlands, stock is excluded within 3 years;
- At least a 5 metre setback (averaged across the property with a minimum set back of 1 metre) from rivers and lakes; but no setback from drains;
- 10 years to move existing fencing; and
- An opportunity to apply to reduce setback and/or extend timeframe.

In other areas a risk-based approach is taken, with stock exclusion required where there is:

- Dairy/pig farming unless fully housed;
- Cattle or deer break-fed on fodder crops;
- Cattle or deer on irrigated pasture; and
- Cattle or deer where stocking rate exceeds 14 stocking units/ha.

All stock crossing points require bridge/culvert with two crossings per month permitted without bridge/culvert (exceptions for deer).

### 6.1 Introduction

As with farm environmental planning, good progress has been made on riparian management around the country, and particularly stock exclusion. The financial costs of the working draft proposal for stock exclusion are likely to be highly variable between regions. Pastoral farming is a more important component of some regions than others. Approaches to riparian management are not consistent within and between regions, in part because of the uniqueness of individual waterbodies and their surroundings (MPI, 2016). In general, the regions will fall into two groups: those regions where stock exclusion is well-established and the new proposal will mean shifting fences and extending setbacks, and those where stock exclusion is still developing and can take account of the requirements of the new proposal.

The proposal for stock exclusion replaces a previous draft proposal developed in 2016. The new proposal is in two main parts and has four essential differences to the 2016 version. Broadly, this proposal:

1. expands the types of waterbodies for stock exclusion in lowland areas
2. introduces minimum setbacks from waterbodies;
3. changes the timeframes for stock exclusion in lowland areas; and
4. introduces a risk-based approach for non-lowland areas.



Overall, the new Stock Exclusion proposal appears to be more stringent in lowland areas (increasing financial costs), and less stringent in non-lowland areas (decreasing financial costs). The inclusion of smaller streams appears to follow this research finding:

*On average, the yields of all contaminants increased with increasing stream order in catchments dominated by agriculture (generally lowland and pastoral REC land cover classes). Loads from low-order small streams (<1 m wide, 30 cm deep, and in flat catchments dominated by pasture) exempt from potential fencing regulations accounted for an average of 77% of the national load (varying from 73% for total N to 84% for dissolved reactive P). This means that to substantially reduce contaminant losses, other mitigations should be investigated in small streams, particularly where fencing of larger streams has low efficacy.*

McDowell, Cox and Snelder (2017)<sup>12</sup>

It is understood that “lowland” is still to be defined, but the working concept is “land with an average slope of less than or equal to 5 degrees when measured at the land parcel scale”. If the definition includes rolling land, in addition to flat land, then this will increase the financial costs. If it includes all lowland areas (i.e. no altitude constraint) then it may impact hill and high country farms, which are often mixed slope and have a sizeable proportion of lowland area. Regions may find that there are further financial costs to meet their swimmability targets if more stock exclusion is needed in non-lowland areas where there may be a higher proportion of lower-order streams, and especially in the upper catchments.

For many regions, the national approach to stock exclusion may change, rather than build on existing work. The financial costs of the draft proposal are the establishment and maintenance of fencing and riparian buffers created by the setbacks, and also the need for stock drinking water reticulation and more limited access to waterbodies. Reticulation of stock drinking water can lead to the subdivision of paddocks and some increases in stock numbers in the hill and high country (MPI, 2016)<sup>13</sup>.

The introduction of average minimum setbacks will increase a farm’s “ineffective” area, which may also reduce a farm’s nitrogen and phosphorus losses if the remaining effective area is not intensified as a result. The cost-effectiveness of the setback will depend on how the use of the 5 metre average minimum setback for a farm promotes variable widths between critical source areas and other areas. Use of an across-farm average may add to the complexity. There is also a risk of further costs where attention is focused on the minimum setback distance and it restricts the potential for larger widths on some stream reaches to manage other issues (e.g. biodiversity or carbon emissions).

Where the proposal requires stock exclusion, the financial costs will be determined by the length and type of waterbody, the land use (i.e. types of stock), and how stock exclusion is achieved. Fencing in the lowlands usually has lower labour costs than in the hill and high country, and deer is the most

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<sup>12</sup><https://landwaterpeople.co.nz/wp-content/uploads/2018/02/Consideration-of-proposed-fencing-rules-in-New-Zealand-with-respect-to-contaminant-generation-at-the-national-scale.pdf>

<sup>13</sup><https://www.mpi.govt.nz/dmsdocument/15478-economic-evaluation-of-stock-water-reticulation-on-hill-country>

expensive stock type to fence. Estimates of costs are influenced by assumptions and, while those used for labour and materials for different stock types are reasonably standard, there is large uncertainty around the length of each type of waterbodies and how these relate to land use.

The financial costs will also depend on how much stock exclusion work has already been done and how much it needs to change. For dairy farms, fencing is likely to have been completed for waterbodies > 1 metre on most dairy platforms but there is less for waterbodies on the run-off blocks, and smaller waterbodies and wetlands. Where waterbodies have been fenced, setbacks may be minimal. The extent of stock exclusion from waterbodies on other pastoral land uses is less clear. On drystock farms, fencing is more likely to occur on smaller properties - the length of fencing required on larger farms can be over 100 kilometres, making it very expensive. Stock exclusion is not a one-off cost; additional maintenance costs will be incurred over time.

An MPI stock exclusion cost report (2016)<sup>14</sup> found labour costs vary across fencing contractors in different regions and tend to be cheaper in the South Island, while wooden fencing material costs tend to be cheaper in the North Island. Other fencing materials were the same price within companies across New Zealand, but there were price differences between companies. The tight timeframes in the proposal may create a short-term labour and material constraints, and increase prices. Consequently, any estimates of financial costs may be conservative. These constraints will differ between regions depending on the extent of existing fencing, and the type of livestock.

Depending on how it is achieved, stock exclusion may have future financial costs. MPI (2016) note that “(l)ow volume/flow waterways can become raging torrents during high rainfall events depending on the size of the catchment and their location in it. Careful fence and landscape design may be required to reduce the risk of physical damage to waterways as a result of debris trapped in fence-lines. In these situations, it may be more beneficial to use higher density planting, sediment traps, wetlands, buried drains or a combination of these and stock management strategies to enhance waterway health in the lower catchments.”

In June 2016 Environment Southland moved to introduce stock exclusion requirements, based on the 2016 draft proposal, in the notified version of the Southland Water and Land Plan. At present the Southland Water and Land Plan is under appeal in the Environment Court. It is likely that when the proposed Plan becomes operative, any new proposal for stock exclusion in the Essential Freshwater Package will be added to its existing requirements. In such a situation, the most stringent controls will be the new draft proposal’s requirements in lowland areas and Southland’s existing requirements for dairy, dairy support, deer and beef cattle on slopes greater than three degrees (undulating/rolling and steeper land).

In Southland, the proposed risk-based approach in non-lowland areas may not be particularly relevant: the extent of dairying on hill country is relatively small and likely to be already fenced, and there is little or no pig farming, cattle or deer on irrigated pasture, or relatively intensive cattle or deer. The break-feeding of cattle or deer on fodder crops is captured by existing rules, although the setbacks may differ. The proposed risk-based approach will be more relevant in other regions.

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<sup>14</sup> MPI Stock Exclusion Costs Report (2016) <https://www.mpi.govt.nz/dmsdocument/16537/direct>

## 6.2 Modelling – Mataura (Southland)

To test the financial costs of the new draft proposal for stock exclusion, a Stock Exclusion scenario focusing on setback distances was developed and modelled for the Mataura Freshwater Management Unit in Southland.

The modelling compared the Counterfactual scenario (which includes the proposed Southland Water and Land Plan’s stock exclusion provisions) to a new scenario that adds the additional requirements for lowlands (smaller streams, minimum average setbacks, and new timeframes).

The rules considered contain both more-strict and less-strict requirements for fencing when compared to the Southland Water and Land Plan. On the one hand, it is understood that the new rules do not require the same level of fencing on hill and high country, provided stocking rates are less than 14 stock units per effective hectare. On the other hand, on lowland properties more streams will be required to be fenced as there is no exception for streams less than 1 metre wide.

It was challenging to determine the extent of the implications of these changes in rules for Southland because of:

- Difficulty in mapping streams and identifying those either more or less than 1 metre wide;
- No easily available data on the proportion of streams in lowlands versus hill and high country properties; and the associated stocking rates on hill and high country properties
- Uncertainty around the quantity of existing fencing;
- Uncertainty around the quantity of existing fencing that will be compliant with new regulations; and
- Some incompatibility between the geographic definitions used in the new regulations (e.g. lowlands) with spatial definitions used in Southland datasets and economic models.

It was decided to focus the modelling on the effective land within the setback (i.e. the land being taken out of agricultural production), rather than the fencing costs.

The main setback scenario tested was similar to (but not the same as) the Stock Exclusion proposal:

1. **Stock Exclusion with a 5 metre setback** – For “flat” farms and flat land on “mixed slope” or “large” farms (estimated to be an average of 25% of effective area), streams must be fenced with a 5 metre setback. Fencing must occur by 2023 for dairy and by 2025 for other pastoral systems. If there are more stringent requirements under the Counterfactual scenario then those apply.

An alternative (and hypothetical) setback scenario was also tested in the modelling purely to better understand setback distances:

2. **Stock Exclusion with a 10 metre setback** – This alternative scenario is the same as above except the setback modelled is set at 10 metres rather than 5 metres. **This second scenario is NOT part of the Stock Exclusion proposal in the Essential Freshwater Package NOR is it being promoted by the Regional Sector.**

*The farm classifications used in these scenarios are explained in section 4 and details about land uses in the Maitava Freshwater Management Unit are included in section 7.2.*

There are at least two important caveats in the scenario modelling. At the time of modelling, no definition of lowland was available and it was understood that the lowland provisions applied to all pastoral systems: in the first instance to “dairy and dairy support” and later to “other pastoral systems”. In the Stock Exclusion scenarios:

- The reference to “other pastoral systems” was interpreted as including sheep, which it is now understood to not be the case. It may be possible to do further modelling work to omit sheep but it is complicated by the presence of other stock on these farms.
- The definition of lowland is lowland on all farms, including flat land on hill and high country farms, rather than the Ministry for the Environment’s working concept of lowland properties (i.e. land parcels with an average slope of less than or equal to 5 degrees).

