

**BEFORE THE ENVIRONMENT COURT
AT WELLINGTON**

**I TE KŌTI TAIAO O AOTEAROA
TE WHANGANUI-A-TARA ROHE**

IN THE MATTER of the Resource Management Act 1991

**AND
IN THE MATTER** of appeals under Clause 14 of Schedule 1 of the
Resource Management Act 1991 against the
decision of the Manawatū-Whanganui Regional
Council on Proposed Plan Change 2 to the One
Plan ("PC 2")

BETWEEN **TE RŪNANGA O RAUKAWA**
(ENV-2021-WLG-00020)

NGĀTI TURANGA
(ENV-2021-WLG-00021)

ANDREW DAY
(ENV-2021-WLG-00022)

WELLINGTON FISH AND GAME COUNCIL
(ENV-2021-WLG-00023)

Appellants

AND **MANAWATŪ-WHANGANUI REGIONAL
COUNCIL**

Respondent

**EVIDENCE IN CHIEF OF ALISON MARY DEWES
FOR THE WELLINGTON FISH AND GAME COUNCIL
(Farm Systems)**

Dated: 6 November 2023

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1. QUALIFICATIONS AND EXPERIENCE

1.1 My full name is Alison Mary Dewes.

1.2 I have been a registered veterinarian for 30 years and hold a practising certificate. I graduated with a Bachelor of Veterinary Science (BVSc) and I hold a Masters in Biological Science (Ecology) from Waikato University (2015).

1.3 My additional education has included the following courses: A) Intermediate Nutrient Management, Massey 2009; B) Advanced Nutrient Management Course, Massey 2009; C) Farm Dairy Effluent System Design and Management, Massey 2012; E) Business Lending Fundamentals: Developing Client Relationships and Negotiate Client Solutions: Tier 111 registration for Agribusiness, Commonwealth Bank

of Australia 2007; F) In Calf Training, Certified 2006; G) Certified Adult Trainer, Melbourne 2004; H) Dairy Leadership Course Melbourne 2004; I) Advanced Dairy Nutrition, Australia 1999; J) Dairy Nutrition Course, Lean, Massey 1990; K) Soils and Pastures Course, Massey 1993; L) Milking Machine Testers Course, Flockhouse, 1992.

- 1.4 I am a director of my own company Tipu Whenua covering One World One Health issues at governance, policy and farm level. Tipu Whenua specialises in land use strategy, farm systems, business health and ecological improvement and protection. Presently the team is the Project Manager for a catchment remediation project in Bay of Plenty.
- 1.5 I was elected to the NZ Veterinary Association Board of Directors in 2015 and a Ministerial appointment to the NZ Health Research Council and Molesworth Steering Committee in 2018 and the Freshwater Leaders Group in 2019. I was a finalist for the NZI sustainability champion in 2014, received a commendation for community impact for work with farmers, and a finalist in the 2015 Women of Influence Awards in Public Policy. In 2019-20 I was the recipient of the NZ River Voice Award.
- 1.6 Most recently I was the Head of Environment for Pamu (trading as Landcorp) from 2018 – 2021, after being on the Environmental Reference Advisory Group from 2015-2018. Pamu is a state-owned enterprise that operates a nationwide pastoral farming business of dairy, sheep, beef and deer farms totalling 116 farm units over 365,257 hectares. My role included assessing over 125 Overseer files annually for validity and farm systems for compliance, across the business.
- 1.7 I practised as a dairy and equine veterinarian in Waikato from 1987 to 1997 and was also a Director of Hamilton Analytical Laboratories (Consultants in Animal Nutrition and Applied Science).
- 1.8 I am a fourth-generation farmer and, in partnership with my husband, spent 20 years dairy farming in New Zealand and Australia. We share milked in the Waikato then bought and developed three pasture-based and irrigated dairy and support farms in Victoria, Australia.

Independently, I now farm a property in Hamurana, Lake Rotorua (a nitrogen-constrained catchment).

- 1.9 In the period from 1997 to 2001, I held a position in Milk Procurement, for Nestle, in Warrnambool, Western Victoria, Australia. During this time, I was involved in the development of the “on farm quality assurance programme” for Nestle Australia.
- 1.10 In 2001, I took over as Business Development Manager for Intelact Agribusiness Consultancy in Australia. The business services were based on full farm analysis for intensive pastoral farms, businesses were faced with reconfiguration of systems as they faced major clawbacks on their surface and ground water allocations. This challenge was amplified by two major droughts occurring between 2002 – 2007. In 2006, I became an Agribusiness Lender for the Commonwealth Bank of Australia and was heavily involved in the appraisal and risk assessment of new farm businesses.
- 1.11 In 2009, I returned to New Zealand. I was contracted to Agfirst and undertook the Upper Waikato Nutrient Efficiency Study. As part of that study, I analysed more than 380 Overseer files for eco-efficiencies for Ministry of Agriculture and Fisheries (MAF) farm monitoring during 2009 and 2011.
- 1.12 From 2010-2014 I was a Sustainable Land Use advisor for Raukawa Charitable Trust.
- 1.13 My MSc (2015) focused on what farms were the most economically and environmentally efficient in the Upper Waikato Freshwater Management Unit. I developed a scorecard to complement and yet still rely on Overseer, and ground-truthed it on 100 sets of verified farm datasets.
- 1.14 Since completing my MSc, I have developed environmental scorecards for Dairy Business of the Year for 4 years, for Pamu (Landcorp) for both Sheep and Beef farms and Dairy, and for our Catchment Project in Coastal Bay Of Plenty. All scorecards relied on Overseer files, but also added risk scores for environmental risks not covered by Overseer.

- 1.15 I have been an expert witness on agricultural matters for the Horizons One Plan, the proposed Canterbury Land and Water Plan (2013), the Tukituki Catchment Plan Change 6 (2013), the proposed Variation 1 (Selwyn - Waihora) and Variation 2 (Hinds Hekeo Plains) to the Proposed Canterbury Land and Water Regional Plan, the South Waikato District Plan Change, the Havelock North drinking water enquiry, the Greater Wellington Regional Plan (2017) and the proposed Waikato Plan Change 1 (2020). In 2022 I was an expert witness on the hearings for a Water Conservation Order for Te Waikoropupu Springs.

2. CODE OF CONDUCT FOR EXPERT WITNESSES

- 2.1 I confirm that I have read the Environment Court's Code of Conduct for Expert Witnesses as contained in the Environment Court's Practice Note 2023. I have complied with the Code when preparing this written statement and will do so when I give oral evidence before the Court. The data, information, facts and assumptions I have considered in forming my opinions are set out in this statement to follow. The reasons for the opinions expressed are also set out in the statement to follow. Unless I state otherwise, this evidence is within my sphere of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

3. BACKGROUND

- 3.1 Plan Change 2 (**PC 2**) applies to farming that constitutes 'Intensive Land Farming Uses' (**ILFUs**) and these are identified in Policy 14-5(a). They are:
- (i) Dairy farming;
 - (ii) Commercial vegetable growing;
 - (iii) Cropping; and
 - (iv) Intensive sheep and beef.
- 3.2 "*Intensive sheep and beef farming*" refers to properties greater than 4ha engaged in the farming of sheep and cattle, where any of the land grazed is irrigated.

- 3.3 “*Dairy farming*” means using any area of land greater than 4 ha for the farming of dairy cattle for milk production, and:¹
- includes land used as a dairy cattle grazing runoff but excludes any dairy grazing arrangement. A dairy grazing arrangement is a third party commercial arrangement between the owner of dairy cattle and another landowner for the purpose of temporary grazing.
- 3.4 These farms are managed for nitrogen leaching, within targeted water management subzones (**WMSZs**).
- 3.5 Manawatū-Whanganui Regional Council (**Horizons**) expert (David Horne) together with Federated Farmers of NZ Ltd (Paul le Miere), and input from Elizabeth Parlato (Wellington Fish and Game Council (**Fish & Game**) and Ngāti Turanga), have developed a specific pastoral nitrogen risk assessment tool for use in the Horizons Region (**risk assessment tool**). The risk assessment tool is contained in Schedule [X] of the proposed provisions filed by Horizons Regional Council on 22 September 2023 (**proposed provisions**).
- 3.6 As I discuss further, my understanding is that this risk assessment tool was developed in light of the Government’s response to the Overseer whole model review report. Following this response, Horizons sought to develop a method for assessing and setting limits for nitrogen loss from IFLU in target WMSZs, as an alternative to Overseer.
- 3.7 I understand the risk assessment tool is primarily intended to be used as a consenting gateway, and to divide farms into different consenting activity classifications. The tool is also proposed to be used in the policy framework once a resource consent application is lodged, along with other tools, with consent applicants being able to make a choice as to which tool to measure their farming activity against.²

¹ Glossary to the Horizons One Plan.

² Policy 14-6(e)(ii) in proposed provisions: “*The extent of the activity’s exceedance of the limits specified in Policy 14-5(d)(i), (ii) or (iii)*”. Policy 14-5(d)(i) refers to Table 14-2 which contains limits for different land use classes based on Overseer. Policy 14-5(d)(ii) refers to the nitrogen leaching risk calculated in accordance with Schedule X).

4. SCOPE OF EVIDENCE

- 4.1 Fish & Game has asked me to comment on the risk assessment tool, and compare it to OverseerFM (**Overseer**). Because the risk assessment tool uses the Fonterra Nitrogen Risk Scorecard as a basis (as is outlined in Professor Horne's evidence), I also discuss the development and utility of the Nitrogen Risk Scorecard (**NRS**).
- 4.2 My evidence does not cover the Commercial Vegetable Production (**CVP**) tool developed by Dr Jolly, proposed in Schedule [Y]. However my comments on scorecards generally, apply to that tool.
- 4.3 Dr Alec Mackay addresses the development of Table 14-2 of the One Plan.

5. DOCUMENTS AND MATERIALS REFERENCED

- 5.1 In producing this statement of evidence I have reviewed the following evidence:
- David Horne, Anne-Maree Jolly and Paul le Miere for the Manawatū-Whanganui Regional Council regarding the development of the risk assessment tool;
 - James Hanly updating Table 14-2 of the 'One Plan' following Overseer version changes;
 - Tim Cox and Ton Snelder (water quality modelling);
 - Alan Passey and Murray Holdaway (Federated Farmers); and
 - That part of Christine Foster's evidence dealing with the risk assessment tool – in particular her Schedules [X] and [Y].
- 5.2 I have also reviewed:

- *Overseer whole-model peer review by independent experts*
Project overview including panel terms of reference (14 February 2020);
- *Ministry for the Environment and Ministry for Primary Industries Government response to the findings of the Overseer peer review report* (August 2021);
- Overseer Redevelopment Programme Report MPI Technical Paper No: 2023/12 (August 2023); and
- *Assessment of Overseer Model Performance with experimental data from grazed pastures* Jean Paul Tavernet (August 2023).

5.2.1 I also refer to evidence of Richard Allen that has been heard in appeals against Proposed Plan Change 1 to the Waikato Regional Plan (attached to my evidence as Appendices 1 and 2), in my discussion of the NRS.³

6. EXECUTIVE SUMMARY

6.1 While Overseer has limitations, it is still the best tool we have for assessing nitrogen loss risk from the root zone from farms, if it is used appropriately within those limitations, which are comprehensively covered in recent reports and reviews.

6.2 Overseer covers a range of industry sectors, providing flexibility for farm systems to explore other land use options, to reduce their footprint and enhance their long-term business resilience. It also considers edge of field mitigations, such as riparian planting, and land retirement/restoration because Overseer accounts for the farm total area.

³ Appendix 1: First Statement of evidence of Richard Allen 22 June 2023 on Behalf of Fonterra Co-operative Group Ltd and Dairy NZ,
Appendix 2 Second Statement of evidence of Richard Allen 22 June 2023 on Behalf of Fonterra Co-operative Group Ltd and Dairy NZ
(Environment Court hearings into Plan Change 1 to the Waikato Regional Plan).

- 6.3 Farmers need to be incentivised and recognised for their work to reduce nutrient loss, which may include land use change, across their total landholding (edge of field mitigations) and across a range of enterprises, rather than just what they are doing in the effective grazed of a single industry.
- 6.4 The NRS and the risk assessment tool are modifications of a single industry (dairy) approach to assessing risk, in this case to ease the consenting pathway. Neither of these tools address the complexities of having the most suitable land use on the most suitable land type. In my opinion, speeding up and simplifying a complex problem, will not solve the core (source) challenges New Zealand (**NZ**) agriculture is faced with, which is significant contaminant reduction in overallocated catchments.
- 6.5 Long term trend (input data) on farm systems is important, to understand if progress is being made in resource management at catchment scale. Without long term verified input data that is checked for validity, we will not be able to compare land management trends over decades and align such trends with long term water quality information.
- 6.6 A broad range of policy approaches (N Cap⁴, Resource Management (Freshwater Farm Plans) Regulations 2023 and National Policy Statement Freshwater Management 2020 (**NPSFM**)) have been introduced to reduce diffuse discharges of contaminants to water from farming. This has been overwhelming for landholders and agricultural advisors alike. In my opinion, this is complicating an already complicated environment. However, the approach to simplification of by use of a scorecard, is unlikely to address the fundamental causes of water quality decline in the long term.
- 6.7 I do not believe the use of end of pipe mitigations such as constructed wetlands and detainment bunds are a solution to catchment remediation. While they have a place as a mitigation in an integrated

⁴ Regulation 32, Resource Management (National Environmental Standard for Freshwater Regulations 2020: "nitrogen cap, for the land in pastoral land use in a contiguous landholding, means the application of nitrogen at a rate of no more than 190 kg/ha/year—
 (a) to all of that land, as averaged over that land; and
 (b) to each hectare of that land that is not used to grow annual forage crops."

catchment plan, a core focus needs to be on appropriate land use, suited to land type, and farmers being supported to fully investigate this in a scientifically robust manner.

- 6.8 Simplified industry specific scorecards and expensive end of pipe mitigations are not the only answer in my opinion and scorecards that focus on dairy farm management actions only introduce a dangerous sense of false security for industry, farmers and regional councils.
- 6.9 I acknowledge that the risk assessment tool includes some biophysical and inherent risk factors. Given the absence of wider peer review and more extensive analyses involving ground-truthing across a range of farming systems and conditions, complemented by quantification of sensitivities and uncertainties around associated nitrogen loss reductions and water quality effects, I consider the risk assessment tool requires greater caution with respect to use in a regulatory setting compared to Overseer at this time.

7. DEVELOPMENT OF SCORECARDS / NRS

- 7.1 I developed a scorecard in the Upper Waikato for my MSc thesis in 2015, using 100 datasets. The purpose of this scorecard was to strengthen assessment of farm system risk to the receiving environment, by wrapping more proxies around Overseer, for risk assessment. My scorecard (Dewes 2015) relied on outputs from a professionally built Overseer.⁵ It wrapped around Overseer, 6 verified outputs, 18 more criteria, and assessment of management mitigations. (The intention was to reward mitigations that were not well reflected in Overseer and highlight areas that could be improved across the total farming area.)
- 7.2 In 2018 while I was Head of Environment at Pamu (2018-2021), I was approached by Fonterra (Richard Allen) because Fonterra had concerns about the cost of utilising Overseer and its recent changes (2017-2018). Following this, I understand the scorecard I had

⁵ Including 3 efficiency measures (GHG/Kg MS, N Suplus/ha, N Conversion Efficiency) and Nutrient Loading Metrics (Kg N leached/Ha, Kg P runoff/ha). Also, Effluent Efficiency metrics utilised from input data showing BMP (% of farm irrigated with effluent, including the presence of a Lined Effluent Pond rather than drop test, presence of SMD irrigation, and alerts for application precision). Furthermore, Dewes (2015) assessed the risk from overfertilization – such as having Olsen P levels well above the optimum range, and impacts on Soil Structure from poor management (such as pugging frequency and winter management).

developed, originally informed some of Fonterra's Nitrogen Risk Scorecard (NRS) design. The NRS, provides a self-reported measure of risk, of 6 key factors that influence risk and intensity on a dairy farm.

7.3 I understand the NRS was created by using data from Fonterra's Overseer results from the Sustainable Dairying Water Accord period and using that information to decide some relative risks. The validity of some of those assumptions can certainly be questioned – such as the correlation of efficiency metrics to risk. To my knowledge, the NRS has only had one peer review - "*Evaluation of Fonterra's Scorecard Factors on Overseer Nitrogen Statistics*" Neville Jopson, Abacus Bio Limited 1 November 2019 (Attachment 3 to Richard Allen Second Statement of Evidence 22 June 2023, in my Appendix 2).

7.4 In his Second Statement of Evidence for the purpose of Waikato PC1, Richard Allen notes:⁶

The Fonterra position on Overseer is that the model was not fit for regulatory purpose at this time and is likely to have limited relevance to the regulation of farming going forward. The lack of farmer engagement and trust in the model, the significant costs associated with its use, input data complexity and subjectivity, the ongoing lack of transparency of model workings and the ability of users to 'game' the model all make any reference to Overseer inappropriate. Even before the science review of the model Fonterra did not believe that such a complex and uncertain model was the best way to regulate farming and engage farmers in significant practice change that would reduce farming impacts.

(Emphasis)

7.5 I deal with some of these issues below, as I understand there are similar concerns at this hearing, around the use of Overseer and whether an alternative 'gateway' should be provided in addition to Table 14-2.

⁶ [7.16] Second Statement of evidence of Richard Allen 22 June 2023 on Behalf of Fonterra Co-operative Group Ltd and Dairy NZ, my Appendix 2.

8. OVERSEER

- 8.1 Overseer is a farm-level web-based tool that generates nutrient budgets based on farm specific information describing the farm natural resources including topography and soils, the farm system, the key interventions and management decisions. It is commonly used by New Zealand farmers and advisors to calculate farm nutrient budgets, and by regional councils to determine losses of nutrients off-farm.
- 8.2 Notwithstanding there have been limitations with Overseer, it is still the best and most widely utilised tool we have for assessing N loss risk from the root zone in NZ, on pastoral farming systems. Milk companies Synlait, Open Country Dairy, Miraka, Olam, Westland, Pamu, Oceania and Tatura all continue to use Overseer on an annual basis, for their farmers. The cost of the licence is paid for by the company or the farmer directly.
- 8.3 The cost of Overseer licence annually is \$690 + GST and is deducted from supplier's milk checks. This amounts to \$58 per month, for a farm. As explained below, if users increase, the price reduces.

9. DATA INPUT, ACCURACY AND RETENTION

- 9.1 Overseer provides for long term record keeping, data management and trends. This assists to robustly guide farmers what levers to pull *via* scenario analysis, to lessen their nutrient loads to water.
- 9.2 To assist accuracy of predictions, and outputs, Massey University has trained 1215 Advanced Sustainable Nutrient Management (**ASN**M) professionals across NZ.⁷ This investment in time and training by agricultural professionals ensures high quality data capture, minimising subjectivity and use of the model in a Best Practise Standard way. This reduces input error, assesses validity and provides independent checks and balances to the outputs.
- 9.3 These independent trained professionals offer a safe repository for data collected on their clients' farms prior to entry into the Overseer model,

⁷ The Fertiliser, Lime, Research Centre at Massey has provided these course completions for last 10 years by agricultural consultants and professionals:

- Intermediate Sustainable Nutrient Management 2844
- Advanced Sustainable Nutrient Management 1215

meaning that valid datasets are retained for long term comparisons of farm systems over time. (I personally have data input sets retained from 14 years ago - this would allow me to build and compare a farm system over that time if required).

- 9.4 Retention of validated farm input data is essential for tracking farm system change and emissions (nutrient and gaseous) over long periods.
- 9.5 As models are updated, new versions can be rebuilt with the original farm data to track system improvements over time. This is also essential for long term water quality assessments (many such assessments rely on historical data that spans decades).
- 9.6 Traceability of data (reference files and input data that has been scrutinised by trained professionals) is important where files have been built for compliance purposes. Input data is retained by both farmers and ASNM trained professionals.
- 9.7 I understand Fonterra moved away from the old legacy version of Overseer where data management was certainly a problem. One of the challenges of the legacy Overseer software was that it was 'all things to all people', so had several functions which were designed for scientists, but which were 'abused' by some users. OverseerFM was established to help resolve this. The redevelopment of the software and launch of OverseerFM (for farm management), OverseerSci (for scientists and researchers) and OverseerEd (for training) means that each software service has the appropriate data entry fields for those requirements. Additional new tools which have been added to the software, such as the comparison tool, and feasibility tool also make it much easier to determine if an analysis is robust. The Overseer Timeline allows farms to track their changes over time as well. (An example of the timeline is in Appendix 3).
- 9.8 The farmer is the owner of their farm account and controls who has access to that farm account. They can 'publish' information to companies/entities e.g. Fonterra, Regional Councils etc. In a 'read only' format. This protects farmers and is especially useful for corporate farms wanting to report to shareholders and the public. In addition to

regulatory use/compliance, interrogation of input data can also be used for trade or provenance claim requirements.

- 9.9 An up-to-date Overseer model is an ideal tool to banks/lending institutions⁸ and producers,⁹ as sound validated evidence that a nutrient budget has been undertaken. Farms wanting to secure future funding and the most competitive interest rates from banks and lenders, are increasingly required to follow best practice for nutrient management and soil health. A nutrient budget may be required, together with records of what fertiliser is applied where:¹⁰

2.2	Pollution prevention and control
2.2.1	The farm shall develop and implement a nutrient budget aimed at reducing risk of pollution to the surrounding environment. The nutrient budget should be reviewed on a schedule best suited to the farming system.
2.2.2	Nutrient application decisions shall be informed by the nutrient budget and industry best management practices. This shall include (but not be limited to) balancing soil macronutrient tests and plant nutrient requirements. Records of nutrient application shall be kept, such as date, person or company, application, and location.
2.2.3	Chemical application (including pesticides and herbicides) shall be in line with product specifications and industry best management practices. Records of chemical applications shall be kept, such as date, person or company, application, and location.

Figure 1 *Nutrient Management & Proof of Placement Requirement– Westpac Sustainable Loan*

10. SCENARIO TESTING

- 10.1 For catchment-based modelling for nitrogen (N) and phosphorus (P) loads, where water bodies are over-allocated, it is essential to monitor and track relative degrees of improvement of a farm system from a legitimate and audited baseline. This proves improvement or change (% reduction in contaminants), driven by farmer innovation to meet an outcome to improve water quality.
- 10.2 Scenario modelling allows farms to be able to assess what is the best option for their business to reduce risk to the receiving environment. It provides a quantitative measure of N reductions relative to baseline/reference years.
- 10.3 I note Professor Horne appears to agree:¹¹

⁸ Westpac NZ Sustainable Farm Loan requires a nutrient budget for lower interest rate loans.

⁹ NZ FAP PLUS for Silver Fern Farms – to attract premium payment.

¹⁰ <https://www.westpac.co.nz/agribusiness/sustainable-farm-loan/#sustainable-farm-loan>

¹¹ Horne EIC at [62].

I remain of the view that Overseer has a place in helping farmers to identify the most appropriate and effective GMP/BMPs to help reduce the N leaching rate from their farm. Overseer has been developed for New Zealand conditions and is built on the results and knowledge produced in many years of research conducted locally. I am of the view that if we stop over-interpreting the actual values generated by Overseer and concentrate more on the general impact it suggests that GMP/BMPs will have on leaching rates then it can be a useful tool in the search for improved water quality.

10.4 In cases where load reductions are required such as Rotorua Lakes (38%) and Canterbury, for example:

- The Overseer model allows farm advisors to highlight any inefficiencies in fertiliser use and explain how nutrient budgeting works. This can result in considerable cost savings for farmers (providing for efficient fertiliser use can save farms tens of thousands of dollars in the long term).¹²
- The model enhances and advises the most appropriate use of effluent and area to apply it. This applies to N loading (for effluent consenting purposes) – effluent N + bought in feed N + applied N. This in many cases needs to be <150 kg N per ha. Given a significant number of farms still require effluent upgrades and consent renewals, having an Overseer file ensures the most appropriate advice (on N, P, K loadings) and subsequent design is achieved for the farmer, resulting in considerable savings for farmers moving forward.
- Overseer also requires accurate input data for irrigation management. This again, is essential for helping farmers understand what is most efficient in terms of depth of application (mm/ha/year) and system risks and efficiencies (volume of water used annually relative to tonnages grown) and will only become more important over time as water use is increasingly monitored.

¹² In the catchment project I am involved with in the Coastal Bay of Plenty, our farm systems team recently assessed 60 overseer files and this suggested a large percentage of all dairy blocks have excessive amounts of Phosphorus on their dairy farms (have overfertilised with phosphate). 57% had high risk levels of Olsen P (exceeding 40ppm). (Refer Case Study at section 24 of my evidence).

11. OVERSEER VERSION CHANGES

- 11.1 From time to time there are version upgrades as new science or refinements are made to the Overseer model. Version changes result in a relative change to the output numbers (N loss for example) and can be unsettling for users. To mitigate this, regional councils (such as Rotorua) have kept reference files, whereby the relative change can be identified.
- 11.2 Where Overseer has been used over successive years by companies or professionals, records of input data should be kept, to allow this reliance on reference files.
- 11.3 I agree with James Hanley¹³, that reference files can be a solution to smooth changes to the model as science is updated.
- 11.4 The new software OverseerFM makes version control much easier, with a comprehensive audit log available which makes clear when and if farm results have changed because of version change. In addition, the centralised database makes it much easier for the inclusion of impact assessments within Overseer version release notes.
- 11.5 I farm in the Rotorua Lakes catchment and have personally traded N in the Nitrogen Incentives Scheme for that catchment. While the implementation of Overseer by Bay of Plenty Regional Council (**BOPRC**) has been to an absolute number, which is not ideal (that method of implementation has now been recognised as unsuitable), my experience with how the BOPRC has dealt with changes to the model versions (using reference files) is now understood by farmers and we are working with it.

12. PAN-SECTOR / 'MULTI' FARM ENTERPRISES

- 12.1 The Overseer model copes with pan sector enterprises in a multi enterprise farm system.

¹³ Hanly EIC at [37]-[38].

- 12.2 While Overseer is still upgrading its science and ability to model other farm systems – and it is still not ideal for horticulture or vegetable growing – in time it will improve and enhance our ability to model diversified land uses and assess risk in what is the best pan-sector, science based and peer reviewed model we have at our disposal in NZ at the current time.
- 12.3 Corporate farms need to be able to compare across multi enterprises (dry stock, dairy, arable, forestry, sheep milking, goat milking and horticulture). Overseer allows for this and is continually updating the science models that underpin it to improve on this.
- 12.4 This ability of Overseer also has advantages for single enterprise farms wishing to diversify. The scenario modelling available in Overseer incorporates changes from higher footprint farming systems to lower footprint farming systems (such as extensive dry stock or support land or sheep or goat milking, forestry or native restoration or rotational catch cropping systems) in the total farm system area thereby giving farmers information to address land uses that are best suited to land and catchment vulnerabilities. I discuss this further below.

13. TRANSPARENCY / OWNERSHIP / 'COMMERCIALISATION'

- 13.1 Reinvestment of Overseer is required on an annual basis to provide good science and adapt to new innovations that may arise from GHG and nutrient reductions. New science, in the form of mitigations and tools for reducing environmental impact of farming, are now included in Overseer much more quickly than occurred under the old legacy software eg. Urease inhibitors, updates to wetland modelling, plantain, new crops, deeper rooted plants etc.¹⁴ I understand from Alistair Taylor, Business Development Manager, Overseer that around \$5 million per annum needs to be spent on the Overseer model, to keep it current and protect its integrity (pers. comm, 24 Oct 2023). This needs to be funded by Overseer.
- 13.2 Over 15,000 farms are setup in OverseerFM with farm accounts and there are over 10,000 users. Around 5,000 accounts are used each

¹⁴ <https://www.overseer.org.nz/page-timeline>.

year, with around 1,500 users active each month. If the users increased to over 10,000 for example, the annual cost would halve, to allow continued maintenance of the software, to keep it fit for purpose, and aligned with the latest science.

- 13.3 Although Overseer Limited is setup by the model owners¹⁵ Item 5 of the constitution precludes distributions from the company, making it effectively a not-for-profit industry body tasked with managing and developing the software.

14. FUTURE BENEFIT FOR 'OUTPUT' CONTROLS

- 14.1 By quantifying nutrient losses off-farm, Overseer allows regulators to adopt effects based (i.e. output) policy and regulations rather than rules based on-farm input controls, which are inherently more inefficient with respect to the impact on farm productivity.
- 14.2 This approach benefits both the agricultural sector and the wider community, in enabling flexibility in production systems while achieving environmental mitigation, as discussed Journeaux "Valuation of the Benefits of the OVERSEER® Nutrient Budget Model", 2 Sept 2016 (Appendix 4).
- 14.3 In the future, such output controls may utilise P. Neither the NRS nor, to my knowledge, the risk assessment tool, provide substantive information on P. I note, this is also important for current management.

15. NEW ZEALAND INVESTMENT IN OVERSEER

- 15.1 While PC 2's planning approach will not prevent IFLU farmers using Overseer, I have a concern that a move toward a scorecard approach in the regulatory context, will put at risk existing investment in Overseer.
- 15.2 While this may not be a planning concern, in the strict sense, over the 20 year life of Overseer, over \$16 million has been spent on developing

¹⁵ (MPI, Agresearch and Fertiliser Association of NZ) as a limited liability company, the constitution of the company
<https://app.companiesoffice.govt.nz/companies/app/service/services/documents/FE294E76536A24D9B79CFFC7EED76640>

it. During its 50 year lifetime, it is projected to offer a \$3.3 billion benefit (Appendix 4).

- 15.3 This does not count investment made by certified professionals. To be a Certified Nutrient Management Advisor (CNMA), requires recertification each year, and to have completed both the Intermediate and Advanced Sustainable Nutrient Management courses. This is a significant time and cost commitment.¹⁶
- 15.4 In my opinion, there are substantial benefits to NZ of having a tool like Overseer, that allows farmers to be more precise in farming systems and use of accurate nutrient budgeting, GHG reduction plans, and traceability of net nutrient input and loss reductions. These information components culminate in significant value presently and will only increase over time.¹⁷
- 15.5 Most recent developments include our trading partners asking for legitimate GHG metrics to be provided. In my opinion, the potential benefits to NZ agriculture, of having a robust model with a suite of trained professionals to implement it, and provision of legitimate, clean, validated data for international trade scrutiny could well amount to multiple billions in the next 5-10 years.
- 15.6 I now turn to the issue of Overseer's use in regional planning regulation.

16. CURRENT USE OF OVERSEER IN REGULATION

- 16.1 Overseer has already been utilised across a range of regions (Waikato, Horizons, Bay Of Plenty Lakes, Lake Taupo, Canterbury, Hawkes Bay) and for catchment modelling to guide N load reductions. While in a regulatory sense it has not been perfectly implemented in the past, I believe users and regional councils have learnt a lot in the past decade on how Overseer can be best used.

¹⁶ The expected study time for the Intermediate course is 40-80 hours (depending on previous experience) over 12 weeks (~3-7 hours/week). The expected average study time for the Advanced course is 150 hours over 19 weeks (~ 8 hours/week). So for the two courses together, would be in range of 24-29 full days of study in total (pers Comm James Hanly 24 October 2023). Hence for 1215 professionals across NZ who are certified in both courses, have invested time and money for the course costs (Intermediate course (10 credits) = \$2000 + GST Advanced course (15 credits) = \$2,500 + GST).

¹⁷ <https://www.stuff.co.nz/business/farming/76804115/overseer-worth-271m-a-year-to-farming-economy>; as at 2016 refer Journeaux, Appendix 4: "The Overseer nutrient management tool benefits the rural economy to the tune of \$271 million a year."

- 16.2 Recommendations from more recent reports since the Parliamentary Commissioner for the Environment's (**PCE's**) Report in 2018, is that the outputs from Overseer are appropriate to guide relative change from an N Loss baseline, and that other tools and information should be relied on to assist interpretation of farm system risk alongside Overseer, in decision-making.
- 16.3 Since the PCE's Report in 2018 that suggested the levels of documentation and transparency were not desirable for a regulatory setting, there has been considerable work on Overseer addressing the shortcomings, and since then, a scientific advisory panel (**SAP**) provided an independent review, then a redevelopment programme was set up in 2022, (NIWA, AgResearch, Plant and Food, Manaaki Whenua, and Overseer Ltd) to address the issues raised by the PCE and the SAP.
- 16.4 In October, the August 2023 Redevelopment Report was publicly released.¹⁸ The Report considered climate (daily vs averaged), sensitivity and uncertainty of input data and agreed that Climate and Soil were the main drivers of N loss uncertainty in the model. The work has also considered new crops and deep-rooted plants, N mineralisation and immobilisation, and is developing a multi layered hydrology model.
- 16.5 The August 2023 Report reinforces confidence in appropriate use of Overseer for monitoring relative risks:
- Point 7 (page 2):
- The validation used internationally accepted performance measures for nutrient models. These performance measures show that the Overseer model produces "very good" results in estimating nitrogen leaching from grazed pastures and "satisfactory" and "good" results for cropping data. This analysis further improves the confidence in the use of Overseer for estimating nitrate loss from grazing systems and, importantly, in cropping systems used for summer and winter feed on dairy and dry stock platforms, a key source of nitrate loss in some dairy systems.

¹⁸ Overseer Redevelopment Programme Report Technical Paper No: 2023/12 ISSN: 2253-3923 ISBN: 978-1-991087-83-6 (New Zealand Government).

(Emphasis)

Point 8 (page 3):

The Overseer validation work is comparable with other work that shows a strong correlation between measured and modelled nitrate loss data. This provides further confidence for users of the Overseer model.

16.6 MFE provided this advice in July 2023 Report:¹⁹

The Ministry suggests councils remain alert to the Science Advisory Panel's concerns and become familiar with the technical reports released publicly on the redevelopment programme. Where possible, within their existing policy and consenting frameworks, councils should adopt a best information approach. They should look for opportunities to support decisions made using OverseerFM data with multiple lines of evidence.

When issuing new consents, preparing new regional plans, or changing existing plans, councils should use wording that will provide for maximum future flexibility for assessing nutrient loss from a range of tools that may become available.

(Emphasis)

And:²⁰ Importantly, any alternative approaches to OverseerFM-based limits on resource use will need to give effect to the National Policy Statement for Freshwater Management 2020 (NPS-FM). Plan changes that give effect to the NPS-FM must be notified by 31 December 2024 (section 80A of the Resource Management Act 1991).

16.7 Overseer has always clearly stated the limitations of the model, when interpreting results.²¹

¹⁹ Ministry for the Environment. 2023. Responding to the Overseer model redevelopment review: A guide for councils. Wellington: Ministry for the Environment (July 2023), page 7

²⁰ Above-cited at page 9.

²¹ Assessment of Overseer Model Performance with experimental data from grazed pastures Jen Paul Tavernet, Aug 2023 (released Sept 2023) at Appendix A.

KEY OVERSEER MODEL ASSUMPTIONS AND LIMITATIONS

The Overseer model incorporates important hypotheses and limitations that are outlined below (derived from Watkins & Selbie, 2015):

Model scope

- The Overseer model boundary relevant to this report is the farm boundary and the root zone (below 600 mm).

Key Assumptions

- The Overseer model assumes steady-state conditions (i.e., inputs and site characteristics are in equilibrium with farm production).
- The Overseer model estimates annual average outputs assuming that the farm management and inputs are constant.
- The Overseer model assumes that the production did occur for the given inputs.
- The Overseer model assumes that certain practices or levels of practice ("good management practices") are occurring, e.g., fertiliser is spread evenly, dairy shed effluent ponds are sealed.
- The Overseer model assumes long-term average rainfall, PET, and temperature and a specific daily rainfall pattern based on location.

Limitations

- The Overseer model assumes near equilibrium farm systems; the losses that occur as the system changes are not captured.
- OverseerFM and the Overseer model are not a day-to-day decision management tools.
- The Overseer model does not model extreme episodic events (landslides, severe flood...)
- The Overseer model is not spatially explicit beyond the level of defined blocks.
- Not all management practices or activities that have an impact on nutrient losses are captured in the Overseer model.
- OverseerFM and the Overseer model do not represent all farm systems in New Zealand.
- Components of the Overseer model have not been calibrated against measured data from every combination of farm systems and environment.
- Scientific knowledge has been used to add components and to extrapolate to circumstances where calibration data has not been collected. The estimated loss uncertainties are likely to increase according to circumstances.

16.8 Given the range of reports that have emerged in response to the PCE Report in 2018, demonstrating a response and refinement of the Overseer, and the considerable investment and peer review that has been undertaken in the past 4 years, I do not agree with the use of the risk assessment tool being an alternative 'gateway' to the revised Table 14.2. I discuss the NRS and risk assessment tool in the next sections of my evidence. First I discuss one issue that I agree does require improvement within Overseer.

17. SPORADIC CLIMATE EVENTS

17.1 While Overseer can provide good nutrient budgets, as well as guide how farm systems can change and be a good scenario planning tool for lowering GHG and water contamination, it is a long-term model, and does not cope well with sporadic events.

- 17.2 This was also noted as a risk by the Overseer Review Panel (MPI 2021)²², whereby historical patterns cannot be reliably used to assess risks in the future:

Overseer assumes that, over the long-term (e.g. 30 years), the results from the model with average climate and management inputs will be equivalent to those that would be obtained by using actual inputs and then averaging the results. In general, this is only true for linear systems. Furthermore, by ignoring actual climate variation, the corresponding variable characteristics of nutrient flows in response to climate are not captured in model outputs. For example, periods of high (but not uncommon) rainfall may lead to significant runoff, deep drainage, and losses of nutrients, and such events will not be captured when only using average rainfall. As well as these concerns, determining average rainfall patterns is difficult since these must capture both the frequency and amounts of rain, and these are highly variable (MPI 2021).

- 17.3 Increasingly volatile weather patterns are already illustrating a new normal in 2023.²³
- 17.4 While Overseer is limited in how to cope with extreme weather events that are becoming more frequent and severe, the NRS and risk assessment tool are far less refined nor able to do so. Scenario planning for farmers to prepare for more extreme weather events will require insightful planning.

18. COMPARE NRS AND HORIZONS RISK ASSESSMENT TOOL

- 18.1 Ms Foster states:²⁴

²² Overseer whole -model review Assessment of the model approach. MPI technical Paper no: 2021/12

²³ MFE – Summary of Pressures on our Climate.

Our atmosphere and climate 2023(MFE) provides further evidence that emissions from human activities are putting pressure on our climate, which is adversely impacting the environment, communities, Māori interests, infrastructure, and the economy. The Ministry's Deputy Secretary – Joint Evidence, Data and Insights Group, Natasha Lewis, says eight of the ten warmest years recorded in Aotearoa up to 2022 have been in the last decade.....About 750,000 New Zealanders and 500,000 buildings worth more than \$145 billion are near rivers and in coastal areas already exposed to extreme flooding. Major urban centres, sites of cultural significance, taonga (treasured) species, and food security are also at risk in these areas.

Extreme weather events, such as those leading to floods and slips in Tairāwhiti and Auckland, storms in Westport and Nelson, and droughts across the country, are becoming both more frequent and severe. Concern is increasing that changes in the frequency of events will lead to a higher risk of multiple severe weather events that overlap in time and/or space.(MFE)

²⁴ Foster EIC at [150].

The score cards build on the Nitrogen Risk Scorecard used by Fonterra, but have been adapted for pastoral to reflect One Plan requirements (effluent disposal for example) and for CVG, with a focus on nitrogen practices. Both scorecards, as I understand it, represent a subset of the complexity of management variables built into Overseer®. In this way as well, the scorecards are coarser than Overseer®, but still focused on the same management tools.

18.2 Dr le Miere states:²⁵

Compared with Overseer, the NRS is reasonably crude because it only assesses practices and at a reasonably coarse level e.g. it assesses stocking rate per hectare whereas Overseer attempted to model where individual stock units were grazing and how much they were eating. However, in my view this is also the appeal of the NRS – it does not suffer the same uncertainty or subjectivity issues as Overseer because the data entry is simple with very little discretion. It also avoids some of the issues with modelling and attempting to proxy the complexities of real-life farm systems.

18.3 In the PC 1 (Waikato) hearings it was acknowledged by Mr Allen that the NRS in its raw form does not consider geophysical risks. He also noted that it only coarsely represents N loss risk from the root zone with a considerable degree of error when connected to receiving water bodies (given attenuation factor range).²⁶

18.4 I understand that Dr le Miere and Professor Horne have tried to include two key risk factors to improve the NRS, those of climate, and profile available water – representing soil leaching risk.

18.5 I fundamentally disagree that scorecard approaches for managing water quality, are preferable due to cost and ease of management. As I explain, I consider such approaches could result in negative effects and more stress for farmers, in the longer term.

²⁵ Le Meire EIC at [22].

²⁶ Allen Second Statement of Evidence 28 July 2023 at [8.13], attached to my evidence as Appendix 2.

19. NRS/RISK ASSESSMENT TOOL DATA INPUT AND CHECKS

- 19.1 The NRS relies on self-reporting by farmers on inputs to their farm system, who for no fault of their own, may erroneously record data inputs.
- 19.2 The NRS does not have data sense-checked or validated by a farm systems or suitably qualified Overseer user/professional.
- 19.3 The NRS does not provide validated detail of what fertiliser has been placed on what management block (proof of placement) or the timing of it. This system does not provide enough transparent nor validated detail to show for example inappropriate use of imported nitrogen to a farm (as feed, or fertiliser). My experience in the Bay of Plenty has indicated that self-reporting of inputs (for the purpose of industry plans) is only about 30%-50% accurate.
- 19.4 For the Horizons risk assessment tool, although Horizons have stated a commitment to implementation, it is not entirely clear how similar issues will be managed. Overseer has an established system managed by an independent farm systems/Overseer trained professionals.

20. LACK OF PEER REVIEW

- 20.1 The scorecard approaches are not underpinned by best science available (compared with multiple peer reviews and ground truthing of Overseer over the past 15 years). A lack of peer review means the metrics may not provide accurate information to farmers about their relative risk to receiving water quality. Yet, as I have outlined above, farmers making investment decisions should rely on the best science available.
- 20.2 The NRS has a focus on efficiencies (Purchased N Surplus/kg MS, N conversion efficiency etc) of a farm system rather than being more precise using load and concentration leaving the root zone (N loss per ha). Although this provides for simplicity, it could lull farmers into a false sense of security perceiving their farms are low risk, when in fact if the best available science were used to assess a farm risk (Overseer) then

the farmer would be legitimately guided as to their farm's risk to receiving catchment. The NRS does not provide the best available information on how to adapt to tightening nutrient limits, that may apply presently or in the future.

- 20.3 In other words, through the lack of provision of the best available peer reviewed science on N Loss to water, the NRS leads farmers to believe in many cases based on their N Risk scorecard that they are low risk (including relying on efficiency measures that do not directly correlate with risk to water). By not engaging in the use of Overseer monitoring on an annual basis, even when they are in nutrient constrained catchments (for example Rotorua Lakes), this can lead to farmers assuming all is well when it is not.
- 20.4 Although the risk assessment tool is an improvement on the NRS, neither the NRS or risk assessment tool go into a mathematical model to provide for cross checking of system input errors or subsequent outputs (such as Pasture Harvested per ha per annum).
- 20.5 The failure to cross check and ultimately collate input data, can lead to cumulative errors and risk scores that could be relied on by council, who will have to investigate/audit these files in cases. As distinct from relying upon an established system (Overseer), this will be costly, and complex.
- 20.6 While the risk assessment tool adds Climate and Soil (PAW) risks, it relies on a number of proxies on proxies, that in my opinion have not been adequately compared with Overseer outputs.
- 20.7 The risk assessment tool does not consider different block variations, variations in management according to block, slope nor the influence of irrigation. Whereas Overseer provides information on total N Loss per ha, and N concentration leaving the root zone, from each block influenced by each block's management factors inside a farm. Thus is a more precise indicator of risk by management block, slope, soils, climate, and irrigation effects etc. This is important for nutrient management specifically on blocks that vary in management and use.

