BEFORE THE HEARING PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of proposed Plan Change 2 for the One Plan

JOINT WITNESS STATEMENT OF EXPERTS

FARMING AND GROWING MANAGEMENT PRACTICES; FARM SYSTEMS MODELLING AND FARM-SCALE ECONOMICS

21 and 22 July 2020

INTRODUCTION

1. This joint witness statement relates to expert conferencing on the topics of Farming and Growing Management Practices, Farm Systems Modelling and Farm-Scale Economics.

2. This joint witness statement relates to proposed Plan Change 2 (**PC2**) of the One Plan;

   (a) by examining the on-farm practicability and N leaching loss benefits of 'good management practices', 'best management practices', and the merits of 'additional innovations' in minimising N leaching loss;

   (b) with a particular focus on the usefulness of Overseer and other alternative models in setting limits for IFLU activities and in assessing applications for consent for IFLU activities under PC2; and

   (c) by examining the on-farm economic impacts of a range of 'GMP', 'BMP' and 'additional innovations', where these are adopted or required (to varying degrees) to secure consent for IFLU activities under PC2.

3. The expert conferencing was held on 21 and 22 July 2020 at Palmerston North.

4. Attendees at the conference were:

   (a) **Dr Jane Chrystal**;

   (b) **Richard Parkes**;

   (c) **Adam Duker**;

   (d) **Dr Graeme Doole;**

   (e) **Dr Paul Le Miere;**

   (f) **Dr David Horne;**

   (g) **Stephen McNally;**

   (h) **Dr Anne-Maree Jolly;**

   (i) **Stuart Ford;**

   (j) **Jack Feltham;** and

(k) **Dr Iain Kirkwood.**

CODE OF CONDUCT

5. We confirm that we have read the Environment Court Practice Note 2014, and in particular Appendix 3 – Protocol for Expert Witness Conferences, and agree to abide by it.

PURPOSE AND SCOPE OF CONFERENCING

6. The purpose of conferencing was to identify, discuss and highlight points of agreement and disagreement on farming and growing management practices, farm system modelling and farm system economic issues arising from PC2, and the submissions received on the proposed plan change.

7. In addition, questions arising from pre-hearing meetings between submitters and Horizons have been circulated for our consideration as part of conferencing. We have addressed those relevant to our areas of expertise.

8. The scope of the issues covered at this conference included:

(a) **Horizons One Plan - Plan Change 2**

(b) **Farming and Growing Management Practices, and Farm Systems Modelling.**

KEY FACTS AND ASSUMPTIONS

9. Annexure A

METHODOLOGIES AND STANDARDS

10. Appendix 6 and 7

AGREED ISSUES

11. Refer to Annexure A.

DISAGREEMENT AND REASONS

12. Refer to Annexure A.

PRIMARY DATA

13. None

RESERVATIONS

14. Experts are concerned how GMP and BMP will be used in the consent process. Experts consider that these should be used as a toolbox in the consent process.

15. We are interpreting 5.8 (d)(i) and the rule 14-1 for the controlled activities and the matters to which control is reserved, that GMPs will be imposed on those who are already meeting the table.

16. We need more clarification in the role of GMPs and BMPs, and how they will be used in the consent pathways. The lack of clarity may impact the definition of GMP and BMP.

17. GMP and BMP will evolve, this list should not be exclusive and prevent innovation.

18. Policy 14.6 (f)(i) there is a disconnect with how the nutrient management plan is used in controlled consent pathway, where it is just about compliance to table 14.2 and nitrogen. Compared to where it is used in the discretionary pathway, which widens out to cover all contaminants.

19. There is a need to be clear in the definition and the use of the term of nutrient management plan compared to a farm management plan or other such plans that covers other contaminates that they refer to such as faecal contaminants and sediments.

Date: 21 and 22 July 2020

Dr Jane Chrystal

Richard Parkes

Adam Duker

I sign as an expert under Topic 2. I was not an expert for Topic 1, as this topic is outside my qualifications and expertise as set out in my Statement of Qualifications and Evidence.