For the modelling of the Stock Exclusion scenarios, the only available existing stream length dataset was that used in the modelling of the Counterfactual scenario. It is uncertain the proportion of streams less than 1 metre wide that is included in this dataset and conversely the proportion that is excluded. Consequently, it was not possible to model the implications of increasing the extent of streams included in the Stock Exclusion proposal. This is a possible area for further work.

In terms of timeframes, there do not seem to be major differences between the Counterfactual and Stock Exclusion scenarios. For the Counterfactual it was already assumed that fencing would be phased in over time, and it is reasonable to assume that the priority will now be given to lowland streams to comply with the earlier timeframe under the new proposal. The main difference is in relation to dairy farms, but most of the dairy platforms are already assumed to be fenced. It is likely that many of these fences will not comply with the new setback widths in either Stock Exclusion scenario, but the extent of non-compliance is unknown and was not assessed.

An important consideration is the loss of land in stream setbacks. Another is the cost of riparian planting if this is required. These aspects were not included in the modelling because of the time constraints but they are also a possibility for further work.

Setbacks are a form of land retirement (i.e. a change from developed to undeveloped land) that reduces the effective areas of a farm. As a result, both sectoral outputs (e.g. milk, lambs) and inputs (e.g. fuel, labour) are assumed to reduce. In calculating the number of hectares retired under the different scenarios the following assumptions are made:

- Existing regional rules (even before baseline) require that where cultivation occurs it is not less than 3 metre from a watercourse – so this restriction was considered;
- While in the Counterfactual scenario cultivation is not allowed near a watercourse, other activities are not prohibited and the setback is not ‘full’ land retirement; and
- The first metre next to a stream is considered to have negligible productive value.

Table 6 gives details on the estimated reductions in effective hectares as a result of the three stock exclusion scenarios for the Maitara Freshwater Management Unit. Only the total land retirement under each scenario is given below (i.e. the final), even though fencing and setbacks will be phased in over time. For the Stock Exclusion (5 metre setback) scenario, which is the scenario closest to the proposal, the estimated decrease in total effective area is 1,785 hectares. To give some context, this result represents less than 1% of agriculture’s total effective area on flat land in the Maitara Freshwater Management Unit. The corresponding annual changes to value added for the pastoral industries (i.e. dairy, sheep and beef, and deer) in the Maitara are -\$1 million in 2023, and then -\$2 million from 2025 onwards (in \$2015).

**The results are dependent on how “lowland” is interpreted – here it was represented as lowland on all pastoral farms but in the Stock Exclusion proposal it may just be lowland pastoral farms.**

The scenarios are a “first cut” and further modelling work can be done if required to test variations around the definition of lowland, timing, and adoption rates (low, medium and high). Other work may also consider the proposal relating to the costs of fencing, bridges and culverts.

**Table 6: Land area in setbacks under Stock Exclusion scenarios for the Maitara Freshwater Management Unit**

<b>Industry</b>	<b>Farm type</b>	Counterfactual (eff. ha)	<b>Stock Exclusion 5m setback (eff. ha)</b>	Stock Exclusion 10m setback (eff. ha)
<b>Dairy</b>	Mixed slope	3	<b>7</b>	14
	Flat	71	<b>475</b>	1,156
<b>Sheep and Beef</b>	Large farms	24	<b>59</b>	117
	Mixed slope	27	<b>67</b>	131
	Flat	122	<b>804</b>	1,959
<b>Deer</b>	Large	13	<b>31</b>	62
	Mixed slope	7	<b>18</b>	35
	Flat	49	<b>328</b>	800
<b>Total</b>		317	<b>1,785</b>	4,273

**Note – rounding in the figures for each industry may mean their sum differs from the totals.**

## 7 On-farm nitrogen cap

### NESFM – Nitrogen Cap

Interim regulations in catchments without rules and where there are 'highly nitrogen impacted waterbodies' (described via criteria or listed catchments).

- Farm environment plans to determine discharges (using Overseer where possible) and farm inputs across catchment;
- Identify those with the highest nitrogen discharges;
- Set a percentile (75% or 85%) threshold for N-leaching for the catchment; and
- Resource consent will be required for landowners above the threshold.

A different approach is taken for vegetable growers.

A consent is required for those above the identified threshold for high nitrogen leaching, and provision of a farm environment plan and Overseer budget will be a requirement.

This provision is dependent on information from individuals or from dairy processors (Fonterra).

An option also being considered is applying a fertilizer input cap.

### 7.1 Introduction

Different allocation methods create various distributional impacts, both within and between agricultural industries, and consequently across people and communities in a catchment. Where there are strong economic connections between agricultural industries, the financial costs will quickly flow through a local economy: for dairy these connections usually occur off-farm, and for drystock and arable they tend to occur on-farm. The main drivers in a farm's nitrogen loss are the land use activity and the land's biophysical characteristics (especially soil drainage and rainfall).

The Nitrogen Cap proposal is intended to target poor environmental practices within a group or "cohort" of farms on land with similar biophysical characteristics – rather than all farms across a catchment, which would target their land use and biophysical characteristics. The proposal appears to assume that the farms with relatively high nitrogen losses within a group are there because of their poorer environmental practices, which given variability in natural systems, may not be the case. As well, while some farmers are able to achieve good environmental and financial performance, there is no clear relationship between nitrogen loss and farm profitability within a land use. Consequently, a higher nitrogen loss farm within a lower loss grouping may be either a high profit farm or a low profit farm. Appendix 3 gives details on the lack of a clear relationship between nitrogen loss and farm profitability.

To a large extent, the financial costs of the Nitrogen Cap proposal will be driven by the mitigations available in Overseer, which is narrower than the full set of relevant mitigations. Except for reducing excess fertiliser use there are few mitigations that make a difference to farm nutrient loss in OVERSEER® that do not also reduce its profitability. There are many cost-effective technologies available, such as peak flow control structure, but their usefulness is dependent on how well they are

represented in Overseer (if at all). If the use of Overseer incentivises less cost-effective mitigations then it is likely to be a sub-optimal solution.

Within a land use, there is variability in farm nitrogen losses and profitability between regions. The Sustainable Dairying: Water Accord reports on nutrient management, including average nitrogen loss for dairy by region:

*Since the Accord's launch the sector has been steadily building a comprehensive dataset on nitrogen (N) loss and N use efficiency. The data generated by the 2016/17 audit has been included in the dataset and used to produce the regional average N leaching loss data. The observed variance in regional N leaching loss is a function of several factors, including soil type, drainage characteristics (including rainfall and/or irrigation) and farming practices. This data has also been used to derive a national average N-loss which is 41 kg N/ha/yr and is a slight increase on the 39 kg N/ha/yr reported last season.<sup>15</sup>*

Table 7 gives the dairy farm average per hectare nitrogen loss by region as reported in the Sustainable Dairying Water Accord Progress Report 4.

**Table 7: Regional average nitrogen leaching loss and sample size across 13 regions for 2016/2017**

Region	Average nitrogen loss (kg N/ha/yr)	Sample size (number of farms)	Rolling average over last four seasons*(kg N/ha/yr)
Northland	26	825	24
Auckland	21	262	20
Waikato	35	3,735	35
Bay of Plenty	44	638	43
Gisborne/Hawke's Bay	38	81	36
Taranaki	54	1,565	53
Manawatu	31	803	29
Wellington	37	167	34
Tasman	73	111	71
Nelson/Marlborough	37	47	40
Canterbury	59	1,143	58
Otago	38	399	38
Southland	35	851	34

\* The rolling average nitrogen loss is calculated by taking the annual results as processed through the relevant version of Overseer at that time. It is not a true weighted average; it is an average of individual farm results.

\*\* The West Coast had only two farms reported this season so the average nitrogen loss has not been reported to protect the anonymity of the farmers' information and because it is a small sample size.

<sup>15</sup> <https://www.dairynz.co.nz/media/5791340/water-accord-progress-report-4-years-on-dnz-40-011-web.pdf>

It is unclear how nitrogen leaching from horticulture will be included because Overseer is not suited to this sector. In the Bay of Plenty the Kaituna-Maketū and Waihi estuary catchments have about 215 pastoral farms but 1,000 kiwifruit or other horticultural blocks. In Southland there are a handful of horticulture and tulip bulb growers that tend to rotate around the suitable soils on blocks of land leased from drystock farms.

## 7.2 Modelling – Mataura (Southland)

To build understanding around the proposal for a nitrogen cap, a range of Nitrogen Cap scenarios were developed and modelled for the Mataura Freshwater Management Unit in Southland. The intent of the Nitrogen Cap proposal is to reduce excessive nitrogen leaching caused by poor practice until longer term measures are in place. The proposal uses a 75<sup>th</sup> percentile concept based on that used in proposed Plan Change 1 and Variation 1 to the Waikato Regional Plan (Healthy Rivers).

The Ministry for the Environment supplied James Allen’s (AgFirst Waikato) statement of evidence for Fonterra Co-operative Group Ltd. on the proposed methods to manage nitrogen. Appendix 4 includes summary comments from this evidence and a link to the statement of evidence in full, which contains explanatory graphs.

For the scenario modelling, the Ministry for the Environment (5<sup>th</sup> July) also supplied the following advice and questions, some of which have been able to be built into the first round.

- *Vary the percentiles (e.g. 70%, 80%, 90%);*
- *Vary the time allowed to reach the threshold (e.g. require consents in 2022 and reach threshold in either 2025 or 2027);*
- *Test also applying a nitrogen cap to dairy support;*
- *Look at how horticulture fits in relation to the dairy distribution;*
- *Test a 10% reduction in nitrogen for farms well in excess of the threshold that are unable to reach the threshold in 5 years while remaining viable;*
- *Do some types of dairy farms need a high threshold because of specific characteristics e.g. winter milk suppliers?*
- *What are the step-wise actions - needed to reach the threshold?*
- *What are the impacts on highly indebted farms vs. debt-free farms?*
- *What is the nature of the farms over a threshold (e.g. dairy system, demographics, farm size)?*

The Ministry for the Environment’s advice helped inform the modelling scenarios and commentary below. In general terms, the scenarios modelled were designed to test the intent of the nitrogen cap (i.e. reducing nitrogen loss from poor practice) for dairy and higher loss drystock (i.e. including dairy support). Multiple scenarios (described below) were modelled to build understanding of how different allocation methods play out.