21. FAILURE TO REWARD MITIGATIONS/ INNOVATION/ DIVERSIFICATION

- 21.1 The NRS Manual makes it clear the calculations for risk are based on the effective grazed area of the dairy farm (rather than the total farm area).²⁷ The effective grazed dairy area at times can be only a proportion of an entire farm system that is operated by one owner, or land manager.
- 21.2 The effective grazed area is used as the denominator that N use, N surplus, cropping areas and GHG emissions are divided by. This effectively means that when a farmer does mitigations such as retiring critical source areas, retiring steep slopes or protecting wetlands and riparian areas on top of the other ineffective areas (tracks buildings etc), the result is not recognised or rewarded because the effective area shrinks.
- 21.3 So, with respect to systems approach, the approach of using a scorecard only on the pastoral (effective) area²⁸ (and only relevant to one industry enterprise) misrepresents a total farm system. It fails to reward farmers by not recognising their lower footprint less intensive land uses (edge of field mitigations) on their landholding.
- 21.4 Because the NRS/risk assessment tool only provides risk metrics for the effective area of a single (IFLU) industry unit rather than the total farm area, good things that are being done on a farm such as permanent plantation forestry, diversification into alternative land uses, riparian zones, tree planting and retirement of critical source areas, are not counted to reduce overall N loss.
- 21.5 To me, it is short-sighted to have single industry (drystock, dairy) scorecards that relate only to the effective area and that are disconnected from reality of diversified farm systems, in this way. The approach is not connected well to a requirement for catchment wide reductions of nutrient loads, because it does not recognise diversification of land uses required on vulnerable land classes.

²⁷ E.g. 5.1.1 in Manual: Stocking Rate The calculation for this factor is the number of peak animals converted to stock units (Appendix) then divided by the dairy farm effective area & Risk points calculation: The total percentage of the farm cultivated by Conventional method is calculated as the total cultivated area by Conventional divided by the total effective area of the farm.

²⁸ Effective area for the risk assessment tool is defined as "the area of land used for grazing livestock (including the milking platform), cropping or as sacrifice paddocks.", Schedule [X] page 29.

- 21.6 Many farmers are planting vulnerable areas in part of their total farm to reduce GHG and surface losses of contaminants to water such as N, P, sediment and *E Coli*. If a farmer is to do the right thing for water quality and reduce the grazed area, by retiring erodible land, critical source areas or ephemeral streams (as per Figures 2 – 5 below), in the NRS and the risk assessment tool the stocking rate metric will go up because the denominator (effective farmed area) will reduce. Similarly, the cultivation risk component metric will go up as the effective farm area reduces:

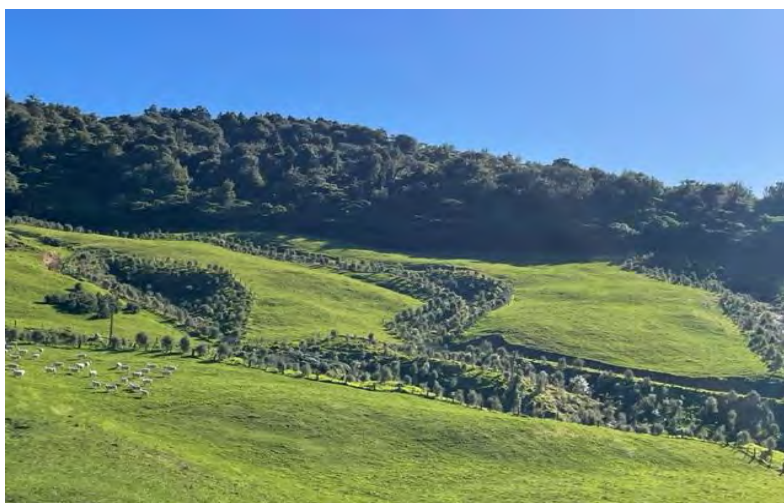


Figure 2: *Edge of field mitigations (retirement of ephemeral stream pathways)*



Figure 3: *Retiring highly erodible land classes into woodlots or native bush*



Figure 4: *Removal of areas into native bush*

- 21.7 The same comment applies to good practices that a farmer may put in place such as a detainment bund below critical risk areas for P loss (to reduce surface phosphate runoff, such as the example in Figure 5 below, which captures surface runoff water from pastoral landscapes during inclement weather events and allows the sediment to settle, thereby reducing the P load making their way to receiving water bodies.



Figure 5: (Photo: Dylan Clarke) *A typical detainment bund, designed to temporarily pond ephemeral stream water, Waiteti Stream catchment, Rotorua, March, 2012. This photograph has been taken after a runoff event and the pond is still draining.*

- 21.8 Although it may be more complex, the Overseer model calculates the N loss and P runoff risk (and GHG) from the entire mixed industry enterprise and rewards mitigations that are put in place in an even-handed way.
- 21.9 The risk assessment tool is only suited to the IFLU area and cannot explore other options which may be better for water quality improvement such as land retirement, carbon income, dry stock, horticulture or forestry.

22. RESPONSE TO THE EVIDENCE OF DR LE MIERE

- 22.1 Dr le Miere notes the risk assessment tool is crude, does not go into energetic balancing for a system, and that the data entry is simple with very little discretion.
- 22.2 Dr le Miere creates a synthetic farm to show what would be required to reduce a risk score (203 to 86)²⁹, where decisions would need to be made on stocking rate reductions and feed supply matters. This analysis contains no energetic nor economic calculations (such as a Farmax/Overseer approach). Dr le Miere's acknowledges:³⁰

In reality, a farm planner would work with the farmer to understand how changes to practices and the farm system would operate “on the ground” and whether they were practicable for the particular farmer, farm and location. This would be an iterative process and could be fairly complex.

- 22.3 This iterative and professional process would involve a farm consultant building a farm system and series of cascade models (such as Overseer combined with UDDER, Farmax dairy or sheep and beef, alongside spatial mapping for forestry and or land retirement and linking to carbon or other income). This is because system changes are highly impactful and it is essential that a farm business (often worth multimillions of dollars) prepares any plan and future security to farm,

²⁹ Dr le Miere's evidence covers this from [49].

³⁰ Le Miere EIC at [52].

using the best tools available. The insinuation that this can be simplified into a quick and easy coarse process is, in my opinion, highly risky.

- 22.4 For scenario testing, I believe it would be completely inappropriate to encourage a farmer to use a quick and simple model (when far better options are available) to determine a systems strategy on farm that could significantly affect the farm's future business survival.
- 22.5 In many cases, farmers will need to be advised by a cross disciplinary team of a farm systems specialist, who can run pastoral farm models as well as scenarios in Overseer alongside spatial mapping capabilities, whereby the most appropriate land uses are adapted to land class. (This approach would also involve professionals who have expertise in forestry, agroforestry or native establishment on suitable land classes.)
- 22.6 It is my understanding that the risk assessment tool does not transparently connect to any other models or predictive systems that farmers have been utilising for decades, which allow professionals and farmers to explore alternative land uses and farm systems (i.e. in the way that Overseer does).
- 22.7 Based on this limited analysis, Dr le Meire has adjusted Professor Horne's 'matrix' scores.³¹
- 22.8 Dr le Miere asserts that meeting the risk levels via the gateway proposed by Professor Horne will result in 30-40% lower profitability³², without doing any full system assessment on the farm and management skills, economic situation, nor biological modelling.³³ There are numerous studies that show that farms can reduce their nitrogen and contaminant footprints and retain economic viability.³⁴ This depends on what level of intensity the farm is at when de-intensification (e.g: reducing inputs or stocking rates) begins.

³¹ Le Mierre EIC [52] – [79].

³² Le Mierre EIC at [54]: *"These mitigations reduced the kilograms of milk solids produced by the synthetic farm by over 20%. I estimate that this would be approximately a 30-40% reduction in operating profit and I do not consider that such a farm would be economically viable. Given that this was the 80th percentile farm, the remaining 20% of farms above the 80th percentile would find it even more difficult to reduce to a nitrogen risk score of 86."*

³³ Dr le Mierre reduced cow numbers, milk, fertiliser and on that basis assumed less profit, assuming production and profit are linearly related.

³⁴ Anderson, W.J; Ridler, B.J. 2017. The effect of dairy farm intensification on farm operation, economics and risk: a marginal analysis. *Animal Production Science*. 2017 pp. 1350-1356

- 22.9 Dr le Miere has not utilised a farm systems approach that considers alternative land uses and income streams, in planning for a farmer to adapt to change. This is further evidence of the problems of using a risk tool that caters for intensive pastoral land use. Whereas the Overseer tool encourages and allows use of transdisciplinary advice (across for example forestry and dairy systems), to find the most suitable land use and 'sweet spot' for profitability.
- 22.10 The 'IFLU-land only approach' ignores that reductions in N leaching can come from via a range of options, including land retirement in vulnerable areas, that allow continued profitability (even if the farm is to remain as 100% dairying). These demonstrate how increased profit, and a significantly lower footprint for water use, nitrogen loss, GHG and cost structures can be achieved simultaneously (finding the optimal point of intensity that matches human and environmental health needs while protecting business resilience).
- 22.11 In my experience farms can reduce contaminant losses and emissions by 10 to 40%, in some cases more, with some farm system modifications and time to adapt. A range of studies of the past decade have provided excellent case examples of this being applied. However the degree of reduction is dependent on how intensive the system is, and the natural capital vulnerabilities of the farm. These studies are listed in my Appendix 5.

23. COMMENT ON COMPLEXITY VS SIMPLICITY

- 23.1 Rural agricultural professionals are presently grappling with a complex environment, and multiple policy approaches to manage nitrogen loads in catchments, while also trying to retain farmer confidence and business certainty.
- 23.2 As a farm advisor and taking on board the MPI and MFE reports (2017 to 2023) I firmly believe that we need a mix of the best available tools to help our farmers adapt to change.
- 23.3 My concern is that if PC 2 supports a simpler pathway using the risk assessment tool, farmers will be encouraged to take the simple, but

coarse, option to continue 'business as usual' in the face of more rapid change and potential future threats to their business.

- 23.4 In addition, NZ agricultural professionals could be faced with an unwieldy number of scorecards to navigate, region by region and industry by industry.
- 23.5 I acknowledge that as models develop (to quantify phosphorus, sediment and pathogen loss risk such as the MitAgator and the forthcoming MfE Risk Index Tool³⁵) more appropriate output control methods may emerge to allow better quantification of diffuse losses to complement the output control relying on N and P loss from Overseer. But in my opinion a risk assessment tool should not be accepted in the way suggested for PC 2, without further thorough analysis.
- 23.6 While trying to simplify and reduce cost, the NRS / risk assessment tool will in my opinion complicate an already complicated environment.

24. CASE STUDY: WAI-KOKOPU CATCHMENT PROJECT IN THE COASTAL BAY OF PLENTY

- 24.1 The following case study illustrates some of the points made in my evidence. In the past 4 years, I have been Operations Manager of a \$4.5 million project - Wai-Kokopu in the Coastal Bay of Plenty: <https://www.wai-kokopu.org.nz/>.
- 24.2 This project was funded to deliver on a range of outcomes, including getting farmers on a journey of change to reduce their nutrient losses to water.
- 24.3 The ~34,000 ha catchment is one of the most degraded in NZ, and load modelling undertaken by BOPRC indicated there is a need for a 70% drop in N load and 30% drop in P load to the estuary to achieve a moderate state of health. Further to that, our monitoring of drinking water in the catchment (rural sources) has indicated that around 25% of rural drinking water has nitrogen enrichment with more than 5.5 mg/L

³⁵ Letter from MfE to Chief Executive Horizons and Waikato Regional Councils 31 July 2023 regarding the development of a Risk Index Tool.

of Nitrate N and 10% of the rural drinking water samples we have tested have more than 11 mg/L of Nitrate N.

- 24.4 In 2020-2023, the 34,500-ha catchment has around 68 Dairy farms (13,000 ha) that contribute to around 60% of the N load, and 2,000 ha of horticulture, and a balance of forestry, and dry stock in the upper catchment.
- 24.5 Our project needed to deliver on a pan sector digital farm plan which could show the overall N and P loss risk from a pan sector farm and demonstrate how a range of land uses may assist in lowering the nutrient load to the receiving catchment.
- 24.6 Some contiguous land blocks have up to 19 different land management units on them, and five different enterprises (horticulture, forestry, riparian zones, dairy, arable and dry stock).
- 24.7 These mixed enterprises are not uncommon in the Bay of Plenty, and are becoming increasingly common across NZ as landowners diversify their businesses.
- 24.8 An example of what we have been modelling is shown in the figure below:



Figure 6: A pan sector model from Overseer map, showing 17 different management blocks, covering 5 types of industries on a single farm

- 24.9 In this case, if the farmer only had the NRS or risk assessment tool, there would be no opportunity to demonstrate the overall farm nutrient loss risk to the receiving catchment, to investigate scenarios for reduction of N loss, P loss risk and GHG mitigations, required for integrated farm planning.
- 24.10 Overseer enables a farm systems advisor to advise on the best land uses, for the appropriate land classes, alongside an economic/farm system model, considering risks (risks that include factors in addition to nitrogen).

COMPARISON OF MODELS and REPORTING TOOLS

Functional Ability	Overseer	Nitrogen Cap - via FWFP	Nitrogen Risk Scorecard - Fonterra	Horizons Risk Assessment Tool
Relative Risk of Nitrogen Leaching from Root Zone	Yes	No	No (<50%) chance of being relative as a proxy. Does not have data input checks see below	While PAW and Rainfall and intensity improves the relative risk assessment, remains a poor/uncertain proxy for Risk.
Verified Inputs	Yes, trained professionals check and validate data, and keep assumptions and data input forms recorded on file. Audit log & comparison reports available in software. Best Practice Input Standards reducing risk of model error.	No – self-reported. While a FWFP certifier can check, they will generally not go through the same rigorous process as Overseer to check and validate the number reported.	No –self-reporting. Lacks sense checks.	Yet to be addressed (by Horizons) in proposed implementation plan.
Will it be suitable across soils across whole of NZ?	Relies on S-maps for soil data. While S-map still does not account for all soils across NZ, this is work in progress, as well as work to improve understanding of how water transits via the soil profile, the effects of drainage (vertical movement), and climatic.	Unsuitable as has no consideration of soils, geology, climate (kilograms of fertiliser bought, excludes organic sources and excludes maize or arable crop use.)	Unsuitable as has no consideration of soils, geology, climate.	The Horizons risk assessment tool would need to be adapted for other catchments, and farm types, leading to risk matrix permutations for industries, soils and catchments.
Does it measure loads relevant to total farm enterprise	Yes – Covers all management blocks and effective and total areas. Also takes into account different land uses (dairy, horticulture, forestry, drystock etc)	Total N applied only to total farm area	No – Metrics only focus on Effective Grazed Area (of Dairy).	No – Metrics only focus on Effective Area of Dairy/Irrigated sheep and beef.

Functional Ability	OVERSEER	Nitrogen Cap – Via Freshwater Farm Plan	Nitrogen Risk Scorecard	Horizons Risk Assessment Tool
Can the tool it be used to understand transit of N from the farm root zone to receiving water body.	No, does not indicate risk beyond the root zone of 60 cm, to the receiving water body. But can be used to predict the concentration of N in groundwater leaving the root zone. Also provides load/Ha.	No, as no account of soils, geology or climate	No, as no account of soils, geology or climate	While improvement on the NRS, can only inform relative risk from the effective area, not a quantified concentration nor load.
Does this method account for Phosphorus loss risk which is as important for water health	Yes	No	No	No
Does it provide information on other emissions – such as GHG	Yes	No	Yes – the Scorecard approach does provide a self-reported calculation – GHG loss, but is not verified by independent advisor as Overseer.	No
Pan Sector Ability – does it assess risk & benefits across horticulture, dairy, drystock, forestry etc.	Yes	No	No	No
Irrigation (driving leaching) Risk	Yes	No	Yes	No

Alison Mary Dewes

Appendix 1:

**First Statement of Evidence of Richard Allen 22 June 2023 on Behalf of
Fonterra Co-operative Group Ltd and Dairy NZ**

IN THE ENVIRONMENT COURT
AUCKLAND

I TE KŌTI TAIAO O AOTEAROA
KI TĀMAKI MAKĀURAU

ENV-2020-AKL-000083
ENV-2020-AKL-000084
ENV-2020-AKL-000085
ENV-2020-AKL-000086
ENV-2020-AKL-000087
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ENV-2020-AKL-000093
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ENV-2020-AKL-000101
ENV-2020-AKL-000102
ENV-2020-AKL-000103
ENV-2020-AKL-000147
ENV-2020-AKL-000148
ENV-2020-AKL-000149

IN THE MATTER

of the Resource Management Act 1991 ("RMA")

AND IN THE MATTER

of appeals under clause 14 of Schedule 1 of the
RMA against the decision of the Waikato Regional
Council on Proposed Plan Change 1 to the Waikato
Regional Plan ("PC1")

Continued

**FIRST STATEMENT OF EVIDENCE OF RICHARD GRANT ALLEN
ON BEHALF OF FONTERRA CO-OPERATIVE GROUP LIMITED AND DAIRYNZ
LIMITED**

22 JUNE 2023

**Russell
McLeagh**

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Auckland

BETWEEN

AUCKLAND WAIKATO & EASTERN REGION FISH AND GAME COUNCILS, BEEF + LAMB NEW ZEALAND LIMITED, CNI IWI LAND MANAGEMENT LIMITED, DAIRY NZ LIMITED, DIRECTOR-GENERAL OF CONSERVATION, FEDERATED FARMERS OF NEW ZEALAND, FONTERRA CO-OPERATIVE GROUP LTD, HAMILTON CITY COUNCIL, HORTICULTURE NEW ZEALAND, IWI OF HAURAKI, LANDCORP FARMING LIMITED, LOCHIEL FARMLANDS LIMITED, MERCURY NZ LIMITED, OJI FIBRE SOLUTIONS (NZ) LIMITED, PUKEKOHE VEGETABLE GROWERS ASSOCIATION, ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND INCORPORATED, SOUTH WAIKATO DISTRICT COUNCIL, TAUPO DISTRICT COUNCIL, WAIKATO AND WAIPĀ RIVER IWI, WAIKATO RIVER AUTHORITY, WAIPĀ DISTRICT COUNCIL, WAIRAKEI PASTORAL LIMITED

Appellants

AND

WAIKATO REGIONAL COUNCIL

Respondent

AND

AUCKLAND WAIKATO & EASTERN REGION FISH AND GAME COUNCILS, BATHURST RESOURCES LIMITED AND BT MINING LIMITED, BEEF + LAMB NEW ZEALAND LIMITED, CNI IWI LAND MANAGEMENT LIMITED, CONTACT ENERGY LIMITED, DAIRY NZ LIMITED, DIRECTOR-GENERAL OF CONSERVATION, FARMERS FOR POSITIVE CHANGE (F4PC), FEDERATED FARMERS OF NEW ZEALAND, FONTERRA CO-OPERATIVE GROUP LIMITED, GENESIS ENERGY LIMITED, GENETIC TECHNOLOGIES LIMITED, GRAEME GLEESON, GRAHAM PINNELL, HAMILTON CITY COUNCIL, HANCOCK FOREST MANAGEMENT NZ LIMITED, HAURAKI DISTRICT COUNCIL, HORTICULTURE NEW ZEALAND, KING COUNTRY ENERGY LIMITED, LANDCORP

FARMING LIMITED, LOCHIEL FARMLANDS LIMITED, MATAMATA-PIAKO DISTRICT COUNCIL, MERCURY NZ LIMITED, MIRAKA LIMITED, NEW ZEALAND DEER FARMERS' ASSOCIATION, OJI FIBRE SOLUTIONS (NZ) LIMITED, OTOROHANGA DISTRICT COUNCIL, PUKEKOHE VEGETABLE GROWERS ASSOCIATION, RAVENSDOWN LIMITED, ROYAL FOREST AND BIRD PROTECTION SOCIETY, SOUTH WAIKATO DISTRICT COUNCIL, SOUTHERN PASTURES LIMITED PARTNERSHIP, TAUPO DISTRICT COUNCIL, TIMBERLANDS LIMITED, WAIKATO DISTRICT COUNCIL, WAIKATO AND WAIPĀ RIVER IWI, WAIKATO RIVER AUTHORITY, WAIPĀ DISTRICT COUNCIL, WAIRAKEI PASTORAL LIMITED

Section 274 Parties

1. INTRODUCTION

1.1 My full name is Richard Grant Allen.

1.2 I am the Environmental Policy Manager at Fonterra Co-operative Group Limited ("**Fonterra**"). In this role I am responsible for ensuring Fonterra policy positions are effectively represented in the various planning processes across New Zealand that may impact dairy farmers and the dairy industry.

Experience

1.3 I have a Bachelor of Agriculture Degree from Massey University and a Bachelor of Laws Degree from Waikato University. I also hold the Advanced Sustainable Nutrient Management Certificate from Massey University.

1.4 I have been employed by Fonterra since 2008. In my time with Fonterra I have been involved in the development and implementation of the on-farm environment programmes – namely the Effluent Programme, the Stock Exclusion (Waterways) Programme and the Nitrogen Programme. I was also part of a small team that developed and rolled out the Nitrogen Risk Scorecard ("**NRS**") to all Fonterra suppliers.

1.5 I was seconded to DairyNZ in 2010 to develop a dairy industry protocol for the use of Overseer. This protocol formed the basis of the Overseer Best Practice Data Input Standards. I was also a member of the Technical Advisory Group for the Overseer Best Practice Data Input Standards prior to the Overseer model rework and business restructure.

1.6 Prior to my employment with Fonterra, I worked for the Waikato Regional Council ("**Council**") in the Resource Use Group. My role with the Regional Council primarily involved monitoring and enforcement of the farm rules in the Waikato Regional Plan.

1.7 I have previously owned and operated a medium hill country drystock property in the King Country (Upper Waipā catchment) running sheep, cattle and deer, and until recently farmed a 20ha deer property.

1.8 I am familiar with the provisions of the PC1 to the Waikato Regional Plan and have been involved in PC1 for Fonterra since it was notified and was involved in the submissions and further submissions. I am authorised by Fonterra to provide this statement on its behalf.

Scope of evidence

- 1.9 The purpose of this statement of evidence is to provide detail on the NRS – how it was developed, what its core principles are, how it works in practice and what it is currently used for. I will be providing a separate statement of evidence on other matters in due course.

2. BACKGROUND TO THE NITROGEN RISK SCORECARD

- 2.1 Fonterra developed the NRS after using Overseer for several years as a support tool to achieve behavioural change on farm. Lessons from the use of Overseer at scale were key to designing the NRS.

Core principles behind the NRS

- 2.2 For Fonterra, an effective risk assessment tool must:
- (a) make sense to farmers and those who provide advice / support to farmers. Provide visibility to farmers, at a glance, how changing practices on their farm impact on changing risk over time;
 - (b) support the objective identification of specific risks that need to be addressed with actions in a farm plan. The NRS is to be used to directly support the Farm Environment Plan ("FEP") process;
 - (c) reduce data provision requirements and have data entry systems that are efficient, user friendly and non-duplicative. Data is readily available for most farmers and can be validated;
 - (d) only require input data that can be entered directly by a farmer or their advisor with no need for data interpretation by an expert. The tool will calculate the reported metrics based on the actual data entered. (There is no intermediary required between data entry by the farmer and calculation output reporting back to the farmer);
 - (e) be transparent – the calculation approach will be freely available, and Fonterra will not seek to establish any IP rights or control third party use of the tool; and
 - (f) be stable and repeatable – the tool is a simple representation of highly complex and interrelated risks. For Fonterra's purposes it will not require frequent change to be useful. It is recognised that significant mitigation developments might be added in the future (for

example plantain or Nitrogen ("N") inhibitors could be added as practices that reduce N loss risk).

3. WHAT THE NRS IS AND HOW IT WORKS

- 3.1 The Nitrogen Risk Scorecard Manual (at **Attachment 1**) provides a detailed description of how the NRS works and how the approach provides an objective risk assessment tool that, in conjunction with a robust FEP process, can support on-farm change.
- 3.2 The NRS is not a 'model' in the sense that Overseer is a model, it does not try to interpret and metricise complex interrelationships between biophysical / geophysical variables and unknowns, it is, simply put, a calculation tool that applies a quantified value or 'metric' to a particular input or practice based on:
- (a) the known range for each input and practice understood to exist across the dairy sector; and
 - (b) the relationships between those practices and the potential for contaminant losses to the environment.
- 3.3 The NRS provides a risk score for six farm management factors. These six factors are the key drivers of manageable risk for N loss. While the geophysical factors that influence N loss from a farm system remain basically unchanged (and unchangeable) over time, it is the farming intensity of operation and management factors that can and do change to influence contaminant loss risks.
- 3.4 The six farm management factors, which are also referred to as the key risk drivers are:
- (a) stock management;
 - (b) nitrogen fertiliser;
 - (c) imported feed;
 - (d) cropping and cultivation;
 - (e) effluent management; and
 - (f) irrigation.

- 3.5 Fonterra has a robust understanding of the range of practices that exist for each of the key risk drivers. It was therefore possible to align the known range of practices against a score range. Detailed data analysis was carried out to then ensure there was reasonable relativity between each key driver score. For example, the Nitrogen Fertiliser risk score at 80 points would, on average, have a similar impact on the risk of N loss as would a Stocking Rate risk score of 80.
- 3.6 For each of the six farm management factors, points are attributed to the main driver of risk for that factor. For example, peak stocking rate is the main driver of risk for stock management and total tonnes of N applied per effective hectare is the main driver of risk for nitrogen fertiliser. Other specific sub-practices that will increase or decrease the risk for each farm management factors are then used to moderate the score.

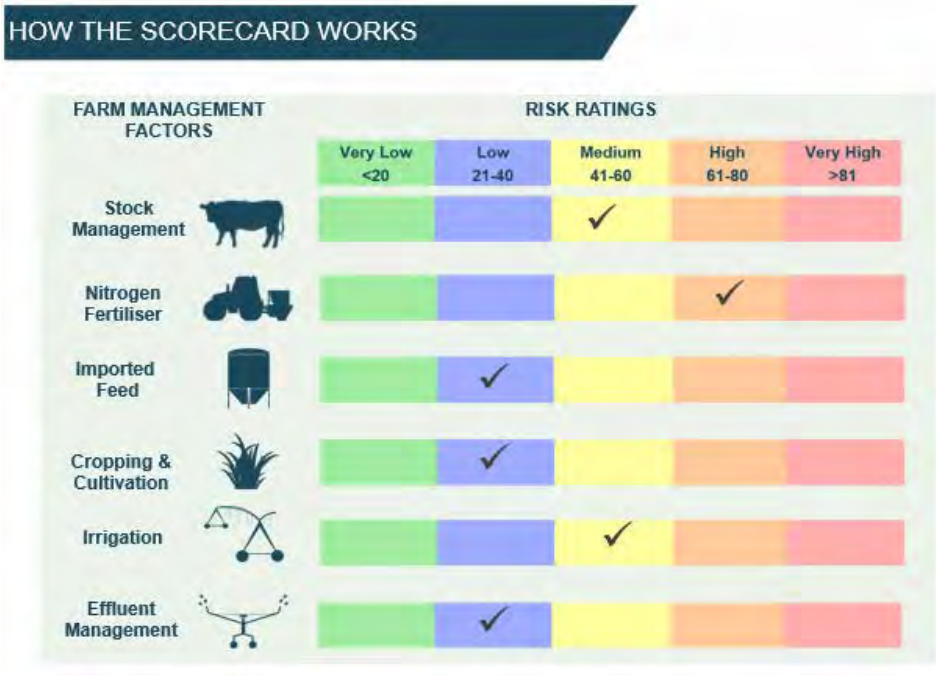


Figure 1: Overview of how the NRS works

- 3.7 As illustrated in Figure 1 above:
- (a) Each farm management factor receives a risk rating.
 - (b) The level of risk is determined by a score based on the farm data provided.
 - (c) The risk score is calculated for each key farm factor. That score is then modified by consideration and scoring of 'sub factors' (also

known as moderating practices) that might exacerbate or decrease the level of risk.

- (d) High risk practices receive higher points than lower risk practices, and mitigating practices carry negative points.

- 3.8 Sub-practices / moderating practices that increase the risk of nitrogen loss attract additional points while sub-practices that reduce N loss risk carry negative points. For example, wintering animals off-farm reduces the score for stock management (with the reduction varying depending on how long they are wintered off farm) and the timing of nitrogen fertiliser application may increase the score (if it is applied outside the months of September to April).
- 3.9 The reported risk for each of the six farm management factors is based on a final score determined by points assigned to the key driver of the particular risk area. This is then modified by the consideration of a number of sub-practices (eg animals held on stand-off areas equates to a negative score as the stocking rate risk is reduced by the specific practice). Where data granularity allows, the sub practice points are on a variable scale (eg as the data shows a higher percentage of animal hours are spent on a structure where effluent is collected, the corresponding risk points are proportionally decreased).
- 3.10 An example of how the NRS calculation works is provided in Figure 2 below, which describes the allocation of points for the Stock Management section. Each key farm practice calculation follows a similar approach.

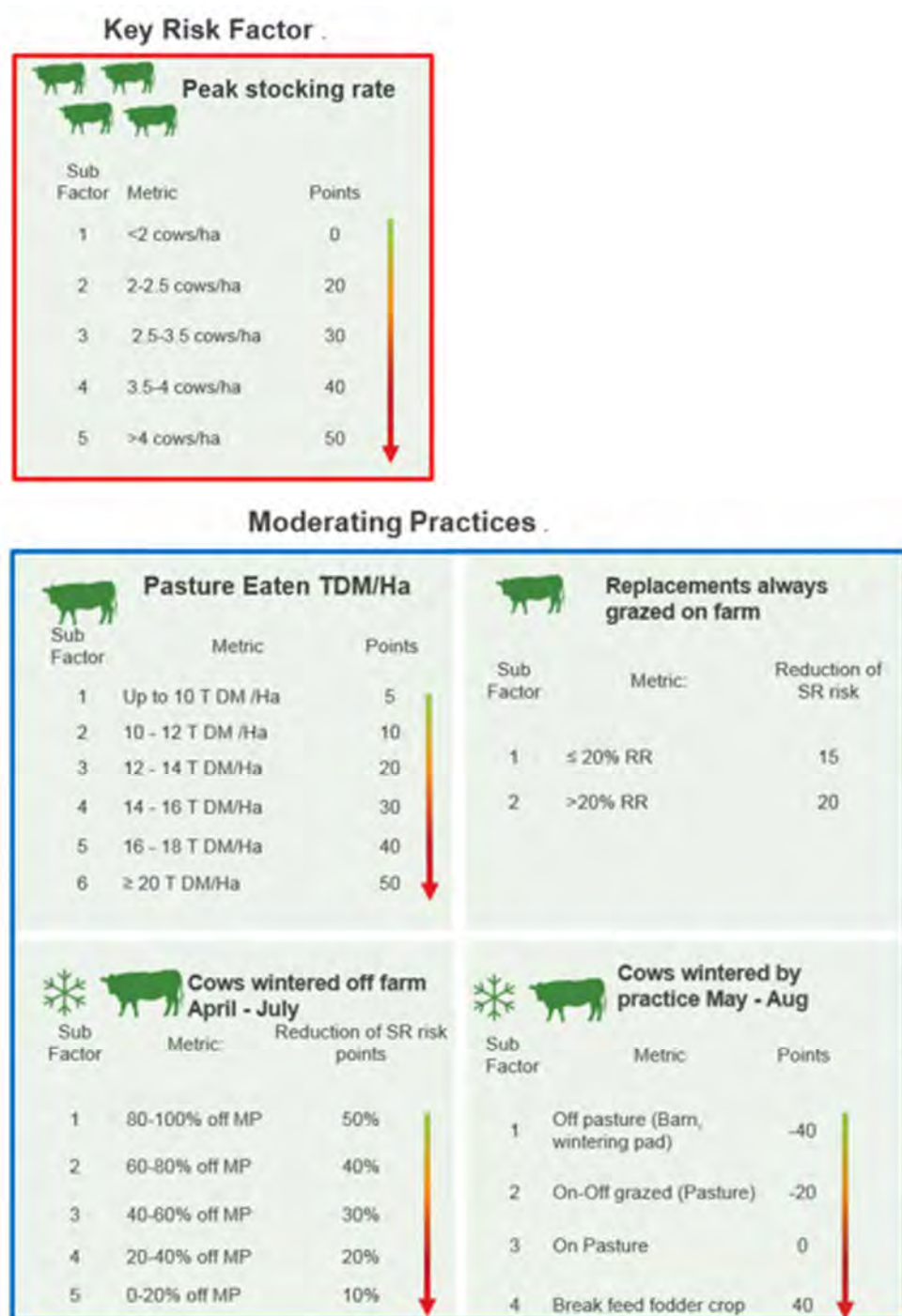


Figure 2: Allocation of points for stock management

- 3.11 The NRS also allows for an aggregated score to be calculated for each property. This aggregated score can be used for benchmarking and then for monitoring and reporting change from the benchmarked number. Each of the six key farm practices contribute varying amounts of risk to each farm's whole farm N loss risk, therefore they are weighted to appropriately represent the relative risk. Scores for each individual risk factor are calculated and summed to generate a farm level risk score – the aggregated score. An example of an aggregate score is provided in **Attachment 2**.

- 3.12 Fonterra considers that an aggregated score from the NRS could be used in PC1 including for the following purposes:
- (a) To baseline the risk level of dairy farm systems.
 - (b) To provide a numeric threshold for an activity status or an additional standard in rules. (Populate the Schedule B rule thresholds table).
 - (c) To require a reduction in risk for higher risk systems by requiring a proportional reduction in aggregated score or requiring a farm to achieve a threshold value through change over time.
- 3.13 Fonterra commissioned an independent evaluation of the NRS in 2019. A copy of this evaluation is provided at **Attachment 3**.

Purchased nitrogen surplus

- 3.14 A further output metric from the NRS is the Purchased Nitrogen Surplus ("PNS"). This is reported to farmers (alongside the individual risk ratings) to provide a simple whole farm efficiency type metric. Fonterra considers that PNS, as an efficiency type metric, encourages farmers to look for opportunities that will decrease the gap between N inputs and productive outputs.
- 3.15 PNS is a calculation of the amount of nitrogen that is purchased and brought into the farm system but has not left the farm as product:

$$\text{PNS} = \text{N in fertiliser} + \text{N in imported feed} - \text{N in productive output}$$

- 3.16 PNS provides an indication of the amount of purchased nitrogen that remains within the soil profile and is available to be lost to the environment (i.e. either leached below the root zone or as gas). This provides an indication of risk at a whole farm level. It is a useful comparative risk metric – both between farms (particularly farms with similar geophysical values and limitations) and for an individual property over time.

4. CURRENT USE OF THE NRS

- 4.1 The NRS has been the primary assessment tool used by Fonterra over the last five years, enabling an objective annual assessment of nutrient loss and intensity related risk on all supply farms.

- 4.2 The NRS is currently used by Fonterra to support on-farm change in three ways:
- (a) The tool enables an objective identification of contaminant loss risk associated with on farm practices, system intensity and input decisions, and the development of appropriate actions to address risk, during the development of each tailored FEP.
 - (b) Farmers provide the relevant data through their Farm Dairy Records and receive a detailed Farm Insights report annually that sets out farm performance for each of the six key risk drivers from the NRS, and the PNS for the previous season.
 - (c) The 75th percentile PNS is used by Fonterra as a threshold metric for the 'Co-operative Difference' environmental performance payment.
- 4.3 At the end of each dairy season (30 May) Fonterra supply farms are required, as a condition of supply, to provide farm data that allows for the NRS process to be carried out. The farm data is a subset of the data that was previously (prior to 2017) required to run the Overseer model. The data requirements are less onerous than more complex modelling would require and there is an emphasis on data that can be supported / validated. Fonterra contracted service providers carry out an on-farm audit process on NRS data; in part because market claims and farmer incentive payments rely on this information. Fonterra considers that the Council would need to develop similar data collection, storage and verification / audit processes.
- 4.4 Each year Fonterra provides its farmers with a 'Farm Insights' report. An example of the environmental section of that report is provided at **Attachment 4**. That report contains the farm's NRS (with a very low, low, medium, high, or very high-risk rating for each of the six farm practice management areas), a breakdown of the nitrogen risks for each farm management factor and a PNS calculation for the farm. The NRS and its output metrics are also used to support the development of tailored actions in FEPs.

5. ESTABLISHMENT OF GATEWAY THRESHOLD METRICS FOR DAIRY

- 5.1 Fonterra has input data and output metrics from running the NRS for all supplying dairy farms since the 2017 / 2018 dairy season. Based on this dataset, we can establish normal distribution curves and percentile aggregated

scores for each of the Waikato Farm Management Units (or for the PC1 catchment as a whole).

- 5.2 These are summarised and provided in the document *Aggregated Score Data for PC1*, provided as **Attachment 5**.

Richard Grant Allen

22 June 2023

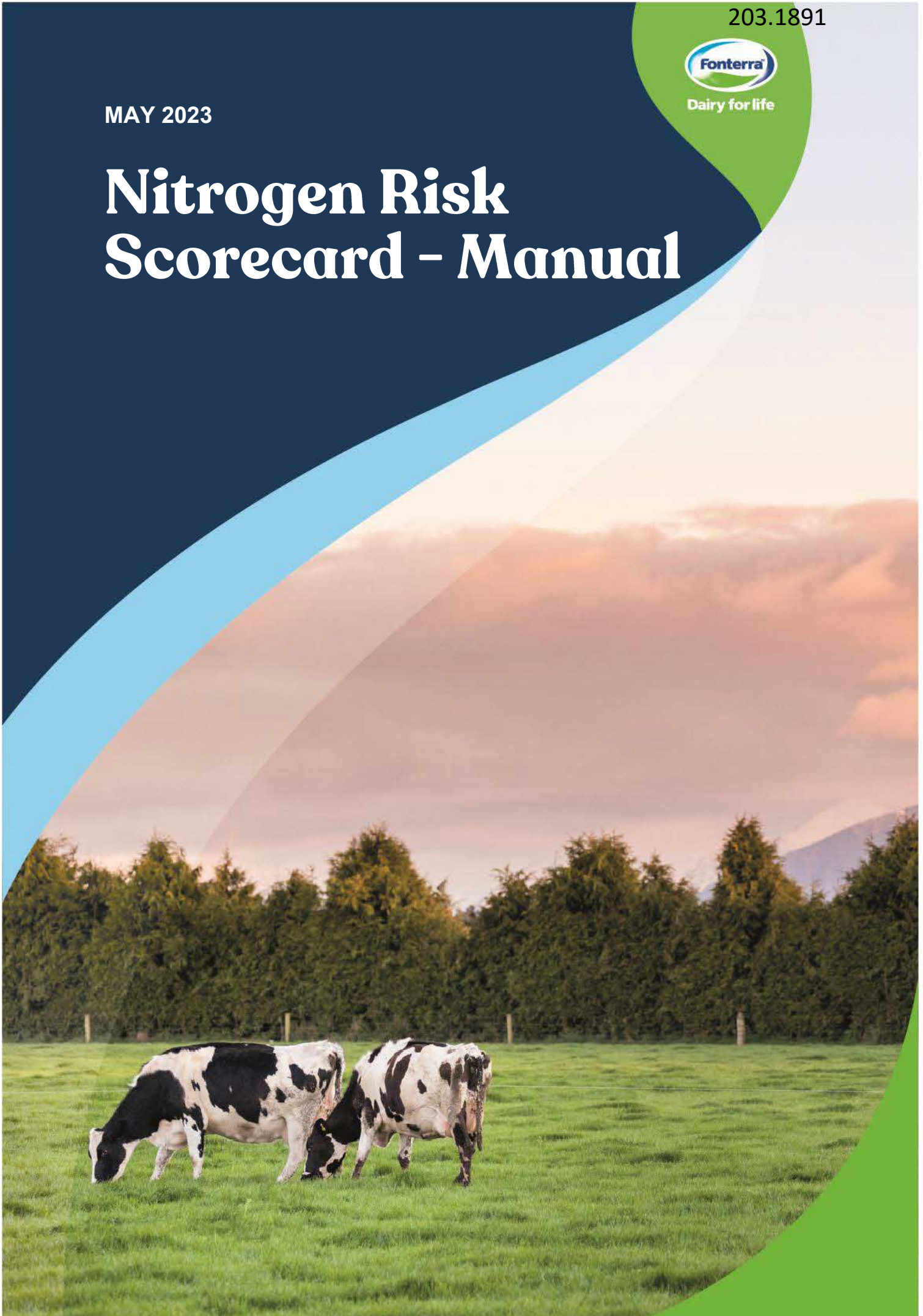
ATTACHMENT 1 - The Nitrogen Risk Scorecard Manual

203.1891



MAY 2023

Nitrogen Risk Scorecard – Manual



306.0014

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1 Introduction

Fonterra has committed to ensuring every one of our farmers has a tailored Farm Environment Plan (FEP) by 2025. These FEPs will help farmers to efficiently address environmental risks through practical and clear actions set out in the Plan.

Fonterra has a team of 40+ Sustainable Dairying Advisors (SDA) dedicated to supporting farmers through the delivery of FEPs. We believe that tailored FEPs are the best way to accelerate the adoption of good management practices and therefore decrease the impacts of farming on water quality.

The farm walk / visual assessment of critical source areas is suitable for identifying actions to manage contaminants such as sediment, pathogens and phosphorus. However, assessing nitrogen loss risk (and putting actions in place to address the risk factors) requires a different approach. This is primarily because nitrogen loss risk (N loss risk) is not generally associated with a visible source of a contaminant load that could be transported overland to waterways. Detailed information about the farming practices needs to be collected and assessed to provide an objective understanding of the level of N loss risk.

It is our view that the Nitrogen Risk Scorecard (or “Scorecard”) is a tool that can make the N loss risk assessment more objective, while remaining administratively efficient and presenting information back to farmers and farm plan advisors in a format that is intuitive and easy to engage with.

2 Background

Fonterra’s Nitrogen Programme has been operating since the 2012/2013 season, forming part of Fonterra’s commitments under the Sustainable Dairying: Water Accord. This included the collection of nutrient management data and modelling it in OVERSEER®, using agreed industry protocols to report on nitrogen leaching to water and a nitrogen use efficiency metric to all farmer suppliers.

The Nitrogen Programme has been successful in raising farmer awareness of the environmental risks around nitrogen. However, there are limitations to reporting farm level metrics when trying to focus farmer attention towards identifying and changing specific practices that are contributing to the N loss risk.

As a result, Fonterra has developed an alternative approach to identifying environmental risks related to N loss. This approach aligns with our strategic focus on achieving good farming practice outcomes through Farm Environment Plans.

The Scorecard has been developed for use as a tool which provides a simplified and objective assessment of the level of N loss risk from a farm. The Scorecard uses annual farmer data relating to six key farm practices and applies a level of risk to each practice against a set of benchmark parameters. The Scorecard also includes a calculated purchased nitrogen surplus (PNS) metric for the farm.

Additionally, the Scorecard can generate a single aggregated risk score for the whole farm. While farmer reporting does not currently include this metric, this may be a useful Scorecard output for baselining risk and monitoring change in risk over time.

With no manual data processing the Scorecard is a practical and cost-effective method of identifying high risk farms or inefficient management practices. Our SDAs can utilise the Scorecard results to inform appropriate actions to manage the identified risks through our tailored Farm Environment Plans. Our SDAs can then focus their time more efficiently on supporting farmers.

In future the Scorecard may also be used within a regulatory framework. The Scorecard concept was introduced by Fonterra as an alternative option during the submissions process for Healthy Rivers Wai Ora Plan Change 1 (PC1) in the Waikato. It is Fonterra’s view that the Scorecard may have a place in other regulated catchments because it is simple to implement, improves farmer engagement, accelerates the adoption of good farming practices, and decreases the cost and complexity of managing nitrogen. A method that reports on practices understood by, and within the control of farmers, is more likely to lead to enduring change than other approaches that focus on a modelled whole farm leaching metric.

3 What is the Nitrogen Risk Scorecard?

The Nitrogen Risk Scorecard (or 'Scorecard') is an automated tool that is a simplified and objective assessment of the level of N loss risk from a farm.

The Scorecard engine assesses annual farmer data submitted through the Farm Dairy Records (FDRs) and applies a level of risk against a set of benchmark parameters to each of the six key farm management practices:

- Stock Management,
- Nitrogen Fertiliser,
- Imported Feed,
- Cropping and Cultivation,
- Effluent Management,
- Irrigation

The Scorecard does not model the whole farm effect of detailed scenarios, nor does it provide a detailed nitrogen conversion efficiency metric that includes fixation and gaseous losses. It can be used to assess individual practices within the farmer's control that increase the risk of N loss to the environment.

3.1 How does the Scorecard assess risk?

- Each management practice receives a risk rating
- The level of risk is determined by a score based on the farm data provided in the FDRs
- The risk score is calculated for each key farm practice.
- That score is then modified by consideration and scoring of 'sub factors' that might exacerbate or decrease the level of risk.



Figure 1: Example of the Scorecard outcomes for each management practice

The level of risk for each of the six farm management practices is determined by calculating an overall score for each of the practices, with a score of less than 20 being very low risk ranging up to a score greater than 80 being very high risk.

Points are attributed to the main driver of risk for each management practice (e.g. stocking rate is the main driver for the Stock Management risk factor). Other specific sub practices that will increase or mitigate the risk are used to moderate the score within each management practice. Practices that would increase the N loss risk attract additional points, while practices that reduce the risk of N loss carry negative points.

The resulting risk rating for each of the six farm management practices is determined by aggregating all points applied to each of the sub practices, which results in the risk rating (very low – very high) as seen above in Figure 1. (e.g. animals held on stand-off areas equates to a negative score as the stocking rate risk is reduced by the specific practice). Where data granularity allows, the sub-practice points are on a variable scale. For example, if the data shows a higher percentage of animal hours are spent on a structure where effluent is collected, then the corresponding risk points are decreased proportionally).

Each management practice starts on '0' points or 'no risk' with points then added or subtracted depending on the risk associated to the key driver and other sub-practices. Total scores for the overall management practice risk can range from a negative score to a score greater than 80. Scores for each management practice fall into the categories of:

- Very Low risk (scores ≤ 20)
- Low risk (scores 21-40)
- Medium risk (41-60)
- High risk (61-80)
- Very high risk (scores ≥ 81)

Points are calculated on a proportional basis where data granularity allows. For instance, the points attributed for how animals are managed through winter are determined by calculating the percentage of animals being wintered in each location and multiplying the percentage by the points for each location. The risk rating doesn't increase for a score above 80 (very high).

The results of the Nitrogen Risk Scorecard are available to farmers on the submission of their FDRs on the Farm Source website and are also sent to farmers as part of the Farm Insights Report each in September each season (PDF format). The report includes the individual management practice risk ratings and the purchased nitrogen surplus metric.

3.2 Environmental Factors

The primary focus of the Scorecard is to assess the level of risk associated with each of the six key management practices that are within the control of farmers. This focus is more likely to lead to enduring change compared to a modelled whole farm leaching number.

Environmental factors such as rainfall and soil type play a significant role in determining how much of the surplus nitrogen within a farm system leaches below the root zone. Environmental Factors are not explicitly considered in the Scorecard, although they are accounted for in management decisions that are included in the Scorecard. Utilising the Scorecard alongside the risk assessment and actions set out in a Farm Environment Plan provide an assessment of the whole farm and the risks associated with the farm's system.

3.3 Purchased Nitrogen Surplus

A farm's purchased nitrogen surplus (a whole farm system risk metric) is included alongside the Scorecard as an additional tool for benchmarking / referencing and monitoring performance over time.

The purchased nitrogen surplus output does not consider all inputs / outputs of nitrogen from the farm system, such as nitrogen fixation by plants and gaseous N losses. It is therefore a simplified calculation based on farm data rather than a complex model, such as Overseer's 'surplus' output.

The purchased nitrogen surplus is a useful efficiency metric that can be used to inform a farmer / advisor conversation around imported resource cost and profitability opportunities. It can also be used to reference and monitor change over time without the requirement for large amounts of data.

3.4 Aggregated Score

An aggregated score allows for farm performance to be benchmarked and relative risk compared on a year-by-year basis. The aggregated score can also be used to benchmark N loss risk against any selected peer group (by soils, climate, farm system, catchment etc).

Fonterra is not currently reporting a whole farm risk aggregated score, but this may become more important where regional plans require evidence of risk (contaminant loss) reductions over time.

The total points from all six management practices contribute to the aggregated score for a farm (negative points are rounded up to 0).

4 Data behind the Scorecard

The FDRs are completed by farmers on the Farm Source website at the end of each season and farmers are required to detail animals and practices from the dairy farm effective area for the season. Fonterra also utilises milk collection data from Milk Test NZ to provide the most accurate milk collection data. FDR data is sufficiently detailed to ensure all key risks can be robustly assessed. The Scorecard does not require the same level of detail as an Overseer file, but still requires comprehensive farm management information to robustly assess risk. While Fonterra uses FDRs to collect the data required for the Scorecard, the data could be collected through any templated data collection method that aligns with the Scorecard data requirements. Fonterra has developed a Microsoft Excel version of the FDRs and Nitrogen Risk Scorecard to show how this could be achieved.

For example, to assess the level of risk associated with the use of nitrogen fertiliser, data is required that describes:

- total amount of N fertiliser applied annually,
- application rates,
- timing of applications,
- the use of feed planning/budgeting and
- production kg MS (for an efficiency calculation).

See **Error! Reference source not found.** below for an example of the format Fonterra farmers submit this information in.

Ballance Nrich Urea

SELECT FERTILISER BRAND

Ballance

SELECT PRODUCT APPLIED

Nrich Urea

TOTAL AMOUNT APPLIED

13.5

Tonnes

HIGHEST APPLICATION RATE (EXCLUDING CROPS)

100

kg/ha

Tick the months you applied Nitrogen fertiliser

Jun

Jul

Aug

Sep

Oct

Nov

Dec

Jan

Feb

Mar

Apr

May

☐

☒

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Figure 2: Example of Fonterra's FDR format for collecting fertiliser data

4.1 Data quality

During data collection, measures are in place to minimise data entry errors to ensure that the data is fit for purpose. Some fields within the online FDRs are typically constant in steady-state farm systems across multiple seasons. These fields are pre-populated from previous season's FDR data (where this data was previously submitted) such as farm area. This allows farmers to review and update the data if it has changed between seasons. Other data entry fields have built in validation to ensure accuracy (such as ensuring the sum of all irrigation areas is less than the dairy farm effective area). Like other farm system models, such as Overseer, data quality ultimately remains the responsibility of the farmer.

4.2 Processing of the data

The FDR data used to generate the Scorecard is submitted in digital format directly into Fonterra's website. Data is then stored in tables within our internal CRM system ('Farmer Central'). The Scorecard engine queries the data held and attributes points to each individual risk factor based on the pre-set benchmark parameters. This is then used to populate the farmer facing report.

Fonterra also has a Microsoft Excel version of the Farm Dairy Records and resulting Nitrogen Risk Scorecard, which can be used on a per-farm basis and is useful for testing, research, and development.

5 The six underlying management practices considered within the Scorecard

This section outlines the six key management practices that will impact on N loss risk:

- Stock Management
- Nitrogen Fertilisers
- Effluent Management
- Imported Supplement
- Cropping & Cultivation
- Irrigation

These practices are the main contributing practices to a farms' N loss risk that are within the farmer's control. It is acknowledged that rainfall and drainage play a significant role in nitrate leaching in pastoral farming, however, the Scorecard's primary purpose is to inform farmers on the level of risk associated with their management practices.

5.1 Stock Management

Management practice overview

High stocking rate is a key driver for increased nitrogen leaching on farm. Excess nitrogen ingested by animals (nitrogen that is not converted into milk or meat), increases the urinary nitrogen concentration, which is then deposited back to the soil via urine patches. Having other animals such as replacements on farm will also increase the N loss risk. The amount of nitrogen in a urine patch far exceeds plant requirements and the excess is therefore susceptible to leaching during winter months when soil drainage is highest. The Stock Management section moderates the stocking rate risk by considering:

- total dry matter eaten (increasing risk as more DM is consumed)
- management of animals on the farm over the winter months
- if animals are grazed off farm

To do this, the Scorecard calculates the total number of hours over the winter months and how many of these hours the animals spend on an off-pasture facility where the effluent is captured. Points are applied proportionally in situations where there is a split between different wintering options.

5.1.1 Stocking Rate

The calculation for this factor is the number of peak animals converted to stock units (Appendix) then divided by the dairy farm effective area:

Stocking Rate (total stock units / ha)	Points	Risk rating on report
≤ 16.0 su/ha	0	≤ 16.0 su/ha
> 16.0 and ≤ 20.0 su/ha	20	> 16.0 and ≤ 20.0 su/ha
> 20.0 and ≤ 28.0 su/ha	30	> 20.0 and ≤ 28.0 su/ha
> 28.0 and ≤ 32.0 su/ha	40	> 28.0 and ≤ 32.0 su/ha
> 32.0 su/ha	50	> 32.0 su/ha

5.1.2 Dry Matter Eaten

The Scorecard moderates the stocking rate risk by assessing the total amount of dry matter eaten using DairyNZ's DairyBase model. It is acknowledged that stocking rate alone as a method of assessing N loss risk does not account for differences in size and age of animals, both of which will contribute to differences in total dry matter eaten. The higher the amount of dry matter eaten (in tonnes of dry matter per ha; tDM/ha), the higher the amount of nitrogen ingested by the animal, resulting in excess nitrogen from the diet being returned to pasture as urinary N and N in excreta.

Dry Matter Eaten	Points	Risk rating on report
≤ 10.0 tDM/ha	5	≤ 10.0 tDM/ha
> 10.0 and ≤ 12.0 tDM/ha	10	> 10.0 and ≤ 12.0 tDM/ha
> 12.0 and ≤ 14.0 tDM/ha	20	> 12.0 and ≤ 14.0 tDM/ha
> 14.0 and ≤ 16.0 tDM/ha	40	> 14.0 and ≤ 16.0 tDM/ha
> 16.0 and ≤ 18.0 tDM/ha	60	> 16.0 and ≤ 18.0 tDM/ha
> 18.0 tDM/ha	80	> 18.0 tDM/ha

5.1.3 Wintering off / Culling

Wintering animals off the farm reduces the number of animals depositing nitrogen back onto soil via excreta (mainly from urine patches) during the time of highest risk, therefore reducing the overall N loss risk.

Sub practices - risk points calculation:

This section moderates the peak stocking rate risk by reducing the points attributed under the peak stocking rate section. This is calculated using the percentage of time animals spend off farm between the months of May – August. A maximum risk reduction of 50% is available and is attributed to a farm where 80% or more of the animals are wintered off through this period.

Wintering Off / Culling	Reduction of points	Risk rating on report
≥80% animals off farm	50%	≥80% animals off farm
≥60% and <80% animals off farm	40%	≥60% and <80% animals off farm
≥40% and <60% animals off farm	30%	≥40% and <60% animals off farm
≥20% and <40% animals off farm	20%	≥20% and <40% animals off farm
<20% animals off farm	10%	<20% animals off farm

5.1.4 Winter Practices

The way animals are managed in winter has a major impact on the overall risk profile of the farming system. A farm system that practices 'on/off' grazing, reduces the amount of time cows spend on pasture, also reduces the overall N loss risk for the farm. The winter months for the purposes of this calculation are May – August and have a total of 2,952 hours.

The Scorecard uses data from several different sections within the FDR's, such as cropping, winter stand-off/housing, and monthly animal numbers to calculate the total hours animals spent in each of these activities over the winter.

Sub practices - risk points calculation:

The points scale for winter practices ranges from -40 to 40. Negative points reflect the mitigating factor of having animals off pasture / off crops and instead on a surface with a contained effluent management system.

The overall risk is determined by allocating points on a pro-rata basis from the percentage of the time (total hours) animals spent on either:

- Off pasture facility – Wintering Pads / Standoff Pad / Feed Pad
- Break fed fodder crop
- On pasture (this is simply calculated as the time NOT spent on structures OR on crops)

Winter Practices	Points	Risk rating on report
Off pasture facility %	-40	Off pasture facility %
On pasture %	0	On pasture %
Break fed fodder crop %	40	Break feed fodder crop %

Working Example:

165 hours on off pasture facility (5.6% of total winter hours)	5.6%	x	-40	-2.24
1,484 hours break fed fodder crop (50.3% of total winter hours)	50.3%	x	40	20.12
1,301 (remaining hours) hours spent on Pasture	44.1%	x	0	0

Total Points

17.88

These points are then added to the score achieved by calculating the initial stocking rate risk.

5.2 Nitrogen Fertiliser

Management practice overview

The Scorecard assesses the level of risk associated with nitrogen fertiliser applications by evaluating:

- the total kgN applied per hectare,
- the maximum application rate applied to pasture,
- the timing of applications,
- the ratio of nitrogen fertiliser to milk solids production, and
- the use of feed budgeting to inform strategic use of nitrogen.

Nitrogen fertiliser is one of three ways that nitrogen is introduced to a farm system; along with imported supplements and atmospheric fixation (which is not considered in the Scorecard).

Nitrogen surplus is the measure of the amount of nitrogen brought into the farm system that does not leave the farm as product. The nitrogen surplus is therefore the amount of nitrogen that remains within the soil profile available to be leached. The higher the nitrogen surplus, the greater the potential for leaching.

Increasing the efficiency with which imported nitrogen is converted to product, (exported supplements, milk & meat) will help reduce the surplus nitrogen that might be lost to the environment.

Typically, higher amounts of nitrogen fertilisers will increase the surplus. Although fertilisers are not generally a large direct contributor of N loss risk (except at high application rates and when applied in high-risk months), they do contribute indirectly by supporting a higher stocking rate.

5.2.1 Nitrogen Fertiliser Applications

The total amount of nitrogen used per annum is the main driver for the nitrogen management risk factor, which will be moderated by the remaining sub risk practices. This is calculated by summing the total amount of nitrogen fertiliser applied annually across the effective area (kgN/ha). The higher the amount of imported nitrogen, the greater the number of points and N loss risk that will be attributed to the farm as displayed in the table below.

5.2.1.1 Risk points calculation

The points scale for imported nitrogen ranges from 0 to 200 representing 'very low risk' at 0 through to 'very high risk' above 60. This is the main driver and therefore, the starting score for this management practice which will be moderated by the remaining sub risk practices.

Nitrogen Fertiliser Applications	Points	Risk rating on report
≤ 50 kgN/ha	0	≤ 50 kgN/ha
> 50 and ≤ 100 kgN/ha	10	> 50 and ≤ 100 kgN/ha
> 100 and ≤ 150 kgN/ha	30	> 100 and ≤ 150 kgN/ha
> 150 and ≤ 175 kgN/ha	50	> 150 and ≤ 175 kgN/ha
> 175 and ≤ 200 kgN/ha	60	> 175 and ≤ 200 kgN/ha
> 200 and ≤ 225 kgN/ha	70	> 200 kgN/ha
> 225 and ≤ 250 kgN/ha	90	
> 250 and ≤ 300 kg/ha	150	
> 300 kgN/ha	200	

5.2.2 Milk Solids per kg Nitrogen Used

The conversion efficiency calculates how many kgs of milksolids (kgMS) are produced per kg of N applied. The more imported nitrogen that is converted to product the greater the conversion efficiency and the lower the nitrogen surplus will be, reducing the overall N loss risk.

Sub practice - risk points calculation:

This sub factor is calculated by dividing the total kgMS produced by the total kgN applied via fertiliser.

Milk Solids per kg Nitrogen Used	Points	Risk rating on report
> 25 kgMS / kgN	-40	> 25 kgMS / kgN
> 12 and ≤ 25 kgMS / kgN	-20	> 12 and ≤ 25 kgMS / kgN
> 8 and ≤ 12 kgMS / kgN	0	> 8 and ≤ 12 kgMS / kgN
> 4 and ≤ 8 kgMS / kgN	20	> 4 and ≤ 8 kgMS / kgN
> 1 and ≤ 4 kgMS / kgN	40	> 1 and ≤ 4 kgMS / kgN
≤ 1 kgMS / kgN		≤ 1 kgMS / kgN

5.2.3 Timing of Application

This sub practice assesses the timing of application of nitrogen fertilisers. Fertiliser that is applied to cold wet soils in winter months when plants are not actively growing, will have a significantly higher chance of leading to nitrogen leaching due to the higher rainfall and lower plant uptake.

The Scorecard looks at the timing of every fertiliser application applied throughout the year and groups them into the parameters in the table below. September to April is the lowest risk window for application, when the soils are warmer, and the plants are actively growing. The highest risk period is considered between May – June, with July – August considered medium risk.

Sub practice - risk points calculation:

The Scorecard works by grouping each of the farm's fertiliser applications into one of the three parameters and reports the worst result i.e., if any fertiliser is applied in May - June then the result for this sub section will be "High Risk".

This approach intends to highlight the risk associated with applying fertiliser during high-risk periods.

Timing of Application	Points	Risk rating on report
Sept – Apr	-10	Sept – Apr
Jul – Aug	20	Jul – Aug
May – Jun	40	May – Jun

5.2.4 Feed Budget

This section recognises the good farming practice of using a feed budget or wedge as a tool to help plan strategic fertiliser applications rather than using a routine or blanket N use strategy. Using a feed budget or wedge to identify any potential feed gaps provides a farmer with the opportunity to evaluate the best way to fill the deficit. Options could include the strategic use of low rates of N fertiliser, or it could be to substitute N by importing a low protein feed such as maize silage.

Feed budget	Points	Risk rating on report
Yes	-20	Yes
No	0	No

5.2.5 Highest Application Rate

The application rate is an important consideration as research shows there to be diminishing responses at high application rates. Smaller and well-timed applications have the potential to grow more dry matter, particularly when matched to good growing conditions as this will ensure the opportunity for loss to the atmosphere and water are reduced.

Sub practice - risk points calculation:

This sub practice assesses the highest amount of N applied in any given month.

If the highest fertiliser application rate is ≤ 25 kg/ha this reduces the overall N fertiliser risk.

Highest Application Rate	Points	Risk rating on report
≤ 25 kg/ha	-20	≤ 25 kg/ha
> 25 kg/ha	0	> 25 kg/ha

5.3 Imported Feed

Management practice overview

Imported supplementary feed contributes to purchased nitrogen surplus through the addition of nitrogen contained within the feed. This section assesses the contribution that importing supplementary feed into the farm system makes. The greater the amount of imported feed, the more N that enters the farm system. The total amount of imported feed and the N content of the feed is important to understand. Feeding imported feed with high protein content increases the N concentration in animal's urine. A high amount of N introduced into the farm system can increase the N surplus and therefore the N loss risk. This section assesses imported feeds that were fed to animals in the given season i.e., stored feeds are not assessed.

Risk points calculation:

In this section the total amount of imported N from imported feed is assessed against the parameters in the table below. The average N% of all imported feed is also assessed providing the farmer an indication of the potential increased risk through increasing urinary N.

These two parameters allow a farmer to understand how much N is entering their farm and where on the risk scale their chosen imported feed sits in terms of N content. This enables a farmer to investigate if there is an opportunity to utilise a lower N content feed. The conversion efficiency of the N from supplements into products is also assessed.

5.3.1 Nitrogen Imported from Feed

This sub practice calculates the total amount of N introduced to the farm via all imported feed. This is then displayed per ha (dividing the total N by the total effective area of the farm) this allows the figures to be comparable between farms.

Nitrogen Imported From Feed	Points	Risk rating on report
≤ 40 kgN/ha	0	≤ 40 kgN/ha
> 40 and ≤ 80 kgN/ha	20	40 and ≤ 80 kgN/ha
> 80 and ≤ 120 kgN/ha	40	80 and ≤ 120 kgN/ha
> 120 and ≤ 160 kgN/ha	60	120 and ≤ 160 kgN/ha
> 160 kgN/ha	80	> 160 kgN/ha

5.3.2 Nitrogen Content

In this sub practice, the Scorecard calculates the average N content of the imported feed.

Nitrogen Content	Points	Risk rating on report
$\leq 1\%$	0	$\leq 1\%$
$> 1\%$ and $\leq 1.5\%$	3	$> 1\%$ and $\leq 1.5\%$
$> 1.5\%$ and $\leq 1.75\%$	6	$> 1.5\%$ and $\leq 1.75\%$
$> 1.75\%$ and $\leq 2.0\%$	9	$> 1.75\%$ and $\leq 2.0\%$
$> 2.0\%$ and $\leq 2.25\%$	12	$> 2.0\%$ and $\leq 2.25\%$
$> 2.25\%$ and $\leq 2.5\%$	15	$> 2.25\%$ and $\leq 2.5\%$
$> 2.5\%$ and $\leq 3.0\%$	18	$> 2.5\%$ and $\leq 3.0\%$
$> 3.0\%$	20	$> 3.0\%$

5.3.3 Nitrogen Use Efficiency of Imported Supplements

The Scorecard calculates the conversion efficiency of N introduced via imported feed to product. This measures the efficiency of Nitrogen from imported feed converted into kgMS.

Nitrogen Use Efficiency of Imported Supplements	Points	Risk rating on report
> 50	-40	> 50
> 30 and ≤ 50	-20	> 30 and ≤ 50
> 20 and ≤ 30	0	> 20 and ≤ 30
> 10 and ≤ 20	20	> 10 and ≤ 20
> 1 and ≤ 10	40	> 1 and ≤ 10
≤ 1		≤ 1

5.4 Irrigation

Management practice overview

Irrigation generally increases the N loss risk of a farm as there is potential for over-irrigation, which induces drainage events (and N loss). This can be caused by incorrect management of irrigation event scheduling

without accounting for environmental conditions or, the system is not capable of varying application rates or return periods. Some systems are inherently riskier than others irrespective of management, such as border dyke.

This section assigns a level of risk to a farm's irrigation system infrastructure, and the management of that system e.g. the ability to monitor when to start and stop irrigating as well as knowing how much water to apply at each event. The base risk is set by irrigation system type and is then moderated by the method of scheduling and management of applications. This section is designed so that only a pivot/linear system with soil moisture monitoring and variable rate irrigation (VRI) can achieve "very low risk". All other systems, dependant on the management will range from medium to high risk.

5.4.1 Irrigation Method

Evaluates the farm's irrigation method, with the pivot/ linear system being the most efficient irrigation method in terms of water use, and border dyke the least efficient.

Risk points calculation:

Points are allocated on a pro rata basis calculated by the percentage of each irrigation method in use on the farm.

Irrigation Method	Points	Risk rating on report
Pivot or Linear	40	Pivot or Linear
Rotary Boom, Gun or K-line	60	Rotary Boom, Gun or K-line
Border dyke or wild flood	90	Border dyke or wild flood

5.4.2 Irrigation Scheduling

This section evaluates the farm's irrigation scheduling method. The options are grouped into two distinct approaches:

- (i) where a farmer does some measurement/modelling (soil moisture tapes/probes/budget) to inform irrigation decisions, or
- (ii) irrigation occurs as a fixed routine or decisions are based on visual assessment only.

Risk points calculation:

If a farm has multiple irrigation scheduling methods, points are allocated on a pro rata basis across the methods.

Irrigation Scheduling	Points	Risk rating on report
Soil moisture tapes/budget	-15	Soil moisture tapes/budget
Visual assessment OR when water is available	30	Visual assessment OR when water is available

5.4.3 Irrigation Application Method

This section evaluates a farm's irrigation scheduling method categorised into three options. Fixed depth & return method doesn't allow the farmer any flexibility to adjust for the soil's current moisture content. A deficit irrigation method is described as a system and management that provide for an application rate sufficient to refill the soil to a target water content. Lastly a VRI system, typically a pivot, can deliver variable rates of

water in a single pass of the irrigator based on programmed GIS GPS data such as underlying soil type, crop type and stage of growth, position in the grazing round, or pre-programmed high-risk areas.

Risk points calculation:

If a farm has multiple methods of irrigation, the Scorecard allocate points on a pro rata approach

Irrigation Application Method	Points	Risk rating on report
VRI	-10	VRI
Deficit irrigation	0	Deficit irrigation
Fixed depth & return	30	Fixed depth & return

5.5 Effluent

Management practice overview

The way in which effluent is managed can have an impact on the farm's N loss risk in several ways. Management practices, such as the effluent disposal method (spread to land or treated and discharged to water), storage volume, application rates and effluent block area are assessed to derive the overall score and risk rating for the effluent section.

Discharging to water carries the maximum 'very high-risk' due to the fact these types of systems are often discharging high levels of nutrient directly to water. Often these are legacy systems that haven't undergone infrastructure upgrades as the farm has grown. They also discharge other contaminants into water, such as *E. coli*.

These systems are followed in risk by a mixed system (both discharge to land and water). Non-optimal (Low storage) discharge to land is where the system either doesn't have capacity to store effluent during periods where soil moisture levels are not appropriate for effluent to be discharged, or the farmer has described their decisions around when to irrigate as being based on factors other than soil moisture content. i.e. when the pond is full, or on a set schedule.

This section also measures the risk of effluent application depth.

5.5.1 Effluent Discharge Method

There are three potential options within this section: discharging to land, discharge to water or a system that utilises both water and land discharges. Discharging treated effluent to land with sufficient storage (< 10 days) to store effluent during wet conditions is lowest risk, through to discharge to water as the highest risk.

Risk points calculation:

Discharge Method	Points	Risk rating on report
Discharge to Land	0	Discharge to Land
Discharge to Land (Low storage)	40	Discharge to Land (Low Storage)
Discharge to Land and Water	80	Discharge to Land and Water
Discharge to Water	100	Discharge to Water

5.5.2 Application Depth

The Scorecard evaluates the effluent systems ability to apply effluent at low depths. Lower application depths ensure greater management flexibility with more irrigation days available. This also ensures plants have a greater chance of using the nutrients within the effluent rather than it being lost by draining through the soil profile or running off to surface water.

Risk points calculation:

Farms will attract the points from the highest risk activity only.

Application depth	Points	Risk rating on report
<12 mm	0	<12 mm
≥ 12 mm	10	≥12 mm

5.5.3 Effluent Irrigation Area

Ensuring the effluent disposal area is sufficiently sized for the farm system is important from both an environmental compliance and animal health perspective. An under sized effluent area can result in the amount of nitrogen applied exceeding local rules and regulations. Higher application rates can also promote animal health issues during calving from excessive build-up of soil potassium levels.

The nitrogen content of effluent fluctuates depending on several factors such as diet, the time cows spend on the yard during milking, time spent on a feed pad/housing, the amount of time the effluent is stored in a pond, the pond characteristics (depth, surface area) and if the system has solids removal.

The Scorecard assesses the level of risk associated with the effluent disposal area by evaluating it based on the number of cows/ha of disposal area and whether or not the farm utilises an off-pasture facility (e.g. feed pad). This approach removes the need to estimate the many variables in the nutrient loading of stored effluent that is applied to land. Simple effluent area thresholds are well suited for identifying those systems where the area is likely to be marginal, and further assessment may be required.

Risk points calculation:

Best practices shows that the disposal area should be > 4 ha/100 cows for farms that don't utilise an off-pasture facility and > 7 ha/100 cows for farms that do utilise an off-pasture facility.

See Appendix 1 for further calculations:

Without a feed pad:

Effluent Irrigation Area (without feedpad)	Points	Risk rating on report
> 4 ha/100 cows	0	> 4 ha/100 cows
> 3 and ≤ 4 ha/100 cows	10	> 3 and ≤ 4 ha/100 cows
> 2 and ≤ 3 ha/100 cows	20	> 2 and ≤ 3 ha/100 cows
> 1 and ≤ 2 ha/100 cows	30	> 1 and ≤ 2 ha/100 cows
≤ 1 ha/100 cows	40	≤ 1 ha/100 cows

With a feed pad:

Effluent Irrigation Area (with feedpad)	Points	Risk rating on report
> 7 ha/100 cows	0	> 7 ha/100 cows
> 5 and ≤ 7 ha/100 cows	10	> 5 and ≤ 7 ha/100 cows
> 3 and ≤ 5 ha/100 cows	20	> 3 and ≤ 5 ha/100 cows
> 1 and ≤ 3 ha/100 cows	30	> 1 and ≤ 3 ha/100 cows
≤ 0 ha/100 cows	40	≤ 0 ha/100 cows

5.6 Cropping and Cultivation**Management practice overview**

Cropping and cultivation can impact on nitrogen leaching due to the release of mineral nitrogen after cultivation. The release of mineral nitrogen, when not up taken by a crop, can lead to leaching. Full cultivation stimulates faster soil organic matter decomposition and mineral nitrogen release than minimum or no-till practices. Direct drilling is considered to have an insignificant impact on mineralisation and therefore, is attributed a risk rating of 'very low' regardless of the area drilled. It is reported within the Scorecard for transparency when interpreting the final report. Therefore, the total area cultivated each year is one of the determining factors in the amount of N that becomes mineralised.

This section evaluates the risk posed by total area of a farm cultivated (by minimum till & conventional only), in conjunction with the method/type of cultivation used. Farms with routine pasture renewal using minimum tillage techniques are considered as a 'low' or 'very low' risk, with larger areas cultivated, use of winter crops and conventional cultivation is considered higher risk. The harvest season also plays a role in N loss risk with crops harvested in winter posing a higher risk to leaching both due to how they are harvested, (e.g. grazed in situ) and if they are left fallow through the winter period with high rainfall.

The method of harvest is not included as a risk factor for the Cropping and Cultivation section, but it has been included in the Stock Management - Wintering Practices section.

The Scorecard assesses each of the cultivation methods for each farm. For example, a farm cultivating 10% of the farm via minimum till and another 10% of the farm via conventional will attract a total of 70 points.

5.6.1 Minimum Till

This section evaluates the risk of the total area cultivated under minimum tillage. This is a lower risk activity than conventional cultivation, however, the risk increases with the total area cultivated.

Risk points calculation:

The total percentage of the farm cultivated by Minimum Till is calculated as the total cultivated area by Minimum Till divided by the total effective area of the farm.

% of Farm Cultivated Annually	Points	Risk rating on report
≤ 2%	0	≤ 2%
> 2 and ≤ 4%	5	> 2 and ≤ 4%
> 4 and ≤ 6%	10	> 4 and ≤ 6%
> 6 and ≤ 8%	15	> 6 and ≤ 8%
> 8 and ≤ 10%	20	> 8 and ≤ 10%

> 10 and ≤ 15%	30	> 10 and ≤ 15%
> 15 and ≤ 20%	40	> 15 and ≤ 20%
> 20%	50	> 20%

5.6.2 Conventional

This section is evaluating the risk of the total area cultivated under conventional cultivation. This is a higher risk activity and the risk increases with the total area cultivated.

Risk points calculation:

The total percentage of the farm cultivated by Conventional method is calculated as the total cultivated area by Conventional divided by the total effective area of the farm.

% of Farm Cultivated Annually	Points	Risk rating on report
≤ 2%	10	≤ 2%
> 2 and ≤ 4%	20	> 2 and ≤ 4%
> 4 and ≤ 6%	30	> 4 and ≤ 6%
> 6 and ≤ 8%	40	> 6 and ≤ 8%
> 8 and ≤ 10%	50	> 8 and ≤ 10%
> 10 and ≤ 15%	70	>10%
> 16 and ≤ 20%	90	
> 20%	120	

5.6.3 Direct Drill

This section is evaluating the risk of the total area cultivated under Direct Drill. There is no risk from Direct Drilling, but this is included for informational reasons back to farmers.

Risk points calculation:

There is no risk for Direct Drill. The total percentage of the farm cultivated by Direct Drill is still calculated as the total cultivated area by Direct Drill divided by the total effective area of the farm.

% of Farm Cultivated Annually	Points	Risk rating on report
> 0%	0	> 0%

5.6.4 Season of Harvest / Grazing

Crops harvested in winter pose a higher risk of leaching due to how they are harvested, (e.g. grazed in situ) and if they are left fallow through the winter period with high rainfall which increases the risk of leaching. The season of harvest utilises which month the crop was harvested or grazed. The method of harvest and the risks associated with the different harvest options are assessed under the Winter Stock Management section.

Risk points calculation:

The season of harvest is taken directly from the harvest date recorded for each crop. If any crop's harvest date falls in April, May, June, July, August or September, the farm will fall in the Winter Harvest category below.

Season of Harvest / Grazing	Points	Risk rating on report
Summer Grazing	-30	Summer Grazing
Winter Grazing	30	Winter Grazing

5.6.5 Timing of Fertiliser Application

This sub practice considers whether nitrogen fertiliser was applied to crops during the high-risk months of May, June, July and August

Risk points calculation:

Timing of Fertiliser Application	Points	Risk rating on report
No fertiliser applied during winter	0	No fertiliser applied during winter
Fertiliser applied during winter	30	Fertiliser applied during winter



Appendix

6 Appendix

6.1 Dairy Effluent Area

Example table to use in the calculations of the effluent area. Taken from then DNZ 'A guide to managing dairy farm effluent – Auckland'

Nutrients in the effluent from 100 cows under different scenarios

	Nutrient in effluent from 100 cows (kg/yr)			Effluent area needed to apply 150 kgN/ha	
	N	P	K	% of farm	ha/ 100 cows
No Feed Pad - Farm dairy effluent					
All grass system (milking 270 days, twice a day)	590	70	540	11	4
Feeding 2tDM/ha of maize silage in paddock	668	80	668	12	4.4
Using a feed pad - farm dairy effluent plus feed pad effluent (Feeding 2tDM/ha of maize silage)					
Time on the pad	N	P	K	% of farm	ha/ 100 cows
1/2 hour per day on the pad	838	100	868	14	5.6
1 hour per day on the pad	1008	120	1044	17	6.8
2 hours per day on the pad	1348	160	1396	22	8.8
Feed comparisons (2 hours/day on the pad)					
4tDM/ha/yr Maize silage	1360	164	1460	25	8.8
4tDM/ha/yr Grass silage	1588	184	1668	29	10.4

Taken from the DNZ 'A guide to managing dairy farm effluent – Auckland'

6.2 Stock Units

Beef and lamb's stock units for where possible taken from- <https://beeflambnz.com/data-tools/benchmarking-tool> these are represented in the table below

Milking Herd	Milking Cows	Replacements – R1s / Calf	Replacements – R2s	Breeding Bulls
Friesian				
Jersey_Cross	8.0	2.0	4.2	5.0
Ayrshire	6.7	2.0	3.6	5.0
Friesian	8.5	2.0	4.5	5.0

Jersey	6.5	2.0	3.5	5.0
Kiwi Cross	7.4	2.0	4.2	5.0
Milking Shorthorn	7.8	2.0	4.2	5.0
Friesian Ayrshire Cross	7.8	2.0	4.2	5.0
Brown Swiss	8.1	2.0	4.2	5.0
Guernsey	7.8	2.0	4.2	5.0
Other	8.0	2.0	4.2	5.0

Species	STOCK UNITS
Sheep - Ewe	1
Sheep - Ram	0.8
Sheep - Lamb	0.7
Deer - Fawn	1.2
Deer - Yearling	1.8
Deer - Stag	2.2
Deer - Hind	2
Dairy - Carryover	5.5
Beef - Bull	5.5
Beef - Cow	5.5
Beef - Calf	3.5
Beef - Yearling	3.5
Goat - Kids	0.6
Goat - Adult	0.8
Horse	11
Pony	7
Alpaca - Adult	0.7
Alpaca - Cria	0.4
Llama - Adult	1.8
Llama - Cria	1
Pig	1.6

ATTACHMENT 2 – Example of an aggregate score

Nitrogen Risk Scorecard - 12345

2021/2022



Purchased Nitrogen Surplus



Nitrogen Risk Scorecard

Aggregate Score

89

Stock Management



HIGH

Nitrogen Fertiliser



VERY LOW

Imported Feed



LOW

Cropping & Cultivation



VERY LOW

Effluent Management



VERY LOW

Irrigation



VERY LOW

Stock Management

HIGH

Stocking Rate

The higher the stocking rate (peak), the greater the nitrogen loss

Total	27.5 su/ha	MEDIUM
Milking herd (2.9 cows/ha)	24.3 su/ha	
Replacement /other animal	3.2 su/ha	

Dry Matter Eaten*

The more dry matter eaten per hectare the more nitrogen ingested by the animal and returned to pasture as dung and urine

Total	15.8 tDM/ha	MEDIUM
--------------	--------------------	---------------

Grown on this farm

Pasture/forage/fodder crops	13 tDM/ha
-----------------------------	-----------

Imported to this farm

Pasture/forage/fodder crops	1.3 tDM/ha
All other feeds	1.5 tDM/ha

*The Dry Matter Eaten calculations utilise Dairy NZ's Dairybase model to calculate energy requirements and feed consumption.

Wintering Off/Culling

Reducing the number of animals on farm (from peak numbers) by culling and/or wintering off (May-Aug) will reduce the nitrogen loss risk

Animals wintered off/culled	40 %	VERY LOW
------------------------------------	-------------	-----------------

Winter Practices

Reducing the number of animals on farm (from peak numbers) by culling and/or wintering off (May-Aug) will reduce the nitrogen loss risk

Hour in Off pasture facility	0 %	N/A
Hours On pasture	100 %	LOW
Hours on Break feed fodder crop	0 %	N/A

Nitrogen Fertiliser

VERY LOW

Nitrogen Fertiliser Applications

The higher the amount of applied nitrogen, the greater the nitrogen loss risk

Nitrogen applied	68 kgN/ha	LOW
------------------	-----------	-----

Nitrogen Use Efficiency of Fertiliser

The greater the conversion efficiency, the lower the nitrogen surplus available to be lost

kgMS per kgN applied	17 kgMS/kgN	VERY LOW
----------------------	-------------	----------

Timing Of Application

Fertiliser applied during the winter months will significantly increase the chance of nitrogen being lost

Sep - Apr	
Jul - Aug	
May - Jun	HIGH

Highest Application Rate

Lower application rates reduce the nitrogen loss risk

Below 25 kgN/ha	
Above 25 kgN/ha	MEDIUM

Feed Budget

Using a feed budget or wedge to help plan strategic fertiliser application is a good farming practice

Feed budget used	Yes	VERY LOW
------------------	-----	----------

Imported Feed

LOW

Nitrogen Imported From Feed

The greater the amount of imported feed, the more nitrogen that enters the system

Nitrogen imported

53 kgN/ha

LOW

Average Nitrogen Content

The higher the nitrogen content of imported feed, the greater the amount of nitrogen that enters your farm

Average nitrogen content

2.33%

MEDIUM

Nitrogen Use Efficiency of Imported Supplements

The greater the conversion efficiency, the lower the nitrogen surplus available to be lost

kgMS per kgN imported

22 kgMS/kgN

LOW

Cropping & Cultivation

VERY LOW

Conventional

This is the greatest risk method for sowing a crop and the risk increases as the cultivated area increases

% of farm cultivated annually	N/A
-------------------------------	-----

Minimum Tillage

This is a lower risk activity than conventional cultivation, however the risk increases with the total area cultivated

% of farm cultivated annually	N/A
-------------------------------	-----

Direct Drill

This is a lower risk activity than both full cultivation and minimum tillage for establishing a crop

% of farm cultivated annually	9 %	VERY LOW
-------------------------------	-----	-----------------

Winter Harvest / Grazing

Crops harvested/grazed during winter pose a higher risk to nitrogen leaching

Summer	VERY LOW
--------	-----------------

Winter	
--------	--

Timing of Fertiliser Applications

There is greater risk if fertiliser is applied to crops during high risk months of May, June, July and August

No Fertiliser Applied During Winter	VERY LOW
-------------------------------------	-----------------

Fertiliser Applied During Winter	
----------------------------------	--

Effluent Management

VERY LOW



Effluent Disposal Method

Irrigating to pasture is the lowest risk

Irrigated to Pasture

VERY LOW

Effluent Irrigation Area

An undersized effluent area can result in the average amount of nitrogen per hectare applied exceeding local rules and regulations

Disposal Area (without feedpad)

8 ha/100 cows

VERY LOW

Application Depth

Low rates will ensure greater flexibility of management with more irrigation days available and increase the chance of the plant utilising the nutrients within the effluent rather than it being lost

Application Depth

> 12 mm

MEDIUM

Irrigation

VERY LOW

Irrigation Method

Irrigation generally increases the nitrogen loss risk due to the potential for over irrigating to induce drainage events. Some systems are inherently riskier than others irrespective of management

Pivot or linear	N/A
Rotary boom, gun or k-line	N/A
Border dkye	N/A

Irrigation Scheduling

Deciding when to start or stop irrigation is important as poor management of irrigation events can lead to induced drainage

Soil moisture meters / budget	N/A
Fixed routine / visual assessment	N/A

Irrigation Application Method

Having control over the amount and how often water is applied can greatly influence nitrogen loss risk with poor management of irrigation events leading to induced drainage

Variable rate irrigation	N/A
Deficit irrigation	N/A
Fixed depth and return period	N/A

This Fonterra Nitrogen Risk Scorecard ("Tool") was last updated on 14th December 2022. The Tool is intended for calculating your farm's Nitrogen Risk Scorecard results. All results, advice, data or information generated by it are based on data entered, assumptions and other information you provide and are intended to be used for estimate and reference purposes only. We make no representations or warranties as to whether information, advice or data provided by this Tool is accurate correct, reliable, or suitable for your purposes. The results generated by the Digital Nitrogen Risk Scorecard may vary to the results produced by this Tool. We do not accept any liability, direct or indirect, for any loss or damage which may directly or indirectly result from any information generated by this Tool whether negligent or otherwise. You are solely responsible for the actions you take in reliance on the information or data generated by the Tool.

ATTACHMENT 3 – Independent evaluation of the NRS

EVALUATION OF FONTERRA'S N SCORECARD FACTORS ON OVERSEER NITROGEN STATISTICS

Prepared for

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1 November 2019

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Executive summary

Fonterra has developed a Nitrogen Risk Scorecard (N-Scorecard), which is a tool that provides an objective assessment of the level of risk of nitrogen loss from a farm based on farm records submitted through Farm Dairy Records (FDR). FDR data relates to six key farm management practices which the Scorecard assesses and applies a level of risk. The assignment of risk level is based on scientific literature and industry best practice.

There are many elements that contribute to nitrogen loss including environment, soils, and management practices. The N-Scorecard is designed to determine the effect of management practices on nitrogen loss. The aim of this report was to mine an N-Scorecard dataset to validate the prediction of the Nitrogen-loss to water figure estimated in Overseer from the six factors and 31 sub-factors, and to further understand N-Scorecard factors, sub-factors and points allocation method. Each factor was tested individually for its prediction of Overseer N-loss to water and then the six factors combined to test overall prediction. Additionally, prediction of Overseer N-Surplus from all factors combined was also evaluated. A total of 6,568 FDRs from the 2017/2018 season were included in the analysis. All analyses were carried out in R (R Core Team, 2013) using two approaches, namely general linear models and stepwise variable selection regression models, using the core R and “olsrr” libraries, respectively.

Overall, the N Scorecard is providing very useful feedback to farmers on their farm management practices. The moderate accuracy of prediction of Overseer N-Loss to water from the Scorecard sub-factors is encouraging, given that major environmental data which affect nitrogen loss to water are not included in the Scorecard. There are a small number of factors that dominate in the prediction of Overseer N-Loss to water, i.e. Nitrogen applied kg/Ha and Effluent – Discharge destination, but there are many minor factors that are statistically significant and combined add to the overall prediction.

The points allocated to N Scorecard answers have mostly been shown in this analysis to account for variation in Overseer N-Loss well, but the scaling can be changed to give better consistency of weighing in relation to impact. Scalars are included in this report to apply the appropriate adjustments. Several sub-factors have been significantly overweighted for the level of impact on Overseer N-Loss observed in this study. However, this is considered appropriate as there are effects over and above consideration only on the basis of impact on nitrogen. The main example is that Effluent Discharge Destination has been significantly overweighted because it potentially has major impacts on water turbidity and water pathogen content.

Point allocation recommendations made from the analyses have been reviewed and considered by Fonterra's Sustainable Dairying Team and changes to the Scorecard Engine were subsequently applied where appropriate to three sub-factors:

- Stock Management: Pasture Eaten Tonnes Dry Matter /Ha;
- Supplementary Feed: Average Nitrogen content of imported supplements;
- Effluent Management: Effluent Discharge Application Depth

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Background

Fonterra has developed a Nitrogen Risk Scorecard (N-Scorecard), which provides an objective assessment of the risk of nitrogen loss from a farm based on records submitted through Farm Dairy Records (FDR). FDR data relates to six key farm management practices which the Scorecard assesses and applies a level of risk. The assignment of risk level is based on scientific literature and industry best practice. Sub-factors within each of the six management practices were allocated risk using a points-based scale. This risk was then aggregated within each of the six management factors using a risk scale of very low to very high.

There are many elements that contribute to nitrogen loss including environment, soils, and management practices. The N-Scorecard is designed to determine the effect of management practices on nitrogen loss. The aim of this report was to mine an N-Scorecard dataset to validate the prediction of the Nitrogen-loss to water figure estimated in Overseer from the six factors and 31 sub-factors and to further understand N-Scorecard factors, sub-factors and points allocation method. Each factor was tested individually for its prediction of Overseer N-Loss to water and then the six factors combined to test overall prediction. A total of 6,568 Farm Dairy Records from the 2017/2018 season are in the analysis.

Further information can be obtained from the Nitrogen Scorecard Engine Documentation.

Objective and definitions

The objective of these analyses was to understand and verify the allocation of risk within each management practice and across all management practices.