**The scenario modelling has focused on applying the 75<sup>th</sup> percentile concept to dairy farming in the Mataura Freshwater Management Unit. The modelling also investigated some other allocation**



methods for dairy and drystock. It has not applied the 75<sup>th</sup> percentile concept across agricultural land, largely because of the complexity of the task. However, the analysis has considered how this proposal may play out, and whether it is likely to achieve its intent (i.e. reducing excessive nitrogen leaching caused by poor practice until longer term measures are in place).

### The Mataura Freshwater Management Unit

The Matāura FMU covers around 640,000 hectares and it is the second largest developed FMU in Southland. Around 550,500 hectares, or 86% of the land, is developed (the highest percentage of any FMU in the region) and there are large areas of public conservation land. It is also the second most populated FMU with about 18,035 residents (or 2.8 people/km<sup>2</sup>). The FMU lies within Southland and Gore Districts and towns include Edendale, Wyndham, Waikaia, Gore and Matāura with water takes, wastewater and/or stormwater schemes. The FMU has mostly dairy farming on the plains and a mix of drystock properties in the hills. It also includes several large high country stations that straddle the regional boundary with Otago and include Crown Pastoral Lease Land. Table A5 gives estimates of land use activities for the Matāura FMU.

In 2016, the estimated land use in the Mataura Freshwater Management Unit was as follows:

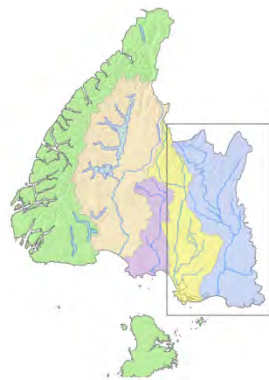
- **Dairy and dairy support** land accounted for 87,100 hectares over 471 properties. This area was 15.8% of total land in the Mataura, and 33.1% of dairy and dairy support land in Southland.
- **Sheep and beef** land accounted for 392,400 hectares over 1,062 properties. This area was 71.3% of total land in the Mataura, and 51.5% of sheep and beef land in the region.
- **Deer** land accounted for 13,300 hectares over 35 properties. This area was 2.4% of total land in the Mataura, and 30.7% of deer land in the region.

Table 8 gives estimates of the land use activities for the Mataura FMU. Figure 7 shows the distribution of land uses within the Matāura Freshwater Management Unit.

**Table 8: Agriculture, forestry and urban areas in the Matāura FMU**

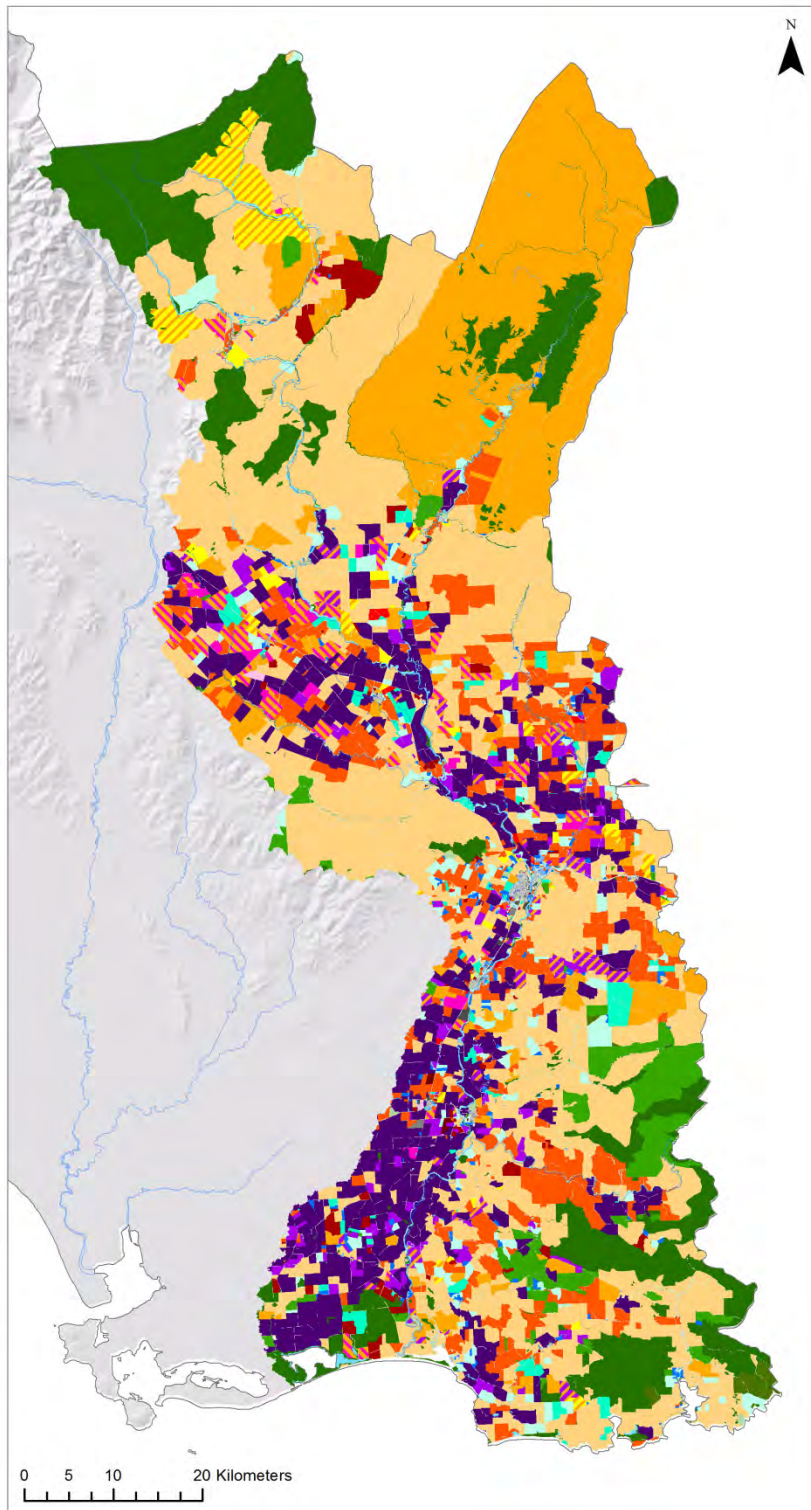
Land Use	Total land in FMU (ha)	Share of developed land in FMU	Share of total land use in region that is present in this FMU	Number of properties in FMU
Sheep and beef	392,399	71.3%	51.5%	1,062
Dairy (incl. support)	87,083	15.8%	33.1%	471
Deer	13,294	2.4%	30.7%	35
Arable	12,522	2.3%	53.5%	66
Horticulture	232	0.0%	46.1%	10
Other	16,394	3.0%	-	1,051
Forestry	18,139	3.3%	19.4%	87
Urban	10,397	1.9%	22.6%	6,958
<b>Total</b>	<b>550,460</b>	<b>100.0%</b>		<b>9,740</b>

Source: Southland Land Use Map, Pearson and Couldrey (2016)



**Land Use**

- Conservation
- Recreation and Tourism
- Plantation Forestry
- Indigenous Forestry
- Beef
- Sheep
- Specialist Deer
- Sheep and Beef
- Mixed Livestock (sheep, beef, deer)
- Majority Deer with Mixed Livestock
- Other Animals
- Dairy
- Livestock Support
- Dairy Support
- Dairy Sheep
- Dairy Support and Other Livestock
- Arable
- Mixed Livestock and Arable
- Horticulture
- Flower and Bulb Growers
- Nurseries and Orchards
- Small Land Holding
- Lifestyle
- Industry and Airports
- Commercial Use
- Residential Use
- Public Use
- Unknown Land Use - Pastoral
- Unknown Land Use - Indigenous Cover
- Unknown Land Use - Non-agricultural
- Lakes and Rivers
- Road and Rail



**Figure 7: Land use within the Matāura FMU**  
 Source: Southland Land Use Map, Pearson and Couldrey (2016)

## Southland dairy farms

The 41 dairy farms in The Southland Economic Model were selected from broad areas across the region: lower Waiau, Te Anau Basin, Southland Plains, and Mataura. Within each area the dairy farms covered four groups (or cohorts) based on the land's biophysical characteristics: wet or dry (above and below 1,000mm), and poorly drained or well-drained. Had this work been done in other regions, such as Canterbury, Otago or the Manawatu, then an additional "irrigated" group may have been considered. In other words, the need for irrigation would have been treated more as a biophysical characteristic of a farm than a management practice. In Southland only a handful of the dairy farms surveyed had irrigation, but those that did tended to have relatively high nitrogen leaching on free draining soils.

The different biophysical characteristics (e.g. soil and rainfall) of land roughly locate the farm groupings to general localities. In the Mataura, dry farms tend to be in the upper Mataura (on the Waimea Plains north of Gore) and lower Mataura (on part of the Southland Plains south of Gore). Similarly, dry well drained farms and dry poorly drained farms tend to be in specific localities in the upper Mataura, just as the wet well drained farms and wet poorly drained farms are in the lower Mataura. An implication of the spatial nature of land's biophysical characteristics is that, in freshwater management areas where there is strong variability in climate and soil drainage, a nitrogen cap on the highest nutrient loss activities may concentrate its impacts on particular communities.

Of the 41 dairy farms, 14 farms were from the Mataura Freshwater Management Unit; with seven farms situated on predominately poor or imperfectly drained soils and seven farms on predominantly well or moderately well-drained soils. Six farms were classed as Upper Mataura and eight were classed as Lower Mataura (the split was north and south of Gore). Rainfall ranged from 802 mm per year to 1,378 mm per year. The six farms in Upper Mataura all receive below 1,000 mm of rain per year in comparison to the eight farms in Lower Mataura that were above 1,000 mm per year. Only two farms were irrigated. All system types were represented with nine medium input farms, three high input farms and two low input farms.