Definitions

- Answers: Information extracted from the data provided by farmers through the FDRs
- Points: Points allocated to the risk for each answer within risk sub-factors

Analysis methods

Data collected from Fonterra's FDRs in the 2017/2018 season was analysed to validate the scorecard results in terms of the relative weighting of scorecard factors and to evaluate their overall predictability for two Overseer outputs, namely "Nitrogen loss to water" within each of the N scorecard factors and "Nitrogen surplus" for all factors combined. All analyses were carried out in R (R Core Team, 2013) using two approaches, namely general linear models and stepwise variable selection regression models, using the core R and "olsrr" libraries, respectively.

A challenge for these predictive analyses is the 'multicollinearities' that exist in this type of dataset. This means that many of the N scorecard factors are highly correlated with each other which makes it difficult to determine which factor is actually responsible for causing the observed effect on Overseer nitrogen measures. For example, we would expect that stocking rate will be correlated with Nitrogen applied per hectare as high stocking rates are often supported by high nitrogen fertiliser use. If there was a one to one relationship between the two variables, then there is no way a statistical analysis is able to distinguish between the two variables, so their relative contributions cannot be allocated properly. In a normal linear model, the variable that is fitted first in the statistical model would get

the greater weighting and the second correlated variable would get the smaller 'remainder' of variance. This means that the result changes depending on the order that variables are fitted to the statistical model. For this analysis, we have dealt with the collinearities by using the "Type III sums of squares" (Type III SS) to calculate the amount of variation explained by each variable. In effect, this gives us the proportion of variation that each variable accounts for *independent of all other variables in the model*. For example, what effect does stocking rate have on Overseer N-Loss to water if stocking rate increased without changing the level of any other variable in the model? The Type III SS remove the collinearity effects and are independent of the order the terms are fitted so give reliable estimates of the independent effect of each variable.

Analysis of scorecard factors

The prediction of Overseer N-Loss to water based on the variables in each of the six scorecard factors (i.e. Stock Management, Cropping and Cultivation, Effluent Management, Imported Feeds, Irrigation Practices and Nitrogen Application) was tested. Two analyses were run for each factor, one with 'Answers' (the variable is the answer to the question fitted as a categorical variable) and the second with 'Points' (the variable fitted as the number of points allocated for each answer and fitted as a covariate).

Solutions for effects fitted in the within-scorecard factor models were retrieved. The solution for each effect provides the scalar to apply to the allocated points to balance up the impact of each effect on the allocation on the scale of Overseer N-Loss. This scaling has no effect on the proportion of variation that each sub-factor explains, but simply expresses each effect on the same scale for the prediction of Overseer N-Loss.

Analysis of the full scorecard model

Analysis of the overall models were done in a two-stage process. A stepwise variable selection analysis was used to identify sub-factors that were significant predictors of Overseer N-Loss and N-Surplus using the Ordinary Least Squares Regression ("olsrr") package in R. The model was fitted with forward and backward regression meaning significant terms were added and terms which subsequently became non-significant were removed from the prediction model. Once the significant sub-factors were identified, they were fitted in a linear model so that the Type III SS could be calculated for each term. Prediction equations were developed on a random 75% of the dataset, and the remaining 25% were set aside to test transportability of the prediction equations.

Prediction equation transportability was tested by fitting the prediction equation developed on the training dataset to predict Overseer N-Loss and Overseer N-Surplus, and then regressing each of these against the actual Overseer N-Loss and N-Surplus, respectively. If similar correlations were achieved to the training set, then the equations were deemed to be transportable, i.e. they can be applied to other datasets with some confidence.

Results

The results are divided into two sections:

- Variation in Overseer N-Loss explained by N scorecard sub-factors within a factor, including analysis of points scaling

- Variation in Overseer N-Loss and Overseer N-Surplus explained by sub-factors from all six factors combined

Variance in prediction of Overseer N-Loss to water from sub-factors within a factor

Each factor was analysed individually to determine the overall prediction accuracy for that factor, as well as the relative contributions of sub-factors within the factor. Models were fitted as either Answers or Points assigned to the answer so sub-factors were tested as categorical values or covariates, respectively. Scalars for sub-factors were retrieved from the solutions for the linear models to determine how much the points allocated to sub-factors would need to be scaled to balance their contribution to overall prediction of Overseer N-Loss

Stock management

There were seven Stock Management sub-factors, six of which were analysed to predict Overseer N-Loss for the Stock Management factor. The seventh factor (Wintering – on pastures) was not fitted to the model used to estimate the Type III SS as it created a singularity from a part-whole relationship between wintering methods. The Answers and Points models accounted for a moderate amount of the observed variation in Overseer N-Loss, with an R^2 of 15.6% and 14.5%, respectively. The Answers and Points models were in good agreement (Figure 1) meaning that the Answer 'bins' represented a linear progression in risk of N-Loss. Of the five sub-factors, Stocking Rate was the dominant effect accounting for around 57% of the explained variation. Pasture eaten (tDM/Ha) accounted for a further 31% of the explained variation in Overseer N-Loss, while the other three sub-factors all individually accounted for less than 5%.

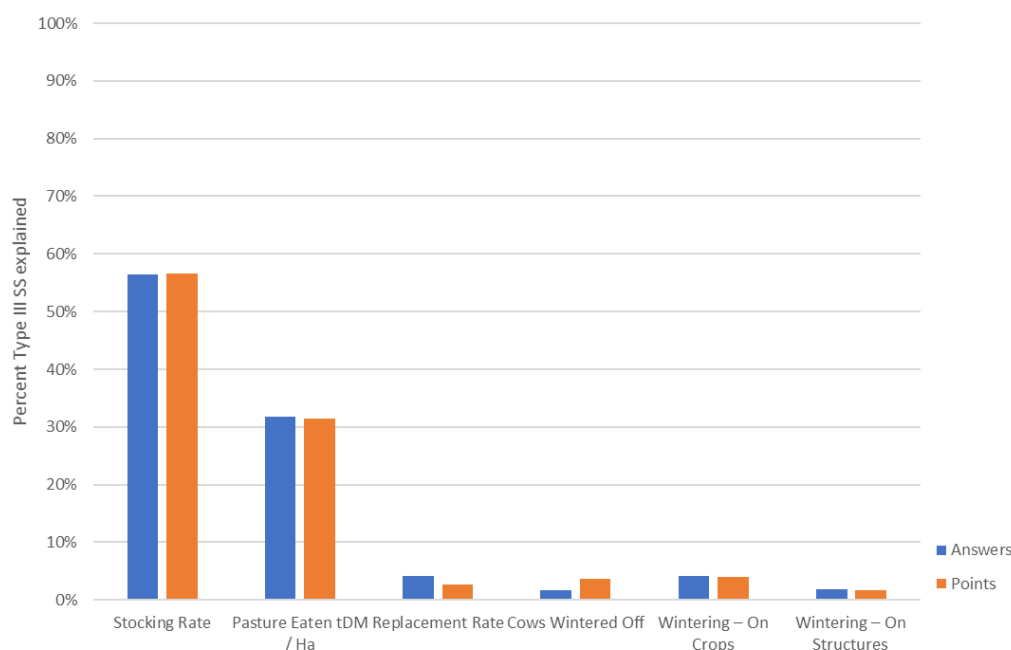


Figure 1. Proportion of the explainable variance in Overseer N-Loss accounted for by stock management sub-factors based on Scorecard Answers or Points

The relative weighting for sub-factors from a linear model fitted to the Points dataset are plotted in Figure 2 below. The scaling factor has been expressed relative to Stocking Rate in Figure 2 to give an indication of the weighting each sub-factor has had on the prediction of Overseer N-Loss. If all the sub-factors had a value of one, then a 'point' would have equal value across all sub-factors. A value greater than one (e.g. Pasture Eaten has a value of 1.45 in Figure 2) indicates that the point allocated to the sub-factor is under-weighted relative to a point allocated for stocking rate. Conversely, a value less than one (e.g. Wintering - on crops has a value of 0.65 in Figure 2) indicates that the point allocated to the sub-factor is over-weighted relative to a point allocated for stocking rate.

In Figure 2, we see a range of weighting from 0.65 to 1.45 for sub-factors, with Pasture Eaten and Replacement Rate under-weighted relative to Stocking Rate, and Cows wintered off, Wintered – on crop and Wintered -on structures all slightly over weighted. It should be noted that the weighting has no effect on the proportion of variation explained. The points data could be scaled and it would not change the Points data in Figure 1.

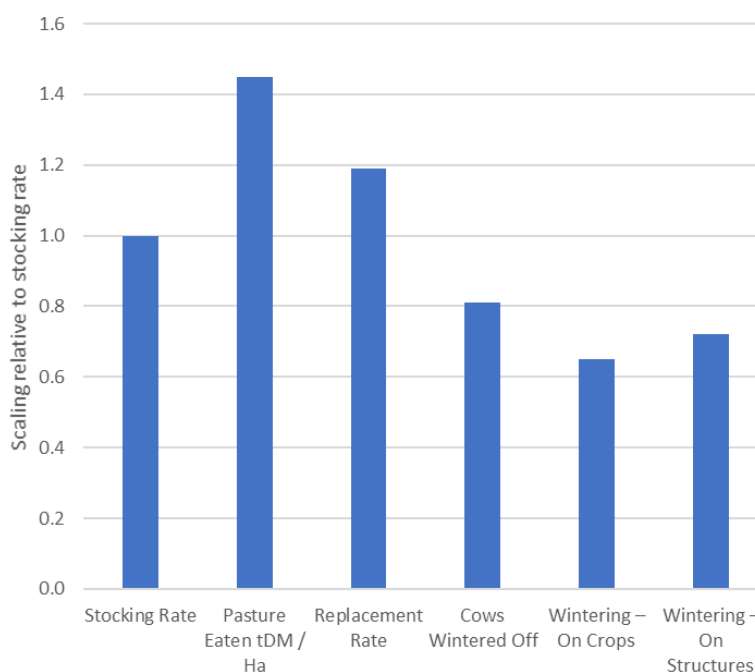


Figure 2. Scaled regression coefficients for the Stock Management factor relative to the Stocking Rate sub-factor

The data are presented again in numeric form in Table 1.

Table 1. Scaled regression coefficients for the Stock Management factor relative to Stocking Rate

Sub-factor	Weighting
Stocking Rate	1.00
Pasture Eaten tDM/Ha	1.45
Replacement Rate	1.19
Cows wintered off	0.81
Wintering – On Crops	0.65
Wintering – On Structures	0.72

Cropping and cultivation

Only farms that practiced some form of cropping and cultivation were included in this analysis, which was around 36% of all farms. There were four Cropping and Cultivation sub-factors, all of which were analysed to predict Overseer N-Loss for the Cropping and Cultivation factor. The Answers and Points models only accounted for a small amount of the observed variation in Overseer N-Loss, with an R^2 of 2.1% and 1.9%, respectively. For the relative proportion of explained variation accounted for by the sub-factors, the Answers and Points models were in good agreement (Figure 3), which again means that the Answer 'bins' represented a linear progression in risk of N-Loss. Of the four sub-factors, Crops Harvest Season was the dominant effect accounting for around 85% of the explained variation. Fertiliser applied to crops in winter accounted for a further 14% of the explained variation, while the other two sub-factors are barely visible on the graph and together only accounted for 1 to 2% of the explained variation in Overseer N-Loss.

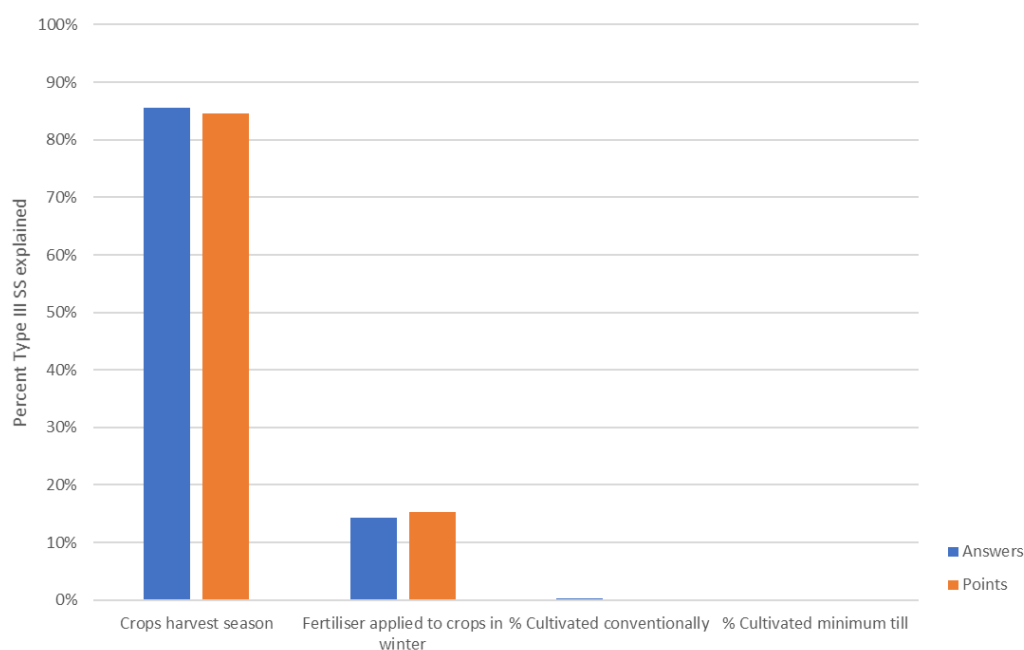


Figure 3. Proportion of the explainable variance accounted for by Cropping and Cultivation sub-factors based on Scorecard Answers or Points (only for farms with crops)

The relative weighting for Cropping and Cultivation sub-factors from a linear model fitted to the Points dataset are plotted in Figure 4 below. The model only includes farms that have crops which reduces the dataset to 1841 farms. The scaling factor has been expressed relative to % Cultivated Conventionally in Figure 4 to indicate the weighting for each sub-factor in the prediction of Overseer N-Loss. All three remaining sub-factors in Figure 4 are greater than one meaning that the points allocated were underweighted relative to % Cultivated Conventionally. The range of weightings were between 3.5 and 64.9 for sub-factors. In particular, Fertiliser applied to crops in winter was significantly underweighted relative to the other three sub-factors.

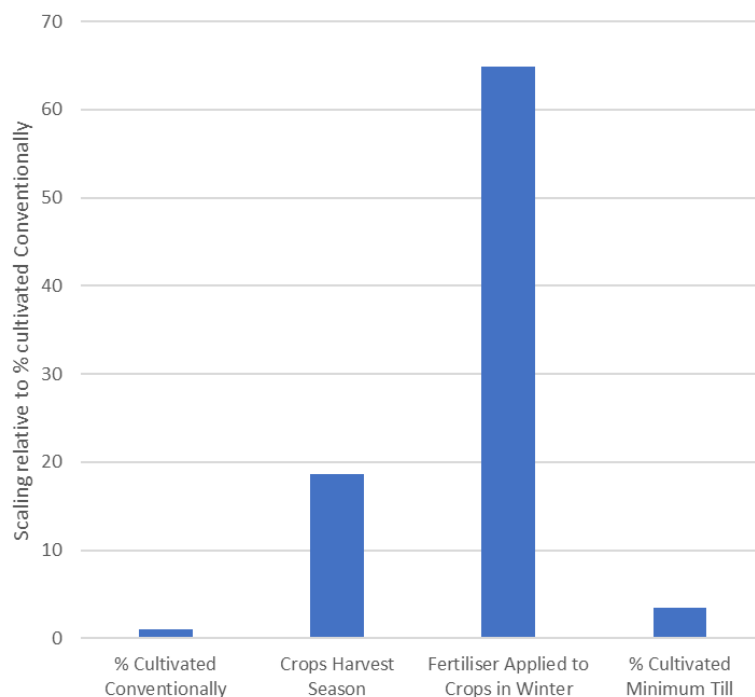


Figure 4. Scaled regression coefficients for the Cropping and Cultivation factor relative to the % Cultivated Conventionally sub-factor

The data are presented again in numeric form in Table 2.

Table 2. Scaled regression coefficients for the Cropping and Cultivation factor relative to % Cultivated Conventionally

Sub-factor	Weighting
% Cultivated Conventionally	1.0
Crops Harvest Season	18.7
Fertiliser Applied to Crops in Winter	64.9
% Cultivated Minimum Till	3.5

Effluent management

There were four Effluent Management sub-factors, all of which were analysed to predict Overseer N-Loss for the Effluent factor. The Answers and Points models only accounted for a small amount of the observed variation in Overseer N-Loss, with an R^2 of 3.6% and 2.8%, respectively. The Answers and Points models differed considerably in the proportion of variance explained. Around 99% of explainable variance was accounted for by Discharge Destination for the points model (Figure 5). Discharge destination still accounted for the greatest proportion of variation at 55%, but Disposal Area with a feed pad and Application Depth accounted for 33% and 11% of the variation, respectively. The reason for the difference is likely to be that points allocated to Discharge Destination reflect an industry objective (stopping any effluent discharge direct to waterways) which has a higher priority than can be justified solely on the basis of Nitrogen loss to water.

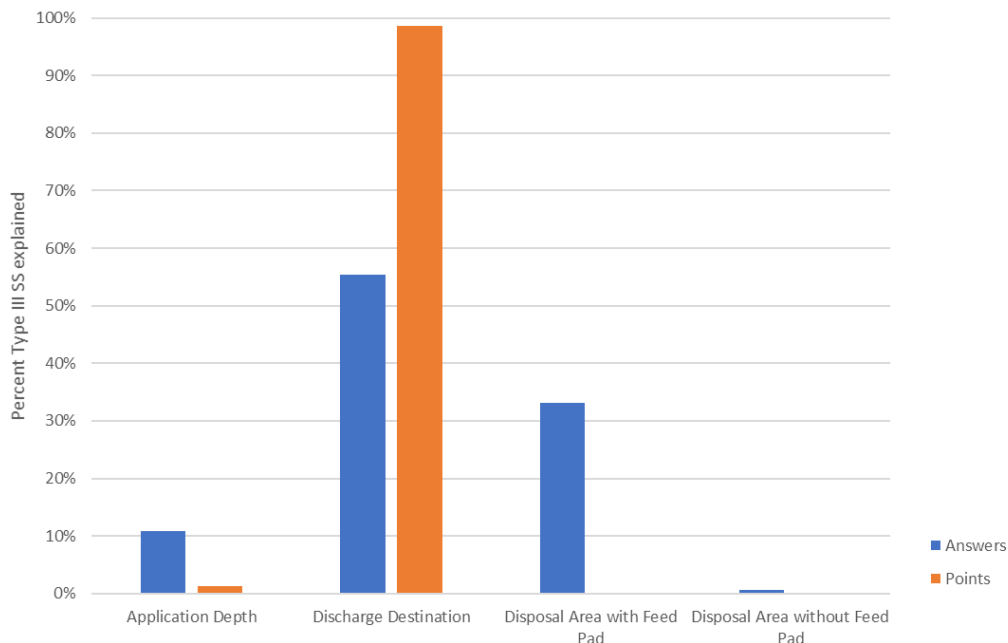


Figure 5. Proportion of the explainable variance accounted for by Effluent Management sub-factors based on Scorecard Answers or Points

The relative weighting for Effluent Management sub-factors from a linear model fitted to the Points dataset are plotted in Figure 6 below. The scalar for each sub-factor has been expressed relative to Discharge Destination to indicate the weighting for each sub-factor in the prediction of Overseer N-Loss. All three remaining sub-factors in Figure 6 are less than one meaning that the points allocated were overweighted relative to Discharge destination. The range of weightings were between 0.17 and 0.40 for sub-factors. Disposal Area with Feed Pad was the most overweighted with the remaining two sub-factors (Application Depth and Disposal Area without Feed Pad) weighted similarly.

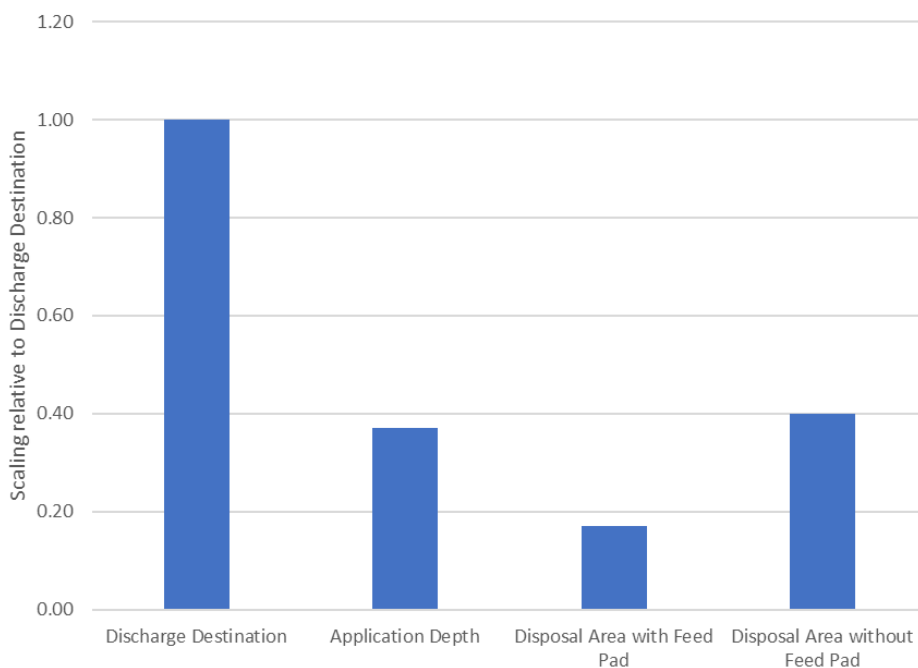


Figure 6. Scaled regression coefficients for the Effluent Management factor relative to the Discharge Destination sub-factor

The data are presented again in numeric form in Table 3.

Table 3. Scaled regression coefficients for the Effluent Management factor relative to Discharge Destination

Sub-factor	Weighting
Application Depth	0.37
Discharge Destination	1.00
Disposal Area with Feed Pad	0.17
Disposal Area without Feed Pad	0.40

Imported supplementary feeds

There were three Imported supplementary feeds sub-factors, all of which were analysed to predict Overseer N-Loss for the Imported feed factor. The Answers and Points models accounted for a low to moderate amount of the observed variation in Overseer N-Loss, with an R^2 of 7.7% and 5.4%, respectively. The Answers and Points models were in reasonable agreement (Figure 7) with Nitrogen Imported kg/Ha accounting for over 50% of the explained variation, Avg Nitrogen % account for 10% or less of the variation, and Nitrogen imported per kgMS intermediate between the other two. However, the Points allocation resulted in 15% more variation explained by Nitrogen Imported kg/Ha which came equally from the other two factors.

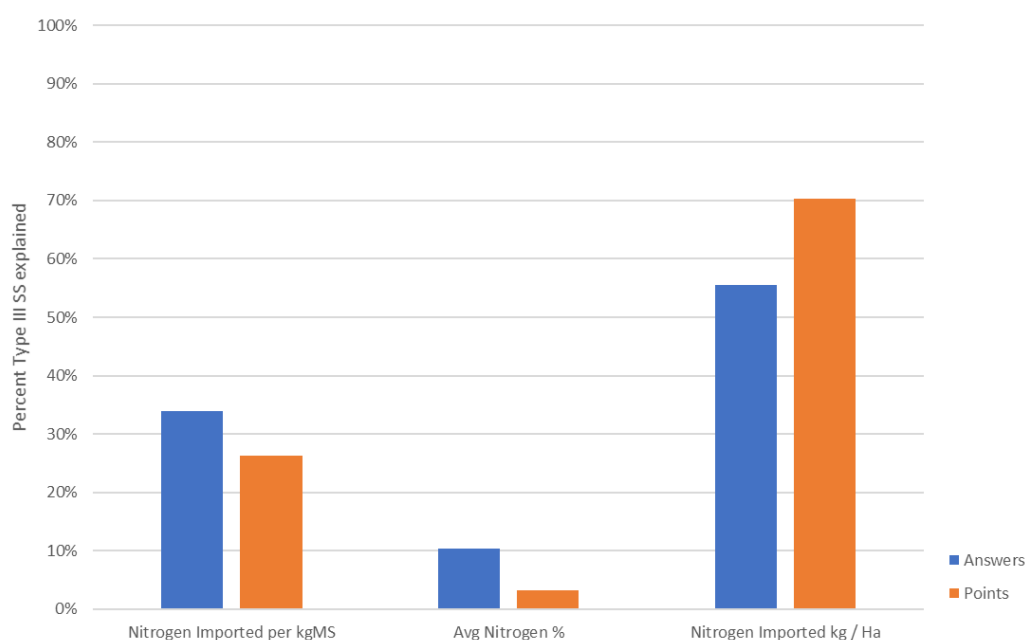


Figure 7. Proportion of the explainable variance accounted for by Imported Supplementary Feed sub-factors based on Scorecard Answers or Points

The relative weighting for Imported Supplementary Feed sub-factors from a linear model fitted to the Points dataset are plotted in Figure 8 below. Scaling factor has been expressed relative to Nitrogen Imported kg/Ha in Figure 8 to indicate the weighting for each sub-factor in the prediction of Overseer N-Loss. Relative to Nitrogen Imported kg/Ha, the other two sub-factors are less than one meaning

that the points allocated were overweighted. The weightings were 0.48 and 0.20 for Nitrogen Imported per kgMS and Avg Nitrogen %, respectively.

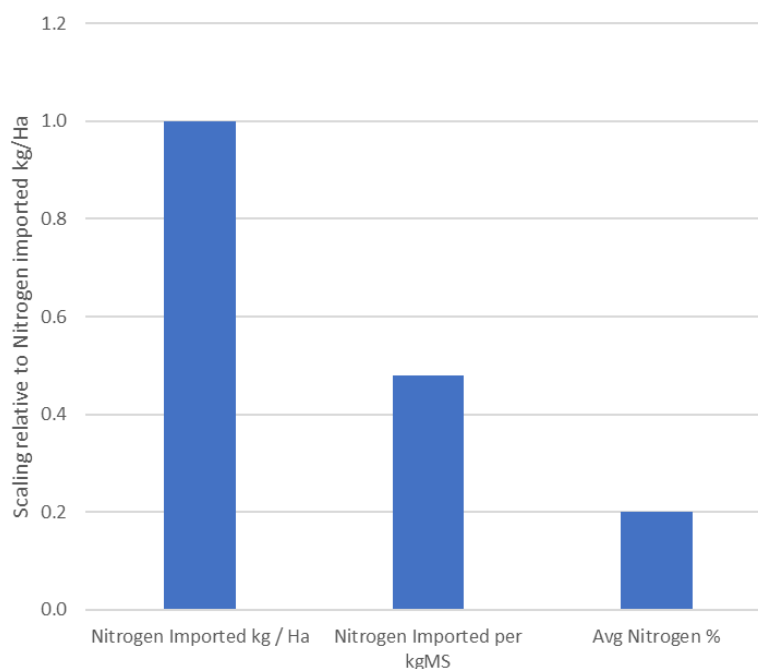


Figure 8. Scaled regression coefficients for the Imported Supplementary Feed factor relative to the Nitrogen Imported kg/Ha sub-factor

The data are presented again in numeric form in Table 4.

Table 4. Scaled regression coefficients for the Imported Supplementary Feed factor relative to Nitrogen Imported kg/Ha

Sub-factor	Weighting
Nitrogen Imported per kgMS	0.48
Avg Nitrogen %	0.20
Nitrogen Imported kg/Ha	1.00

Irrigation Practices

There were seven Irrigation Practice sub-factors, five of which were analysed to predict Overseer N-Loss for the Irrigation factor. Two sub-factors (Application – Deficit Irrigation and Scheduling – When Water is Available) were not fitted to estimate the Type III SS as they created singularities from part-whole relationships. The Answers and Points models accounted for a moderate amount of the observed variation in Overseer N-Loss, with an R^2 of 16.7% and 16.6%, respectively. The analysis included only those farms that irrigated which reduced the dataset to 550 farms. The Answers and Points models differed in the proportion variation assigned to each sub-factor (Figure 9). The Answers model had the three ‘methods’ (i.e. Border Dyke and Wild Flood, Rotary Boom, Gun or K-Line and Pivot or Linear) each accounting for around 30% of the explainable variance. The Points model was markedly different with Border Dyke or Wild flood accounting for 85% of the explained variation and the other two Methods each explaining less than 5% of the variation. Most of the remaining variation in the Points model (10%) was accounted for in Scheduling – Soil Moisture Tapes or Budget.

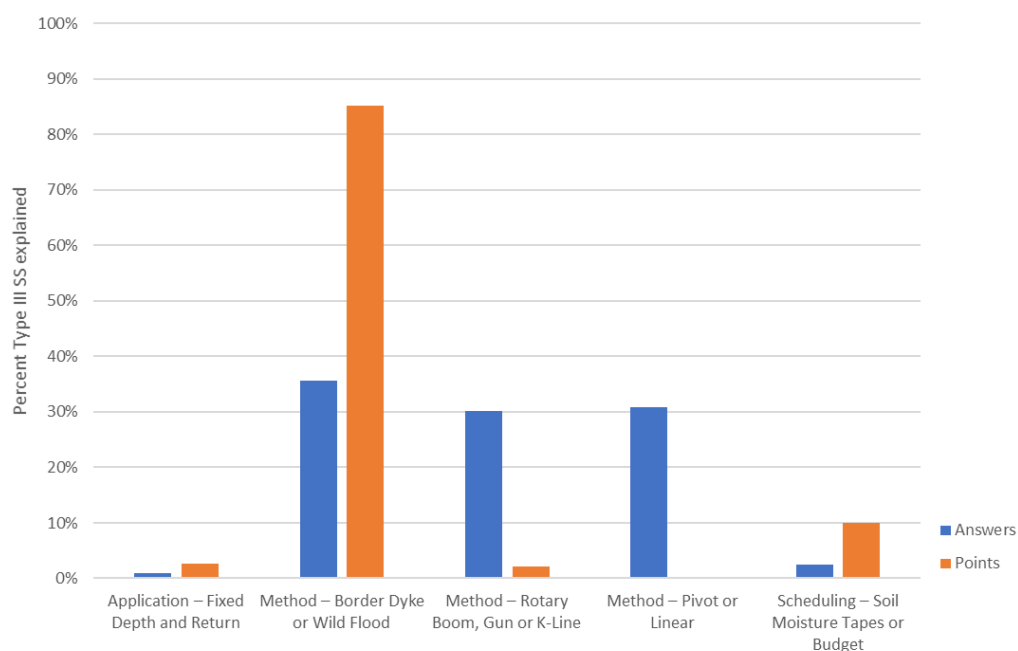


Figure 9. Proportion of the explainable variance accounted for by Irrigation Practice sub-factors based on Scorecard Answers or Points (only farms that irrigate)

The relative weighting for Irrigation Practice sub-factors from a linear model fitted to the Points dataset are presented in Figure 10.

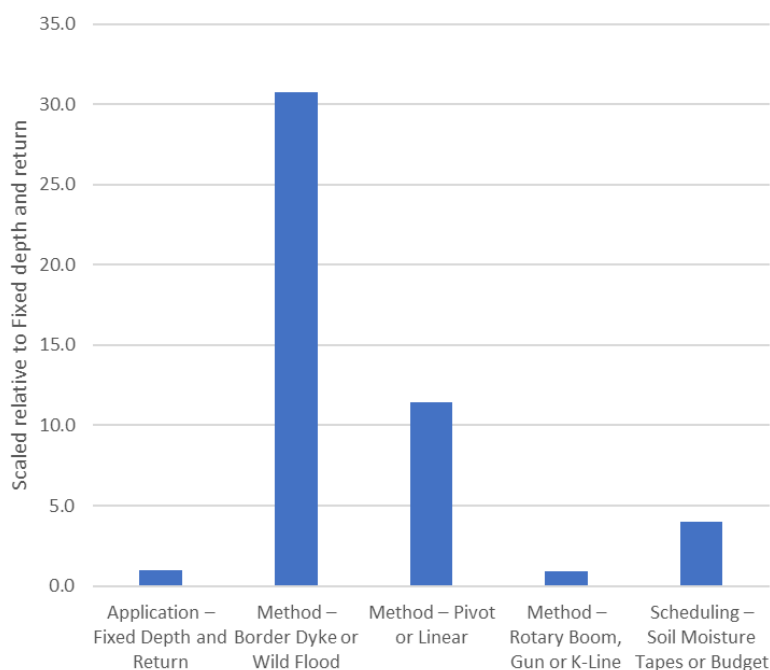


Figure 10. Scaled regression coefficients for the Irrigation Practice factor relative to the Application – Fixed Depth and Return sub-factor

The model only includes farms that irrigate which reduces the dataset to around 550 farms. Scaling factor has been expressed relative to a value of one for Application – Fixed Depth and Return to

indicate the weighting for each sub-factor in the prediction of Overseer N-Loss. Method – Rotary Boom, Gun or K-Line had the same weighting (0.98) and the remaining three sub-factors were all significantly greater than one meaning that the points allocated were underweighted relative to Application – Fixed Depth and Return. The weighting for Method – Border Dyke or Wild flood and Method - Pivot or Linear were substantially underweighted as their scaling factors were 30.7% and 11.5%, respectively. Scheduling – Soil Moisture Tapes or Budget was underweighted by a factor of four. The data are presented again in numeric form in Table 5.

Table 5. Scaled regression coefficients for the Irrigation Practice factor relative to the Application – Fixed Depth and Return

Sub-factor	Weighting
Application – Fixed Depth and Return	1.0
Method – Border Dyke or Wild Flood	30.7
Method – Pivot or Linear	11.5
Method – Rotary Boom, Gun or K-Line	0.9
Scheduling – Soil Moisture Tapes or Budget	4.0

Nitrogen fertiliser application

There were four Nitrogen Fertiliser Application sub-factors, all of which were analysed to predict Overseer N-Loss for the N fertiliser factor. The Answers and Points models accounted for moderate amount of the observed variation in Overseer N-Loss, with an R^2 of 36.5% and 34.5%, respectively. This was over twice the amount of variation explained for any other single factor. The Answers and Points models were in good agreement (Figure 11) meaning that the Answer ‘bins’ represented a linear progression in risk of N-Loss. Of the five sub-factors, Nitrogen Applied kg/Ha was the dominant effect accounting for over 90% of the explained variation for both Answers and Points models. The only other sub-factor approaching 5% was Nitrogen applied per kgMS in the Answers model.

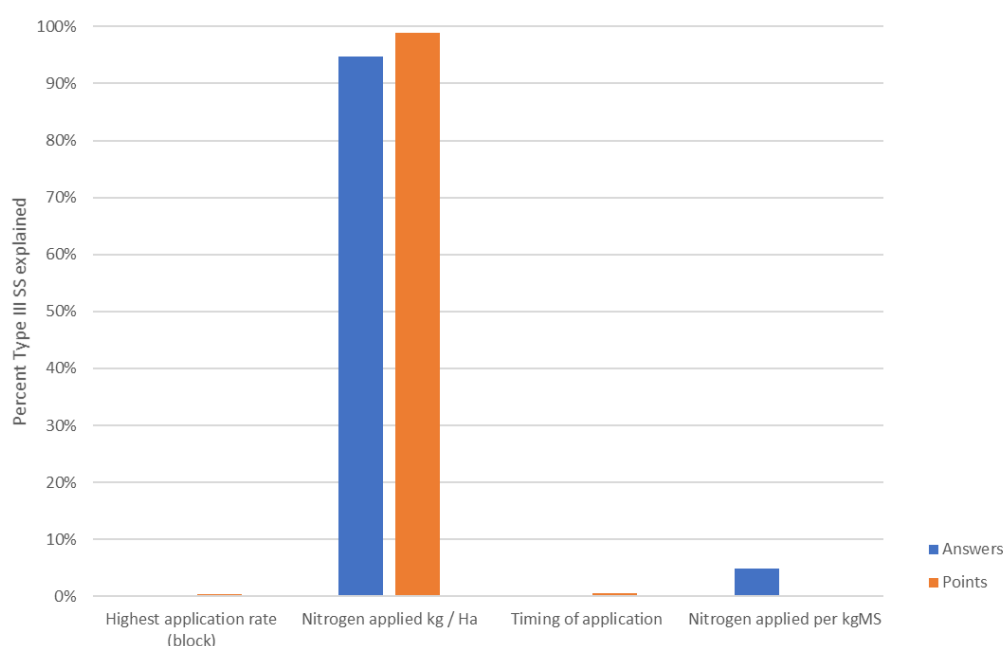


Figure 11. Proportion of the explainable variance accounted for by Nitrogen Fertiliser Application sub-factors based on Scorecard Answers or Points

The relative weighting for Nitrogen Fertiliser sub-factors from a linear model fitted to the Points dataset are plotted in Figure 12. Scaling factor has been expressed relative to Nitrogen Applied kg/Ha to indicate the weighting for each sub-factor in the prediction of Overseer N-Loss. All three remaining sub-factors in Figure 12 are less than one meaning that the points allocated were overweighted relative to Nitrogen Applied kg/Ha. The range of weighting were between 7% and 18% for sub-factors.

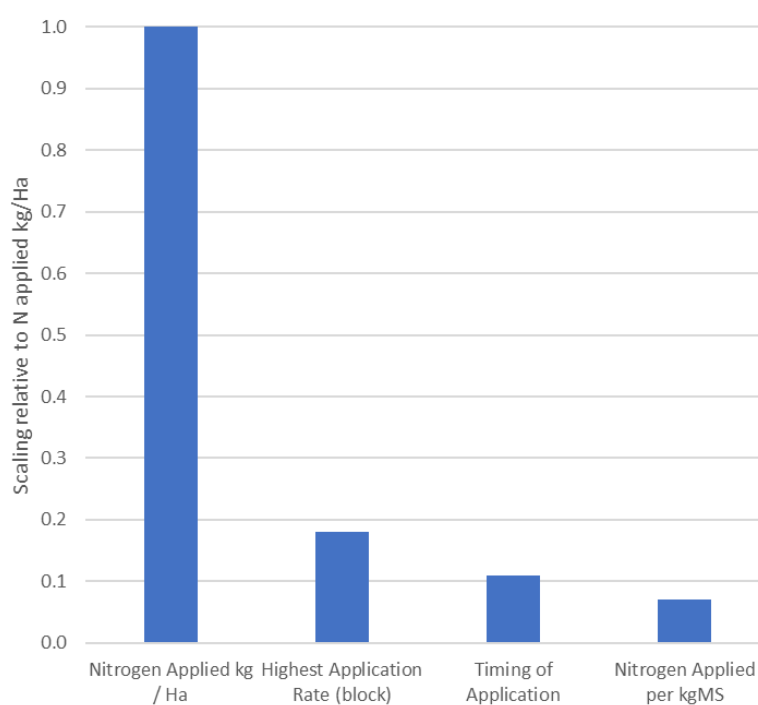


Figure 12. Scaled regression coefficients for the Nitrogen Fertiliser Application factor relative to the Nitrogen Applied kg/Ha sub-factor

The data are presented again in numeric form in Table 6.

Table 6. Scaled regression coefficients for the Nitrogen Fertiliser Application factor relative to Nitrogen Applied kg/Ha

Sub-factor	Weighting
Highest Application Rate (Block)	0.18
Nitrogen Applied kg/Ha	1.00
Timing of application	0.11
Nitrogen Applied per kgMS	0.07

Prediction of Overseer N-Loss and N-Surplus from all N scorecard sub-factors

Three datasets were analysed to test the prediction of Overseer N-Loss to Water and Overseer N-Surplus, namely predictions for farms that do not irrigate, farms that do irrigate and a prediction for the full dataset combined farms that do- and do not irrigate (Tables 13, 14 and 15, respectively). For each analysis, both prediction accuracy and transportability were measured. A random 25% of farms were not used in the prediction of Overseer endpoints to test the transportability of the prediction

equations. The equations developed for the training dataset were then fitted to the transportability dataset to see if they were predicted with similar accuracy to the training dataset. Tables of the results are presented in Appendix 1.

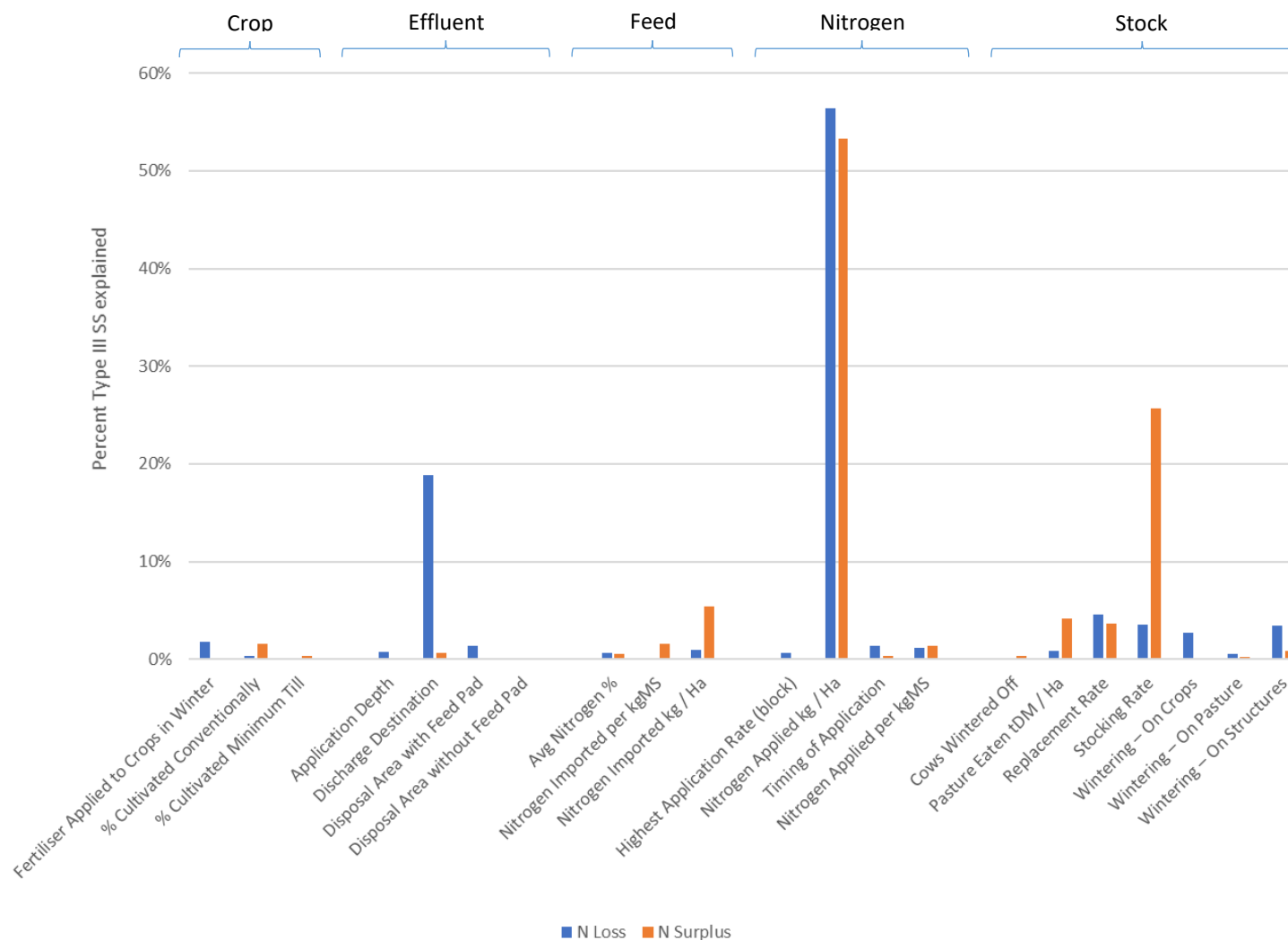


Figure 13. Proportion of variance explained for Overseer N-Loss and Overseer N-Surplus predicted from sub-factors selected from a stepwise regression model for farms without irrigation

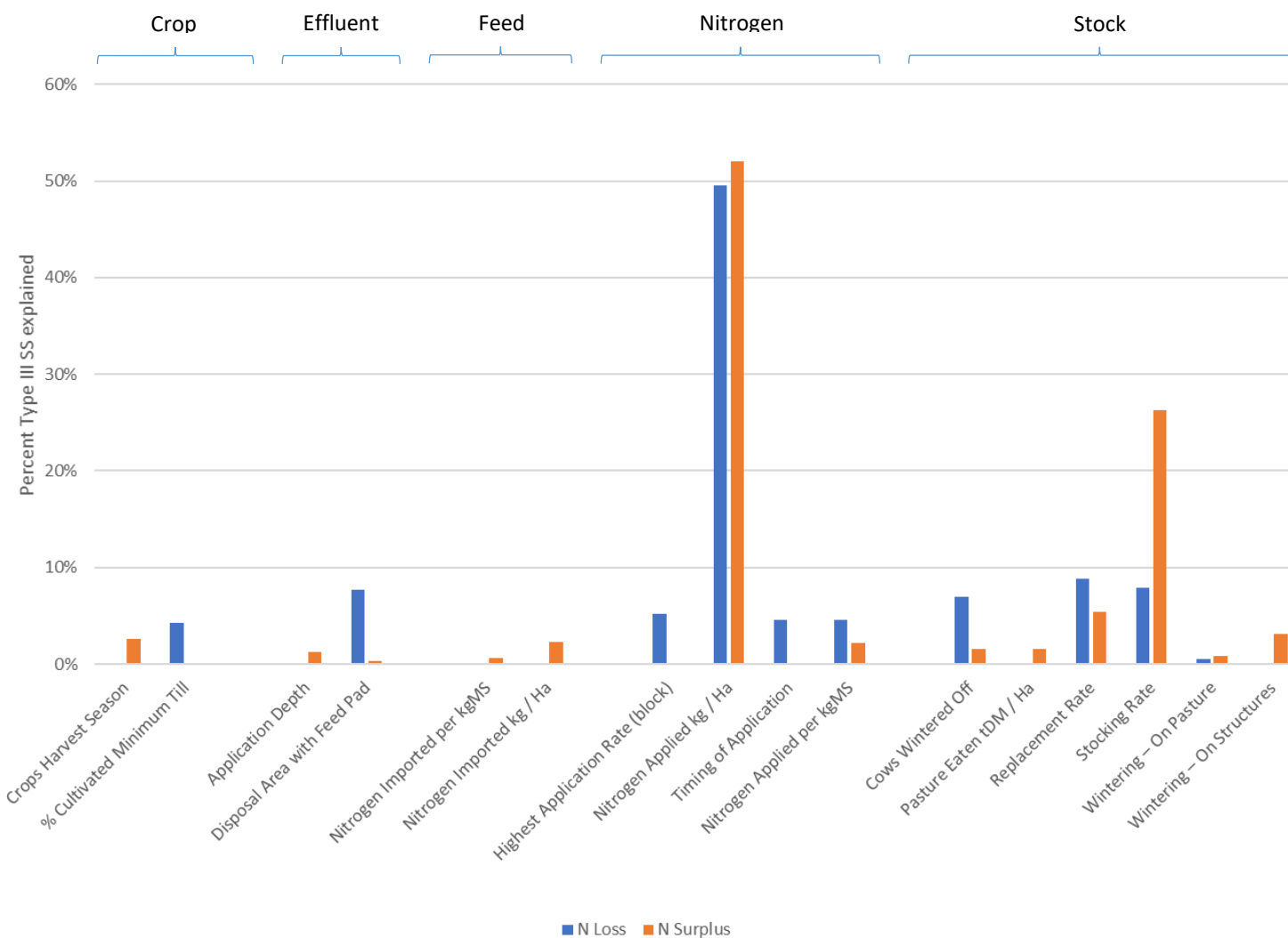


Figure 14. Proportion of variance explained for Overseer N-Loss and Overseer N-Surplus predicted from sub-factors selected from a stepwise regression model for farms with irrigation

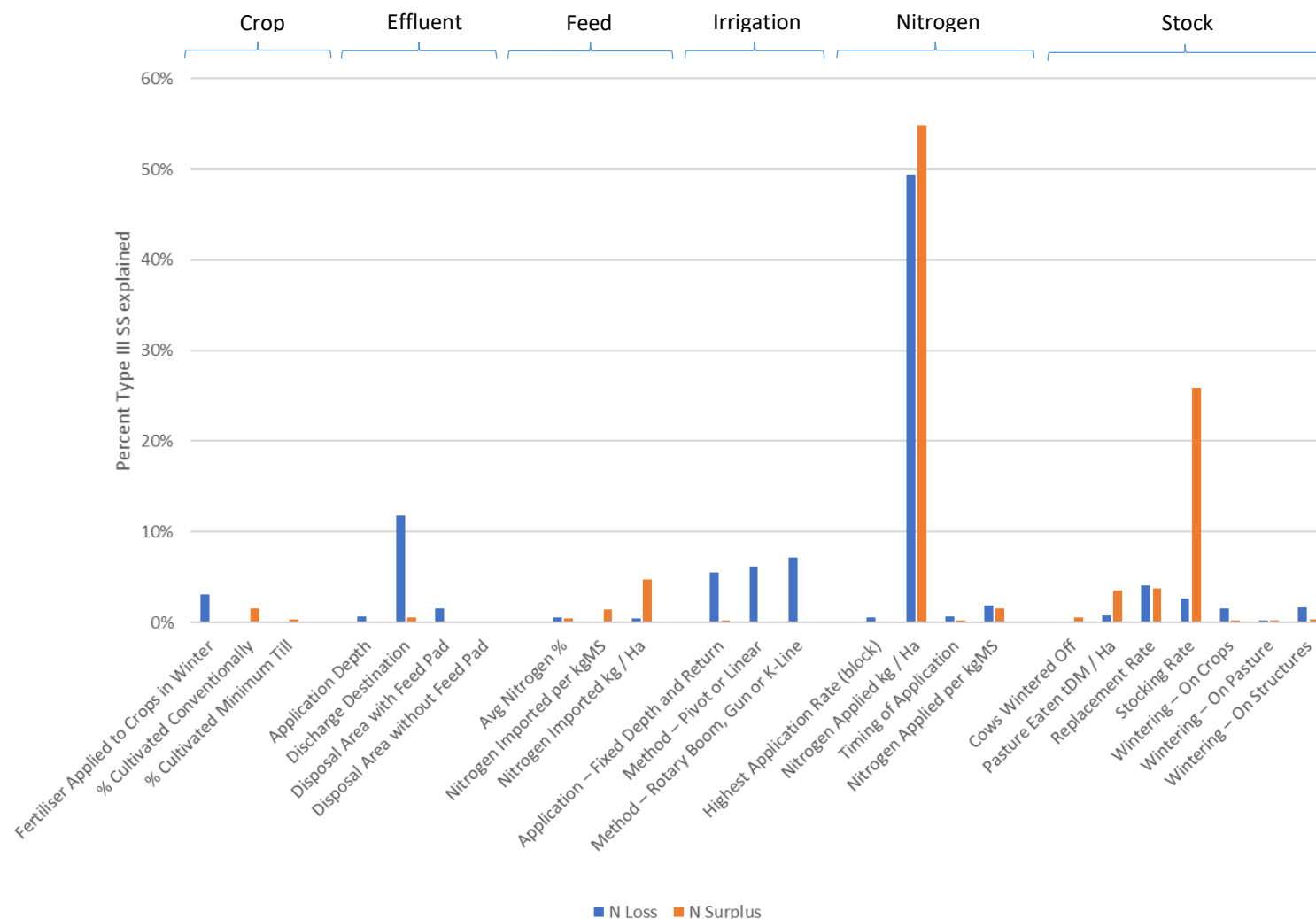


Figure 15. proportion of variance explained for Overseer N-Loss and Overseer N-Surplus predicted from sub-factors selected from a stepwise regression model for all farms in the N scorecard dataset

Predictions of Overseer N-Loss and N-Surplus for farms without irrigation

The sub-factors that proved significant predictors of Overseer N-Loss and Overseer N-Surplus are presented in Figure 13 for farms without irrigation. The results are presented in full in Appendix Table 1.1. The terms in the N-Loss and N-Surplus models explained 42.6% and 88.4% of the variation, respectively. R^2 values were similar for the transportability analysis, at 43.2% and 87.6%, respectively, so the prediction and transportability models were in good agreement. There were 4,358 farms in the prediction, and 1,466 farms in the transportability datasets.

The bars in Figure 13 represent the proportion of explainable variation accounted for by each sub-factor based on the Type III SS. Over 50% of the explained variance in both N-Loss and N-Surplus models was accounted for by Nitrogen Applied kg/Ha. The N-Loss model had one other major predictor, with Effluent - Discharge Destination accounting for around 19% of the explained variance. All other factors, while statistically significant, did not account for more than 5% of the explained variation.

The N-Surplus model also only had one other major predictor, with Stock – Stocking Rate accounting for around 26% of the explained variance. All other factors accounted for 5% or less of the explained variation.

Predictions of Overseer N-Loss and N-Surplus for farms with irrigation

The sub-factors that proved significant predictors of Overseer N-Loss and Overseer N-Surplus are presented in Figure 14 for farms with irrigation. This was a substantially smaller dataset with 567 farms in the prediction, and 168 farms in the transportability datasets. The results are presented in full in Appendix Table 1.2. The terms in the N-Loss and N-Surplus models explained 40.6% and 91.8% of the variation, respectively. R^2 values were similar for the transportability analysis, at 34.5% and 91.9%, respectively. The loss of accuracy for N-Loss between the prediction and transportability models is not surprising given the relatively low number of farms in the datasets. The level of agreement between the models for N-Surplus is a surprise given the low numbers of farms.

The bars in Figure 14 represent the proportion of explainable variation accounted for by each sub-factor based on the Type III SS. As for farms without irrigation, around 50% of the explained variance in both N-Loss and N-Surplus models was accounted for by Nitrogen Applied kg/Ha. All other sub-factors in the N-Loss model accounted for 10% or less of the explained variation.

The N-Surplus model had one other major predictor, with Stock – Stocking Rate accounting for around 27% of the explained variance. All other factors accounted for 5% or less of the explained variation.

Predictions of Overseer N-Loss and N-Surplus for all farms

The significant sub-factor predictors of Overseer N-Loss and Overseer N-Surplus are presented in Figure 15 for all farms (i.e. farms either with or without irrigation combined). This gave a total of 4,925 farms in the prediction, and 1,634 farms in the transportability datasets. The results are presented in full in Appendix Table 1.3. The terms in the N-Loss and N-Surplus models explained 45.1% and 89.4% of the variation, respectively. R^2 values were similar for the transportability analysis, at 43.9% and 91.9%, respectively. This indicates that the model is transportable across datasets and does provide consistent predictions of Overseer N-Loss and Overseer N-Surplus from N scorecard sub-factors.

The bars in Figure 15 represent the proportion of explainable variation accounted for by each sub-factor based on the Type III SS. The results were similar to those for Farms without irrigation with the exception that some Irrigation sub-factors were significant effects in the full model. The similarity between these two models is to be expected given that farms without irrigation make up the vast majority of farms in the “All farms” model. A total of 50 to 55% of the explained variance in both N-Loss and N-Surplus models was accounted for by Nitrogen Applied kg/Ha.

The N-Loss model had one other major predictor accounting for more than 10% of variation explained, with Effluent - Discharge Destination accounting for 11.8% of the explained variance. Three further irrigation sub-factors individually accounted for more than 5% of the variation, with Application – Fixed Depth and Return, Method – Pivot or Linear and Method – Rotary Boom, Gun or K-Line accounting for 5.5, 6.2 and 7.2%, respectively. All other factors, while statistically significant, accounted for less than 5% of the explained variation.

The N-Surplus model also only had one other major predictor in addition to Nitrogen Applied kg/Ha, namely Stock – Stocking Rate, accounting for 25.9% of the explained variance. All other factors accounted for 5% or less of the explained variation.

Discussion and recommendations

Within-factor effects

Overseer N-Loss to water has been used as the main variable of interest in this analysis to determine how the N Scorecard sub-factors influence it. A subset of analyses also considered the prediction of Overseer N-Surplus. The two variables are highly correlated ($R^2 = 0.73$, Figure 16) so the results for the two Overseer measures are similar. Prediction accuracy is much higher for Overseer N-Surplus compared to Overseer N-Loss as there are many environmental variables (e.g. rainfall, temperature, soil type, elevation, slope etc) that contribute to nitrogen loss that are not incorporated into the N scorecard.

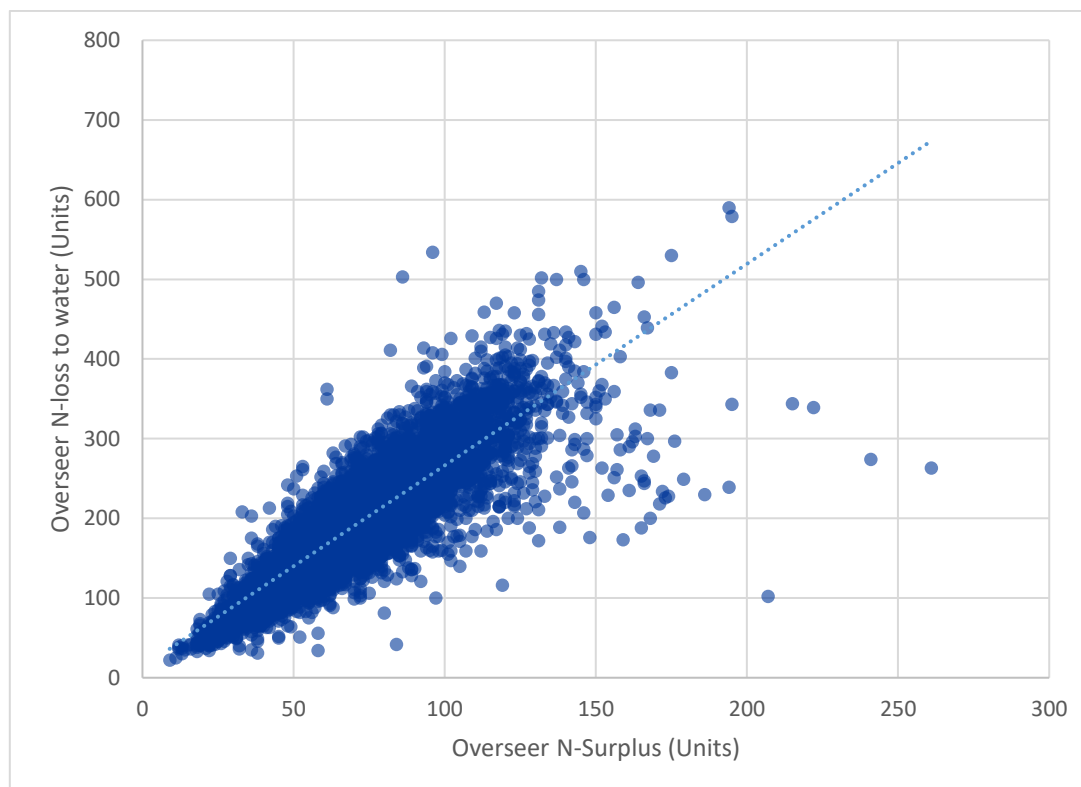


Figure 16. The relationship between Overseer N-Loss to water and Overseer N-Surplus for the farms in the N Scorecard dataset

The N scorecard factors differed greatly in their prediction of Overseer N-loss when each factor was analysed individually. The Nitrogen Fertiliser factor accounted for 36% of the overall variation in Overseer N-Loss to water on its own. Irrigation factor accounted for 16% of the variation in Overseer N-Loss and Stock Management factors accounted for around 15%. Supplementary feeds, Stock Management and Cropping and Cultivation individually accounted for relatively minor proportions of variation in Overseer N-Loss at 6%, 3% and 2%, respectively. These proportions of variation accounted for by each of the six factors are not additive as they do not correct for associations between sub-factors across the six factors. However, it does indicate that the greatest opportunities to reduce nitrogen loss to water relate to practices around Fertiliser, Irrigation and Stock Management.

Fonterra has assigned points to each sub-factor in the N Scorecard based on research results in scientific publications and industry best practice principles. We were able to test whether the points that were allocated for each sub-factor actually put the correct weighting for the prediction of Overseer N-Loss within a factor. The scaling values within a factor are presented above in Tables 1 to 6. Table 7 presents a worked example of how points within the Stock Management factor would need to be scaled to give the appropriate weighting for the prediction of Overseer N-Loss.

Table 7. Demonstrations of change in Stock Management points to balance

Sub-factor	Units	Current Weighting	New weighting
Stocking Rate		NA	NA
Pasture Eaten tDM/Ha	Points	5, 10, 20, 30	7.5, 15, 30, 45
Replacement Rate	Points	0 to 10 in increments of 1	0 to 12 in increments of 1
Cows wintered off	Points	0 to -40 in increments of 2	0 to -32 in increments of 1.6
Wintering – On Crops	Points/10%	4	2.6
Wintering – On Structures	Points/10%	4	2.9

In Table 7, Stocking Rate is the sub-factor the other sub-factors are scaled against so it is listed as NA (i.e. the current allocation of points is not changed). Pasture Eaten tDM/Ha is grouped into four categories for analysis (i.e. low, medium low, medium high and high), and the points need to be increased by a factor of 1.45 to give the same weighting on the prediction of Overseer N-Loss. The range from 5 to 30 points should be increased to 7.5 to 45 points. Likewise, Replacement Rate is grouped into 10 categories from low to high which need to be increased by a factor of 1.2 to give the correct weighting. Cows wintered off had 20 categories from low to high proportions which need to be scaled down slightly from increments of 2 to increments of 1.6 points. The two Wintering sub-factors (On Crops and On structures) were linear functions in their own right, and needed the slopes (i.e. points allocated per 10%) scaled down slightly to give the correct weighting. Wintering – On Crops should drop from 4 to 2.6 points per 10%, and Wintering – On Structures should drop from 4 to 2.9 points/10%.

The allocation of points can be multiplied by the scalars to give appropriate weightings based on the results of this analysis. A recommendation of this report is that the allocation of points be revised to take into account the scalars calculated from this analysis. However, there may be some sub-factors where a decision is made to weight higher than this analysis would suggest because the perceived impact is greater than the impact estimated in this analysis. One such sub-factor is Effluent – Discharge Destination where we estimated the very high allocation of points was greater than could be justified solely on the basis of the impact on Overseer N-Loss to water. This acknowledges that there are effects in addition to Nitrogen that have been considered in setting the points weighting for that sub-factor, for example water turbidity or pathogens entering waterways.

Effects from the full model

Applying all sub-factors in the same statistical model gives the ability to compare factors with each other and exclude any co-linearities (i.e. sub-factors that effectively have a one-to-one relationship with each other). This allows us to compare the independent effect of each sub-factor in the model. The stepwise regression removed any non-significant sub-factors.

After removing the non-significant sub-factors and the co-linearities, the dominant sub-factor across all analyses has been Nitrogen fertiliser applied kg/Ha, accounting for 50% or more of the explained variation. The Type III SS give us the effect of each sub-factor independent of all other sub-factors in the model. In practical terms, the meaning of this result is that there is strong evidence in the N

Scorecard dataset that where Nitrogen fertiliser is applied without changing any other of the sub-factors, there is a very direct relationship to an increase in Overseer N-Loss to water and Overseer N-Surplus. No other sub-factor had anywhere near the impact that Nitrogen Applied kg/Ha did. The independent effect of, for example Stocking Rate which we might expect to have a significant effect on Overseer N-Loss, only accounted for 2.6% of the explained variation. While this is statistically significant, it indicates that Stocking Rate in and of itself is not a major sub-factor in increasing Overseer N-Loss. So if we observe higher Overseer N-Loss in farms with high Stocking Rate, the high nitrogen loss is being caused by other sub-factors that are needed to support that high stocking rate, such as the requirement for more nitrogen fertiliser to provide feed for those cows. The Stocking Rate sub-factor was a major effect in the Overseer N-Surplus model, which is to be expected as urination is a major source of nitrogen onto soils. However, the relationship between N-Surplus and N-Loss to water is not linear and other factors in the N-Loss to water greatly reduce the impact of Stocking Rate in that model.

In the All Farms and Farms without irrigation statistical models, Effluent – Discharge Destination was the second major factor. Examination of the solutions showed a large spread of points between the answers, with “Discharge to water” having a large penalty and contribution to Overseer N-Loss to water.

Conclusions

Overall, the N Scorecard is providing very useful feedback to farmers on their farm management practices. The moderate accuracy of prediction of Overseer N-Loss to water from the Scorecard sub-factors is encouraging, given that major environmental data which affects nitrogen loss to water is not included in the Scorecard. There are a small number of factors that dominate in the prediction of Overseer N-Loss to water, i.e. Nitrogen applied kg/Ha and Effluent – Discharge destination, but there are many minor factors that are statistically significant and combined add to the overall prediction.

The points allocated to N Scorecard answers have mostly been shown in this analysis to account for variation in Overseer N-Loss well, but the scaling can be changed to give better consistency of weighting in relation to impact. Scalars are included in the tables above to apply the appropriate adjustments. Several sub-factors have been significantly overweighted for the level of impact on Overseer N-Loss observed in this study. However, this is considered appropriate as there are effects over and above consideration only on the basis of impact on nitrogen. The main example is that Effluent Discharge Destination has been significantly overweighted because it has potentially major impacts on water turbidity and water pathogen content.

References

R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>.

Appendix 1

Appendix Table 1.1. Accuracy, transportability and proportion of variance explained for Overseer N-Loss and Overseer N-Surplus predicted from factors selected from a stepwise regression model for farms without irrigation

Effect	N-Loss	N-Surplus
Model R ²		
Prediction (<i>n</i> =4358)	42.6%	88.4%
Transportability (<i>n</i> =1466)	43.2%	87.6%
Cropping and Cultivation		
Nitrogen.Fertiliser.Applied.to.Crops.in.the.Winter	1.8%	NA
Percent.cultivated.annually...Conventional	0.3%	1.6%
Percent.cultivated.annually...Minimum.Till	NA	0.3%
Effluent		
Application.Depth	0.8%	NA
Discharge.Destination	18.8%	0.6%
Disposal.Area.with.Feed.Pad	1.4%	NA
Disposal.Area.without.Feed.Pad	NA	0.1%
Feed Imported		
Average.Nitrogen..	0.6%	0.5%
Nitrogen.Imported.per.kgMS	NA	1.6%
Total.Nitrogen.imported.through.Feed.per.Ha	1.0%	5.4%
Nitrogen		
Highest.Monthly.Application.Rate.on.a.Block	0.6%	0.1%
Nitrogen.Applied.per.HA	56.4%	53.3%
Nitrogen.Applied.per.Month	1.4%	0.3%
Nitrogen.Fertiliser.Applied.per.kgMS	1.2%	1.4%
Stock Management		
Cows.wintered.off.April...July	NA	0.3%
Pasture.Eaten.TDM...Ha	0.9%	4.2%
Replacement.Rate	4.6%	3.6%
Stocking.Rate	3.5%	25.7%
Winter.Pasture.vs.Structures...On.Crops	2.7%	NA
Winter.Pasture.vs.Structures...On.Pasture	0.5%	0.2%
Winter.Pasture.vs.Structures...On.Structures	3.4%	0.9%

Appendix Table 1.2. Accuracy, transportability and proportion of variance explained for Overseer N-Loss and Overseer N-Surplus predicted from factors selected from a stepwise regression model for farms with irrigation

Effect		N-Loss	N-Surplus
Model R ²			
	Prediction (n=567)	40.6%	91.8%
	Transportability (n=168)	34.5%	91.9%
Cropping and Cultivation			
	Crops.Harvest.Season	NA	2.6%
	Percent.cultivated.annually...Minimum.Till	4.3%	NA
Effluent			
	Application.Depth	NA	1.2%
	Disposal.Area.with.Feed.Pad	7.7%	0.3%
Feed Imported			
	Nitrogen.Imported.per.kgMS	NA	0.6%
	Total.Nitrogen.imported.through.Feed.per.Ha	NA	2.3%
Nitrogen			
	Highest.Monthly.Application.Rate.on.a.Block	5.2%	NA
	Nitrogen.Applied.per.HA	49.5%	52.0%
	Nitrogen.Applied.per.Month	4.6%	NA
	Nitrogen.Fertiliser.Applied.per.kgMS	4.6%	2.2%
Stock			
	Cows.wintered.off.April...July	7.0%	1.6%
	Pasture.Eaten.TDM...Ha	NA	1.6%
	Replacement.Rate	8.8%	5.4%
	Stocking.Rate	7.9%	26.3%
	Winter.Pasture.vs.Structures...On.Pasture	0.5%	0.8%
	Winter.Pasture.vs.Structures...On.Structures	NA	3.1%

Appendix Table 1.3. Accuracy, transportability and proportion of variance explained for Overseer N-Loss and Overseer N-Surplus predicted from factors selected from a stepwise regression model for all farms in the N scorecard dataset

Effect	N-Loss	N-Surplus
Model R ²		
Prediction (n=4925)	45.1%	89.4%
Transportability (n=1642)	43.9%	88.7%
Cropping.and.Cultivation		
Nitrogen.Fertiliser.Applied.to.Crops.in.the.Winter	3.1%	NA
Percent.cultivated.annually...Conventional	NA	1.5%
Percent.cultivated.annually...Minimum.Till	NA	0.3%
Effluent		
Application.Depth	0.7%	#N/A
Discharge.Destination	11.8%	0.5%
Disposal.Area.with.Feed.Pad	1.5%	#N/A
Disposal.Area.without.Feed.Pad	#N/A	0.1%
Feed.Imported		
Average.Nitrogen..	0.5%	0.4%
Nitrogen.Imported.per.kgMS	#N/A	1.4%
Total.Nitrogen.imported.through.Feed.per.Ha	0.4%	4.7%
Irrigation		
Irrigation.Application...Fixed.Depth.and.Return	5.5%	0.2%
Irrigation.Method...Pivot.or.Linear	6.2%	#N/A
Irrigation.Method...Rotary.Boom.Gun.or.K.Line	7.2%	#N/A
Nitrogen		
Highest.Monthly.Application.Rate.on.a.Block	0.5%	0.1%
Nitrogen.Applied.per.HA	49.3%	54.9%
Nitrogen.Applied.per.Month	0.7%	0.2%
Nitrogen.Fertiliser.Applied.per.kgMS	1.9%	1.5%
Stock.Management		
Cows.wintered.off.April...July	#N/A	0.5%
Pasture.Eaten.TDM...Ha	0.8%	3.5%
Replacement.Rate	4.1%	3.7%
Stocking.Rate	2.6%	25.9%
Winter.Pasture.vs.Structures...On.Crops	1.5%	0.2%
Winter.Pasture.vs.Structures...On.Pasture	0.2%	0.2%
Winter.Pasture.vs.Structures...On.Structures	1.6%	0.3%

ATTACHMENT 4 – Farm Insight Report



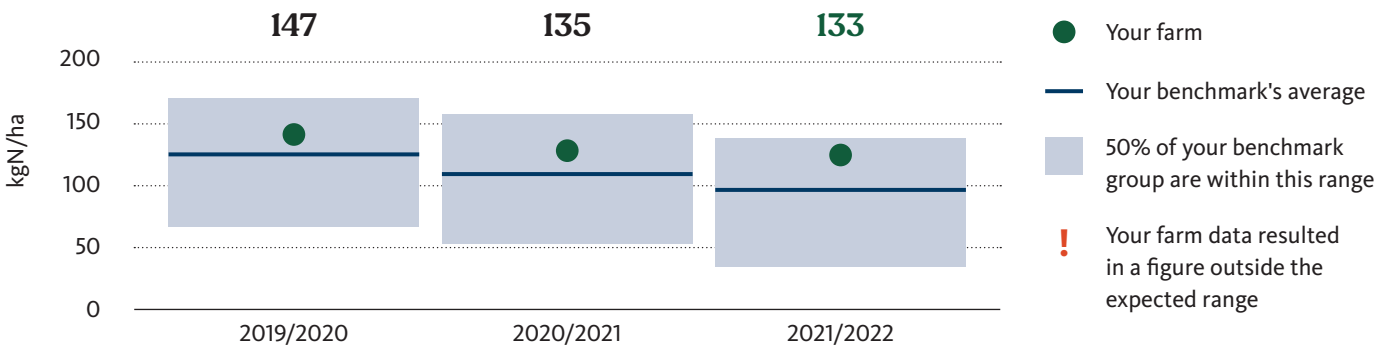
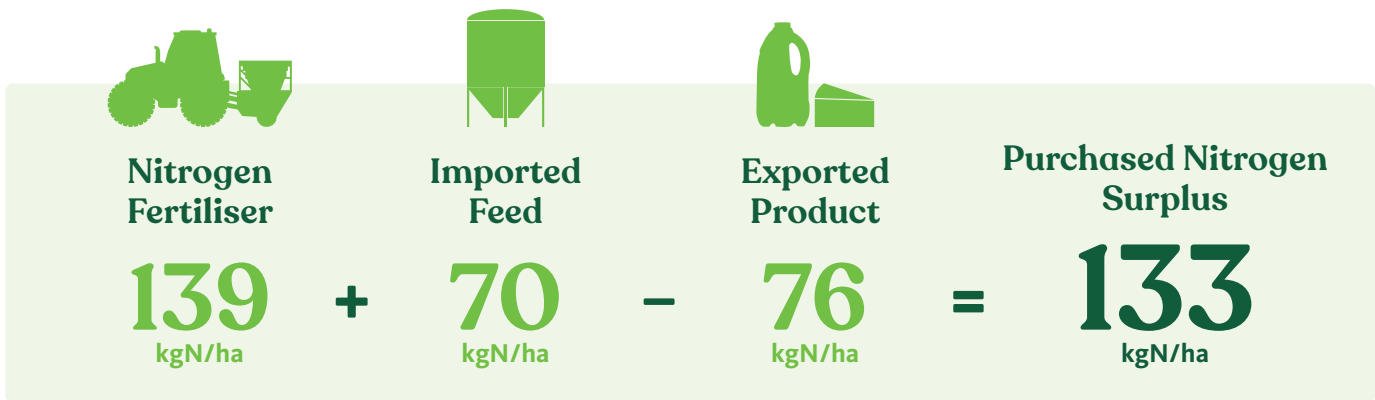
Environment

Your farm's environmental insights are broken down into Purchased Nitrogen Surplus, Nitrogen Risk Scorecard, Nitrogen Fertiliser Conversion Efficiency and Greenhouse Gas Emissions.

Purchased Nitrogen Surplus

Purchased Nitrogen Surplus is the difference between the nitrogen inputs (fertiliser and imported feeds) and the nitrogen outputs (milk, meat, crop, supplementary feed or exported effluent) on your dairy farm effective area. A high number means more nitrogen is at risk of being lost from your farm to the receiving environment.

Your Farm's Purchased Nitrogen Surplus Per Hectare



Your farm is benchmarked against other farms in the Waikato region with production between 1,001-1,200 kgMS/ha.

Your Farm's Nitrogen Risk Scorecard

Stock Management	HIGH	Cropping and Cultivation	LOW
Nitrogen Fertiliser	MEDIUM	Effluent Management	VERY LOW
Imported Feed	HIGH	Irrigation	VERY HIGH

Your Farm's Nitrogen Risks

STOCK MANAGEMENT

HIGH

Stocking Rate

The higher the stocking rate⁽¹⁾ (peak), the greater the nitrogen loss.

Total 21.6 su/ha

Milking herd (3.6 cows/ha) 17.5 su/ha

Replacement/other animals 4.1 su/ha

Dry Matter Eaten

The more dry matter eaten⁽²⁾ per hectare, the more nitrogen ingested by the animal and returned to pasture as dung and urine.

Total 14.3 tDM/ha

Grown on this farm

Pasture and crops 10.0 tDM/ha

Imported to this farm

Pasture and crops⁽³⁾ 4.3 tDM/ha

All other feeds 0.0 tDM/ha

Wintering Off/Culling

Reducing the number of animals on farm (from peak numbers) by culling and/or wintering off (May-Aug) will reduce the nitrogen loss risk on your dairy farm effective area.

10% off platform

Winter Practices

Reducing the amount of time cows spend on pasture and/or crops over winter will reduce the nitrogen loss risk.

Off pasture facility 0%

On pasture 0%

Break fed fodder crop 100%

NITROGEN FERTILISER

MEDIUM

Nitrogen Fertiliser Applications

The more nitrogen fertiliser applied, the higher the nitrogen loss risk.

230 kgN/ha

Milk Solids per kg Nitrogen Used

Using less Nitrogen fertiliser (all other inputs being equal) whilst maintaining production, will lower purchased nitrogen surplus.

6 kgMS/kgN

Timing of Application

Fertiliser applied during the winter months can increase the chance of nitrogen being lost.

Sep - Apr

Jul - Aug

May - Jun

Highest Application Rate

Lower application rates reduce the nitrogen loss risk.

Below 25 kgN/ha

Above 25 kgN/ha

Feed Budget

Using a feed budget or wedge to help plan strategic fertiliser applications is a good farming practice.

No feed budget used

Feed budget used

IMPORTED FEED

HIGH

Nitrogen Imported From Feed

The greater the amount of imported feed, the more nitrogen that enters the system.

68 kgN/ha imported

Nitrogen Content

The greater the average nitrogen content, the higher the amount of nitrogen that enters the system.

Average N content of 3.46%

Nitrogen Use Efficiency of Imported Supplements

The greater the conversion efficiency, the lower the nitrogen surplus available to be lost.

20 kgMS/kgN

⁽¹⁾ Stock Units (su) are a means of calculating stock numbers between species, breeds, and age groups based on relative feed demand. As an example 23.9su is equivalent to approximately 3 cows/ha (Friesian/Jersey cross) or 1500kg liveweight per hectare.

⁽²⁾ Energy model calculations based upon the DairyBase model developed by DairyNZ.

⁽³⁾ Includes feed fed to stock grazed off the dairy farm effective area.

Your Farm's Nitrogen Risks Continued...

CROPPING AND CULTIVATION



Conventional

This is the greatest risk method for sowing a crop and the risk increases as the cultivated area increases.

1% of farm cultivated annually

Minimum Tillage

This is a lower risk activity than conventional cultivation, however the risk increases with the total area cultivated.

Not applicable

Direct Drill

This is a lower risk activity than both full cultivation and minimum tillage for establishing a crop.

Not applicable

Season of Harvest/Grazing

Crops harvested/grazed during winter pose a higher risk to nitrogen leaching.

Summer harvest
Winter harvest

Timing of Fertiliser Application

There is greater risk if fertiliser is applied to crops during high risk months of May, June, July and August.

No fertiliser applied during winter

Fertiliser applied during winter

EFFLUENT MANAGEMENT



Effluent Discharge Method

Discharging treated effluent to land is the lowest risk.

Irrigate to pasture

Irrigate to pasture (low storage)

Discharge to water

Discharge to water and pasture

Effluent Irrigation Area

An undersized effluent area can result in the average amount of nitrogen per hectare applied exceeding local rules and regulations.

7 ha / 100 cows (incl. feedpad)

Application Depth

Low rates will ensure greater flexibility of management with more irrigation days available and increase the chance of the plant utilising the nutrients within the effluent rather than it being lost.

<12 mm application depth

IRRIGATION



Irrigation Method

Irrigation generally increases the nitrogen loss risk due to the potential for over irrigating to induce drainage events. Some systems are inherently riskier than others irrespective of management.

Pivot or linear 0%

Rotary boom, gun or k-line 100%

Border dyke 0%

Irrigation Scheduling

Deciding when to start or stop irrigation is important as poor management of an irrigation event can lead to induced drainage.

Soil moisture monitoring/ water budget 0%

Visual assessment/when water is available 100%

Irrigation Application Method

Having control over the amount and how often water is applied can greatly influence nitrogen loss risk with poor management of irrigation events leading to induced drainage.

Variable rate irrigation 0%

Deficit irrigation 0%

Fixed depth and return 100%

ATTACHMENT 5 – Aggregate Score data for PC1

Metric	season	Upper Waikato River	Middle Waikato River	Lower Waikato River	Waipa River	total
Aggregated Risk 25th Percentile	2017/2018	118	110	118	114	117
	2018/2019	116	130	109	98	107
	2019/2020	110	120	101	90	102
	2020/2021	111	123	109	100	110
	2021/2022	129	131	115	108	118
Aggregated Risk 30th Percentile	2017/2018	129	123	130	127	129
	2018/2019	130	155	122	110	120
	2019/2020	122	128	117	105	115
	2020/2021	128	132	122	112	120
	2021/2022	136	148	126	120	129
Aggregated Risk 50th Percentile	2017/2018	181	170	183	177	180
	2018/2019	182	189	167	150	167
	2019/2020	172	172	158	145	156
	2020/2021	172	180	173	150	164
	2021/2022	175	185	174	158	169
Aggregated Risk 75th Percentile	2017/2018	265	252	265	238	252
	2018/2019	252	241	236	219	236
	2019/2020	239	265	223	203	220
	2020/2021	240	219	231	215	228
	2021/2022	240	241	240	215	229
Aggregated Risk 80th Percentile	2017/2018	282	272	285	254	271
	2018/2019	275	256	257	236	254
	2019/2020	251	278	250	218	240
	2020/2021	256	237	251	228	244
	2021/2022	253	257	251	226	244
PNS 25th Percentile	2017/2018	41	5	42	33	36
	2018/2019	45	30	35	31	35
	2019/2020	39	32	27	23	28
	2020/2021	46	25	31	21	30
	2021/2022	49	52	42	33	40
PNS 30th Percentile	2017/2018	51	19	49	44	47
	2018/2019	57	46	45	40	46
	2019/2020	49	42	35	30	38
	2020/2021	55	38	40	30	40
	2021/2022	59	64	49	41	48
PNS 50th Percentile	2017/2018	94	60	98	85	89
	2018/2019	100	78	89	73	84
	2019/2020	84	88	68	67	72
	2020/2021	89	72	78	63	75
	2021/2022	91	96	84	68	82
PNS 75th Percentile	2017/2018	165	133	168	140	153
	2018/2019	162	143	142	125	142
	2019/2020	141	138	127	111	123
	2020/2021	136	122	123	105	120
	2021/2022	142	133	122	110	126
	2017/2018	186	153	185	153	172

PNS 80th Percentile	2018/2019	189	159	157	136	157
	2019/2020	155	143	138	122	137
	2020/2021	148	130	133	116	133
	2021/2022	151	137	136	121	136

Management practices	Risk band	Upper Waikato River	Middle Waikato River	Lower Waikato River	Waipa River	Total farms
Stock management	Very High	148	48	116	209	521
	High	124	18	93	152	387
	Medium	142	25	115	182	464
	Low	72	5	73	57	207
	Very Low	9	1	25	18	53
Nitrogen fertiliser	Very High	64	11	69	42	186
	High	65	9	72	72	218
	Medium	90	27	76	97	290
	Low	86	11	62	123	282
	Very Low	190	39	143	284	656
Effluent management	Very High	0	0	1	0	1
	High					
	Medium	8	1	4	7	20
	Low	6	0	9	9	24
	Very Low	481	96	408	602	1587
Imported supplement	Very High	124	23	60	101	308
	High	87	22	52	89	250
	Medium	96	13	93	131	333
	Low	42	14	56	66	178
	Very Low	146	25	161	231	563
Cropping and cultivation	Very High	19	3	43	18	83
	High	29	4	58	24	115
	Medium	36	11	49	43	139
	Low	103	6	63	123	295
	Very Low	308	73	209	410	1000
Irrigation	Very High	15	0	7	8	30
	High	6	1	1	0	8
	Medium	7	2	4	1	14
	Low	2	0	2	0	4
	Very Low	465	94	408	609	1576

Appendix 2:

**Second Statement of Evidence of Richard Allen 28 July 2023 on Behalf of
Fonterra Co-operative Group Ltd and Dairy NZ**

IN THE ENVIRONMENT COURT
AUCKLAND

I TE KŌTI TAIAO O AOTEAROA
KI TĀMAKI MAKĀURAU

ENV-2020-AKL-000083
ENV-2020-AKL-000084
ENV-2020-AKL-000085
ENV-2020-AKL-000086
ENV-2020-AKL-000087
ENV-2020-AKL-000088
ENV-2020-AKL-000090
ENV-2020-AKL-000091
ENV-2020-AKL-000092
ENV-2020-AKL-000093
ENV-2020-AKL-000094
ENV-2020-AKL-000095
ENV-2020-AKL-000096
ENV-2020-AKL-000097
ENV-2020-AKL-000098
ENV-2020-AKL-000099
ENV-2020-AKL-000100
ENV-2020-AKL-000101
ENV-2020-AKL-000102
ENV-2020-AKL-000103
ENV-2020-AKL-000147
ENV-2020-AKL-000148
ENV-2020-AKL-000149

IN THE MATTER

of the Resource Management Act 1991 ("**RMA**")

AND IN THE MATTER

of appeals under clause 14 of Schedule 1 of the RMA
against the decision of the Waikato Regional Council on
Proposed Plan Change 1 to the Waikato Regional Plan
("**PC1**")

Continued

**SECOND STATEMENT OF EVIDENCE OF RICHARD ALLEN ON BEHALF OF
FONTERRA CO-OPERATIVE GROUP LIMITED AND DAIRYNZ LIMITED**

28 JULY 2023

**Russell
McAugh**

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Auckland

BETWEEN

AUCKLAND WAIKATO & EASTERN REGION FISH AND GAME COUNCILS, BEEF + LAMB NEW ZEALAND LIMITED, CNI IWI LAND MANAGEMENT LIMITED, DAIRY NZ LIMITED, DIRECTOR-GENERAL OF CONSERVATION, FEDERATED FARMERS OF NEW ZEALAND, FONTERRA CO-OPERATIVE GROUP LTD, HAMILTON CITY COUNCIL, HORTICULTURE NEW ZEALAND, IWI OF HAURAKI, LANDCORP FARMING LIMITED, LOCHIEL FARMLANDS LIMITED, MERCURY NZ LIMITED, OJI FIBRE SOLUTIONS (NZ) LIMITED, PUKEKOHE VEGETABLE GROWERS ASSOCIATION, ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND INCORPORATED, SOUTH WAIKATO DISTRICT COUNCIL, TAUPO DISTRICT COUNCIL, WAIKATO AND WAIPĀ RIVER IWI, WAIKATO RIVER AUTHORITY, WAIPĀ DISTRICT COUNCIL, WAIRAKEI PASTORAL LIMITED

Appellants

AND

WAIKATO REGIONAL COUNCIL

Respondent

AND

AUCKLAND WAIKATO & EASTERN REGION FISH AND GAME COUNCILS, BATHURST RESOURCES LIMITED AND BT MINING LIMITED, BEEF + LAMB NEW ZEALAND LIMITED, CNI IWI LAND MANAGEMENT LIMITED, CONTACT ENERGY LIMITED, DAIRY NZ LIMITED, DIRECTOR-GENERAL OF CONSERVATION, FARMERS FOR POSITIVE CHANGE (F4PC), FEDERATED FARMERS OF NEW ZEALAND, FONTERRA CO-OPERATIVE GROUP LIMITED, GENESIS ENERGY LIMITED, GENETIC TECHNOLOGIES LIMITED, GRAEME GLEESON, GRAHAM PINNELL, HAMILTON CITY COUNCIL, HANCOCK FOREST MANAGEMENT NZ LIMITED, HAURAKI DISTRICT COUNCIL, HORTICULTURE

NEW ZEALAND, KING COUNTRY ENERGY LIMITED,
LANDCORP FARMING LIMITED, LOCHIEL
FARMLANDS LIMITED, MATAMATA-PIAKO DISTRICT
COUNCIL, MERCURY NZ LIMITED, MIRAKA LIMITED,
NEW ZEALAND DEER FARMERS' ASSOCIATION, OJI
FIBRE SOLUTIONS (NZ) LIMITED, OTOROHANGA
DISTRICT COUNCIL, PUKEKOHE VEGETABLE
GROWERS ASSOCIATION, RAVENSDOWN LIMITED,
ROYAL FOREST AND BIRD PROTECTION SOCIETY,
SOUTH WAIKATO DISTRICT COUNCIL, SOUTHERN
PASTURES LIMITED PARTNERSHIP, TAUPO
DISTRICT COUNCIL, TIMBERLANDS LIMITED,
WAIKATO DISTRICT COUNCIL, WAIKATO AND
WAIPĀ RIVER IWI, WAIKATO RIVER AUTHORITY,
WAIPĀ DISTRICT COUNCIL, WAIRAKEI PASTORAL
LIMITED

Section 274 Parties

1. EXECUTIVE SUMMARY

- 1.1 Fonterra Co-operative Group Limited ("**Fonterra**") has been actively and constructively engaged in the PC1 plan change process for more than ten years.
- 1.2 Fonterra supports both the short term (20 percent of the required change in ten years) and the long term (Te Ture Whaimana water quality outcomes) goals for the Waikato and Waipa catchments.
- 1.3 The Decisions Version of the Plan, and the Waikato Regional Council ("**Council**") or ("**WRC**") councils preferred wording as provided in evidence, are not the most efficient and effective methods to ensure the outcomes will be achieved.
- 1.4 All resource users have opportunities and a responsibility to contribute to key contaminant reductions over time to support the achievement of improved water quality.
- 1.5 Fonterra and Fonterra supplying farmers have been proactively putting in place systems, processes and on farm actions that are intended to contribute to the achievement of PC1 objectives.
- 1.6 Fonterra does not support very broad requirements to apply for resource consent to farm, but does support certified, monitored and audited FEPs, minimum standards for permitted activities and annual reporting of risk / intensity through objective risk tools.