Table 9 gives average nitrogen losses and farm sizes for the eight dairy groups within the Mataura – in this context the distinction between mixed slope farms and flat farms is only relevant to the total area, not nitrogen loss. The group with the largest average farm size (wet/poorly drained) has the lowest nitrogen loss and the group with the second largest average farm size has the highest nitrogen loss. Both between groups and within a group, the size of a dairy farm is not considered to be relevant to its nutrient losses (this is in contrast to the drystock farms).

The 14 dairy farms ranged in size from 146 to 717 eff. ha (milking platform) and had stocking rates from 2.1 to 3.2 cows per eff. ha (an average of 2.8 cows per eff. ha). Their production ranged from 763 to 1,546 kg milksolids per eff. ha (milking platform) (an average of 1,168 kg of milksolids per eff. ha). Nine farms had support blocks (owned or leased), ranging in size from 32 eff. ha to 558 eff. ha., and these were included in the modelling. On average, the 14 farms had an ineffective area equal to 10% of their effective milking platform and support block land area. Thirteen of the farms grew crops (summer and/or winter) - with a range from 1% to 16% of effective land area (milking platform and support block) used for cropping. The effluent application area ranged from 14% to 100% of the effective milking platform, with an average of 118 hectares (or 38%).

Table 9: Mataura dairy farm nitrogen loss and farm size

Slope class	Zone	Total area (ha in 2015)	Weighted average nitrogen loss (kg N / total ha)
Mixed slope	Well drained/wet	373	44
	Poorly drained/wet	147	25
	Well drained / dry	438	47
	Poorly drained / dry	442	31
Flat	Well drained / wet	11,647	44
	Poorly drained /wet	15,350	25
	Well drained / dry	11,058	47
	Poorly drained /dry	7,653	31

For the 41 dairy farms a systems approach was used for the dairy modelling, rather than “mitigation bundles” or a “menu” of mitigations. DairyNZ documented the mitigation modelling for all 41 farms. In this approach each farm is taken on its merits (i.e. it is not optimised first). The modeller considers the existing farming operation and tests adjustments in its inputs to determine the series of most cost-effective actions that flow across and into each other. For example, reducing supplementary feed may either mean less production or a reduction in cows. Farmer feedback on the dairy modelling was that reducing cows is well down the order in terms of priority.

The dairy modelling did not include barns or constructed wetlands because information was not collected about the lie of the land or farmer’s attitudes towards these capital investments, but they are still a possible mitigation option. The main driver for investment in a barn is usually a desire for more control over the production system.

In the dairy modelling, a milk price of \$6.50 was used to reflect the longer-term average price and long term expectations. It is based on the average price received including dividend payments for owner operators for the five years prior to, and including, the season modelled (2013-14), as well as the forecast milk price for the two seasons after this.

Details on the 46 drystock farms (sheep, beef and deer) are available in Moran *et al.* (2107) <https://contentapi.datacomsphere.com.au/v1/h:es/repository/libraries/id:1tkqd22dp17q9stkk8gh/hierarchy/Scientific%20reports/Agriculture%20and%20Forestry%20Report.pdf>

The drystock modelling used the farm prices and costs from 2013-14. A single year was used because of the complexity involved with multiple enterprises. From 1990-91 to 2016-17, inflation-adjusted lamb prices have increased steadily by a compound rate of 2.6% each year, which is about the same rate as the farm-gate milk price. Lamb prices have been generally less variable than milk prices.

Figure 8 shows the distribution of estimated nitrogen losses for 84 drystock (sheep and beef, deer) and dairy farms across Southland in 2013-14 using OVERSEER version 6.2.1. In both cases, the set of farms tends to be skewed towards the lower end of the distribution curve, particularly for drystock, but the upper 25% of nitrogen loss rates is likely to be wide – meaning that the highest lost farms may have some distance to cover to reduce to the 75<sup>th</sup> percentile.

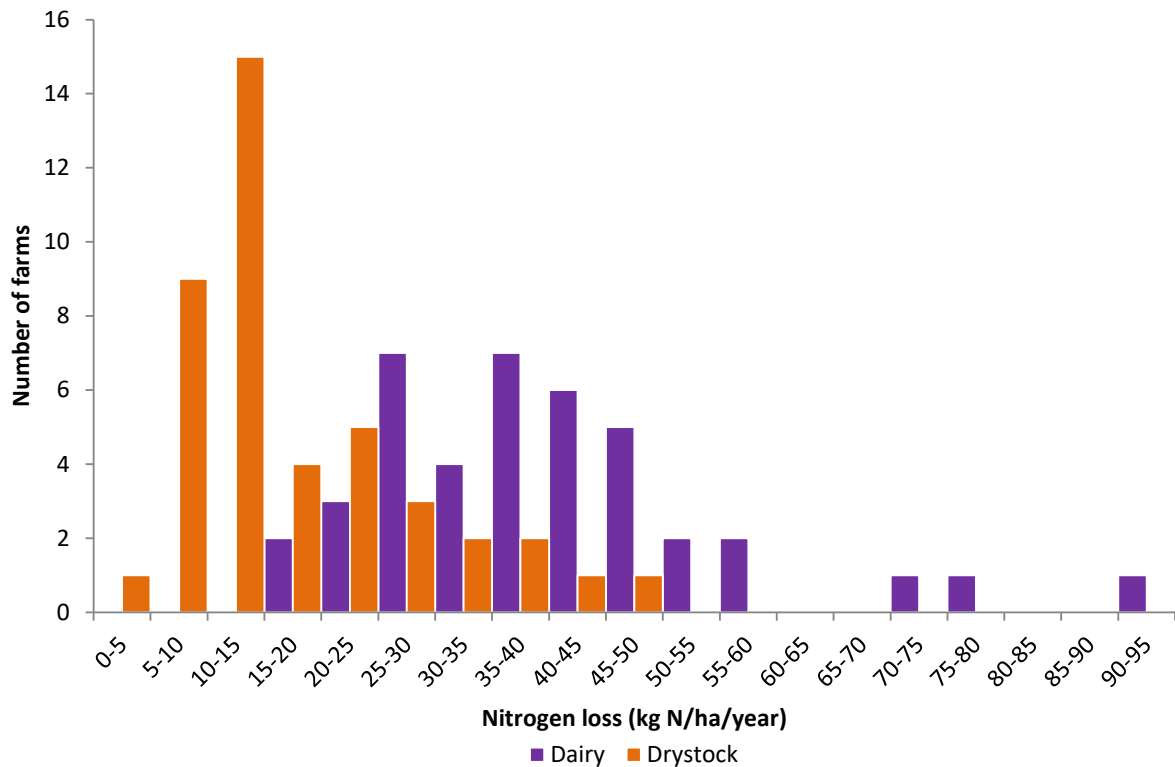


Figure 8: Nitrogen loss for 84 Southland farms by industry in 2013-14 (using OVERSEER Version 6.2.1)

For the 41 dairy farms modelled the main factor in a farm’s nutrient loss was (unsurprisingly) its soil drainage characteristics. For the 36 sheep and beef farms modelled there were at least four factors that appear to be related to nitrogen loss: farm size, the presence of dairy cows, and to a lesser extent, the proportions of ineffective area or effective area in crop.

Figure 9 shows the distribution of estimated nitrogen losses across the 84 Southland pastoral farms for 2013-14 (i.e. dairy and drystock shown in Figure 8 combined). For the Nitrogen Cap proposal, distributional curves will be needed on land with similar biophysical characteristics. Of the total land in the Maitava (86% of which is developed land), 31% is considered poorly drained (Drainage Classes 1-3) and 69% is well drained (Drainage Classes 4 and 5). The Maitava tends to be drier in the north and wetter in the South, particularly around the Catlins near the coast. The Riversdale area on the Waimea Plains (north of Gore) is the driest part of Southland and in this area mean annual rainfall is around 700mm.

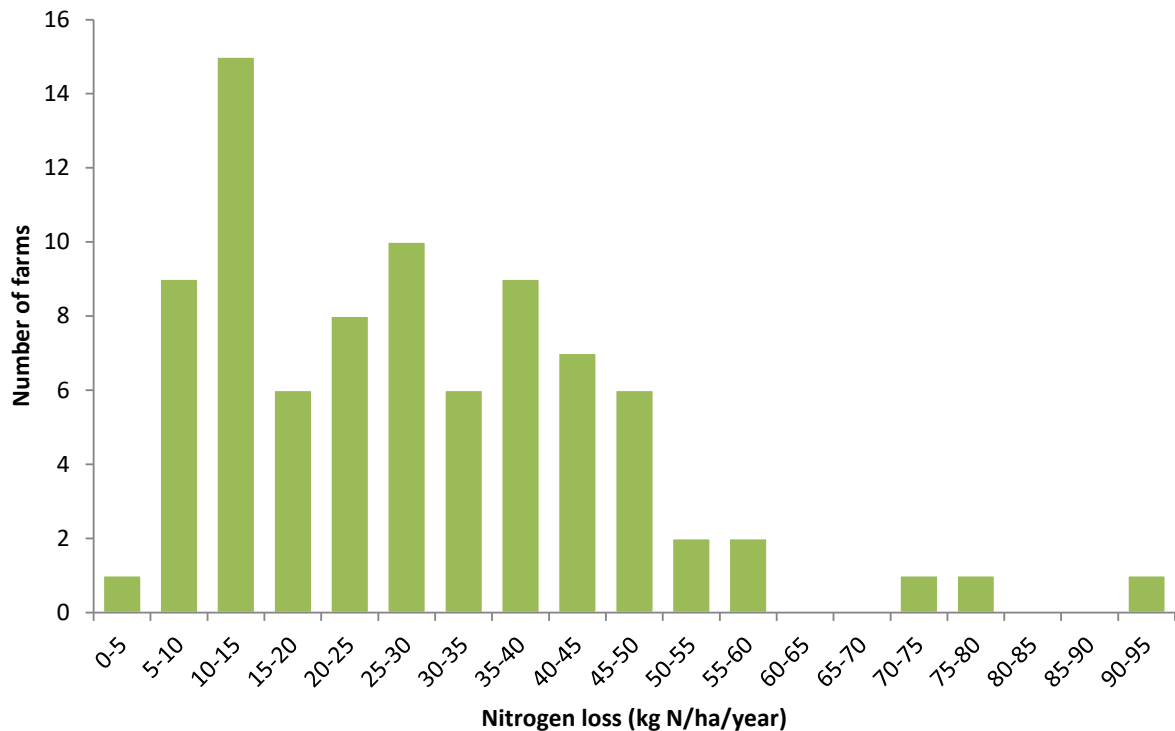


Figure 9: Nitrogen loss across the 84 Southland pastoral farms in 2013-14

### Nitrogen Cap scenarios

The scenarios modelled were designed to test the intent of an initial nitrogen cap for dairy and higher loss drystock rather than the exact Nitrogen Cap proposal. There were a range of reasons for this approach, including:

- Although extensive farm system modelling has been undertaken, mitigation modelling is not available for all farms in Southland and other farms must be approximated;
- It is uncertain how the Nitrogen Cap proposal may be allocated among different farm types and different soil/rainfall/physiographic types, which are usually a more important factor than management practices;
- Even for the 84 farms, only a subset of relevant mitigations was modelled in Overseer. Potentially, some farmers may need to undertake more advanced mitigations that have not been modelled (i.e. those that require capital investment such as wetlands or barns);
- For reasons of confidentiality, the farms within the dairy industry were aggregated into a weighted average “farm” that represented each of 10 different economic zones within Southland. Designing scenarios where nitrogen reductions are specified as an absolute target, specific mitigations, or it applies to only some of the farms within a zone can be problematic.

In total 10 Nitrogen Cap scenarios were identified as potentially useful to help build understanding around financial costs. These scenarios test different ways to estimate the intent of the Nitrogen Cap proposal, as well as different adoption rates and timeframes. Some scenarios include drystock farms, including one scenario that uses sheep and beef farms with nitrogen losses over 25 kg N/ha/year as a proxy for dairy support. Table 10 gives the technical detail of each scenario.

Scenarios 3.1 and 3.2 are the closest to applying the 75<sup>th</sup> percentile concept to a specific land use on land with similar biophysical characteristics.

For clarity, Scenario 3.1 applies:

- A 20% nitrogen reduction to 25% of dairy land in the dry-well drained zone, and
- A 10% reduction to 25% of dairy land each of the other 3 zones.
- The rule is notified in 2022, farmers start adopting mitigations in 2023, and the requirement is achieved in 2025.

Scenario 3.2 is exactly the same as above except that it uses a slightly longer time period: the rule is notified in 2022, farmers start adopting mitigations in 2025, and the requirement is achieved in 2027. It is understood that these timeframes align with those being considered in the Nitrogen Cap proposal.

However, Scenarios 3.1 and 3.2 only apply the 75<sup>th</sup> percentile concept to dairy, unlike the Nitrogen Cap proposal which applies it across all agricultural land uses (except horticulture) on land with similar biophysical characteristics.

Scenarios 4.1 and 4.2 are the closest to applying the 75<sup>th</sup> percentile concept across land uses on land with different biophysical characteristics.

For clarity, Scenario 4.1 applies:

- Requires all dairy farms with nitrogen losses above 45kg N/ha to use mitigations until they reach this threshold.
- The rule is notified in 2022, farmers start adopting mitigations in 2023, and the requirement is achieved in 2025.

Scenario 4.2 is exactly the same as above except that the requirement to use mitigations until a threshold is reached also applies to drystock farms with nitrogen losses above 25kg N/ha.

**These scenarios are similar in intent, but do not fully capture, the Nitrogen Cap proposal, which applies across agricultural land and appears extremely challenging to model. Further work on this proposal is being undertaken.**

Table 10: Nitrogen Cap scenarios

Scenario Number	Description of Scenario
1.a.1	All land uses in Matura must reduce by 10%, except if already under 10kg/ha no reduction required. Rule notified 2022, people start adopting 2023, achieved 2025. Medium adoption rate.
1.a.2	All land uses in Matura must reduce by 10%, except if already under 10kg/ha no reduction required. Rule notified 2022, people start adopting 2025, achieved 2027. Medium adoption rate
1.b.1	All land uses in Matura must reduce by 10%, except if already under 15kg/ha no reduction required. Rule notified 2022, people start adopting 2023, achieved 2025. Medium adoption rate
1.b.2	All land uses in Matura must reduce by 10%, except if already under 15kg/ha no reduction required. Rule notified 2022, people start adopting 2025, achieved 2027. Medium adoption rate
2.1	All land uses above 30kg/ha in Matura need to make 10% reduction. Rule notified 2022, people start adopting 2023, achieved 2025. Medium adoption rate
2.2	All land uses above 30kg/ha in Matura need to make 10% reduction. Rule notified 2022, people start adopting 2025, achieved 2027. Medium adoption rate
3.1	25% of dairy land in Matura dry-well drained zone must reach a 20% reduction in N loss. 25% of dairy land in other zones must achieve a 10% reduction. All other dairy land can stay at current losses. Rule notified 2022, people start adopting 2023, achieved 2025. Medium adoption rate
3.2	25% of dairy land in Matura dry-well drained zone must reach a 20% reduction in N loss. 25% of dairy land in other zones must achieve a 10% reduction. All other dairy land can stay at current losses. Rule notified 2022, people start adopting 2025, achieved 2027. Medium adoption rate
4.1	All dairy farms in Matura must reach 45kg/ha (this cannot be applied directly in model - see notes below). Rule notified 2022, people start adopting 2023, achieved 2025. Medium adoption rate
4.2	All dairy farms in Matura must reach 45kg/ha (this cannot be applied directly in model - see notes below). Any drystock farms in Matura with greater than 25kg/N must reduce to 25kg/N per ha - if none of the mitigations modelled reach this level they must apply the mitigation modelled that achieved the greatest loss reduction. Rule notified 2022, people start adopting 2023, achieved 2025. Medium adoption rate

The following tables report the estimated impacts on pastoral sector value added, and the estimated changes in nitrogen loads generated under these ten scenarios. Table 11 gives the results for the dairy and drystock industries in the Matura. More detailed results are available and further work can be done to understand the wider economic impacts. By 2030, Scenarios 3.1 and 3.2 (the closest interpretation to the 75th percentile concept) have the highest cost for the dairy industry of the 10 scenarios modelled. By 2030 the annual net change in value added for the dairy industry is -\$17 million (\$2015), or -7% in value added for a 9% reduction in nitrogen loss.



**Table 11: Annual results by industry in Maitara for Nitrogen Cap scenarios by 2030**

Scenario	Industries directly impacted	Net change in industry value added (\$2015)	% change in industry value added	% change in industry nitrogen loss
1.a.1 and 1.a.2	Dairy	-11 million	-5%	-8%
	Drystock	-31 million	-15%	-13%
1.b.1 and 1.b.2	Dairy	-11 million	-5%	-8%
	Drystock	-14 million	-7%	-10%
2.1 and 2.2	Dairy	-8 million	-4%	-6%
	Drystock	-4 million	-2%	-4%
3.1	Dairy	-\$17 million	-7%	-9%
3.2	Dairy	-\$17 million	-7%	-9%
4.1	Dairy	-\$10 million	-4%	-8%
4.2	Dairy	-\$10 million	-4%	-8%
	Drystock	-\$2million	-1%	-3%

Note – The scenarios sets (1.a.1 and 1.a.2), (1.b.1 and 1.b.2), and (2.1 and 2.2) are all variations in implementation timeframes so there is no difference within each set by 2030.

Table 12 gives the results for the pastoral industries in the Maitara as a whole. When considered across pastoral, by 2030 Scenarios 3.1 and 3.2 have a -4% net change in value added and -4% change in nitrogen loss. Other scenarios are likely to achieve similar reductions in nitrogen loss for less financial cost – notably scenarios 4.1 (all dairy farms must reduce to 45 kg N/ha/year) and 4.2 (the same as 4.1 but also drystock farms must reduce to 25 kg N/ha/year). In these scenarios, it appears that focusing on the higher nutrient loss farms within groups of similar biophysical characteristics is less cost-effective than focusing on farms with higher nutrient losses overall.

**Table 12: Annual results for the pastoral farming in Maitara of Nitrogen Cap scenarios by 2030**

Scenario	Industries directly impacted	Net change in pastoral value added (\$2015)	% change in pastoral value added	% change in pastoral nitrogen loss
1.a.1 and 1.a.2	Dairy and drystock	-\$42 million	-10%	-10%
1.b.1 and 1.b.2	Dairy and drystock	-\$25 million	-6%	-9%
2.1 and 2.2	Dairy and drystock	-\$12 million	-3%	-5%
3.1	Dairy only	-\$17 million	-4%	-4%
3.2	Dairy only	-\$17 million	-4%	-4%
4.1	Dairy only	-\$10 million	-2%	-3%
4.2	Dairy and drystock	-\$12 million	-3%	-5%

Note – The scenarios sets (1.a.1 and 1.a.2), (1.b.1 and 1.b.2), and (2.1 and 2.2) are all variations in implementation timeframes so there is no difference within each set by 2030.

Of the 10 scenarios modelled, the one with the highest cost overall is scenario 1.a.1 (all land uses achieve a 10% reduction in nitrogen unless under a cap of 10 kg N/ha/year). This scenario applies to the largest land area and appears to disproportionately impact drystock farming (-\$31 million (\$2015)). Over all pastoral industries, the net annual change in value added is -\$42 million (\$2015) for a 10% reduction in nitrogen loss. When the cap is increased from 10 to 15 kg N/ha/year (scenario 1.b.a) the change in value added drops to -\$25 million for a 9% reduction in nitrogen loss across pastoral.

Under the scenarios 1.a.1 and 1.a.2, the change in nitrogen loss achieved by drystock farms is higher (-13%) than what was required under the scenario (-10%). This result is because only a limited number of mitigations were able to be tested for drystock farms in Overseer. In this modelling the mitigations selected are those that will meet the target most easily, but these may also go beyond the policy target.