2. INTRODUCTION

- 2.1 My full name is Richard Grant Allen.
- 2.2 I prepared a statement of evidence dated 22 June 2023 ("**First Statement** ") on behalf of Fonterra relating to the Nitrogen Risk Scorecard ("**NRS**").
- 2.3 My qualifications, experience and involvement in PC1 are set out in paragraphs 1.2 – 1.8 of my First Statement.
- 2.4 While I am employed by Fonterra, there are aspects of my evidence where I address matters from my own farming experience (set out in paragraph 1.7 of my First Statement) and where this is the case I have differentiated that from where I am setting out a Fonterra position

Scope of evidence

2.5 My evidence addresses the following matters:

- (a) Overview of Fonterra interests in PC1 catchments.
- (b) Dairy Farming in the Waikato Region.
- (c) Fonterra's overall approach to PC1.
- (d) The importance of managing four contaminants and all sectors.
- (e) Assessing the risk of contaminant discharge.
- (f) Fonterra's approach to managing diffuse contaminant discharges.
- (g) Comments on Rule Thresholds technical meetings.
- (h) Role of the Nitrogen Risk Scorecard in PC1.
- (i) Establishment of gateway threshold metrics for dairy farming.
- (j) Efficiency of consenting framework in PC1.
- (k) Farm Environment Plans.
- (l) Minimum Farming Standards.
- (m) Fonterra experience with Overseer.

3. FONTERRA INTEREST IN PC1

- 3.1 Approximately 1660 dairy farms in the PC1 catchments are shareholder owners of Fonterra Co-operative Group Ltd and supply milk to the Company. Fonterra collects and processes around 80 percent of PC1 dairy production and is the largest single contributor to the regional economy.
- 3.2 Fonterra is a major exporter of high quality food and depends upon efficient, sustainable and profitable dairy farms to provide raw milk for processing. Fonterra recognises the need for continuous improvement and reduced environmental footprint over time but believes controls over farming must also be efficient, practical and non-duplicative of existing industry programmes.
- 3.3 This evidence is focussed on the effects of PC1 on dairy farmers and milk supply ('on farm interests'). Evidence covering issues specific to Fonterra manufacturing interests is presented separately by Ms O'Rourke.

4. DAIRY FARMING IN THE WAIKATO REGION

Fonterra shareholder farms and environmental performance

- 4.1 Dairy farming in the Waikato is already subject to more control and oversight than other forms of farming through the council's monitoring programme for effluent management and consent requirements for dairy farm water use. Additionally, around 85% of dairy farmers in the Waikato / Waipa already operate under a high quality industry FEP that can be rapidly transitioned to include PC1 and FWFP requirements.
- 4.2 Dairy farming generally occurs on better classes of land (compared to other pastoral farming) with higher quality more resilient soils and lower average slopes, higher average pasture cover (and higher residual or post - grazing covers). Stock are generally fully excluded (prior to any legal requirement to do so) from all intermittent and permanent waterways and drains, i.e. well beyond the requirements of the Resource Management (Stock Exclusion) Regulations 2020.
- 4.3 Dairy interests have proactively developed quality farmer support tools and directly employed sustainability advisors to provide one on one support with environmental performance and practice change on farm. For Fonterra suppliers good environmental performance is directly linked to incentive payments under the Cooperative Difference Programme.
- 4.4 Despite the uncertainty created by such a drawn-out process (PC1) dairy has, as an industry, moved well in advance of any regulatory requirement coming out of the plan change. Dairy farmers in the Waikato have not relied on the ongoing regulatory uncertainty as an excuse not to improve environmental performance over this period. Waikato dairy farmers have been supported by the dairy companies and their industry body to make meaningful on farm change and there has been a significant shift in awareness and acceptance of the need for change.
- 4.5 On Fonterra supply farms within the PC1 catchments the on-farm change that has occurred over the last ten years includes:
 - (a) All dairy farms now have systems in place to irrigate effluent to land, there are no remaining consented discharges of treated dairy effluent to water.
 - (b) Effectively 100% stock exclusion from all permanent waterways, including drains, regardless of size. Stock exclusion has been a

milk supply contract condition since 2013 with the required standard now including waterways (including drains) of all sizes.

- (c) Around 85 percent voluntary uptake of farm environment plans, that involve a detailed and consistent risk assessment, risks identified spatially and recorded in a digital / GIS system, specific timebound actions put in place based on the Good Farming Principles (covered in detail in EIC of Mr Wright – Stow) and current regulatory standards.
- (d) All Fonterra suppliers receiving a detailed annual environmental performance report including NRS reporting.¹

5. FONTERRA'S OVERALL APPROACH TO PC1

- 5.1 Fonterra supports the long-term goals of Te Ture Whaimana and the staged approach to achieving those outcomes. We agree that 20% of the change required can reasonably be achieved over the next 10 years, however the policies and rules in the Decisions Version of PC1 are inconsistent with achieving this outcome.
- 5.2 This gap between expected outcome and robustness / credibility of methods is particularly apparent in relation to the management of contaminants other than nitrogen from dairy farming. Changes have been proposed by some parties (in part supported by the regional council) that would increase the risk that the methods will not achieve the objectives (for example weakening of minimum standards, broadening the application of Rule 3.11.4.1 so as to decrease FEP requirements, decreasing the requirement to show intensity / risk is not increasing). Fonterra does not support changes that would mean farmers, across all sectors, would need to do less than anticipated by the Decisions Version.
- 5.3 In this statement, I explain why I consider the council's preferred wording (in part) does not represent the most effective, efficient, and equitable way to achieve the stated outcomes.
- 5.4 Fonterra seeks a more balanced, effective and efficient regulatory approach that would ensure better management of all four contaminants from all sectors that contribute to the issues.

¹

An example of this report was included as Appendix 2 in my first evidence dated 22 June 2023.

- 5.5 Fonterra has adapted and evolved positions considerably as significant changes to the resource management framework have been taking place over the ten years since the plan change process began. RMA amendments (in particular Part 9A), the direction of freshwater reform processes, the availability / usability of tools and models, the NES-F, NPS-FM 2020, the s360 stock exclusion regulations and most recently the FWFP Regulations all have implementation implications for PC1.
- 5.6 Fonterra has provided policy and rule wording that would efficiently resolve the Overseer issues in PC1 as well as ensuring improved management of risk across all contaminants and an ability to track changing intensity and risk levels across all sectors. These changes are described further in Mr Willis' evidence.
- 5.7 Fonterra considers that the council should have a greater regard to the dairy industry proactive commitment to improving on farm environmental performance when considering the need for more regulatory oversight.
- 5.8 There are a range of challenges facing PC1. I have outlined some of these below.

6. THE IMPORTANCE OF MANAGING ALL FOUR CONTAMINANTS AND ALL SECTORS IN PC1

Focus on all four contaminants

- 6.1 My understanding of the water quality issues in the Waikato / Waipa catchments is that four key contaminants must be managed (decreased) if the plan objectives and the aspirational outcomes of Te Ture Whaimana are to be met. Despite this the planning approach in PC1 appears to focus heavily on nitrogen ("N") and particularly nitrogen lost from dairy farming, rather than on other contaminants and other sectors. I understand that the most challenging contaminant reductions are in fact likely to be sediment and microbial pathogens, which in my experience are likely to be linked to slope, erodibility of soils and stock accessing waterbodies – factors more commonly linked to non dairy farming. While I understand and support the need for dairy to have some focus on nitrogen reductions, the lack of any equivalent expectations for activities that might disproportionately impact sediment and microbial pathogen levels is difficult to reconcile. Many of the changes Fonterra recommends therefore are focussed on ensuring that firstly, dairy improvements that result in decreased contaminant losses are not just offset by increases from other sectors, (ie "gains" made go firstly to the River and

where possible to allow for Tangata Whenua Ancestral Lands development) and secondly, that those contaminants that are disproportionately lost from non-dairy farming sectors are managed with a similar level of rigour.

- 6.2 The policy and rule framework should be consistent with achieving reductions in all four contaminants in an equitable and efficient way. The Decisions Version provided for an approach that could credibly be expected to achieve the N reduction requirements from dairy farming but does little to prevent other land uses from increasing their intensity-related losses, thus undermining the gains made. Fonterra is not seeking any reduced action expectation for dairy farmers and for nitrogen reduction expectations, but rather seeks a strengthening of the policies and rules to ensure better management of all risks across all land classes and farm types.
- 6.3 While it is accepted that dairy is generally more intensive than drystock farming (on a dry matter consumed per effective ha basis) and more likely to have a relatively high per hectare N loss risk, I do not agree with the council position that appears to consider that, due to average intensity (stocking rate) dairy contributes more of all contaminants to water. Comparing stocking rate intensity across farming sectors as a measure of comparative risk for the four contaminants, is misleading in that different sectors occupy very different land and carry out particular farm management practices that result in a different contaminant footprint. In my opinion any assumption that dairy farming contributes more of all contaminants (than drystock farming), because on average dairy has higher stocking rates, is a simplistic view that may misrepresent the contaminant contributions (and opportunities to improve) of the different farming sectors.
- 6.4 It is possible to provide a metric that represents the risk of nitrogen loss from a dairy farm such that a *comparison* of risk between farms can be made – ie suitable for a rule threshold (see information provided to the court and parties on the Nitrogen Risk Scorecard in my first statement of evidence filed on 22nd June 2023). It is also possible to provide for a simple objective assessment of how stable an individual farm system is in terms of the intensity of the operation over time. In my opinion the changing ‘riskiness’ over time of each farm can best be understood and tracked through a requirement to monitor and report on changes to intensity and practices that support further intensification. An intensity metric can act as a proxy for *changing* contaminant loss risks over time at a farm scale. The reason this intensity metric can be considered a valid all contaminant risk metric is that given a farm’s geophysical factors remain unchanged over time it is changing

intensity and practices that will determine the changing four contaminant loss risks of each system (before mitigation actions are applied).

The need to manage all farming sectors

- 6.5 While dairy is seen by many as a relatively easy target for regulation, in the PC1 context different sectors may be the primary cause (or disproportionate contributor) of particular contaminant issues in different catchments. There are opportunities to decrease contaminant losses on all properties and in many cases there are efficiency opportunities that when actioned can increase farm profitability while decreasing contaminant losses.
- 6.6 These efficiency opportunities have been a major focus of the dairy industry farmer change programmes (eg fertiliser use efficiency, pasture management, feed budgeting, genetics / breeding programmes etc). Engaging farmers in change and identifying easy environmental improvements and profitability opportunities will not occur in the absence of quality certified farm environment plans with regionally specific outcome expectations. If most drystock farms can avoid any requirement to have a regionally appropriate (i.e. includes standards and actions intended to support the achievement of Te Ture Whaimana) certified farm environment plan the credibility of PC1 methods achieving the objectives must be questioned. Mr Willis, Dr Depree and Mr Wright–Stow all provide further evidence on this topic.
- 6.7 In my opinion, adding to the regulatory burden on the most proactive farming sector through a very broad requirement to seek resource consent to farm, alongside a requirement to have a certified plan and to apply tools that metricise change over time, makes little sense from either an economic / administrative efficiency or a water quality improvement perspective. The management of nitrogen, and broader intensity related risks from the dairy sector under this plan, is the most clear, certain and credible part of PC1 (i.e. more suited to permitted activity status) and other than for higher risk farms should not in my opinion require resource consent to farm. It remains unclear just what value the controlled activity consent category for moderate risk dairy farming will add to the achievement of outcomes. I am not suggesting farmers should do any less than anticipated but I do not think a consent requirement for most dairy farming will do anything beyond adding cost, delaying implementation, and adding inefficient process duplication. I consider the consenting issues further under section 12 of this evidence.

Managing within farm intensification

- 6.8 Farming, like any other business, will respond to factors such as land prices, product prices, access to resources, government signals, technological developments and current knowledge as they attempt to optimise profitability and business sustainability within the regulatory constraints present at the time. All of these factors were of relevance to, or drivers of, the rapid dairy expansion of the 1990's to early 2000s. Without meaningful oversight and appropriate levels of control, these factors might lead to existing farms (all sectors) trying to increase production on the same land area (more animals or larger animals supported by increased inputs such as fertiliser, imported feed, irrigation and cropping), without putting in place the actions to address the increased risk associated with increased intensity.
- 6.9 Fonterra is particularly concerned at the lack of clear and consistent controls on (or even effective monitoring of) within farm intensification under PC1. To achieve the anticipated outcomes it is our position that both land use change, that increases contaminant loss risk (currently a non complying activity), and within farm intensification (generally permitted for lower intensity farming with no meaningful controls except for moderate / high risk dairy) that might have the same effect (as land use change), must be effectively managed. Drystock intensification in response to higher land prices is a reasonably likely scenario in the short to medium term and failing to robustly manage this risk (contaminant losses increasing with intensity) would put the achievement of water quality outcomes, and the ability to allow some development of tangata whenua lands, directly at risk. An additional concern for the dairy industry is that the reductions achieved by the sector are undermined by increases from other sectors and dairy is expected to make further reductions because of this.
- 6.10 Fonterra understands that some drystock farms may need to intensify to remain profitable and we are not seeking changes to PC1 that would prevent such intensification of farms currently operating at low levels of intensity. Given the clear risk to water quality outcomes though, our position is that intensity or risk must be objectively tracked over time for all farms, and where an increased risk is identified the FEP should be reviewed and updated so that the required actions are relevant and appropriate to address the risks actually present. An ongoing assessment of intensity / intensity related risk is also clearly required to ensure farms remain under the appropriate rule for the nature of their farming activity, over time. The provisions drafted by Mr Willis provide for a much-improved understanding and management of

changing risk over time and the methods required to manage increasing intensity that might otherwise risk the success of PC1.

7. ASSESSING THE RISK OF CONTAMINANT DISCHARGE

How does PC1 assess the risk of contaminant discharge

- 7.1 Overseer is central to the regulation of dairy farming in the Decisions Version of the plan. Dairy farms are categorised as to activity status through the single farm level Overseer output of kgN leached per hectare. There is no corresponding obligation on drystock farming even if they were operating at the same levels of intensity. There are no meaningful controls in the Decisions Version on increasing intensity and / or increasing nitrogen loss risk on drystock farms. Our concern therefore has been that dairy farming will make significant change and will decrease contaminant losses in a manner consistent with Te Ture Whaimana outcomes and the Plan objectives, but these gains could easily be offset by increased losses occurring from intensification of non-dairy systems.
- 7.2 The only clear objective assessment of risk applied to drystock in the Decisions Version is a winter stocking rate that is used as a gateway test to different rules. There is no robust ongoing requirement to assess changing intensity and associated contaminant loss risks for permitted activity farming unless Schedule D 1 applies, and even then the assessment method (and the need to do anything in response to the assessment) is unclear. In effect the winter stocking rate approach to categorisation will likely do little more than identify that drystock farming on better classes of land are to be considered riskier. (Such farms can winter higher numbers of stock due to better soils, drainage, slope and pastures i.e. greater natural capital). In my opinion this is a clearly flawed risk categorisation, when the contaminants of most concern from drystock are sediment, phosphorus (bound to sediment runoff) and microbial pathogens. These contaminant loss risks are closely linked to slope, erodibility, stock exclusion from waterways and management practices rather than the lowest annual stocking rate that occurs during winter. In my opinion simple winter stocking rate alone is a poor proxy for understanding comparative riskiness (in relation to the four contaminants) of drystock farms.
- 7.3 While I consider the simple winter stocking rate is flawed as a rule gateway and could easily be made more robust, I also have concerns with the numbers of drystock properties that would actually be above the thresholds determined to be appropriate by the Hearing Panel and then as modified in

the council preferred wording. To be clear I have less concern with the higher risk 17 / 13 winter stock units threshold (although in my opinion the rationale for the metric was flawed as I discuss in Section 9 below and very few farms are likely to in practice be above this threshold) as it is my understanding that it is only those drystock farms beneath the 12 / 10 threshold that avoid *any* regional FEP expectations and the associated Schedule D 1 standards under the council's preferred wording.

- 7.4 My own experience, and the data DairyNZ has been able to produce as well as the limited analysis and data from council evidence² would suggest that most PC1 drystock farms on steeper land would easily fit beneath the 12 total / 10 cattle winter stock unit metric (and very few would be above the 17 / 13 threshold). The revised thresholds preferred by the regional council do little to address the issues with the Decisions Version threshold and would perpetuate the lack of meaningful oversight of drystock farming (and the consequential risk to achievement of plan objectives) that was present in the Decisions Version.
- 7.5 Comprehensive and reliable data on stocking rates on drystock farms have been difficult to obtain. I am aware that Beef and Lamb conduct a farm survey³ that can be used to indicate the likely range and percentile stocking rates for the sector. Survey results do not appear to be reported at Waikato region scale but the Upper North Island data grouping may be expected to provide an approximation of the PC1 catchment situation. The key point I take from the survey report is that only in one class of farm (North Island Finishing Farms) did the stocking rates on any drystock farms exceed 12 stock units / ha. (I understand that the survey "stock unit" is not exactly the same as the PC1 "stock unit" and this discrepancy in metric used will mean that the survey data would be reporting a slightly lower stocking rate than under a PC1 stocking rate assessment).
- 7.6 For the most intensive class of drystock farm (North Island Finishing) it appears that only the top quintile (i.e. the most highly stocked 20% of finishing farms) would be anywhere near the 17 SU/ha threshold. (80th %ile at 15SU/ha) Even with the required allowance for the different stock unit approaches (between the survey data and the PC1 stock unit tables) it seems from the survey reports that almost no drystock farms would be expected to be above 17 SU / ha and around 80% of hill country farms and

² EIC Adrian Brocksopp at [59 - 62].

³ "Data Tools Sheep Beef Farm Survey" Beef + Lamb New Zealand <[Sheep & beef farm survey | Beef + Lamb New Zealand \(beeflambnz.com\) 2023](https://beeflambnz.com)> 2023

perhaps 50% of finishing farms would fall under the 12 SU / ha threshold. (Recognising this is an approximation only, based on the graphs below) The number of farms *forecast* to have stocking rates above the thresholds - actual data bars are for the 2020 – 21 years, decreases again for the 2022 -23 season.

7.7 Beef and Lamb survey stocking rate graphs:



7.8 My understanding is that the Agribase dataset that the technical experts referred to, similarly shows that few drystock farms would be expected to be above the 17 / 13 threshold.

7.9 Fonterra is concerned that the changed council position on Rule 3.11.4.1 (that occurred in the middle of mediations and after expert conferencing on appropriate risk thresholds) represents a significant diminishment of the credibility of methods achieving objectives. The plain words of 3.11.4.1 in the Decisions Version meant that 3.11.4.1 did not provide a loophole rule that would mean a large proportion of drystock farms would have no oversight or expectation of change under PC1 (beyond the very limited requirements of Schedule C that are also themselves being challenged as too onerous by some). The current council position would mean that many large farms would not have to do an FEP under this plan and therefore Schedule D 1 standards would no longer be applicable to those same farms (including once FWFPs are required). Given that many Schedule D 1 standards are clearly focussed on managing risks associated with steep land, it seems illogical to then exempt many of the farms, where these risks will be present, from having to meet the relevant standards. Under the council's preferred wording there would be no clear regionally specific outcomes required for these farms even when certified FWFPs came into force. I.e. there can be no expectation that the FWFP process will address the gap in PC1 effectiveness created by the councils preferred wording changes to Rule 3.11.4.1.

- 7.10 In the absence of good data or any detailed analysis from the council on how many drystock farms might fall into each rule category, (and what the farming systems in each category might tend to look like in practice) I have considered my own farming experience on medium to steep hill country in the upper Waipa catchment. This farm ran a beef breeding herd, a deer breeding / finishing operation and sheep breeding / finishing. Practice (common on many farms and often described by drystock interests throughout the PC1 process as “farming to the grass curve”) was to decrease stocking rate right back to primarily capital stock (breeding and replacement animals) by end April each year. The environmental risks (and opportunities to improve) on this property were considerable. My farming operation would comfortably have met the winter stocking rate threshold for rule 3.11.4.1 and therefore would not have had any oversight or practice change expectation, beyond Schedule C standards, under PC1
- 7.11 My own farm could not, in my opinion, be considered truly “very low risk” as to impact on water quality objectives. Large mobs of deer with unrestricted access to water courses, beef cows on restricted grazing pre calving, heavy beef animals on steeper slopes all created clear environmental risks. I do not think that such systems generally should require a consent to farm, however I do believe that such a farm system is not inherently “very low risk” and the requirement to have a certified farm plan and to meet some basic standards (as per Schedule D 1) would lead to better farmer understanding and engagement in change as well significant water quality improvements over time. My own farming experience provides a good example of the opportunities to contribute to the catchment outcomes that exist across sectors and the large gap between methods and intended outcomes, particularly with regard to sediment and e coli outcomes, without the changes we are proposing.
- 7.12 In my opinion many of the farms that would avoid any PC1 oversight under council preferred wording for 3.11.4.1 are not what an informed person with farm systems understanding would consider very low intensity / very low risk. The large scale, very low stocking rate farm systems that occur in other parts of the country (truly low intensity / low impact pastoral farming) generally occur under much harsher climate and landscape conditions than are present in the Waikato region (with the possible exception of high-altitude extensive farms to the South of the region). In the Waikato context my own farm, as described above would, in my opinion, be more typical of a farm that will be categorised as ‘very low risk’ if the council wording is adopted.

- 7.13 In his expert evidence for council, Mr Brocksopp⁴ discusses the Decisions Version gateways and for drystock states that it is winter stocking rate that determines the very low, low, moderate thresholds. My understanding of the words in the Decisions Version is that a less than or greater than 20ha farming area was used to define the threshold between very low risk and low risk drystock farming (unless the farm was primarily carrying horses or poultry).
- 7.14 Mr Brocksopp further provides some commentary⁵ on the drystock rule expert conferencing outcomes that has led to the council's preferred rule thresholds. Mr Brocksopp acknowledges he was not involved in the expert meetings on this subject. In agreeing with the appropriateness of the thresholds agreed to by the majority of the experts, he sets out his understanding that:

The farm system experts discussed levels of risk for drystock farming. I understand that the experts sought to identify risk levels in a general sense relative to the drystock industry (i.e. what would be considered a low, moderate or high risk drystock farm). The experts considered that drystock farming that does not exceed either of the risk factor values specified below is Low risk:

- 7.15 Significantly, in my opinion, Mr Brocksopp has not made it clear that in fact the experts were considering "low risk" drystock farms as the group they believed would be appropriately managed under Rule 3.11.4.3 (low risk) not 3.11.4.1 (very low risk) that was understood to be a pathway limited to farms under 20ha (with poultry and equine exceptions). The council had not shared the changed wording (or indicated any intention to make such changes) that significantly affected the scope of Rule 3.11.4.1 at the time the technical conferencing and the following small group of farm system expert meetings occurred.

Overseer in PC1

- 7.16 The Fonterra position on Overseer is that the model is not fit for any regulatory purpose at this time and is likely to have limited relevance to the regulation of farming going forward. The lack of farmer engagement and trust in the model, the significant costs associated with its use, input data complexity and subjectivity, the ongoing lack of transparency of model workings and the ability of users to 'game' the model all make any reference

⁴ EIC Adrian Brocksopp at [41].

⁵ EIC Adrian Brocksopp at [55].

to Overseer inappropriate. Even before the science review of the model Fonterra did not believe that such a complex and uncertain model was the best way to regulate farming and engage farmers in significant practice change that would reduce farming impacts.

- 7.17 Shortcomings with Overseer for use in regulation were identified in a report to the government by the Parliamentary Commissioner for the Environment (PCE) in 2018⁶. In response the government initiated an expert panel review of the model - although the scope of the review was considerably narrower than the concerns raised by the PCE. The programme of work to address the Science Advisory Panel report and recommendations is ongoing, although apparently near completion. The Government position on the future place of Overseer in regulation is yet to be confirmed.
- 7.18 Overseer has not been used by Fonterra since 2017 and the systems and expertise that would be required to support an Overseer-based approach at scale going forward are simply no longer available. Fonterra proactively used Overseer as an environmental improvement support tool for several years but due to the many issues with the use of this model Fonterra completely removed any requirement for Overseer use from farmer change programmes (effluent management, stock exclusion, nitrogen management, farm environment planning) and changed the focus of on farm change programmes to Farm Environment Planning supported by risk-based tools. Based on Fonterra's learnings from extensive previous use of the Overseer model (and the problems later identified by the PCE and the independent review of Overseer), Fonterra does not support any regulation requiring this model to be used by farmers.
- 7.19 Overseer is a complex expert user model that would have required direct council or sector scheme oversight to ensure it was not being 'gamed'. Its removal from PC1 (as a tool to provide a threshold metric and as an assessment of loss to water changing over time) allows for methods to be considered that are relatively simple, require no modelling - of what are highly complex biophysical systems and interrelationships - and are far more transparent, ie better suited for use in regulation and particularly in a permitted activity context.
- 7.20 At section 15 of this evidence I have set out the Fonterra experience with using Overseer to support on farm change.

⁶ Overseer and regulatory oversight: Models, uncertainty and cleaning up our waterways. Dec 2018.

Other tools

- 7.21 Central government is progressing the development of a Risk Index Tool (RIT)⁷ that might fulfil a similar function to the NRS (in the sense that it indicates farm level risks to water and provides an alternative N risk metric to an Overseer leaching output prediction). However, this tool is likely to be relatively complex compared to the NRS (although hopefully simpler and more transparent and engaging than the Overseer model), requiring more data input fields, more user input decisions and attempting to model interactions between farm practice and a complex biophysical system at individual farm scale. Fonterra intends to assess the place (if any) of the RIT in our farmer support programmes when the new tool has been tested and becomes available.

8. FONTERRA'S APPROACH TO MANAGING THE RISK OF CONTAMINANT DISCHARGE

- 8.1 The use of objective risk assessment tools on an ongoing basis for all sectors is, in our opinion, fundamental to ensuring farm level risk is not enabled to increase without appropriate remedial / offset actions being taken. Allowing any sector to increase contaminant losses will decrease the likelihood of meeting short term and long term objectives, will diminish the ability to provide a pathway for development of Tangata Whenua Ancestral Lands (TWAL) and will require greater reductions over time from activities that have committed to making reductions. The changes Fonterra and DairyNZ propose resolve what appears to be a significant disconnect in the Decisions Version between objectives, policies and rules.
- 8.2 Fonterra supports the use of sector specific objective intensity / discharge risk assessments, for both dairy and drystock farming under Schedule B (using different metrics that reflect the best available approach to assess contaminant loss risks for the different pastoral farming types), as the simplest and most transparent way to ensure each farming sector is being equitably regulated to manage the particular contaminant risks associated with the activity.
- 8.3 While PC1 parties have had limited opportunities to consider the Commercial Vegetable Production risk tool (and associated minimum standards), I do consider that the draft documents we have seen might indicate that this sector can provide a robust method to ensure that environmental impacts

⁷ <Risk index tool for on-farm nutrient management | Ministry for the Environment>

(risk) can be tracked over time. The finalising of these tools and inclusion into CVP provisions would be a significant step forward in ensuring PC1 provisions aligned with objectives and that changing risks across all sectors can be tracked by council.

- 8.4 Dairy is the only sector that has put forward a well-developed and robust approach for the objective assessment of whole farm risk to categorise farms so as to ensure appropriate rule conditions and levels of regulatory oversight are applied. The approach and tools we have proposed would also allow for an ongoing assessment of farm scale risk over time. During this plan change process Fonterra has provided information on risk tools that are less simplistic (than the winter stocking rate assessment for drystock farming approach), to assist with understanding all pastoral farming intensity related risks on an ongoing basis. Our position is that all farming sectors can, and should be required to, use objective risk tools on an annual basis to ensure changing contaminant loss risks associated with changing farm system intensity are understood and consistently managed.
- 8.5 It has been frustrating for dairy interests through this process to hear other sectors argue that it is not possible to monitor risk changing over time for their farmers. A sector failure to engage in developing tools and methods to improve environmental outcomes should not provide the rationale for an easier and less prescriptive regulatory pathway. Conversely dairy, which has proactively developed and implemented such tools and methods, should not attract additional regulation and cost just because it is easier for the council to apply additional oversight.

Dairy discharge risk – the Nitrogen Risk Scorecard

- 8.6 Fonterra has put forward the NRS that can objectively identify likely risk areas within the farm system and can act as a proxy for the management and farm practice risks on a dairy farm. (Noting that under this approach the geophysical and linkage to water risks are to be identified and managed through the FEP assessment process).
- 8.7 Detail of the NRS approach and process documentation has been provided in my first evidence provided to the court and parties on 22 June 2023.
- 8.8 While the focus of my initial evidence on the NRS was on its use as a threshold metric for determining rule entry thresholds for dairy farming, the NRS also can provide for an objective assessment of *changes* to risk level on both dairy and (particularly the higher risk) drystock farms as it includes all the key drivers for manageable intensity related risk – being stocking rate

detail, nitrogen fertiliser, feed imported, cultivation and irrigation. These drivers are just as relevant to drystock as to dairy farming when considering, at a whole farm level, if intensity (and related risk to water) is increasing or decreasing over time.

- 8.9 The NRS considers all the key measures of *intensity* of pastoral farming systems (dairy and drystock) and therefore can be considered to provide a reasonable proxy for changes in contaminant loss risks that are associated with a change in system intensity. I consider that the underlying risk of contaminant losses to water, for all four contaminants (on a particular farm) will change as intensity of the farming operation changes (unless appropriate mitigations are added to the farm plan and actioned, to counter the impact of system intensity increase).
- 8.10 As described in my First Statement, the NRS has been the primary tool used by Fonterra over the last five years to enable the objective identification and ongoing assessment of nutrient loss and intensity related risk.
- 8.11 The NRS is currently used by Fonterra to support on farm change in three ways:
- (a) The tool enables an objective identification of contaminant loss risk associated with on farm practices, system intensity and input decisions, and the development of appropriate actions to address risk, during the development of each tailored Farm Environment Plan
 - (b) Farmers provide the relevant data through their Farm Dairy Records and receive a detailed Farm Insights report annually that sets out farm performance for each of the 6 key risk drivers from the NRS, and the Purchased Nitrogen Surplus (PNS) for the previous season.⁸
 - (c) The 75th percentile PNS is used by Fonterra as a threshold metric for the Co-operative difference environmental performance payment.
- 8.12 The NRS provides a sound proxy metric for pastoral farming intensity and therefore for the inherent riskiness of a farm system in terms of likelihood of losses of all four contaminants of concern changing over time. For an

⁸ PNS = Nitrogen in imported feed + Nitrogen in imported fertiliser – Nitrogen in productive output. This is an output calculation from the NRS.

individual pastoral farm (applies to dairy and drystock – see below) an increasing or decreasing aggregated score will reliably equate to an increasing or decreasing level of risk. Where mitigations that are not recognised by the NRS have been actioned, there is an expectation that the efficacy of the mitigation to address the particular risk would be assessed by a qualified person before being relied on as a qualifying FEP action.

8.13 Some perceived weaknesses of the NRS are:

(a) The NRS does not directly consider geophysical factors in establishing risk levels.

(i) While this limitation does mean the geophysical risks must be considered through an on farm assessment, it is my experience that this process step actually acts to increase farmer engagement and is a far more robust method than any reliance on a single metric from a model. Not including the geophysical removes much of the uncertainty and distrust associated with more complex tools. The link between farm practice / management risks and the possible impact on water should be addressed through the FEP farm-scale risk assessment process undertaken in conjunction with catchment context information and the NRS. It is the Fonterra view that the FEP content and methods described in the Schedules must contain minimum standards, a rigorous assessment process that fully considers the geophysical characteristics of a farm property and detailed consideration of the water quality issues / catchment context. Along with a robust monitoring and audit programme such an FEP / Risk Tool approach can ensure that the risks associated with the soils, slope and climate of individual farms are managed effectively through tailored mitigations underpinned by practice standards where necessary.

(b) The scorecard output cannot be directly equated to a contaminant load that reaches water.

(i) In my opinion it has been a common (and fundamental) misunderstanding of the use of Overseer in regulation that this model could provide a metricised load lost to water

(from a single property). This was never credible because Overseer only estimates (with significant error) a load at the root zone. It is well known that attenuation variability between root zone and receiving water bodies is highly variable (20 – 80% attenuation may occur from root zone to waterbody). Because of this misapprehension of Overseer capability, it was considered by some to allow for robust catchment scale accounting of contaminants and their source. As Overseer cannot consider attenuation or linkages to water and was only ever going to be applied to around 50% of farms, such an accounting approach was completely unrealistic.

Drystock discharge risk

- 8.14 In anticipation of the need for a risk assessment tool tailored for drystock farming (with more focus on the particular drivers of sediment and E.coli risk), Fonterra invested in producing such a tool (in draft) for further discussion with both the drystock sector and the council. Fonterra continues to consider that such a tool is both possible and necessary for objectively and robustly identifying higher risk farms, and for ensuring changing levels of intensity / risk can be tracked over time at farm level. While we agree that a crude stocking rate assessment is a possible way to classify drystock farms into risk bands, in practice such a limited method will generally simply identify better land (soils and slope) as a higher risk (because these farms can grow more grass and carry higher stocking rates without causing damage to soils or impacting animal health through winter). The draft Drystock Scorecard as previously shared with parties, has been attached to this evidence as **Attachment 1**.
- 8.15 Without some form of ongoing assessment of intensity for non-dairy pastoral farming, I do not consider that there can be any confidence that the Plan is not allowing for an increase in contaminants to occur, without a clear corresponding obligation to address such an increase through FEP review and actions. If intensity or contaminant loss risks are allowed to increase over time without monitoring or reporting of that change, and FEP actions are not required to be reviewed so as to ensure additional environmental effects are managed, there can be no confidence that water quality improvements will in fact occur.
- 8.16 While I accept that the winter stocking rate is a (rather crude) proxy for drystock farming risk, it is my opinion that there are better options readily

available. Relying just on the winter stocking rate will mean many farms on high quality land (ie they have the natural capital and biophysical conditions that makes a higher stocking rate lower risk environmentally) will be subject to more oversight than those on erodible soils with steep land carrying out higher risk practices. In this respect the winter stocking rate threshold appears a rather token categorisation method.

- 8.17 Those who have supported the simple winter stocking rate as an appropriate rule gateway test appear to have no confidence in the ability of the same metric to be used to track changing risk over time. (Recognising that evidence on this has not been seen at time of writing). In my opinion the opposite is probably true. The simple stocking rate does not robustly identify comparable riskiness *between* drystock farms well for the reasons set out above, however it could be used reasonably robustly to identify when a particular property has changed practice over time in a way that makes it more intensive and therefore more likely to discharge contaminants at a higher rate.
- 8.18 My position on the use of tools or metrics used to track changing intensity and associated changes in risk, is that there should be annual data provision requirements (commensurate to the scale of risk associated with the activity), but the reported risk level should be on a rolling three- year average basis. This is to recognise that there will be annual fluctuations within a stable system that should not trigger a regulatory response

Councils changed position on coverage of Rule 3.11.4.1

- 8.19 Following the technical conferencing where the revised drystock thresholds were arrived at, that the council now supports, the council position on the appropriate scope of 3.11.4.1. changed and they now propose a wording change that would mean that a large proportion of drystock farms would now be considered “very low” risk and would require no FEP and would no longer have to meet Schedule D 1 standards. In Mr Trebilco’s preferred provisions council have now (without any apparent recognition or consideration of the impact) applied the experts finding on appropriate “low” risk to the “very low” risk rule.
- 8.20 It is my view that these changes (greatly broadening the coverage of Rule 3.11.4.1 and wrongly applying the experts low risk finding to the very low risk rule) will have a significant negative impact on the effectiveness of PC1. It is unclear to me if the PC1 modelling assumptions took into account that many drystock farms would effectively have no oversight, no obligation to make

changes on farm and no requirement to report on increasing intensity (if the WRC changed wording to 3.11.4.1 is retained) and therefore no mitigation actions could realistically be expected to occur on these properties as a result of PC1.

9. FURTHER COMMENTS ON TECHNICAL MEETINGS

- 9.1 A small group with some farm systems technical expertise was asked to convene by parties to the Overseer Alternatives mediation matters. The task put to this group was to develop further a simple risk matrix for drystock farming that would allow for a robust method of categorising drystock farms into 3 groups (low / med / high) as to risk of contaminants being lost to water. My understanding was that the small group of experts would use the Fonterra provided Drystock Risk Scorecard and the Professor Horne work on a simple risk tool as the basis for a risk tool that could be presented back to all parties in a timeframe that had been set out.
- 9.2 Drystock interests were to provide data that would inform our discussions, unfortunately there were challenges with getting any useful data at the time of the expert discussions and therefore all the decisions made at the time were based on anecdotal / personal understanding of the farm systems we were considering. Even the data that was applied retrospectively to the outcomes set out in the note, (the data was used to test the impact of the decisions already made, not used to determine the right approach during the meetings) appeared to have limited relevance to the total range of farm types under consideration and within the PC1 catchments.
- 9.3 I expressed my concern at the process both during the meetings and during the lengthy period before the note was issued. My opinions are fundamentally different to those expressed in the note and I think the process was flawed and far from robust. I was the only technical expert (other than Mr Palmer for the council) not engaged or employed by drystock interests.
- 9.4 I did not sign the note from the farm systems experts that set out the outcomes of the small group meetings on rule thresholds on the basis that: I did not agree with the process followed; that there was inadequate relevant data to understand the implications of the arbitrary winter stock unit risk thresholds; that the expert group did not in my opinion deliver back to parties what it had been tasked with providing; and, that I did not agree with any part of the outcome of removing from consideration all the key drivers of risk other than winter stocking rate.

9.5 However, I do agree with the other experts that:

- (a) any consideration of stock densities (as a risk assessment metric) should be on an effective hectare basis as to do otherwise would undermine the credibility of a comparative risk assessment that is focussed on farming intensity; and.
- (b) total stocking rate and cattle stocking should be differentiated (although in my opinion deer should be included with cattle due to their much higher risk profile relative to sheep – deer appear to have been overlooked in the risk thresholds set out in the note).

10. ROLE OF THE NRS IN PC1 SUMMARISED

- 10.1 The NRS is well-suited to provide for an objective “gateway” threshold metric that can act to categorise which farms should come under a higher level of regulator scrutiny due to higher risk practices and / or higher intensity relative to peers.
- 10.2 The NRS can be used to track change in risk over time. Because the tool calculations are entirely focussed on the key risk drivers, there can be a very high level of confidence that a stable or decreasing aggregated score represents a stable or decreasing risk of contaminant losses. (What has driven the output change is entirely transparent, there is no scope for “gaming” outputs through subjective or unverifiable data selection nor does an expert user need to ‘interpret’ data or choose data entry complexity).
- 10.3 I note that the NRS would be well-suited to monitoring changes over time to drystock farming intensity related risk (i.e. the aggregated score could act in the same way as the Nitrogen Leaching Loss Rate ("**NLLR**") would have in the decisions' version of PC1 for higher risk drystock farming). This is because the key farm practice / management drivers of intensity associated risk (other than effluent management which would not be relevant), are the same across drystock and dairy. While slope and connectivity to water are not part of the NRS, for any given farm these factors are fixed (not variable) so are not needed to assess changes in risk.
- 10.4 For the NRS to be applied, both for the initial assessment of risk for dairy farms (“gateway” thresholds) and for the ongoing assessment of system intensity and changing risk over time (dairy and higher risk drystock), there would need to be a method developed by WRC to collect the farm data required to populate the tool input fields. This might occur either through

direct farmer entry of data to a WRC managed site, or through an approved third party providing the data and outputs from the tool (with farmer approval) direct to the council. With the limited data requirements and the simple calculation 'engine' of the NRS it should not be difficult for the WRC to enable such a system. Fonterra has experience running this system at a national scale and is open to providing advice and support to the council on system setup if required.

11. ESTABLISHMENT OF GATEWAY THRESHOLD METRICS FOR DAIRY

11.1 Fonterra has input data and output metrics from running the NRS for all supplying dairy farms since the 2017 / 2018 dairy season. Based on this dataset we can establish normal distribution curves and percentile aggregated scores for each of the Waikato FMUs (or for the PC1 catchment as a whole).

11.2 **Table 1: NRS Aggregated Score Percentiles**

Metric	Season	Upper Waikato River	Middle Waikato River	Lower Waikato River	Waipa River	Total
Aggregated Risk 25th Percentile	2017/2018	118	110	118	114	117
	2018/2019	116	130	109	98	107
	2019/2020	110	120	101	90	102
	2020/2021	112	123	109	100	110
	2021/2022	127	131	115	107	115
Aggregated Risk 50th Percentile	2017/2018	181	170	183	177	180
	2018/2019	182	189	167	150	167
	2019/2020	172	172	158	145	157
	2020/2021	172	180	173	150	164
	2021/2022	174	184	173	157	166
Aggregated Risk 75th Percentile	2017/2018	265	252	265	238	252
	2018/2019	252	241	236	219	236
	2019/2020	239	265	223	203	220
	2020/2021	240	219	231	215	228
	2021/2022	239	241	237	212	228
Aggregated Risk 80th Percentile	2017/2018	282	272	285	254	271
	2018/2019	275	256	257	236	254
	2019/2020	251	278	250	218	240
	2020/2021	256	237	251	228	243

Note re table above: This data has been updated from the original table provided to parties during mediations. The first data provided was the aggregated score for four of the six key drivers (a metric Fonterra has been tracking for our understanding of change over time). This updated table is the score for all six key drivers as referred to in the Nitrogen Risk Scorecard documentation.

11.3 Average Aggregated Score Trend (on 3 year average basis)



11.4 Fonterra supports applying a 50th %ile threshold for low to moderate risk and an 80th%ile threshold for moderate to high risk, ie farms identified as in the top 20% of aggregated score would be regulated as high risk. Given the reasonably small variation between FMUs for the aggregated score, (see Table 1 above at 11.2) we suggest that a single threshold metric applied to whole of catchment would be appropriate.

11.5 The 'baseline' year should be set at 2017 / 2018 to best align with the NLLR approach in the Decisions Version. This baseline date also means that any reductions that have occurred over the past five years are recognised in the rule thresholds (as would have been the case with the NLLR from the Decisions Version).

11.6 The data that has been presented does not include dairy farms that supply dairy companies other than Fonterra. In my opinion there is no reason to consider that other dairy company data would be significantly different. If however that was a concern it would be possible to use the spreadsheet scorecard to establish aggregated scores for all dairy farms before establishing the threshold metric.

12. EFFICIENCY OF CONSENTING FRAMEWORK IN PC1

12.1 The original notified version of PC1 provided a rule framework that meant farms that could meet the relevant rule requirements, and were part of a sector scheme, would be permitted activities. (It was anticipated that most

dairy farming including higher intensity / risk, would be permitted). The Decisions Version removed this approach from the plan meaning that most dairy farms and higher intensity drystock farms under the Decisions Version would now require resource consent. Mr Sinclair in his evidence for WRC has set out an estimate of the number of consents now required under PC1 and the staged approach to implementation he prefers to allow for these consents to be processed.⁹

- 12.2 Mr Sinclair has also considered the implementation challenges and costs associated with managing around 2100 new consents under PC1. At paragraph [14] he notes that; *“Amendments to the rules which increase the number of consents required would proportionately increase the challenges in processing the volume of consent applications. For this (and other) reasons, I support the principle that the rules framework should be no more onerous than circumstances require.”*¹⁰ Despite such a clear recognition that the principle of least onerous regulation required to achieve the outcome should be applied, Mr Sinclair (nor any of the other council staff) seems to have considered that far fewer consents (than the Decisions Version) might in fact achieve the same environmental outcome at less cost and with less implementation delays in this instance.
- 12.3 Mr Sinclair at [28] goes on to explain that; *“The question of “permitted” versus “consented” in the PC1 context, is therefore – given the requirement to register and provide an FEP, what are the costs, and what are the benefits, provided by a consent relative to the permitted activity pathway?”*
- 12.4 While the costs side of the “principle” that Mr Sinclair supports are set out reasonably fully, the differentiated benefits (between a controlled activity and a permitted activity with a certified FEP and minimum standards) are less clearly described. His comment at [39] might seem to indicate that it is farmers that are asking for more resource consents (to meet a “desire for certainty”) and therefore more resource consents are to be considered a “benefit” on that basis. This is not a position I would agree with. In my opinion few farmers would consider a near doubling of the council consent team and the added cost and process duplication they would face, to be a positive.
- 12.5 At [43] Mr Sinclair sets out a list of benefits he considers will arise from requiring a resource consent. It is not clear why he is comfortable that 75% of dairy farmers and perhaps 20% of drystock farmers are the appropriate

¹⁰ EIC of James Sinclair at [14].

proportions to manage in this way and why this is consistent with the “principle” of least onerous regulation that he relies on. In my opinion the controlled activity consent will be a rubber stamp exercise where council charges farmers to review a certified FEP with no meaningful additional assessment. In my view, a well drafted permitted activity regime can achieve all of the benefits he describes in [43] with the possible exception of (d) that appears to attribute an outcome benefit to an appearance that council have direct oversight of more activities through consents. Council does not appear to have considered or attempted to quantify the likelihood of any water quality outcome benefit from the controlled activity consent that they prefer for 50% of dairy farmers.

- 12.6 Mr Sinclair’s evidence concludes¹¹ with a comment on the “successful implementation process” for Variation 6 to the Regional Plan (apparently as an example of an implementation process by WRC that should give confidence that the much larger PC1 implementation process would be effective). From an industry perspective the Variation 6 implementation process in fact highlights just how inefficient and ineffective a very broad WRC resource consent rollout could be. In contrast to Mr Sinclair’s assessment of Variation 6 implementation success, I would not consider that any part of Variation 6 implementation was well managed by the council
- 12.7 Variation 6 Implementation issues from the Fonterra perspective included:
- (a) None of the consent timeframe dates were met by WRC – by several years in some instances. Many consent applications were put “on hold” - for years in some cases. Farmers were not charged consent processing fees if they agreed to extended “on hold” periods well outside the statutory timeframes.
 - (b) Because the council rollout process was so ineffective, WRC later relied on the dairy industry to arrange farmer meetings and farmer visits to encourage template applications to be lodged in bulk.
 - (c) The templated application forms were (from a farmer / industry perspective) clearly no more than a rubber stamp exercise. Council staff did not carry out site visits and relied on standard conditions that were cut and paste between consents.
 - (d) For many years there were almost no water take consent specific site visits, farmers were charged an annual administration fee

¹¹ EIC of James Sinclair at [71].

regardless. Even now most farmers have had no direct communication on their consent conditions / compliance (beyond standard comments tagged to other monitoring reports and annual invoices for consent administration).

- 12.8 In my opinion Variation 6 – contrary to Mr Sinclair's position in evidence - provides a direct and pertinent example of why a very broad application of resource consents by WRC under PC1 cannot realistically be expected to be delivered in the way they anticipate. The whole farm issues to be considered under a PC1 farming consent are a great deal more complex than the single issue Variation 6 consent, making standard / templated applications less likely. Further, it would be unrealistic to expect the dairy industry (whose limited farmer support resources will be firmly focussed on FEP / FWFP delivery), to directly support the controlled activity consent process.
- 12.9 Mr Brocksopp, in his evidence as an independent farm systems expert for WRC, also provides his opinion on the appropriateness of consenting most dairy farms under PC1.¹² He considers that *"the potential effects of farming increase as farming intensity increases (all other things being equal)"*. While I agree that generally, (although not always) dairy farming has more animals per hectare than drystock farming, all other things are not equal when considering relative risks between different land uses. (dairy is generally on land with much higher natural capital with lower slopes, less erodible soils, higher average pasture covers, existing stock exclusion on all slopes, reticulated water, greater existing industry and council oversight etc). With respect, in my opinion, Mr Brocksopp's assessment of relative risk is superficial and of limited value in understanding the need for consent to farm. In my opinion the need for resource consent should be determined based on the most efficient way to achieve the required outcome, not on a rather arbitrary 75% of dairy farms should have to operate under a consent because they are more intensive than drystock farms.
- 12.10 It is unclear what value a widely applied resource consent requirement for dairy farming adds to the effective implementation of PC1. A 'rubber stamp' consent process over the top of a certified FEP / FWFP process will add cost, would delay FEP delivery and actions, divert limited resources from farm planning and would create uncertainty about an adaptive approach to existing FEPs leading to the next plan change. It will certainly not act to increase farmer engagement in change.

¹² EIC of Adrian Brocksop at [75].

- 12.11 In my opinion, the dairy industry commitment to on farm change, implementing methods consistent with PC1 requirements well in advance of any operative provisions, should be taken into account. To apply additional cost and council processes to a sector that has made meaningful change and supports clear minimum standards and robust FEP processes and annual reporting of risk through sector developed tools, risks undermining farmer engagement and future commitment. It is Fonterra's experience that farmers will not do more because they are required to have a resource consent. It seems perverse that the sector that accepts and supports the very things that provide for confidence / certainty in terms of outcomes (ie could generally be appropriately regulated through permitted activity rules) will be faced with a more bureaucratic and unnecessarily costly consent regime.
- 12.12 I understand that the Waikato Regional Council supports the use of the FWFP pathway once available *as an alternative to resource consents* for high risk farming activities such as Intensive Winter Grazing. Council staff have indicated that they consider this alternative to consent would remove the need for hundreds of consents in the region. Despite this apparent acceptance that higher risk activities might appropriately be managed through a certified FWFP process the council does not seem to consider that some of the more than 2000 thousand consents required under their preferred wording for PC1 could likewise generally be effectively managed without the need for resource consent.
- 12.13 I do not agree that there is any clear benefit arising from a general requirement for land use / discharge consents for most dairy farming. Adding unnecessary cost to the dairy sector, with no clear basis for expecting any additional beneficial outcome, seems to be the opposite of efficient regulation. Requiring additional administrative processes that have no clear benefit but will clearly act as a barrier to timely implementation (and therefore to actions occurring on farm) and increase costs for farmers, makes little sense.
- 12.14 The Fonterra position is that pastoral farming should be subject to:
- (a) Minimum standards;
 - (b) A requirement for a certified FEP;
 - (c) A requirement to annually produce and report a quantified risk metric; and

- (d) Maintaining or decreasing risk (based on risk metric above and the mitigations described in the FEP).

- 12.15 Accordingly, Fonterra's position on consents to farm is that pastoral farming that meets all the above requirements should generally not be required to apply for a resource consent to farm.
- 12.16 It is widely recognised that there is a significant PC1 implementation risk due to the limited pool of farm systems expertise in the Waikato region. The FEP rollout and professional support for farmers understanding system change implications for their business will be key to realising the outcomes anticipated by PC1. Diverting any part of the limited pool of expertise into building a larger council consenting team and focussing on that process will decrease available capability for farm plan development and certification. Fonterra is concerned that the requirement for large numbers of consents will have the perverse effect of delaying the implementation of PC1 FEP actions.
- 12.17 It is unclear how such a protracted large scale consent rollout process (as preferred by the regional council) is intended to work in the context of a further plan change to come in 2024, that may require additional on farm change on top of that put in place under PC1.
- 12.18 For reasons set out above the Fonterra position is that more farms can be appropriately managed as permitted activities than was the case when the IHP modified the Collaborative Stakeholder Group framework (in the original notified plan). This could be through a simple revisiting of the numeric thresholds that apply to the various rules, or by changing the activity status of the rules that apply to "moderate risk" dairy farming.

13. FARM ENVIRONMENT PLANS

- 13.1 As noted above, Fonterra strongly supports the use of certified FEP as the key method for delivering on-farm change.
- 13.2 All farms over 20ha (and farms under 20ha carrying out higher risk activities) should be required to develop, have certified and then implement an FEP. If support capability limitations exist then implementation timeframes should recognise this rather than simply decreasing the farmer action expectation based on a crude risk assessment such as winter stocking rate.
- 13.3 FEPs should be developed with very clear risk identification and outcome expectation direction set out in the Regional Plan and supporting guidance

material. In my opinion the FEP requirements for the purposes of supporting change required to meet the PC1 outcomes, should be set out in full in the Plan (as opposed to referencing the FWFP Regulations). A plan user should not have to go between the Regional Plan and the FWFP Regulations (and Part 9A of the Act), to understand their obligations. PC1 should clearly set out the more stringent obligation that arises from meeting both the PC1 FEP and the FWFP requirements. Referencing the Regulations that may be subject to change (or repealed) risks leaving an implementation hole in PC1.

- 13.4 All farms should have to meet minimum standard expectations within clear timeframes, and if they cannot do this should be required to show an outcome equivalency (i.e. the same or better environmental outcome as would be expected through meeting a minimum standard) through a robust process with direct council oversight through a resource consent process.
- 13.5 FEPs should be subject to regular and robust monitoring, reporting and audit requirements. Failure to meet reporting and auditing requirements, and / or failure to implement actions in the timeframe set out in the FEP would be a compliance matter for the regional council to manage.
- 13.6 If clear regionally relevant standards / outcomes are not established under the regional plan, the FWFP requirements may have limited effect going forward. The national regulations for FWFPs do not set the regionally appropriate outcomes – it is intended that the FWFP is a minimum framework that will work in conjunction with the regional plan provisions to meet the regional water quality objectives. If regionally appropriate outcomes are not established through PC1 the future FWFP processes cannot be relied upon to address that shortcoming.
- 13.7 Freshwater Farm Plans as allowed for under Part 9A RMA, will provide a base standard for farm plans going forward. The more stringent FEP expectations and outcomes in PC1 will (combined with the FWFP base standard) ensure that the farm planning framework is consistent with achievement of regional plan objectives. Given the minimum approach allowed for in the Regulations it is unclear that there is any particular value in the Schedule D1 farm plan going forward. There is no provision for a lesser standard of FWFP for lower intensity (or lower risk) farms under the Regulations and the idea that there may be uncertified FEPs (as Schedule D1 currently anticipates) or no FEP at all (as council's preferred wording would lead to for many farms under Rule 3.11.4.1) is not contemplated by the Regulations.

- 13.8 Schedule D1 plans might confuse the overarching requirement to have a certified FWFP with consistent administrative processes, risk assessment methodology and action plans. To be clear, we recognise there might be scope issues in completely removing this Schedule and are not strongly opposed to continuing with D1 farm plans as an interim approach, but do question the utility of the PC1 split FEP approach now that the Regulations will be coming in to effect at the same time as PC1. Applying the D2 Schedule to all farming, with the addition of the D 1 minimum standards for farming as a permitted activity added to the relevant rule(s), would better align with the national Freshwater Farm Plan Regulations and would simplify PC1. Mr Willis covers these matters in detail (including drafting provisions) in his primary evidence.

14. MINIMUM FARMING STANDARDS

- 14.1 I support the retention of the minimum standards and where changed wording is required to ensure the standard is clearly articulated, such a change should not reduce the effectiveness of a standard. I also do not agree with any changing of rule thresholds or conditions that would mean fewer farmers had to comply with particular minimum standards. (I note here that while Fonterra supports more permitted activity farming we do not argue for any reduced outcome expectation nor reduced need to comply with all standards).
- 14.2 The decreased stock exclusion outcomes, that council now appears to support, are of particular concern to Fonterra given that its shareholder farmers have gone well beyond the Regulations prior to any legal obligation applying. In my opinion there are no particular practical barriers to stock exclusion (cattle) on land that is less than 15 degree slope, where method flexibility and a reasonable transition period is allowed for. To go from a general expectation that stock are excluded where slope is less than 15 degrees, to a reliance on a map that indicates where a 10 degree slope might occur (the maps have been identified as being unreliable as to actual slope at paddock / farm scale) is a significant step backwards for PC1 outcomes.
- 14.3 While I acknowledge (and have first-hand experience of) the cost for deer exclusion is undoubtedly more of an issue, this needs to be balanced with the level of damage deer can cause to waterways when they do have access.
- 14.4 There has been no credible evidence that would show that there are practical mitigations / practices that could be applied that will achieve the same water

quality outcomes as actually just keeping cattle and deer out of waterways wherever possible.

- 14.5 As an experienced farmer it is my opinion that the presence of a tree or a trough in a paddock where intensive grazing practices are occurring, will never achieve the same outcome as having a fence that keeps animals out of a waterbody and off the banks of that waterbody. I am not aware of any practical alternative mitigation measure that an expert might certify as having the same effect as would providing a physical barrier that means animals can't access a waterway. Providing for an ability to so easily sidestep such an important minimum standard seems likely to lead to far less actual stock exclusion progress than the IHP (and the modelling work they relied upon) anticipated.
- 14.6 The Fonterra position is that all waterways on flat and rolling country (less than 15 degree slope) should be protected from direct stock access wherever possible. This presumption, that all waterways where there are no significant barriers to fence should be fenced, does not flow through from policies and rules of PC1 and we see far too many opportunities to avoid such a basic and sensible pastoral farming good practice standard. It is accepted that on land steeper than 15 degrees full exclusion is not always practical for drystock farming (noting that the dairy industry required exclusion regardless of slope prior to any regulatory obligation and that stock exclusion on steeper land has not generally been problematic) and agree that farming practice on land steeper than 15 degrees should be used to determine if cattle and deer must be kept out of waterways. Transition timeframes should be practical to allow the necessary work to be carried out without the need for large numbers of interim consents.

15. FONTERRA EXPERIENCE WITH OVERSEER

- 15.1 From 2012 – 2017 Fonterra was the largest single user of the Overseer model through the Fonterra Nitrogen Programme. This programme was designed to improve understanding of nitrogen loss risks to water quality from dairy farming, and drive improved nitrogen use efficiency while preparing farmers for future regulation.
- 15.2 When Fonterra made the decision to use Overseer in a change management programme on such a large scale access to the publicly-funded science model was free and Fonterra was able to build its own access systems that protected farmer data from inappropriate use and commercialisation.

Fonterra increased internal capability in farm systems expertise and also contracted service providers to support such a resource intensive programme. Fonterra and DairyNZ both had staff on the Overseer technical advisory group for the best practice use of the model.

- 15.3 Toward the end of this period, Overseer transformed itself as a commercial entity that would charge model users and would look for commercial opportunities to monetise data. The two major fertiliser sales companies and AgResearch, as co-owners, determined that access to the model would be by paid annual subscription (despite the public science / public good basis for the model to that point).
- 15.4 After six years of running such an expensive system (annual Overseer file generation and reporting to farmers), Fonterra had already determined (before the launch of the commercial model for Overseer), that there were significant issues with a reliance on Overseer for our nitrogen programme. The key concerns at that time were:
- (a) The very high cost of the expertise required to run the modelling (Overseer cannot be considered anything other than an expert user model and very few farmers ever interact directly with the model).
 - (b) The version control issues whereby significant changes in reported output metrics occurred with no change in farmer entry data – in effect the model was not stable over time which caused confusion and annoyance for our farmer shareholders. (Farmers could make practice improvements and reduce inputs and see the model output number indicating that farm level losses were increasing).
 - (c) Difficulty in validating (auditing) many input data. The model has considerable data entry complexity and subjectivity – some of the data points can be readily changed with no ability to assess if that change actually occurred. Many of the data points simply cannot be validated.
 - (d) We were aware that “gaming” the model is relatively easy for an expert user due to the entry field subjectivity and complexity and the focus on a single farm scale output metric (kg leached per ha). This was probably not occurring on anything other than a small scale – there was no incentive in the Fonterra programme to “fix the numbers” – but we realised that when applied in a regulatory context there was considerable risk for highly inequitable outcomes.

- (e) It was clear that there were significant issues with identifying actual underlying soil characteristics at a farm block scale. Even with S map data – held out as a solution to this issue, there are obvious issues with desktop generated soil polygons that have not been ground-truthed and that do not represent actual soils present on a property.
- (f) In a similar vein, the use of long term average climate data being used to consider impacts of activities and actions that occur in response to the real (experienced) weather and short term climatic conditions is obviously problematic in terms of reliability of an annual leaching prediction that has compliance (and enforcement) implications.
- (g) I note that there is a programme by Overseer Ltd to address issues raised by external reviews of the model (see below) but that none of the preceding list of issues has yet been resolved through that programme.

Overseer as a Commercial business

- 15.5 Once Overseer relaunched as a commercial entity it became untenable for Fonterra to continue with an Overseer based nitrogen programme approach that was already being replaced with something more conducive to farmer engagement and efficient farmer change.
- 15.6 Fonterra did not agree that commercialisation of the public science behind the model was appropriate. The inability going forward to protect farmers' data from use beyond our own programme needs as well as the significant (and rapidly increased) subscription cost, accelerated Fonterra's complete withdrawal from any large-scale Overseer use in on farm change programmes.
- 15.7 Once Fonterra had identified the issues with Overseer and its large-scale use as described above, the Fonterra Nitrogen Programme team developed and tested a tool that would provide more engaging and useful information for a farmer - the NRS.
- 15.8 Fonterra has not required farmer data to the level of detail that would be required for an Overseer file since 2017 and there is no expectation or requirement that Fonterra's on-farm advisory team will have expertise in the use of the Overseer model.

Parliamentary Commissioner for the Environment

- 15.9 Shortly after the relaunch of Overseer as a commercial entity the Office of the Parliamentary Commissioner carried out an investigation on the use of the Overseer model for regulatory purposes. The subsequent report¹³ raised wide ranging concerns about the model and made a number of recommendations about detailed model review including the need for: clear government positions on appropriate model use and limitations, model workings transparency, independent oversight, governance and ownership, improving farmer / user trust and clarity around model uncertainty. The report was clear that in the opinion of the PCE the model and the way it was owned and operated, meant that it should not be considered fit for purpose in a regulatory context.

Richard Allen

28 July 2023

¹³ Overseer and regulatory oversight: Models, uncertainty and cleaning up our waterways. Dec 2018.

Attachment 1

Contaminant Loss Risk Scorecard

Basic contaminant loss risk assessment tool for dry stock

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2 Basic contaminant loss risk assessment tool for dry stock (regulatory thresholds, baselining and monitoring change)

2.1 Context:

Fonterra supports the use of a nitrogen risk scorecard to identify where additional regulatory oversight might be required to manage nitrogen loss risk (and to act as a proxy for intensity risk, particularly on dairy farms). There is value in also considering if a similarly objective risk approach might be relevant for equitably regulating non-dairy pastoral farming. Fonterra sees value in a tool that while primarily intended for drystock farming, would enable an aligned regulatory approach for the management of farming systems where P, sediment and e coli losses were impacting on the achievement of water quality objectives. The same risk tool might also help to support decision making (FEP actions) and monitoring of progress in relation to non - N contaminants from all pastoral farming.

Such a risk tool needs to have limited data requirements that are practical for most drystock farms to record / provide annually. It would need to consider the primary drivers of diffuse contaminant loss risk (key drivers) and where possible assess against basic mitigations and practice specifics that would act to modify the key driver risk level reported (sub factors / drivers).

The reported numeric for each key driver of loss is an indication of underlying or inherent 'riskiness' and is not an attempt to model or calculate a load of contaminant loss. A higher risk score would not indicate more contaminants are being lost from a property but would objectively identify cohorts that might require a higher level of regulatory or industry oversight (e.g., activity status, policy direction toward further FEP actions, industry standards etc).

Slope has been included as a key driver of sediment, phosphorus and e coli loss risk. This inclusion does deviate from the N risk Scorecard focus on drivers within the farmer's control. However, given the very obvious slope / risk linkage and the fact that unlike climate this driver is fixed (beyond removing steeper land from effective area) and therefore doesn't add an uncontrollable variable, slope has been included.

Soil nutrient status has not been included in this basic risk assessment due to:

- the challenge in getting reliable whole farm representative P status data for most dry stock farms, where soil testing is generally limited
- the value of requiring such data when steeper dry stock farmland predominantly has average Olsen P levels well below agronomic optimum.

It is recognised that managing P levels will be significant in over allocated (for P) catchments, but it is considered that this risk is best managed through minimum standards, rule conditions and FEP assessment / action criteria.

While it is recognised that stock classes on steeper country will be a significant driver of overall risk, it is not considered possible to get detailed data reliably. Therefore, for this risk a simple yes / no threshold for wintering of adult cattle on steeper land in June / July / August has been proposed. This approach signals the practice risk and acts to encourage consideration of wintering practice generally (that should be considered in more detail in the FEP).

3 The four-underlying risk factors considered within the scorecard

The context section above described the parameters within which the scorecard has been designed, i.e., needs to operate effectively using a limited data requirement, is focussed on the main loss drivers for P, sediment and e coli to water and is reasonably aligned with a farmer understanding of environmental risk. The following four key risk factors and their associated subfactors, that can be readily / objectively assessed, form the risk assessment criteria.

1. Stock Management Peak stocking rate expressed as RSU
2. Slope
3. Cultivation
4. Waterway stock exclusion

3.1 Stock Management

The key driver of risk from the stock management factor is the peak stocking rate RSU (550kgDM/yr = 1 RSU). This is the total stock units on farm as at 1 Dec (proposed date) which includes all stock (except unweaned progeny).

This is calculated across the effective area (i.e., grazed ha) of the farm, risk points are attributed to stocking rates on a sliding scale (10 points per RSU) from 0 points for a stocking rate less the 6 RSU/ha to 200 points for 25 RSU/ha¹. E.g. a stocking rate of 13 RSU would receive 80 risk points and a stocking rate of 18 SU/ha 130 points

3.1.1 Peak Stocking rate:

Stocking Rate (Peak Stock Units / ha)	Points
6	10
7	20
8	30
9	40
10	50
11	60
12	70
13	80
14	90
15	100

¹ For the purposes of formatting within the documentation the stocking rate table is capped at 25 RSU/ha, however points will continue to be attributed to stocking rates higher than 25 RSU/ha at the same sliding scale.

Stocking Rate (Peak Stock Units / ha)	Points
16	110
17	120
18	130
19	140
20	150
21	160
22	170
23	180
24	190
25	200

3.1.2 Proportion of total stock that are sheep:

This sub factor moderates the peak stocking rate risk by assessing the proportion of the peak RSU that are sheep. This is calculated on a sliding scale reducing the peak stocking rate risk by up to 50% where the total peak stocking rate is comprised entirely of sheep.

% Sheep RSU's	Multiplier
0%	1
10%	0.95
20%	0.9
30%	0.85
40%	0.8
50%	0.75
60%	0.7
70%	0.65
80%	0.6
90%	0.55
100%	0.5

3.1.3 Proportion of total stock that are adult cattle or adult stags

In this sub factor the Scorecard assesses the proportion of the peak stocking rate that are adult cattle (>18months) or adult stags (>18 months). A higher percentage of mature animals equates to a higher risk which is increased on a sliding scale. This is calculated by using the percentage of adult cattle to look up the corresponding multiplier below, this multiplier is then used to increase the cattle portion of peak stocking rate risk.

% Adult Cattle RSU's	Multiplier
0%	1.00
10%	1.10
20%	1.20
30%	1.30
40%	1.40
50%	1.50
60%	1.60
70%	1.70
80%	1.80
90%	1.90
100%	2.00

3.1.4 Winter stocking rate

The last sub factor for stock management assesses the wintering stocking rate. This is the total stock units on farm on the 1st of July. The scorecard attributes points on a sliding scale, where a winter stocking rate of less than 10 will reduce the risk (remove points).

Winter Stocking Rate	Points
≤7	-20
8	-15
9	-10
10	0
11	2
12	4
13	6
14	8
15	10
16	14
17	18
18	22
19	26
20	30
21	34
22	38
23	42
24	46
25	50

3.2 Slope

Slope is an underlying risk factor that contributes to the level of risk associated with each of the other key drivers. There are no direct mitigations in this risk scorecard for slope related risk, beyond retiring steep land from pastoral use. The Scorecard calculates the total amount of risk from slope by multiplying the percentage of the farm within each land slope class by the corresponding points.

Slope/Contour	Points
Flat to gently undulating	0
Rolling	25
Easy Hill	50
Medium Hill	100
Steep	150

3.3 Total area cultivated

This section is evaluating the risk of the total area (ha) cultivated. The risk points attributed to cultivation increase on a sliding scale as the area cultivated increases.

Cultivation % of farm	Points
5	20
10	40
15	60
20	80
25	100

3.3.1 Cultivation method

This sub factor moderates the total area cultivated risk by reducing the risk score where lower impact methods of cultivation (e.g., direct-drilling or min-tillage) are employed, compared to conventional “full” cultivation methods such as ploughing, use of power harrows.

Cultivation Method	Multiplier
No cultivation	0
Minimum tillage or direct drilling	0.5
Conventional cultivation	1

3.3.2 Cultivation for winter fed crop vs. pasture renewal or summer crops

Crops harvested in winter pose a higher risk of contaminant loss when grazed in situ. This sub factor utilises data identifying which season the crop was grazed to modify the risk by either, increasing the risk for crops grazed in winter or reducing the risk for summer harvested crops.

Season of harvest	Multiplier
Summer	0.75
Winter	1.5

3.3.3 Maximum slope of cultivated land

This sub factor identifies the highest slope land cultivated on a property and adds points to the cultivation score as slope increases. Slopes ≤ 5 degrees receive 0 points, with a sliding scale up to 30 points for slopes cultivated ≥ 20 degrees

Max slope (degrees) of cultivated	Points
≤ 5	0
10	10
15	20
20	30

3.4 Waterway Stock Exclusion

This risk factor assesses the risk associated with stock directly accessing waterways. The risk factor uses farmer provided data, on the percentage of waterways (greater than 1m and permanently containing water) that are fenced to exclude cattle / deer.

% Stock Exclusion	Points
0	100
5	93
10	86
15	80
20	73
25	67
30	60
35	53
40	47
45	40
50	33
55	27
60	20
65	13
70	7
75	0

3.4.1 Reticulated stock drinking water

In this sub factor the Scorecard assesses the proportion of the effective area where stock drink from a reticulated drinking water system. Having access to clean reticulated drinking water will reduce the need, and therefore occurrence of stock entering streams or dams. The greater proportion of the farm covered by reticulated water, the greater the reduction in risk points.

Water Reticulation	Points
0%	0.0
5%	-2.0
10%	-4.0
15%	-6.0
20%	-8.0
25%	-10.0
30%	-12.0
35%	-14.0
40%	-16.0
45%	-18.0
50%	-20.0
55%	-22.0
60%	-24.0
65%	-26.0
70%	-28.0
75%	-30.0

4 Appendix:

4.1 Farm data required to drive the scorecard:

Note: Each data collection point will require a clear description (and examples) of what information is required.

Farm description data

1. Total effective area of the farm (hectares)
2. The percentage of the effective farm area made up of each slope type:
 - a. Flat / undulating
 - b. Rolling
 - c. Easy Hill
 - d. Medium Hill
 - e. Steep / very steep

Livestock data

(supported by a stock class / RSU table)

3. A stock reconciliation sufficient to calculate:
 - a. The peak and winter stocking rates RSU/ha
 - b. The percentage of sheep and cattle / deer
 - c. The percentage of adult cattle / adult stags

Cultivation data

4. The percentage of the farm cultivated annually
5. The cultivation method
6. The season the crop was harvested / grazed
7. The maximum slope cultivated

Waterway stock exclusion

8. Percentage of waterways greater than 1m and permanently containing water, that are fenced to exclude cattle / deer
9. Percentage of effective area that has reticulated water

4.2 Scorecard Examples:

The below examples contain data from eleven (non-representative) farms. Starting on the left, the scorecard attributes points to the key risk driver and either subtracts points for mitigating practices, or adds additional risk points where sub factors (practices) increase the risk. The risk points in the calculation tables below are derived from the factor / sub factor points tables set out in section 3 above.

4.2.1 Stock Management

Farm ID	Stock Management				Total Stocking Rate Risk Points
	Peak RSU	% Sheep	% Adult Cattle	Winter RSU	
1	60	-15	14	-15	44
2	70	-14	28	0	84
3	80	-16	45	2	111
4	70	-32	35	-20	53
5	90	-18	43	0	115
6	70	-21	44	-15	78
7	110	0	77	4	191
8	130	-20	111	4	225
9	130	-33	49	4	150
10	170	-51	48	8	175
11	100	-10	45	4	139

4.2.2 Slope

Farm ID	Slope					Total Slope Risk Points
	Flat	Rolling	Easy Hill	Moderately Steep	Steep	
1	0	0	0	0	113	113
2	0	0	10	50	0	60
3	0	4	30	0	26	60
4	0	2	24	0	68	93
5	0	0	9	49	23	80
6	0	4	8	33	0	44
7	0	9	10	10	23	51
8	0	25	0	0	0	25
9	0	0	5	50	60	115
10	0	3	10	35	38	85
11	0	13	10	10	0	33

4.2.3 Cropping & Cultivation

Farm ID	Cropping & Cultivation				
	Cultivation %	Cultivation Method	Winter Crop Risk	Max slope cultivated Degrees	Total Cultivation Risk Points
1	40	-20	20	6	46
2	0	0	0	0	0
3	20	-10	10	8	28
4	40	0	20	6	66
5	20	-10	10	20	40
6	56	-28	28	10	66
7	16	0	8	7	31
8	100	0	-25	15	90
9	0	0	0	0	0
10	40	-20	-10	6	16
11	40	-20	20	15	55

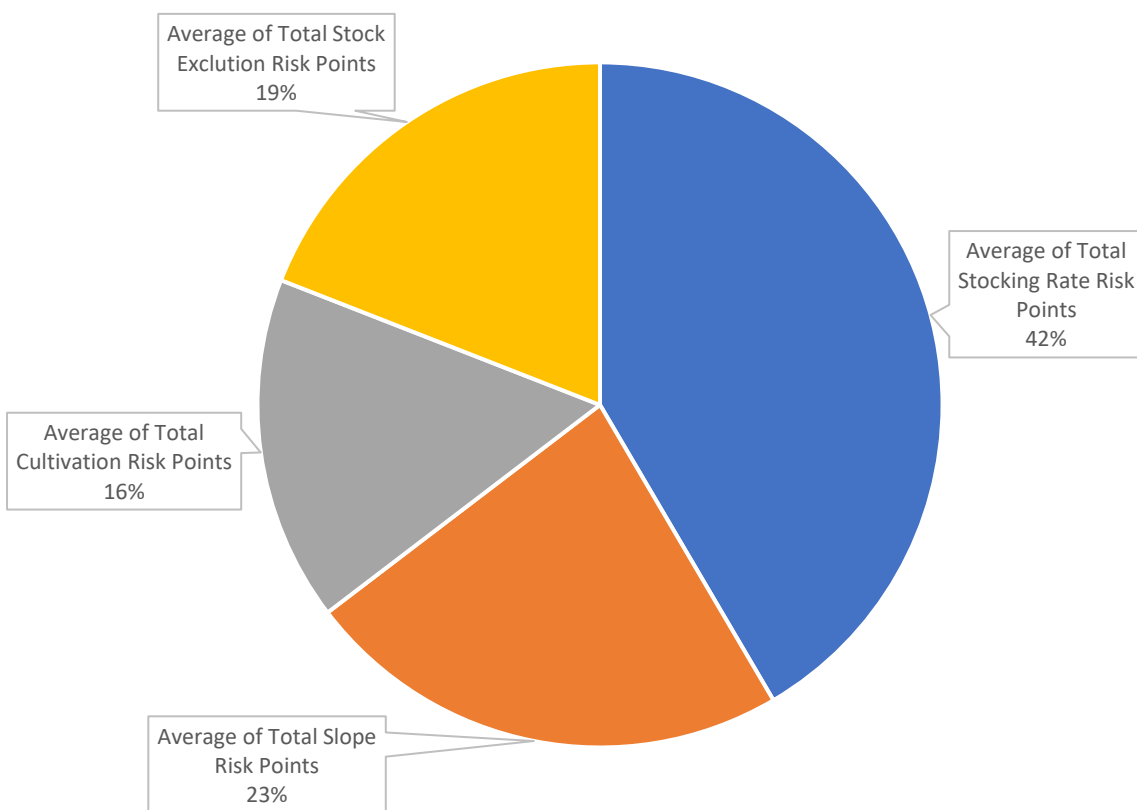
4.2.4 Waterway Stock Exclusion

Farm ID	Waterway Stock Exclusion		
	Stock Exclusion	Stock Water Reticulation	Total Stock Exclusion Risk Points
1	73	-20	53
2	59	-16	43
3	99	-26	73
4	86	-16	70
5	99	-10	89
6	79	-22	57
7	86	-14	72
8	33	-16	17
9	99	-28	71
10	79	-20	59
11	46	-24	22

4.2.5 Summary of the four underlying risk factors including a total risk output metric

Farm ID	Total Stocking Rate Risk Points	Total Slope Risk Points	Total Cultivation Risk Points	Total Stock Exclusion Risk Points	Total Risk Points
1	44	113	46	53	255
2	84	60	0	43	188
3	111	60	28	73	272
4	53	93	66	70	282
5	115	80	40	89	325
6	78	44	66	57	246
7	191	51	31	72	345
8	225	25	90	17	357
9	150	115	0	71	337
10	175	85	16	59	336
11	139	33	55	22	250

4.3 The distribution of risk points across the eleven farms



4.4 References:

B+LNZ Drought Management Regional Case Study -Dargaville, Northland - Case Study Farm: Ashgrove Ltd farmed by James and Janine Parsons, Tangowahine, Dargaville Analysis & Report prepared by AgFirst's Bob Thomson and James Parsons

Perrin Ag Consultants Ltd 2013. Upper Waikato dry stock nutrient study prepared for the Waikato Regional Council and Beef + Lamb NZ Inc

DRAFT

Appendix 3:
**The Overseer Timeline – Tracking farm outputs over time (Bellevue Dairy
Farm report)**

Bellevue Dairy Farm

360 Papatotara Road, Papatotara 9691, New Zealand

! The following shows a timeline for this farm. Each analysis that has a year is shown with high level information that describes the farm system in that year. The changes made between analyses are listed between the years. Only analyses that have results are shown.

2015

N56 kg/ha

P1.1 kg/ha

GHG13,424 kg/ha

✕

REMOVE FROM TIMELINE

📋

VIEW ANALYSIS

Type of analysis	Year end
Area	Total area is 160 ha. Productive area is 149 ha. Irrigated area is 15.75 ha. Effluent area is 29 ha.
RSU	Total stock rate is 31.2 RSU/ha. This is 4% Beef, 96% Dairy
Nitrogen	N surplus is 160 kg/ha. Average annual drainage is 495.6mm
N applied to pasture	N applied as fertiliser on Pasture blocks, 54.3 kg/ha as synthetic and 0 kg/ha as organic.
N imported in supplements	Imported 1 kg/ha of nitrogen from supplements.
Irrigators	Linear and centre Pivot - Trigger point; fixed depth applied (100%)

 PHYSICAL

- Farm area has decreased by 33.0 ha (21%).
- Productive area has decreased by 54.2 ha (36%).

 NUTRIENTS

- N loss per ha has increased by 15.0 kg/ha (27%).
- P loss per ha has decreased by 0.3 kg/ha (27%).
- N Surplus has increased by 44.0 kg/ha (28%).
- N lost in drainage has increased by 5.4 N ppm (64%).

 GHG

- Methane emissions per ha has decreased by 1,161 kg/ha (11%).
- Nitrous oxide emissions per ha has increased by 211 kg/ha (7%).
- Carbon dioxide emissions per ha has increased by 588 kg/ha (85%).

 DRAINAGE/WETLANDS

- Average annual water drainage has increased by 200.3 mm (40%).

 ANIMALS

- Stock changes: Beef has decreased from 182.7 RSU to 0. Dairy has decreased by 1,263.3 RSU (26%).
- Total pasture production has decreased by 989,764 kg DM (33%).
- Milk production has decreased by 90,000 kg milk solids (36%).
- N in imported supplements has increased by 11.0 kg/ha (1,100%).

 IRRIGATION

- Irrigation applied has increased by 132,932 kilo litres (659%).
- Irrigated area has increased in the months March (16 ha), October (16 ha)
- Irrigation applied has increased in the months January (20,318 kilo litres : 368%), February (16,538 kilo litres : 223%), March (25,830 kilo litres), October (27,720 kilo litres), November (24,098 kilo litres : 1391%), December (18,428 kilo litres : 334%)
- Irrigation system changes by area: Linear and centre Pivot has increased by 31.5 ha (50%).
- Irrigation management changes by area: Trigger point; fixed depth applied has decreased from 63.0 ha to 0. Fixed depth; fixed return period has increased from 0 to 94.5 ha.

 FERTILISER

- N applied as synthetic fertiliser has increased in the months February (3,011 kg), April (250 kg : 11%), August (250 kg : 11%), September (3,011 kg), October (470 kg : 60%), November (695 kg : 30%)
- N applied as synthetic fertiliser has decreased in the months December (118 kg : 20%)

N

71 kg/ha

P

0.8 kg/ha

GHG

13,062 kg/ha



REMOVE FROM TIMELINE



VIEW ANALYSIS

203.2015

2016

Type of analysis	Year end
Area	Total area is 127 ha. Productive area is 94.8 ha. Irrigated area is 15.75 ha. Effluent area is 37 ha.
RSU	Total stock rate is 27.9 RSU/ha. This is 100% Dairy
Nitrogen	N surplus is 204 kg/ha. Average annual drainage is 695.9mm
N applied to pasture	N applied as fertiliser on Pasture blocks, 173 kg/ha as synthetic and 0 kg/ha as organic.
N imported in supplements	Imported 12 kg/ha of nitrogen from supplements.
Irrigators	Linear and centre Pivot - Fixed (100%)

CHANGES BETWEEN THE YEARS 2016 AND 2017

NUTRIENTS

- N loss per ha has decreased by 12.0 kg/ha (17%).
- P loss per ha has decreased by 0.1 kg/ha (13%).
- N Surplus has decreased by 17.0 kg/ha (8%).

GHG

- GHG emissions per ha has decreased by 1,492 kg/ha (11%).
- Methane emissions per ha has decreased by 947 kg/ha (10%).
- Nitrous oxide emissions per ha has decreased by 242 kg/ha (8%).
- Carbon dioxide emissions per ha has decreased by 303 kg/ha (23%).

DRAINAGE/WETLANDS

- Average annual water drainage has decreased by 147.5 mm (21%).

ANIMALS

- Stock changes: Dairy has decreased by 387.6 RSU (11%).
- Total pasture production has decreased by 147,354 kg DM (7%).
- Average pasture production per ha has decreased by 1,554 kg DM/ha (7%).
- N in imported supplements has decreased by 11.0 kg/ha (92%).

CROPS

- Cropping area has decreased from 12.2 ha to 0.
- Crops by area: Pasture has decreased from 12.2 ha to 0.

IRRIGATION

- Irrigation applied has decreased by 132,932 kilo litres (86%).
- Irrigated area has decreased in the months October (16 ha)
- Irrigation applied has decreased in the months January (20,318 kilo litres : 78%), February (16,538 kilo litres : 69%), March (25,830 kilo litres), October (27,720 kilo litres), November (24,098 kilo litres : 93%), December (18,428 kilo litres : 76%)
- Irrigation system changes by area: Linear and centre Pivot has decreased by 15.8 ha (17%).
- Irrigation management changes by area: Fixed depth; fixed return period has decreased from 94.5 ha to 0. Trigger point; fixed depth applied has increased from 0 to 78.7 ha.

FERTILISER

- N applied as synthetic fertiliser has increased in the months October (2,567 kg : 204%), December (2,567 kg : 546%)
- N applied as synthetic fertiliser has decreased in the months February (3,011 kg)

2017

Type of analysis	Year end
Area	Total area is 127 ha. Productive area is 94.8 ha. Irrigated area is 15.75 ha. Effluent area is 37 ha.
RSU	Total stock rate is 24.9 RSU/ha. This is 100% Dairy
Nitrogen	N surplus is 187 kg/ha. Average annual drainage is 548.4mm
N applied to pasture	N applied as fertiliser on Pasture blocks, 199 kg/ha as synthetic and 0 kg/ha as organic.
N imported in supplements	Imported 1 kg/ha of nitrogen from supplements.
Irrigators	Linear and centre Pivot - Trigger point; fixed depth applied (100%)

CHANGES BETWEEN THE YEARS 2017 AND 2018

NUTRIENTS

- N loss per ha has increased by 11.0 kg/ha (19%).
- P loss per ha has increased by 0.1 kg/ha (14%).
- N Surplus has decreased by 25.0 kg/ha (13%).

GHG

- GHG emissions per ha has increased by 1,058 kg/ha (9%).
- Methane emissions per ha has increased by 955 kg/ha (12%).
- Carbon dioxide emissions per ha has increased by 100 kg/ha (10%).

ANIMALS

- Stock changes: Dairy has increased by 404.0 RSU (13%).
- N in imported supplements has increased by 4.0 kg/ha (400%).

CROPS

- Cropping area has increased from 0 to 12.2 ha.
- Crops by area: Pasture has increased from 0 to 12.2 ha.

IRRIGATION

- Irrigation applied has increased by 70,885 kilo litres (351%).
- Irrigated area has decreased in the months January (2 ha : 12%), February (2 ha : 12%), March (16 ha), November (2 ha : 12%), December (2 ha : 12%)
- Irrigation applied has increased in the months January (16,384 kilo litres : 297%), February (12,766 kilo litres : 172%), November (21,893 kilo litres : 1264%), December (19,842 kilo litres : 359%)
- Irrigation system changes by area: Linear and centre Pivot has decreased by 21.1 ha (27%).
- Irrigation management changes by area: Trigger point; fixed depth applied has decreased from 78.7 ha to 0. Fixed depth; fixed return period has increased from 0 to 57.6 ha.

FERTILISER

- N applied as synthetic fertiliser has increased in the months November (1,371 kg : 46%)
- N applied as synthetic fertiliser has decreased in the months April (441 kg : 17%), August (376 kg : 15%), September (3,011 kg), October (2,403 kg : 63%), December (1,348 kg : 44%)

203.2017

N

70 kg/ha

P

0.8 kg/ha

GHG

12,628 kg/ha



REMOVE FROM TIMELINE



VIEW ANALYSIS

2018

Type of analysis	Year end
Area	Total area is 127 ha. Productive area is 94.8 ha. Irrigated area is 14.405 ha. Effluent area is 32 ha.
RSU	Total stock rate is 28 RSU/ha. This is 100% Dairy
Nitrogen	N surplus is 162 kg/ha. Average annual drainage is 563.2mm
N applied to pasture	N applied as fertiliser on Pasture blocks, 124.3 kg/ha as synthetic and 0 kg/ha as organic.
N imported in supplements	Imported 5 kg/ha of nitrogen from supplements.
Irrigators	Linear and centre Pivot - Fixed (100%)

CHANGES BETWEEN THE YEARS 2018 AND 2019

NUTRIENTS

- P loss per ha has decreased by 0.1 kg/ha (13%).

FERTILISER

- N applied as synthetic fertiliser has increased in the months April (177 kg : 8%), December (588 kg : 35%)
- N applied as synthetic fertiliser has decreased in the months October (634 kg : 45%)

N

68 kg/ha

P

0.7 kg/ha

GHG

12,384 kg/ha



REMOVE FROM TIMELINE



VIEW ANALYSIS

203.2018

2019

Type of analysis

Year end

Area

Total area is 127 ha. Productive area is 94.8 ha. Irrigated area is 14.405 ha. Effluent area is 32 ha.

RSU

Total stock rate is 27.5 RSU/ha. This is 100% Dairy

Nitrogen

N surplus is 158 kg/ha. Average annual drainage is 563.2mm

N applied to pasture

N applied as fertiliser on Pasture blocks, 127.3 kg/ha as synthetic and 0 kg/ha as organic.

N imported in supplements

Imported 5 kg/ha of nitrogen from supplements.

Irrigators

Linear and centre Pivot - Fixed (100%)

CHANGES BETWEEN THE YEARS 2019 AND 2020

NUTRIENTS

- N loss per ha has decreased by 4.0 kg/ha (6%).
- P loss per ha has increased by 0.1 kg/ha (14%).
- N lost in drainage has decreased by 1.1 N ppm (8%).

FERTILISER

- N applied as synthetic fertiliser has increased in the months April (421 kg : 18%)
- N applied as synthetic fertiliser has decreased in the months December (588 kg : 26%)

N

64 kg/ha

P

0.8 kg/ha

GHG

12,493 kg/ha



REMOVE FROM TIMELINE



VIEW ANALYSIS

203.2019

2020

Type of analysis	Year end
Area	Total area is 127 ha. Productive area is 94.8 ha. Irrigated area is 14.482 ha. Effluent area is 32 ha.
RSU	Total stock rate is 27.9 RSU/ha. This is 100% Dairy
Nitrogen	N surplus is 158 kg/ha. Average annual drainage is 559mm
N applied to pasture	N applied as fertiliser on Pasture blocks, 126.8 kg/ha as synthetic and 0 kg/ha as organic.
N imported in supplements	Imported 5 kg/ha of nitrogen from supplements.
Irrigators	Linear and centre Pivot - Fixed (100%)

CHANGES BETWEEN THE YEARS 2020 AND 2021

PHYSICAL

- Farm area has increased by 11.0 ha (9%).
- Productive area has increased by 25.9 ha (27%).