For example, sheep and beef farm #31 (a farm with 1,000 total hectares and a baseline of 29 kg N/ha/year) has three potential mitigation options to reduce its nitrogen losses:

1. Change nutrient inputs -2% N/ha/year.
2. Change crop policy -19% N/ha/year.
3. Change stock units -7% N/ha/year.

In this case the second mitigation must be selected because it is the only one that will get to 10%, even though it achieves a far greater nitrogen loss reduction. Consequently, it still appears that a 10% reduction in nitrogen losses will have a quite substantially higher impact on industry value added, in percentage terms, for drystock farms compared to dairy farms.

In delaying the policy achievement date, farmers are afforded more time to generate value add from their farm businesses. Such income can be directed towards debt repayment and various other goals. The loss of nitrogen is an externality from farms and delay may create additional environmental costs. It may also increase the nitrogen percentage reduction that is ultimately required to meet limits and achieve freshwater objectives.

The scenario modelling is a “first cut” and further work can be done to test variations around the percentiles, timing, and mitigation adoption rates. The modelling outputs include results for nitrogen surplus (a measure of nitrogen use efficiency), which may be a useful area for further work.

### 7.3 Trends in farm debt

No new analysis has been undertaken on the impact of these proposals on farmers’ ability to service debt or the financial viability of farms. Nevertheless, it is worth considering trends in farm debt. In May 2019 the Reserve Bank<sup>16</sup> noted that New Zealand’s financial system “remains vulnerable to severe, unlikely risks that could cause many highly indebted New Zealand households and dairy farms

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<sup>16</sup> Reserve Bank (2019). Financial Stability Report. Accessed <https://www.rbnz.govt.nz/-/media/ReserveBank/Files/Publications/Financial%20stability%20reports/2019/fsr-may19.pdf?revision=47e0d60a-bdca-4fbb-bddc-2ad9f20a4b2d>

to default". The Reserve Bank also noted about a third of dairy debt is held by farms with high debt-to-income ratios, and that 'many of these farms struggle to make profit and repay debt, despite good milk prices.' In recent years, dairy industry debt increased by around \$2 billion per year, from \$11 billion in 2003 to \$41 billion in 2019, with especially rapid growth prior to the 'global financial crisis' (GFC). This increase was driven by the expansion of dairying in the South Island (particularly Canterbury and Southland), along with amalgamations and capital development on older dairy farms in the North Island.

Over the same period, milk production grew at a rate of 51 million kilograms milksolids per year - less than half the growth rate of debt levels. That is, on a per kilogram milksolids basis, debt has more than doubled from around \$10/Kg MS in 2003 to \$22/Kg MS in 2019. This implies an increasing share of returns have been required to service debt. The additional financial pressures have, however, been somewhat eased by the low interest rates prevailing since the GFC.

The overall increase in debt levels is not spread evenly amongst farms. DairyNZ data<sup>17</sup> shows that 3% of farms had little or no debt, while 15% of farms had debt of over \$40/kg MS. While milk prices are in excess of \$6 per kilogram milksolids and interest rates remain low, it is thought that relatively few dairy farms are experiencing financial distress. At the same time policy driven by banks and the Reserve Bank is requiring farms to repay principle, a move from interest only with the overall outcome more pressure on liquidity and less cash available for development (including environmental upgrades and infrastructure).

Debt levels on their own may not be a major issue, but in combination with farm expenditure, milk prices and land values, could lead to considerable liquidity and financial stress, eventually leading to forfeit of loans or bankruptcy. In the 12 months to June 2019, the median market price per hectare for dairy farms has fallen 21.5 percent<sup>18</sup>. The reductions in market prices may impact on the ability of dairy farmers to access debt or refinance. Over the same period, market prices for finishing and grazing farms have increased by 17.8% and 7.6% respectively. A good understanding of debt levels across the agricultural sector is needed, particularly in relation to the market values for land.

Farm businesses have long been exposed to significant market risks from fluctuations in exchange rates and commodity prices – at least since the market reforms beginning in 1984. Farming trends (e.g. the growth in dairying, the decline in sheep farming, and the increased level of indebtedness) have generally been responses to market-driven incentives. However, the accumulation of debt has made them considerably more vulnerable to these fluctuations and reduces the threshold at which they result in ruin for businesses. This is the background against which the Essential Freshwater reforms will occur.

The types of impacts identified in this report, such as reduced profitability, business failures and land use change will have substantial impacts beyond the agricultural sector. Analysis is needed to understand the outcomes for wellbeing at the regional and national scales.

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<sup>17</sup> See: <https://www.dairynz.co.nz/publications/dairy-industry/dairynz-economic-survey-2017-18/>.

<sup>18</sup> Real Estate Institute of New Zealand (2019). Softer Winter – Harder Market (Media release) <https://www.reinz.co.nz/Media/Default/Statistic%20Documents/2019/Rural/June/REINZ%20Rural%20Press%20Release%20-%20June%202019.pdf>

## Appendix 1      RSWS Advice Note – The DIN “bottom line”

Emma Moran (Senior Policy Analyst / Economist, Environment Southland)

### Introduction

Tin June 2019, the Regional Sector Water Subgroup requested an economic assessment of the Science and Technical Advisory Group (STAG)’s attribute tables for assessing in-stream concentrations for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP)), and specifically, the proposed national bottom-lines.

The STAG has designed these new attribute tables for Ecosystem Health – a compulsory national value in the National Policy Statement for Freshwater Management 2014 (2017) – and they are intended to replace the existing nitrate and ammonia toxicity attribute tables. The STAG report explains that “nationally applicable dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) tables will capture ecosystem effects in soft-bottomed waterways not captured by the periphyton attribute”.

The STAG recommends two changes to the NPSFM 2014 (2017): retaining the periphyton attribute table (including the explanatory note directing councils to set DIN and DRP exceedance criteria); and removing a separate set of bands for productive river classes. The STAG also proposed adding a default DIN and DRP exceedance criteria table for use where FMU specific criteria have not been derived. There is a clear process by which DIN and DRP objectives, exceedance criteria and limits are to be set.

The approach in the economic evaluation was, in essence, to measure the economic impacts of changing from the bottom lines for Ecosystem Health in NPSFM 2014 (2017) to the STAG’s proposed bottom lines for DIN and DRP in the Maitara Catchment and the Selwyn – Te Waihora Catchment (with all other things being equal).

### Establishing the current baseline and the DIN alternative

The evaluation work started with the Maitara Catchment, and the first step was to consider the baseline scenario for the existing situation (i.e. in relation to current NPSFM requirements) and an alternative scenario for the STAG recommendation for a DIN bottom line. Freshwater objectives are yet to be set in any of Southland’s freshwater management units under the NPSFM.

- **The baseline scenario** for the Maitara (and all other rivers) was assumed to be the bottom lines for two NPSFM attributes: nitrate (toxicity) and periphyton (trophic state).

The NPSFM nitrate toxicity bottom line is 6.9 milligrams nitrate-nitrogen per litre as an annual median (or 9.8 mg NO<sub>3</sub>-N/L an annual 95<sup>th</sup> percentile). The NPSFM periphyton attribute includes a note (added as a 2017 amendment) that made it clear that the expectation was to manage nutrients for

periphyton. The periphyton note sets out a specific process for deriving nutrient criteria to manage periphyton that are, in effect, more stringent than the nitrate toxicity bottom line.

- **The DIN scenario** (and any variations on it) was to be based around the STAG recommendation of a DIN of 1.0 mg L<sup>-1</sup>.

These definitions of the baseline and DIN scenarios follow the methodology used in a preliminary report by Dr. Ton Snelder entitled “Maps showing impact of NOF periphyton and N toxicity”. Although brief, the report provides a spatial analysis of the situations where the NPSFM bottom lines and STAG recommendation for a DIN bottom line of 0.88 mg L<sup>-1</sup> (slightly more stringent than 1.0 mg L<sup>-1</sup>) would apply across New Zealand.

The report estimates that 27% of New Zealand’s current total load of nitrogen to the ocean is in excess of that which would achieve the existing NPSFM bottom lines. For the regions the total excess load ranges from 0% on the West Coast to 40% in Waikato, and 41% in both Taranaki and Southland. In other words, it is estimated that the Southland region has current nitrogen loads that are 41% beyond the periphyton bottom line for ecosystem health. The increase in total excess load under the STAG recommendation for a DIN bottom line is an additional 0.6% nationally. The largest increases are for Waikato (+2%), Canterbury (+1.4%), and Southland (+1%). The scenario definitions and interpretations of the report have been confirmed with Dr. Snelder.

The report indicates that where a river or stream supports, or could support, conspicuous periphyton, there will generally be little difference in how much nitrogen needs to be reduced between the two scenarios – at both national and regional scales. The reason is because the NPSFM nutrient concentration limits required for managing periphyton are generally estimated to be of a similar magnitude or less (i.e. more stringent) than the STAG recommendations. Situations where the estimated nutrient concentrations are less than the STAG DIN proposal are river catchments with a combination of warm climate and stable flow regimes.

The report also indicates there are some localities where concentration limits required for managing periphyton are higher (i.e. less stringent) than the STAG recommendations. These situations are dominated by locations with soft bottoms (do not support, or could not support, conspicuous periphyton), where current bottom lines may be interpreted as 6.9 mg L<sup>-1</sup>. It is here where the STAG recommendations will have an economic impact on activities (possible involving both water takes and discharges) during the transition period.

After gathering monitoring data for the baseline scenario in the Maitai, it was determined that the STAG recommendation for a DIN bottom line is likely to mean little or no change over the ecosystem health bottom lines that already exist in the NPSFM 2014 (2017). There may be some exceptions at a local scale, such as streams that have elevated nitrogen but are unlikely to support conspicuous periphyton (e.g. the Otamaiti Stream, which is a tributary of the Maitai River).

However, the NPSFM periphyton note also states: “(w)here there are nutrient sensitive downstream receiving environments, criteria for nitrogen and phosphorus will also need to be set to achieve the outcomes sought for those environments.” In these situations, the downstream receiving environments may be the most restrictive requirement and, as a result, the STAG DIN proposal would

have no impact on economic activities over and above the current NPSFM requirements. This is likely to be the case for the Maitai River, with Fortrose Estuary (Toetoes Harbour) at the bottom of the catchment. Fortrose Estuary is a receiving environment that will require a large reduction in nutrient loads upstream – despite it being more resilient to catchment loads than other nutrient sensitive receiving environments, such as Lake Ellesmere/Te Waihora and Waituna.

It is anticipated that most rivers and streams in developed catchments around New Zealand will either require management of nutrients to achieve periphyton outcomes and/or management of downstream receiving environments (e.g. a hard-bed stream, a lake or an estuary). The analysis by Dr. Snelder suggests that the STAG DIN proposal may not apply widely, but it introduces a further complication in an already complex situation for communities. It may also lead to a focus on a national bottom line that does not sufficiently allow for the variation in local circumstances, which are driven by factors including climate and flow regimes, especially if water quantity issues are not being considered at the same time<sup>19</sup>. Consequently, there is a danger that the STAG bottom line will be adopted where in fact the nitrogen criteria needed to manage for periphyton may actually be more stringent for a large proportion of rivers.

Where rivers and streams do not support, or could not support, conspicuous periphyton, or do not have a nutrient sensitive downstream receiving environment (i.e. only nitrate toxicity applies), the STAG DIN proposal may have relatively more impact on economic activities. There are soft-bed lowland rivers and streams that occur in many parts of New Zealand, including large areas of the upper North Island (Northland, Auckland, Waikato and Bay of Plenty). There may be as many as 26% of waterbodies in New Zealand that are soft-bottomed and so may not have conspicuous periphyton (Snelder et al. 2013; see map below). Many of these waterbodies will have nutrient sensitive downstream environments, particularly lakes, estuaries and coastal zones, but the setting of freshwater objectives and limits may still be in early stages of development.

The economic impacts of situations where a river or stream is beyond any bottom line (whether for periphyton or DIN) will depend to a large extent on the target(s) that are set. They will also depend on scale of the management approach that is used – a finer scale management approach may result in higher financial costs for some localities – and any nutrient allocation method. Some regions may have specific circumstances that are as yet unknown to the author, and so are not covered in in this summary.

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<sup>19</sup> The relationship between periphyton and nutrients is a particularly complex topic, and there are biogeochemical controls over periphyton that may be just as important as nutrients, and mean that a wide view is needed in terms of periphyton management.

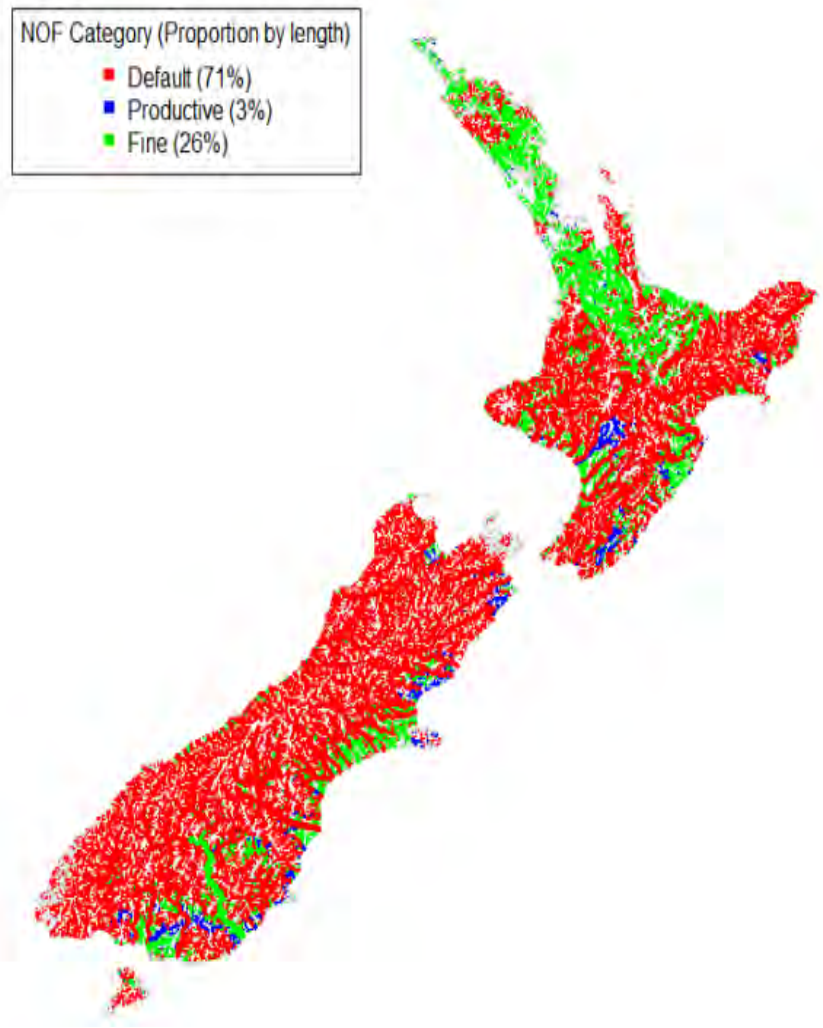


Figure 10: Classification of rivers and streams for NOF periphyton attribute  
 Source – Snelder et al. (2013) National Objective Framework for periphyton  
 Note – Locations that are likely to have fine substrates, which will not support conspicuous amounts of periphyton, are shown in green.

## Appendix 2 Farm environment plans

Farmers can prepare their own farm environment plan, and many are in a good position to do so as they have good existing knowledge of their farm and how it sits within the landscape. Farmer input into farm environmental planning helps with the adoption of mitigations and behaviour change more generally. Knowledge gaps exist, especially with mitigations and detailed nutrient management. Consequently, some level of expert support is essential.

The training of farm advisers requires a relevant degree and takes at least two years' work experience.

To develop regional councils' required farm environment plan a person needs a solid knowledge of natural systems, farm systems, and mitigations to be in a position to manage the movement of contaminants through the environment.

For natural systems, it involves being able to access and understand information on subjects such as:

- Soils (physical and chemical properties);
- Climate (rainfall, temperature regimes, evapotranspiration); and
- Hydrology (drainage properties at a farm and catchment scale).

For farm systems, it involves having a comprehensive understanding of what farming activities are occurring, where they occur, why they take place, and at what time of year. Aspects include:

- Stock movements (in all stock classes into and out of all of the properties in a farm business);
- Planning for winter grazing (cultivation, critical source areas, feeding out practicalities, use of land buffers);
- Riparian management (stock exclusion, planting, biodiversity values);
- Nutrient management (interpret Overseer reports); and
- Other considerations (e.g. bore head protection, biosecurity, local and national regulations).

To become a Certified Nutrient Management Adviser, a person must have the following competencies: at least two year's industry experience, on-going practice and professional development, a degree in agriculture or related field, passed Intermediate and Advanced Level Sustainable Nutrient Management papers, had formal training in soils and farm management fundamentals, and applied use of Overseer. Once Certified Nutrient Management Adviser status is confirmed the adviser will need to compile Continuing Professional Development.

The Fertiliser Association of NZ has created a Nutrient Management Adviser Certification Programme. The programme's aim is to have a transparent set of industry standards for nutrient management advisers to meet so that they provide farmers with nationally consistent advice of the highest standard.



## Appendix 3 Farm nutrient loss and profitability

Research in Southland has shown that there was no relationship between nutrient loss and farm profitability for both dairy and drystock farms (Moran *et al.*, 2017)<sup>20</sup>. The higher nutrient loss farms within, and between, groups of farms on land with similar biophysical characteristics are just as likely to be the least profitable farms as the most profitable. Figure 11 and Figure 12 show profitability and nitrogen loss for the 36 sheep and beef farms and the 41 dairy farms respectively.

For the 41 dairy farms modelled the main factor in a farm's nutrient loss was (unsurprisingly) its soil drainage characteristics. Within land with similar biophysical characteristics, other factors may play a part, such as the choice of production system. In Southland, for the seasons 2011-12 to 2013-14, it is estimated 23% of farms were low input systems, 41% of farms were medium input systems, and 36% of farms were in a high input system. Further work is possible to look at variables such as stocking rate, use of supplementary feed, and production of milk solids per effective hectare for higher and lower loss farms within a group. These variables need to be considered carefully, as production of milk solids per effective hectare may be a sign that a farmer is an efficient pasture producer.