NUTRIENTS

- N loss per ha has decreased by 6.0 kg/ha (9%).
- P loss per ha has decreased by 0.1 kg/ha (13%).
- N Surplus has increased by 18.0 kg/ha (11%).
- N lost in drainage has decreased by 2.7 N ppm (22%).

GHG

- Methane emissions per ha has decreased by 678 kg/ha (7%).
- Carbon dioxide emissions per ha has increased by 157 kg/ha (14%).

ANIMALS

- Average pasture production per ha has decreased by 3,696 kg DM/ha (18%).
- N in imported supplements has increased by 2.0 kg/ha (40%).

IRRIGATION

- Irrigated area has increased in the months January (1 ha : 7%), February (1 ha : 7%), November (1 ha : 7%), December (1 ha : 7%)

FERTILISER

- N applied as synthetic fertiliser has increased in the months February (3,081 kg), April (577 kg : 21%), August (811 kg : 37%), November (1,621 kg : 37%)
- N applied as synthetic fertiliser has decreased in the months October (788 kg)

N58 kg/ha

P0.7 kg/ha

GHG11,884 kg/ha

2021

Type of analysis	Year end
Area	Total area is 137.7 ha. Productive area is 120.7 ha. Irrigated area is 15.078 ha. Effluent area is 56 ha.
RSU	Total stock rate is 25.8 RSU/ha. This is 100% Dairy
Nitrogen	N surplus is 176 kg/ha. Average annual drainage is 553mm
N applied to pasture	N applied as fertiliser on Pasture blocks, 155.8 kg/ha as synthetic and 0 kg/ha as organic.
N imported in supplements	Imported 7 kg/ha of nitrogen from supplements.
Irrigators	Linear and centre Pivot - Fixed (100%)

No significant changes between the years 2021 and 2022

203.2021

N

58 kg/ha

P

0.7 kg/ha

GHG

11,884 kg/ha



REMOVE FROM TIMELINE



VIEW ANALYSIS

2022

Type of analysis	Year end
Area	Total area is 137.7 ha. Productive area is 120.7 ha. Irrigated area is 15.078 ha. Effluent area is 56 ha.
RSU	Total stock rate is 25.8 RSU/ha. This is 100% Dairy
Nitrogen	N surplus is 176 kg/ha. Average annual drainage is 553mm
N applied to pasture	N applied as fertiliser on Pasture blocks, 155.8 kg/ha as synthetic and 0 kg/ha as organic.
N imported in supplements	Imported 7 kg/ha of nitrogen from supplements.
Irrigators	Linear and centre Pivot - Fixed (100%)

CHANGES BETWEEN THE YEARS 2022 AND 2023

NUTRIENTS

- N Surplus has increased by 20.0 kg/ha (11%).

ANIMALS

- Total pasture production has increased by 175,737 kg DM (9%).
- Average pasture production per ha has increased by 1,456 kg DM/ha (9%).

CROPS

- Cropping area has increased by 12.2 ha (100%).
- Crops by area: Pasture has decreased from 12.2 ha to 0. Oats (green manure) has increased from 0 to 12.2 ha. Kale has increased from 0 to 12.2 ha.

FERTILISER

- N applied as synthetic fertiliser has increased in the months December (235 kg : 14%)

N 56 kg/ha

P 0.7 kg/ha

GHG 11,940 kg/ha

NCE: 35

[REMOVE FROM TIMELINE](#)

[VIEW ANALYSIS](#)

203.2022

2023

Type of analysis	Year end
Area	Total area is 137.7 ha. Productive area is 120.7 ha. Irrigated area is 15.078 ha. Effluent area is 76 ha.
RSU	Total stock rate is 25.7 RSU/ha. This is 100% Dairy
Nitrogen	N surplus is 196 kg/ha. Average annual drainage is 557.2mm
N applied to pasture	N applied as fertiliser on Pasture blocks, 155.8 kg/ha as synthetic and 0 kg/ha as organic.
N imported in supplements	Imported 7 kg/ha of nitrogen from supplements.
Irrigators	Linear and centre Pivot - Fixed (100%)

 PHYSICAL	Farm area has increased by 13.0 ha (9%).
 NUTRIENTS	- N loss per ha has decreased by 13.0 kg/ha (23%). - P loss per ha has decreased by 0.1 kg/ha (14%). - N Surplus has decreased by 12.0 kg/ha (6%).
 GHG	- GHG emissions per ha has decreased by 1,118 kg/ha (9%). - Nitrous oxide emissions per ha has decreased by 383 kg/ha (14%). - Carbon dioxide emissions per ha has decreased by 288 kg/ha (22%).
 DRAINAGE/WETLANDS	Wetland area has increased from 0 to 12.9 ha.
 ANIMALS	N in imported supplements has decreased by 2.0 kg/ha (29%).
 CROPS	Crops by area: Kale has decreased from 12.2 ha to 0. Rape has increased from 0 to 12.2 ha.
 IRRIGATION	- Irrigation applied has decreased by 73,579 kilo litres (77%). - Irrigated area has increased in the months January (2 ha : 13%), February (2 ha : 13%), November (2 ha : 13%), December (2 ha : 13%) - Irrigation applied has decreased in the months January (16,981 kilo litres : 74%), February (13,136 kilo litres : 62%), November (22,862 kilo litres : 92%), December (20,600 kilo litres : 77%) - Irrigation system changes by area: Linear and centre Pivot has increased by 7.6 ha (13%). - Irrigation management changes by area: Fixed depth; fixed return period has decreased from 60.3 ha to 0. Trigger point; fixed depth applied has increased from 0 to 67.9 ha.
 FERTILISER	- N applied as synthetic fertiliser has increased in the months April (364 kg : 11%), August (376 kg : 13%), November (751 kg : 13%) - N applied as synthetic fertiliser has decreased in the months February (3,081 kg), December (1,337 kg : 69%)
 STRUCTURES	Animal structure changes by animal time spent: Feed pad has increased from 0 to 7.0 % animal days.

2026

Type of analysis	Plan
Area	Total area is 150.6 ha. Productive area is 120.7 ha. Irrigated area is 16.965 ha. Effluent area is 63 ha. Wetland area is 12.9 ha.
RSU	Total stock rate is 23.3 RSU/ha. This is 100% Dairy
Nitrogen	N surplus is 184 kg/ha. Average annual drainage is 546.6mm
N applied to pasture	N applied as fertiliser on Pasture blocks, 123.8 kg/ha as synthetic and 0 kg/ha as organic.
N imported in supplements	Imported 5 kg/ha of nitrogen from supplements.
Structures	Feed pad
Irrigators	Linear and centre Pivot - Trigger point; fixed depth applied (100%)

CHANGES BETWEEN THE YEARS 2026 AND 2030

203.2025

 PHYSICAL	Farm area has decreased by 13.0 ha (9%).
 NUTRIENTS	- N loss per ha has increased by 12.0 kg/ha (28%). - P loss per ha has increased by 0.1 kg/ha (17%). - N Surplus has decreased by 16.0 kg/ha (9%).
 GHG	- GHG emissions per ha has increased by 951 kg/ha (8%). - Methane emissions per ha has increased by 481 kg/ha (6%). - Nitrous oxide emissions per ha has increased by 286 kg/ha (12%). - Carbon dioxide emissions per ha has increased by 184 kg/ha (18%).
 DRAINAGE/WETLANDS	Wetland area has decreased from 12.9 ha to 0.
 ANIMALS	- Total pasture production has decreased by 291,602 kg DM (13%). - Average pasture production per ha has decreased by 2,416 kg DM/ha (13%).
 CROPS	- Cropping area has decreased by 12.2 ha (50%). - Crops by area: Oats (green manure) has decreased from 12.2 ha to 0. Rape has decreased from 12.2 ha to 0. Pasture has increased from 0 to 12.2 ha.
 IRRIGATION	- Irrigation applied has increased by 73,579 kilo litres (338%). - Irrigated area has decreased in the months January (2 ha : 11%), February (2 ha : 11%), November (2 ha : 11%), December (2 ha : 11%) - Irrigation applied has increased in the months January (16,981 kilo litres : 285%), February (13,136 kilo litres : 164%), November (22,862 kilo litres : 1225%), December (20,600 kilo litres : 346%) - Irrigation system changes by area: Linear and centre Pivot has decreased by 7.6 ha (11%). - Irrigation management changes by area: Trigger point; fixed depth applied has decreased from 67.9 ha to 0. Fixed depth; fixed return period has increased from 0 to 60.3 ha.
 FERTILISER	- N applied as synthetic fertiliser has increased in the months January (1,796 kg), December (1,102 kg : 188%) - N applied as synthetic fertiliser has decreased in the months April (364 kg : 10%), August (376 kg : 11%), November (751 kg : 11%)
 STRUCTURES	Animal structure changes by animal time spent: Feed pad has decreased from 7.0 % animal days to 0.

2030

Type of analysis	Plan
Area	Total area is 137.7 ha. Productive area is 120.7 ha. Irrigated area is 15.078 ha. Effluent area is 56 ha.
RSU	Total stock rate is 25.7 RSU/ha. This is 100% Dairy
Nitrogen	N surplus is 168 kg/ha. Average annual drainage is 553mm
N applied to pasture	N applied as fertiliser on Pasture blocks, 142.5 kg/ha as synthetic and 0 kg/ha as organic.
N imported in supplements	Imported 5 kg/ha of nitrogen from supplements.
Irrigators	Linear and centre Pivot - Fixed (100%)

Appendix 4:
Journeaux “Valuation of the Benefits of the OVERSEER® Nutrient Budget
Model”, 2 Sept 2016

Valuation of the Benefits of the OVERSEER[®] Nutrient Budget Model

2 September 2015

**Phil Journeaux
AgFirst Waikato**



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Executive Summary

This project was initiated by the Overseer Owners, in an endeavour to value the benefits of the OVERSEER model with respect to two aspects:

- (i) The value of the benefits of the current model; and
- (ii) The value of the benefits of the model's ongoing development

The literature on valuing software was of limited use, in that it very largely concentrates on the commercial value of software. There was no literature discovered on valuing the benefits from the use of software.

The exercise therefore was based around determining the benefit of the use of Overseer in three key areas:

- (i) As a research tool
- (ii) As a tool to assist the efficiency of fertiliser use, and
- (iii) As a tool to assist in nutrient management on-farm, particularly around limits on nutrient discharges.

The methodology used to measure this benefit value was largely based on expert opinion; people with expertise and experience in agri-environmental issues and the use of OVERSEER were interviewed as to their thoughts on the benefits accruing from OVERSEER, and particularly how the objectives sought could be achieved in the absence of OVERSEER. These people came from a range of different perspectives. Their views on the absence of OVERSEER was used to develop a "with versus without" scenario, with the difference being used as a basis to estimate the value.

As could be anticipated, information in a number of areas was relatively sparse, and a number of assumptions have been made. Based on these assumptions, estimates have been made relating to the three areas noted above:

- (i) As a research tool: \$51 million/year (range \$26 - \$102 million)
- (ii) As a tool to assist the efficiency of fertiliser use: \$107 million/year (range \$54 - \$161 million)
- (iii) As a tool to assist in nutrient management on-farm: \$113 million/year (range \$73 - \$137 million)

This gives an overall estimated value of \$271 million/year (range \$153 - \$400 million)

If this is treated as an annuity in perpetuity, and converted to a Present Value at an 8% (real) discount rate over 50 years, it gives a value of \$3.3 billion, with a range of \$1.9 - \$4.9 billion.

These figures must be regarded as indicative only, given the range of assumptions and extrapolations that lie behind them. This is particularly so for the estimate of value in assisting with nutrient management, and further work is required to obtain a more definitive figure.

The second component, of the value of continuing to develop OVERSEER, is more problematic. It is inherent within the value of benefits calculated in this paper (as noted above) that they are ongoing, and inherent within this is that the model continues to be developed. In this sense the ongoing value of the current model (as calculated by the NPV) is only valid if the model is kept up to date and new science incorporated. While future development of OVERSEER is therefore essential in maintaining the current benefit of the model going forward, the addition of new science and features also means that the benefit from the model would increase.

In essence what is required therefore is an estimate of whether the marginal (or incremental) benefit from future development is greater than the marginal cost of the development. Determining this is very difficult given the issues in determining the marginal value of the benefit of future development.

The people interviewed as part of this study were unanimous as to the need for further, and continuous, development of OVERSEER, given the value they perceive the model provides to New Zealand agriculture and New Zealand Incorporated, especially in consideration of any alternatives.

1. Background

OVERSEER® is computer software which models the nutrient flows onto and off a farm. It is a long-term equilibrium model which was originally developed for advising/informing farmers and growers on nutrient management on-farm. Increasingly though it is used by regulatory authorities (e.g. Regional Councils) as a tool to measure and monitor nutrient losses (nitrogen and phosphorous) off-farm. As such it is increasingly used to underpin nutrient discharge policies and regulations, given that it is the only tool readily available to quantify diffuse discharges at a farm level.

The OVERSEER owners (Ministry for Primary Industries, The Fertiliser Association of NZ Inc, and AgResearch) want to calculate the value of the benefit of OVERSEER, to validate the benefits of past and current investments and inform future decisions around funding and development.

Within this, the OVERSEER Owners are looking to establish two “values”:

- (i) The value of the benefit of the current model; and
- (ii) The value of continued development of the model in the sense of trying to establish the marginal/incremental benefit from further development; i.e. is the marginal benefit from future development greater than the cost. This would also help prioritise future development.

2. Methodology

The methodological approach to this project was:

- (i) A review of any relevant literature, and
- (ii) (Mostly) interviews with personnel with a range of different perspectives as to the use of OVERSEER, and the benefits accruing. The interviewees were chosen (arbitrarily, but with an endeavour to cover a range of organisations) as people with expertise and experience in agri-environmental issues and the use of OVERSEER, and were interviewed as to their thoughts on the benefits accruing from OVERSEER, and particularly how the objectives sought could be achieved in the absence of OVERSEER. The intent was to endeavour to establish “with versus without” scenarios, with the difference being used as a basis to estimate the value of the benefit. As part of this, opinion was also sought as to the proportion of any value which would accrue to the use of OVERSEER.

The interviews were one on one; some face to face, while most were conducted over the phone.

The questions used in the interview, and a list of people interviewed is shown in Appendices 1 & 2.

3. Valuing Software

There are a number of methodologies available to value software (Wiederhold, 2007, Drommi et al, 2013), but ultimately these relate to a commercial value, and require a price on the software which can be related back to the cost of production, maintenance, and enhancement. None related to valuing the benefits from the the use of the software.

Since its inception, OVERSEER has been disseminated free to users, on the premise that much of the development funding has been public money and hence the software is a “public good”. This goes to the heart of the issue of valuing the benefit, as OVERSEER has a range of both tangible and intangible benefits. The primary beneficiary of OVERSEER is the agricultural sector, but this then has significant spill-over effects over the wider New Zealand economy.

The key benefits of OVERSEER could be summarised as:

- (i) It has a direct benefit to research, in that it readily allows scientists to model systems being researched as to their impact on nutrient balances, thereby speeding up the whole process. It also provides a common platform for this modelling, which eliminates discrepancies if differing models were used;
- (ii) It allows farmers to optimise their on-farm nutrient management, resulting in efficiencies in fertiliser usage, and hence helping to optimise profitability; and
- (iii) By quantifying nutrient losses off-farm, it allows regulators to adopt effects based (i.e. output) policy and regulations rather than rules based on-farm input controls, which are inherently more inefficient with respect to their impact on farm productivity. This approach benefits both the agricultural sector and the wider community, in enabling flexibility in production systems while achieving environmental mitigation.

The paper concentrates on the value of the benefits of using OVERSEER, with respect to the three points noted above.

4. Benefit to Research

Currently the New Zealand primary sectors are grappling with the issue of farming within limits with respect to nutrient discharges and greenhouse gas emissions. This involves trade-offs between profitability and environmental footprint, which in turn requires the ability to quantify losses relative to changes in farm systems.

Within the research arena therefore, OVERSEER is used as the base environmental footprint model at the on-farm¹ level.

While losses can be measured within field trials and experiments, they need to be quantified as part of a farming system. In this respect OVERSEER offers a relatively quick and easy way to achieve this; the use of the model allows the researcher to more easily assess the system's impact on nutrient and greenhouse gas losses, as well as highlighting some of the unintended consequences of systems change.

If OVERSEER did not exist then it would be possible to work out nutrient/GHG discharges from first principles, but at the cost of significantly more time. Similarly, while it would be quite possible to develop spreadsheets to do these calculations, they:

- (i) Would not necessarily cover all the nuances and inter-relationships captured by OVERSEER, and
- (ii) Would be very likely to be inconsistent between spreadsheets given that most scientists would want to construct their own.

The discussion around this issue highlighted two key points:

- (i) For better or worse there is only one nutrient budget model readily available - OVERSEER - so there are no inconsistencies, and
- (ii) The scientists talked to quickly affirmed that if they didn't have OVERSEER, such a model would have to be built as they didn't fancy working everything out from first principles and by long-hand.

The key benefits to research therefore are:

1. The time and effort saved by having a model such as OVERSEER to quickly calculate environmental footprints, and
2. Having the one model means there is consistency (assuming the OVERSEER Best Practice Data Input Standards are followed) in calculations between differing trials and science groups, and as part of this provides a common "language" for discussions around nutrient management research.

In addition there are other direct benefits:

3. Using the model readily informs if there are research gaps which in turn aids and informs research development. Examples of this would include; the fate of urine and the ability to model this, and nitrogen in irrigated pasture;
4. Having OVERSEER means that there is a vehicle to use research in a systems context, which is of direct benefit to both the researcher and the industry; and

¹ In this context farm = a land based operation, covering pastoral, horticulture, and cropping farms.

5. It also offers a direct-to-market technology transfer tool for research results.

The question that then arises, is how to monetise these benefits. The short answer is “*with difficulty*”, although a rough estimate can be generated based on existing data on research spend on agricultural and environmental science and the extent to which OVERSEER is used. Current spending on agricultural and environmental research in NZ is in the order of;

Table 1: Agricultural and Environmental Expenditure in NZ²

	\$m/year
General Agricultural R&D (2012, Govt spend)	213
General Environmental R&D (2012, Govt spend)	196
General Agricultural R&D (2012, Business spend)	194
General Environmental R&D (2012, Business spend)	17
Total	620

Source: Statistics NZ

The degree to which OVERSEER would be used within this work would vary widely. While there are some research programmes, e.g. Pastoral 21, Greenhouse Gas Mitigation and Adaption, some of the PGP programmes, where it would be used heavily, there are other areas, particularly in some of the non-agricultural environmental R&D, where it would be seldom used if at all.

In addition to this the above expenditure would also include the overhead costs of the R&D establishment (e.g. CRI's), where the existence or otherwise of OVERSEER would have little bearing.

It must be noted that the research would continue in the absence of OVERSEER; the benefit of OVERSEER is in reducing time and inconsistency costs associated with the research. If an estimate (by the author) of 5% of the value of the environmental R&D, and 10% of the agricultural R&D is ascribed to this, the benefit is \$51 million per year, with a range of (say) \$26 million (2.5% and 5% respectively) to \$102 million (10% and 20%).

6. Benefit for Efficiency of Fertiliser Usage

6.1 Maintenance Fertiliser

From the mid 1980's to the mid 1990's fertiliser recommendations in New Zealand around phosphorous and sulphur were very largely based on the Cornforth and Sinclair model (Cornforth & Sinclair 1984) which was based on static models that balanced fertiliser inputs with nutrient losses, but could not predict the effect of different fertiliser rates on soil fertility and farm production. The advent of “Outlook” (Metherell et al 1997 – an econometric model that also incorporated economics) and shortly thereafter OVERSEER (Edmeades, 2012) saw these recommendations

² Information to differentiate this research into topic area was not readily available

based on a dynamic biophysical model of P and S nutrient cycling, and pasture and animal production in pastoral farms.

As part of the interviews, the question was raised as to how farmers would obtain best fertiliser recommendation advice in the absence of OVERSEER, particularly pertaining to maintenance applications of phosphorous. Note this related to pastoral farming, as OVERSEER is not extensively used at present for fertiliser recommendations in horticulture or arable cropping.

It was noted that OVERSEER is not designed to deliver fertiliser recommendations, but is used by advisers to inform the development of their recommendations (based on the models estimate of maintenance requirements)

The general responses were:

- There would be a need to go back to guidelines and look-up tables based on the Cornforth-Sinclair model.
- There would be an increase in the level of soil testing to monitor soil P levels, with fertiliser application adjusted as trends became apparent.
- Many would go back to “rule of thumb” approaches
- The cost (of fertiliser recommendations) may well increase as advisors would need more time to calculate recommendations

All noted that in the absence of OVERSEER fertiliser recommendations would be relatively more simplistic, as it would be very difficult to take into account all the variables that OVERSEER does, such as the intensity of the farming system, effluent inputs, level of supplementary feeding, etc.

There was a range of opinion as to whether more or less fertiliser would be applied. Some felt that advisers would be more cautious, with less fertiliser applied, while most felt the opposite – that more fertiliser than necessary would be applied. Most respondents also felt that there would be a greater degree of inconsistency in recommendations.

There was some comment that OVERSEER has limitations with respect to fertiliser recommendations; it couldn't establish where on the nutrient response curve the farm is, and lacked the ability to calculate economically optimum applications (aka the econometric model). But that it was good for scenario comparisons.

The question was raised with respondents as to the difference in the efficiency of P fertiliser usage with or without OVERSEER (given that in the “with” scenario it was used according to best practice guidelines).

The responses varied from nil (didn't think OVERSEER added any more accuracy, but just codifies existing knowledge) through to up to 60%. Most responses were in the 10-30% improvement range.

This could be used as the basis of determining a value of the benefit of OVERSEER in this area.

Table 2: Phosphorus Usage in New Zealand (000t)

1999/00	177.3	2007/08	170.0
2000/01	200.9	2008/09	114.0
2001/02	211.3	2009/10	139.8
2002/03	208.1	2010/11	147.4
2003/04	217.7	2011/12	148.6
2004/05	218.6	2012/13	132.5
2005/06	188.6	2013/14	138.2
2006/07	177.2		

Source: Fertiliser Association of NZ

The 5 year average 2009/10 – 2013/14 is 141,300 tonnes of phosphorus, or the equivalent of 1.57 million tonnes of superphosphate.

Given the following assumptions:

- (i) Proportion of phosphorus used in the horticulture and arable sectors = 15% (No direct statistics are available. Horticulture and arable take up 6% of agricultural land use, but use more fertiliser per unit area)
- (ii) Proportion of the remainder used for maintenance (on pastoral farms) = 75%
- (iii) Applied cost of superphosphate = \$400/tonne

Assuming a 20% improvement in fertiliser usage efficiency (as a mid-point on the above response range), then the value = \$80 million/year, with a range of \$40m (10% improvement) through to \$120m (30% improvement).

[Mid-point calculation being: 1.57 million x .85 (take out the 15% for horticulture & arable) x .75 x \$400]

6.2 Differential Fertiliser Application on Dairy Effluent Blocks

Another component of the benefit of OVERSEER is its role in identifying the need for differential fertiliser recommendations on dairy effluent blocks both as a cost saving measure (reduced need for fertiliser) and as a preventative animal health option (reduced potassium inputs).

The value of more efficient fertiliser application to dairy effluent blocks can be estimated as follows:

Table 3: Fertiliser Value of Dairy Effluent

	Nitrogen	Phosphorous	Potassium
kg/100 cows*			
System 1	782	90	750
System 2	1,058	135	1,050
System 3	1,150	162	1,075
Av Farm Value**			
System 1	\$4,037	\$591	\$4,306
System 2	\$5,462	\$886	\$6,028
System 3	\$5,937	\$1,063	\$6,171

* Source: Dairy NZ 2013.

** Average farm = 413 cows/144 ha (LIC 2015). Current August 2015 fertiliser prices used

The value of the saving in phosphorous is very likely to be a double count with the maintenance saving calculated earlier, and as such is taken out of the subsequent calculations discussed below.

The weighted average³ saving across the farm systems is \$11,451 for the average farm, excluding phosphorous.

As per the earlier discussion, in the absence of OVERSEER, fertiliser applications on dairy effluent areas can be calculated from first principles. The benefit of OVERSEER is that the calculation is done far more expeditiously, and probably far more accurately. Another benefit of OVERSEER is that it can easily be used, in a reverse sense, for calculating the required effluent area for an individual farm.

If the same parameters for the improvement in efficiency via OVERSEER is used as earlier (20% mid-point, range 10-30%), and extrapolated over the national herd (11,927 farms LIC 2015), the benefit gained is \$27.3 million (range \$13.6m - \$41m)

The overall annual benefit from more efficient fertiliser usage (maintenance and effluent savings) is therefore \$107.3 million, with a range of \$53.6 to \$161 million.

6.3 Alternative Methodology

An alternative approach to the above, at least for dairy farms, would be to calculate the level of “over-fertilisation” if the effect of dairy effluent and brought-in feed is not taken into account.

The calculation around dairy effluent is above. Calculating the value of bought-in feed presents its own issues, particularly in obtaining relevant data, with the most obvious being getting good figures on the level of direct inter-farm trading of feedstuffs. Given these difficulties this approach was not used.

³ Based on 30% of farms = System 1 or 2, 41% = System 3, 29% = System 4 or 5. Dairy NZ 2015

7. Benefit for Nutrient Management

This component relates to the use of OVERSEER in managing nutrient and greenhouse gas losses from farm. The main purpose of the discussions was to endeavour to establish a “with versus without” scenario which could then be possibly measured so as to establish the benefit of using OVERSEER in this arena.

In the course of the discussions there was some debate as to whether OVERSEER should be used, and/or how, in a regulatory environment (with respect to setting/monitoring discharge limits). This aspect is outside the scope of this study, and hence is ignored.

7.1. Nutrient Management in the Absence of OVERSEER

The discussion here was centred on how nutrient discharge limits could be set and monitored at a farm level.

A number of respondents noted that while water quality levels could still be measured within water bodies, the issue then became how to ascribe this to individual farms. A number of suggestions around this;

- (i) Direct measurement of nitrogen leaching via lysimeters, although the high cost of this (upwards of \$100,000/farm) would prohibit it in the majority of instances;
- (ii) Operate at a sub-catchment level; if the farms were reasonably homogenous then ascribe equal limits to each farm;
- (iii) Measure the water quality in streams at the top and bottom of each farm and use this as the basis for limits/monitoring, although Southland work has shown this to be somewhat ineffective (Cameron, 2015);
- (iv) Use the results of R&D and apply “rules of thumb” to setting limits;
- (v) Get farmers to use GAP/MGM (Good Agricultural Practices/Matrix of Good Management) approaches – know from R&D what general impact these have on nutrient losses. But difficult to establish a link between this approach and nutrient losses over time;
- (vi) Use an “input less output” approach; it would be possible to calculate (say) the amount of nitrogen going into a farm system, and the output in terms of product going out the gate. The difference would be “lost” nitrogen which would be the factor used to set the limit/monitor losses, although it would not be possible to differentiate these “losses”, e.g. whether nutrient or greenhouse gas. This approach would be significantly cruder relative to OVERSEER.

Most felt that while there are various pros and cons around the above approaches, none would be as efficient as using OVERSEER.

Almost all (90%) the interviewees felt that the most likely approach in the absence of OVERSEER was that the Councils would need to go to an input control type approach.

Most felt that the input controls would need to be relatively onerous (i.e. across the board) in order to ensure any reductions were achieved. Several interviewees cited the European experience, where the main control was on stocking rate, which was readily circumvented by increasing the level of feeding via supplements to achieve a higher per animal production, thereby somewhat negating the purpose of the control.

One suggestion was to put a cap on production (e.g. for dairying, stipulate a maximum production per hectare). The theory being that this would work backwards to restrict inputs.

The end result would be strict controls affecting the farming system. So for (a hypothetical) example, if the water quality testing of adjacent water bodies indicated that a 30% reduction in nitrogen was required, then stocking rates, fertiliser inputs, supplementary feed input from outside the farm, would all have to be reduced by 30%. [Or whatever the relative figure was – responses are not necessarily linear; for example if stocking rate is reduced, animals will eat more pasture, thereby increasing their per head production, as well as excreting more nitrogen. Doole (2013b) notes:

Input-based policies suffer from a number of complications. First, within these farming systems, there is invariably a low correlation between the use of a single farm input and N leaching. For example, stocking rate is a key determinant of N leaching, but large stocking rate reductions of 17 and 30 per cent are still required to achieve N leaching reductions of 10 and 20 per cent, respectively, due to the imperfect correlation. This finding can likely be extrapolated to all grazing systems, given the complicated relationship between input use, production and nitrate leaching (de Klein et al. 2010). Second, leaching levels may remain high under an input-based policy because of substitution with unrestricted inputs. For example, allowing no use of N fertiliser reduces profit by around 30 per cent, but only decreases leaching by around 5 per cent, as supplement use increases by 80 per cent to sustain stocking rate. This behaviour is expected to hold for grazing systems generally, provided that there is some degree of substitutability between the relevant factors. Third, policies that restrict the use of two inputs are costly. For example, restricting nitrogen fertiliser application and stocking rate reduces profit by 30 and 40 per cent for the 10 and 20 per cent N leaching goals, respectively].

Respondents felt that in the absence of any quantifiable data, Councils would tend to be more precautionary, and hence err on the conservative side. The advent of input controls would also have other issues;

- (i) Most Councils felt that an input control system would involve greater cost in auditing farm compliance, although some felt that the cost would be similar if not less than an OVERSEER/output approach – they felt that an input control approach would actually be simpler to enforce. The experience in the Netherlands of the MINAS (Mineral Accounting System) program – a

mechanism to regulate nitrogen and phosphorous surpluses, indicated high administration and transaction costs (OECD 2005).

- (ii) While it would be possible to monitor water quality in adjacent water bodies, trends at an individual farm level could not be monitored.
- (iii) All respondents felt that an input control approach would stifle innovation, relative to an output based approach (based around using OVERSEER). Comments were:
 - If there is a cap on nutrient losses, then we want to encourage innovation as much as possible to maintain productivity/profitability.
 - Input control would constrain farm management; the advantage of OVERSEER is that it allows farmers to explore different management scenarios and hence increases/allows flexibility.
 - Within the horticultural sector, farmers often grow a range of crops on different parts of the farm both within and between years as part of their rotation management. The use of models (to measure nutrient discharges) can ensure this continues, whereas input controls would seriously disrupt this.
 - Example 1. A dairy farmer was seeking to convert a sheep & beef property to dairying. The nitrogen discharge limit was only 10% above the current sheep & beef level. The farmer converted the farm based on a fully housed/cut & carry operation. The end result being a much more intensive system but within the nitrogen discharge limit. The Council noted that without OVERSEER to model this, they would not have allowed the development to happen.
 - Example 2. A farmer reduced his nitrogen leaching well below the set limit, and was able to transfer the difference to other land and intensify it, while staying within the overall limit (of both blocks of land). Again this would not be possible without OVERSEER.
- (iv) While most felt that innovation would be enhanced under an output based limit system, some did note that the advent of regulation (aka input controls) often stimulates innovation as people try to find ways around the constraint.

7.2. Valuing the “With Versus Without” Gap

Some limited work has been done in New Zealand around the cost of input controls (Doole 2010, 2013a, 2013b), although this was not a comparison between input control versus output based regulatory systems.

In the 2013a paper, based on a Waikato River sub-catchment, Doole did provide some figures that illustrate a possible value; for the case study catchment the cost of achieving the required discharge limits under a cap and trade system was \$0.6 million, or \$1,807/dairy farm, as opposed to \$5.1 million, or \$15,361/farm under a uniform cap on stocking rates.

A cap and trade system involving diffuse discharges, could not operate without OVERSEER, whereas a uniform cap on stocking rate is simply an input control which does not require OVERSEER. In this sense therefore, a reasonable component of the value differential of the cap & trade system could be attributed to OVERSEER.

This question was posed to the interviewees; given the example above, what proportion of the benefit could be accrued to OVERSEER, given its critical role in the cap and trade process.

Responses:

1. Some felt that a cap and trade scheme could operate in the absence of OVERSEER, utilising other units of trade, e.g. cow numbers, gross nitrogen input/output. Most of the Councils felt that, if they were to allow a cap and trade system, it would be very unlikely that they would consider anything other than an OVERSEER-based system, trading in either nitrogen or phosphorous units, as the alternatives were too uncertain.
2. A few felt that OVERSEER wasn't suitable to allow trading, given changes in calculated output figures as the result of Version changes. They felt that this was too much of a disruptor, and either another mechanism other than OVERSEER be found as a monitoring/measurement tool, or that the Council would have to stay with a certain version of OVERSEER – which then has the disadvantage of not allowing mitigation strategies to be claimed as they are added to future versions of OVERSEER.
3. Most agreed that a cap and trade system involving diffuse discharges could not operate without OVERSEER. The proportion of the benefit of this system they attributed to OVERSEER varied widely, depending on how they valued other contributors, such as the policy framework.

Some (25%) gave it a 40-50% attribution, whereas the majority (70%) indicated 70-100% (with some just noting “very high”) of the benefit, based mainly around the need for a tool that could measure outputs and allow monitoring of this over time.

These two factors could then be used as a basis to estimate a value of the benefit of OVERSEER in managing nutrient loss from farms. Namely;

- (i) An estimate of the value of an outputs based system based around the use of OVERSEER relative to an inputs based system, and
- (ii) An estimate of the contribution of OVERSEER to this benefit, based on an “expert opinion” basis.

An example of this would be an extrapolation of the benefit noted above as calculated by Doole et al (2013a). This is an extrapolation too far, but illustrates the methodology:

- Difference in benefit between the “with/without” OVERSEER approach = \$13,544/dairy farm
- Number of dairy farms in New Zealand = 11,927 (LIC/Dairy NZ 2015)
- Proportion of benefit attributable to OVERSEER = 70%

Overall OVERSEER benefit = \$113 million/year, with a range of \$73 million (45% of the benefit attributable to OVERSEER) through to \$137 million (85% of the benefit attributable).

Further work would be required to obtain more representative data at a national level that could be extrapolated with more confidence. Discussions (Doole pers com) indicate that a more definite value could be derived, via modelling representative farms across different sectors (dairy, sheep & beef, horticulture, arable), across a range of representative regions, as a basis to identify the value difference of the gap between an input control approach and a nutrient output-based approach.

7.3. Consultancy Value

Somewhat similar to the research component discussed earlier, there is also a value which accrues to consultancy work. In noting this though, the vast bulk of this work is modelling work involving tools such as Farmax to consider various farm management scenarios and then transferring this into OVERSEER to consider the nutrient discharge impact.

This is largely done for farmers directly, or for Regional Councils, in endeavouring to find systems that can comply with nutrient discharge limits. This is part of the issue discussed above in Sections 6.1 and 6.2 above, and in that respect much of the value of the benefit is (or will be) captured as part of that calculation.

7.4 Other Benefits

As part of the discussions, other benefits of OVERSEER were also noted:

- (i) It provides a tool for education around nutrient and greenhouse gas management, with three Universities using it in their courses.
- (ii) It provides a consistent assessment across a range of farm systems and land management across New Zealand. This has advantages for inter-regional comparisons, and capability – someone trained in one region can easily work in another.
- (iii) It has advantages for advisors being certified in nutrient management.
- (iv) OVERSEER has also provided a forum where production and environmental issues can be discussed contemporaneously. Previously they tended to be discussed in isolation to each other.

- (v) One of the benefits of OVERSEER was that it is possible to evaluate the cost effectiveness of different mitigation practices; in the absence of OVERSEER this would be very difficult and could lead to mitigations with limited efficacy being invested in.
- (vi) In a similar vein, the potential impact of nutrient discharge constraints on land values was raised, with the thought that there is a value to the financial sector in not (or limiting) lending to farms at risk. In this sense, OVERSEER is acting as a risk management tool. While banks are lending to farmers on the basis the farmers are compliant within any consent limits, and budgets provided are assumed to be operating within any nutrient discharge limits (Williams, pers com), the advent of nutrient discharge constraints does bring a new complexity to the situation. While consents for (say) effluent systems are relatively straight forward, nutrient discharge limits can mean a fundamental change to the farm system, which has implications for asset values and/or cash flows.

If, for example, a farmer buys a farm in a nutrient constrained catchment, and particularly if land use is to be changed, the bank must be confident that the asset value will be maintained and debt servicing won't be compromised. In this sense OVERSEER definitely has a value to the banks, although this is (again) difficult to quantify (Holgate, pers com).

8. The Benefit of OVERSEER

As outlined in this paper, estimates have been made of the various components of the value of the benefit of OVERSEER. Summarised, they are:

1. Benefit to research, estimated at \$51 million/year (\$26 - \$102 million)
2. Benefit in increasing the efficiency of fertiliser usage, estimated at \$107 million/year (\$54 - \$161 million)
3. Benefit in nutrient discharge management, estimated at \$113 million/year (\$73 - \$137 million)

This gives a total benefit of \$271 million/year, with a range of \$153 – \$400 million.

Taking this as an annuity in perpetuity, and converting it to a Present Value figure, using the Treasury discount rate of 8% (real), over 50 years, the benefit value is approximately \$3.3 billion, within a range of \$1.9 billion to \$4.9 billion.

These figures are indicative only, given the assumptions and extrapolations made.

It must also be noted that the calculation of its benefit for nutrient management has ignored several sectors, e.g. sheep & beef, horticulture, and arable, as no data is available – notwithstanding that horticulture and arable cropping are not currently major users of OVERSEER.

Plus – to point out the obvious, this is an estimate of the value of the benefits from the use of OVERSEER, not an estimate of its commercial value. These benefits are captured across a wide range of people, organisations, and firms.

9. Alternative Approach

Given the difficulty in directly linking influences and benefits as a result of the use of OVERSEER, another approach is to link OVERSEER to the value of the farming systems it supports.

Sinclair (2013) does this by highlighting a number of catchment studies across New Zealand:

“highlighting just five regional catchment studies across New Zealand with specific attention to pastoral livestock activities, primarily dairying and to a lesser extent sheep and beef, and assuming current or potential environmental sustainability for current or expanded farm system use, per catchment/region farm gate gross revenues of \$24 million to \$2.5 billion have been ascertained where OVERSEER (in part) underpins the value. Given the perspective that OVERSEER is used widely across New Zealand, the contribution (in part) of OVERSEER to the primary sector would be considerable in both supporting industry value and environmental sustainability”.

While this approach does not give a distinct value of the benefits of OVERSEER per se, it reflects the value of the model in supporting New Zealand's agricultural industries. This is likely to grow as nutrient discharge limits continue to be imposed across much of New Zealand's farming landscape.

10. The Worth of Future Development of OVERSEER

The issue behind this is whether it's worth continuing to invest in OVERSEER, i.e. is the marginal or incremental benefit from future development greater than the cost.

Given the issues in determining value of the benefits of the model, this question is very difficult to ascertain, and would vary depending on the differing improvements or expansions; a small improvement in accuracy may have significant benefits, whereas an improvement for a particular farming system may have limited (wider) benefits. It is inherent within the value of benefits calculated in this paper that they are ongoing, and inherent within this is that the model continues to be developed. In this sense the ongoing value of the current model (as calculated by the NPV) is only valid if the model is kept up to date and new science incorporated. While future development of OVERSEER is therefore essential in maintaining the current benefit of the model going forward, the addition of new science and features also means that the benefit from the model would increase.

There was unanimous agreement from the interviewees there needed to be continuous development of OVERSEER; no-one wanted to see development stall at the current Version 6.2.0, and everyone felt there needed to be a "big bang" in funding in order to catch-up on new science in some areas, expand and incorporate validation work, and ensure sufficient funding into the future. It was noted that the "wish-list" of OVERSEER improvements was quite long, and again serious funding is needed to address this.

There were some cautions with this, particularly the need to ensure that there are sufficient people resources behind OVERSEER to (a) develop the model, and (b) maintain and provide servicing help as the model expands.

It was also noted that:

- (i) OVERSEER will largely be in a catch-up mode as new science comes to hand, and
- (ii) In as much as it was not developed as a regulatory tool, but is increasingly used as one, work is required as to how best to use it in such a role. (Or, how to frame regulations to best use OVERSEER).
- (iii) Farming in New Zealand faces a range of issues, including rising on-farm cost inflation. The future development of OVERSEER helps to address this by helping to maintain the flexibility of farming systems.
- (iv) OVERSEER offers the possibility for greenhouse gas trading at a farm level if that eventuates.

In posing the above question, i.e. is further investment in OVERSEER likely to have benefits greater than costs, most felt that the answer was yes, even though this was largely an act of faith. But everyone felt that OVERSEER, for all the brickbats thrown at it, was far superior to any alternative.

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Appendix 1. People Interviewed

An acknowledgement and thanks to:

Name	Organisation
Trish Burborough	Ministry for Primary Industries
Darran Austin	Ministry for Primary Industries
Nic Vincent	Ministry for the Environment
Viv Smith	Ministry of Business Innovation & Employment
Warwick Catto	Ballance Agri-Nutrients
Mike Manning	Ravensdown
Ants Roberts	Ravensdown
Doug Edmeades	AgKnowledge
Alan Campbell	Waikato Regional Council
Justine Young	Waikato Regional Council
Chris McLay	Waikato Regional Council
Theresa Wilson	Dairy NZ
Pierre Beukes	Dairy NZ
Mark Neal	Dairy NZ
Adrian Brocksopp	Dairy NZ
Keith Cameron	Lincoln University
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Appendix 2. Interview Questions

Interview question areas

1. On-farm nutrient management – fertiliser usage

- (i) How do you envisage farmers/growers getting “best advice” on fertiliser usage?
- (ii) How would you think this would affect the efficiency/optimisation of fertiliser use?
- (iii) What effect would you think this will have on farm profitability?

2. On-farm nutrient management – nutrient discharges

- (i) How do you think farmers could best understand the level of nutrient discharge from their farm?
- (ii) How would they know when they are achieving any nutrient discharge limits? (e.g. if a farmer undertakes an activity, how would they know whether they would be compliant with any discharge rules)
- (iii) What would be the cost (if any) in these alternative approaches?

3. Setting nutrient discharge limits

- (i) In the absence of being able to quantify (diffuse) discharges, what approach would you envisage being taken to set such limits at a farm level?
- (ii) One approach would be via input controls on farming activities (e.g. controlling stocking rates, fertiliser inputs, supplementary feed inputs)
 - (a) How would you envisage these input levels being set?
 - (b) How would you envisage them being monitored/enforced?
 - (c) What impact would you think they would have on farming efficiency and productivity (relative to an output based system)?
 - (d) What impact would you envisage them having on innovation?
 - (e) What are the cost implications of the above?
- (iii) How would you envisage linking the proposed on-farm limits to other catchment-level modelling?

4. Regional Councils

- (i) What implications would there be for the way in which Councils set and monitor nutrient discharge limits? (e.g. are they likely to be more cautious – take a more precautionary approach)
- (ii) What are the cost implications for the Council (if any)?

5. Input systems versus effects/output based systems – value of OVERSEER

One of the advantages claimed for an effects based system is that it allows for a greater degree of flexibility in how any nutrient discharge limits are achieved - farmers can tailor any mitigation that may be required to their specific circumstances. Activity-based rules may lock in particular types of mitigation, which may be less appropriate over time.

A key component that allows for an effects based system is OVERSEER, in that it readily quantifies diffuse nutrient discharges.

Question: Of the total benefits of having an effects based approach, what proportion of the benefit would you ascribe to OVERSEER?

6. Speed of development of OVERSEER

Currently there is a long list of “wants” regarding improvements to OVERSEER. At the current level of funding these improvements will take several years.

- (i) What are your thoughts on this compared to a “big bang” approach where the improvements would be done as soon as possible, but would require significant funding to do so.
- (ii) What value do you place on continuing to enhance OVERSEER (relative to just staying with the existing model (version 6.2))

Appendix 5:

Publications relied upon at paragraphs [22.10] – [22.11]

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(<https://www.massey.ac.nz/massey/fms/Colleges/College%20of%20Sciences/INR/Soil%20&%20Earth%20Sciences/Rivers%20Workshops/Alison%20Dewes%20Solution%20to%20Pollution%20presentation1.pdf?D36C3C68C79B564C6AD511C7E5D40594>)

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