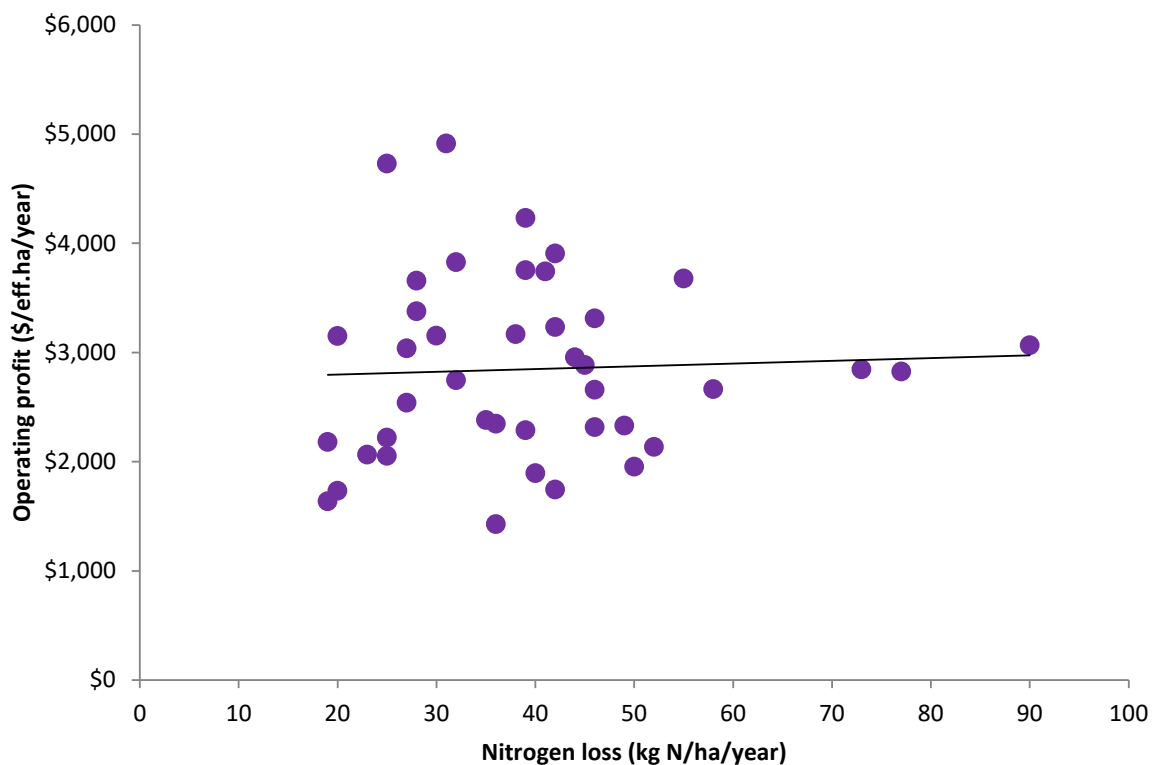


Figure 11: Profitability and nitrogen loss for 41 Southland dairy farms

<sup>20</sup> Moran, E., Pearson, L., Couldrey, M., and Eyre, K. (2017). The Southland Economic Project: Agriculture and Forestry. Technical Report. Publication no. 2019-04. Environment Southland, Invercargill, New Zealand. 340pp. <https://contentapi.datacomsphere.com.au/v1/h:es/repository/libraries/id:1tkqd22dp17q9stkk8gh/hierarchy/Scientific%20reports/Agriculture%20and%20Forestry%20Report.pdf>

For drystock farms, no single factor drives profitability and the complexity of the farms makes it challenging to identify patterns for nutrient loss. For the 36 sheep and beef farms modelled there were at least four factors that appear to be related to nitrogen loss: farm size, the raising or grazing of dairy cows, and to a lesser extent, the proportions of ineffective area or effective area in crop. There were nine large sheep and beef farms (> 1,000 effective hectares) and they all had nitrogen losses of 15kg N/ha/year or less. All of the smaller sheep and beef farms (< 1,000 effective hectares) with nitrogen losses over 20kg N/ha/year either raised or grazed dairy cows.

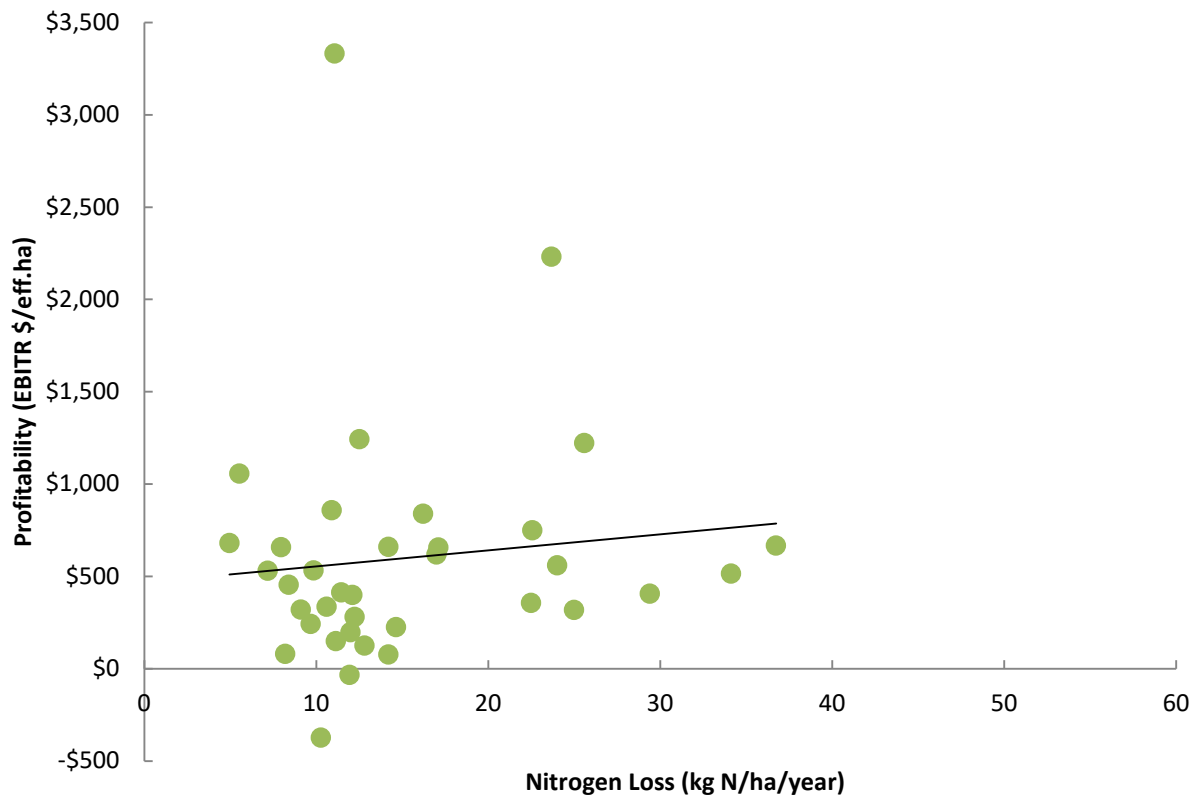


Figure 12: Profitability and nitrogen loss for 36 Southland sheep and beef farms

In addition to these results, an additional 3 sheep and beef farms were unable to be modelled successfully in Overseer without making significant changes to the farm operations. These farms were different in their environmental conditions, stock enterprises and yield, and crops grown. However, all three were relatively complex production systems.

## Appendix 4      The 75<sup>th</sup> percentile

The “75<sup>th</sup> percentile” concept is based on that used in proposed Plan Change 1 and Variation 1 to the Waikato Regional Plan (Healthy Rivers). In his statement of evidence on this plan change for Fonterra Co-operative Group Ltd., James Allen commented on the proposed methods to manage nitrogen:

*For those landowners who are currently leaching above the 75<sup>th</sup> percentile, and are required to reduce their N leaching, many of these farmers should be able to make relatively minor changes to their farm system which will enable them to farm at or below the 75<sup>th</sup> percentile. For example, this could involve changes to timing of nitrogen applications, changes to effluent management, changes in stocking rate, manipulation of the diet, and possibly some infrastructure changes. There will be other farmers who require some significant farm system change and/or investment in infrastructure in order to meet the 75<sup>th</sup> percentile target. Finally, there will be a small proportion of farmers who simply cannot meet the 75<sup>th</sup> percentile target without significant change to farming system, and potentially land use change. Generally speaking, the costs and effort of making reductions to meet the 75<sup>th</sup> percentile will depend on the level of nitrogen leaching reduction required.*

*For some landowners there are some farm management efficiencies available that will result in a small lift in profitability by reducing their N leaching below the 75<sup>th</sup> percentile. For most landowners there will be some loss of profitability when they reduce their N leaching to below the 75<sup>th</sup> percentile. An AgResearch report evaluating the financial impact of dairy farms moving from above the 75<sup>th</sup> percentile to ‘at or below’ the 75<sup>th</sup> percentile stated: “The corresponding range in effects of profitability was +\$106/ha to -\$514/ha, with an average of -\$143/ha”, noting that this was a case study approach on dairy farms, and may not be fully representative.*

James Allen’s full statement of evidence is available at:

<https://waikatoregion.govt.nz/assets/WRC/Council/Policy-and-Plans/HR/Block2/Fonterra-James-Allen-Farm-Management-Evidence.pdf>

## Appendix 5      Agriculture and Forestry Report Key Findings

The Southland Economic Project surveyed and modelled 95 case study farms across Southland. Based on the mitigation modelling for these farms, it was found that:

1. The mitigations usually reduced losses of one or both nutrients (by lesser or greater amounts) but also reduced profitability for most farms. The main reason that managing nutrient losses reduces profitability is it changes the farm production system. While many farms have started adjusting their production systems to manage nutrient losses, they will need to continue managing their nutrient losses in the future, while maintaining profitability.
2. Some farms had less capacity to reduce nutrient losses than others in the Overseer analysis. The main reasons were:
  - a. those farms had low nutrient losses to start with (so the mitigation options had little effect);
  - b. the impacts of the mitigation options on profitability were high;
  - c. the mitigation options were not applicable to a farm; and/or
  - d. the mitigation options were not sufficient to manage the farm's nutrient losses (given its soils and topography).
3. The effectiveness of specific mitigations varied by industry and nutrient. For example, reducing stocking rates was not well suited to drystock because stocking rates were generally within the carrying capacity of the land. On deer farms, managing fence pacing and wallowing was an effective mitigation for phosphorus losses but had limited success in reducing nitrogen losses.
4. Within most industries, the farms with higher baseline nutrient losses tended to have more mitigation options, and these mitigations were usually more effective, than the farms with lower baseline nutrient losses. This finding was not the case for the dairy industry. Some dairy farms had relatively high baseline nutrient losses for the industry and few mitigations. For these farms to achieve relatively low nutrient losses, they will need to consider other options, such as retiring land or a change in farm production system.
5. The impacts on profitability of particular mitigations often varied by farm and industry. For example, in pastoral farming the mitigations that had the least impact often related to fertiliser use (timing and application rates), but similar mitigations had a considerable impact for cropping activities because of the close relationship between fertiliser and crop yields (quantity) and quality. If fertiliser rates and applications do not meet a crop's requirements then growers are unlikely to grow a particular crop.

Key findings taken from Executive Summary in: Moran, E., Pearson, L., Couldrey, M., and Eyre, K. (2017). The Southland Economic Project: Agriculture and Forestry. Technical Report. Publication no. 2019-04. Environment Southland, Invercargill, New Zealand. 340pp.

<https://contentapi.datacomsphere.com.au/v1/h:es/repository/libraries/id:1tkqd22dp17q9stkk8gh/hierarchy/Scientific%20reports/Agriculture%20and%20Forestry%20Report.pdf>