Dr Graeme Doole

Dr Paul Le Miere

Stephen McNally

Dr Anne-Maree Jolly

David Horne

Stuart Ford

Jack Feltham

Dr Iain Kirkwood

ANNEXURE A

In the matter of Proposed Plan Change 2

Expert conferencing – Farming and Growing Management Practices; Farm Systems Modelling; and Farm-Scale Economics

Issue	Statements	Agreed Position	Disagreements, with reasons
Topic 1 – Farming and Growing Management Practices			
What is the range of good management practices for intensive farming land use activities within Horizons region? (as defined by the One Plan). Specifically, for: a) Dairy farming b) Commercial vegetable growing c) Cropping d) Intensive sheep and beef farming	Experts agree that the WSP Draft Horticulture GMP and BMP Memorandum attached as Appendix 1 (to be inserted 1 to 4) as GMP with alterations as follows for **Commercial Vegetable growing:** • 1.12 and 1.13 to remove the wording 'riparian margins' • 3.7 remove practice • 1.14 remove practice • 1.15 to remove wording 'to ensure soil conservation measures are in place.'	All agreed with removal of the wording 'riparian margins' 1.12 and 1.13 All agreed removal of practice 3.7 All agreed removal of practice 1.14 All agreed removal of wording from practice 1.15	I.Kirkwood notes that point 1.13, 5m buffer strip is a good management practice but may not be practical on all potatoes paddocks. P.Le Miere does not agree to include 4.3, he believes it is BMP and not GMP.
	Experts agree that the WSP draft Memorandum of GMP and BMP attached as Appendix 1 (to be inserted 1 to 4) as GMP with alterations as follows for **Cropping/arable IFLU:** - Livestock management on a mixed arable system to be included as a practice.	All agreed	

Issue	Statements	Agreed Position	Disagreements, with reasons
	Due to the complexity of pastoral farming systems, developing a list of GMPs and BMPs is fraught with difficulties due to the sheer number of potential options and the variety of situations they cover. For this reason, the industry developed a list of 21 agreed good farming principles (see Appendix 4) which were tabled yesterday by R. Parkes. I agree that this is the best way to list the GMP's. GMPs for **Dairy IFLU** (Appendix 2): Covers all contaminants. GMPs are relative to what exists on farm and the unique characteristics including infrastructure, machinery and management of the farm. Effluent management will conform to HRC effluent rules. The proposed list (Appendix 2): - Points 1, 3.1, and 3.2 with edits to 3.1 changing months to (may to July) that is below 7 degrees Celsius and when soils are saturated e.g. winter months. - Point 6.1, 6.2, 7.1, 9.2 (where appropriate) and 10.1 to be added as GMP if you have the infrastructure. - Point 3.3 through to 14.7 excluding those above to be added as BMP.	All Agreed.	

Issue	Statements	Agreed Position	Disagreements, with reasons
	In reference to the 'Good Management Practice' guide, Dairy NZ pages 10,11, 14, 15, 18, 19, 22, 23, 26, 27, 30, and 31 (as redacted in appendix 3): - Pg.19 point 4 not relevant - Pg.27 point 3 identified as BMP - Pg.31 point 1 outside of scope J.Chrystal - Sheep and beef farms are complex and diverse. For every farm that a mitigation strategy fits there will be others that it doesn't. Due to this complexity of systems it is best to have an individual tailored approach to farm mitigations. Farm plans that are based on a detailed understanding of the underlying land resource enable a farmer to identify areas of the farm and the farming system that are high risk for contaminant loss. For sheep and beef farms (and deer, of which I also have expert experience) the contaminants of concern are P, sediment and pathogens (as indicated by E. coli). The losses of these contaminants are strongly linked to the natural characteristics of the land (soil type, slope, contour) and of climate (rainfall) as well as farming systems (e.g. deer pacing/wallowing, cultivation practices, grazing management, sheep: cattle). My recommendation is that a detailed stocktake of the land resource in the form of an appropriately generated LUC map at the farm or paddock scale (that takes into account improvements to		

Issue	Statements	Agreed Position	Disagreements, with reasons
	that land, such as drainage systems, that may alter the LUC class) is the first step in understanding risks and opportunities. From that a farm management plan can be developed to identify suitable and relevant GMP/BMPs that mitigate and reduce areas of risk. Due to the complexity of pastoral farming systems, developing a list of GMPs and BMPs is fraught with difficulties due to the sheer number of potential options and the variety of situations they cover. For this reason, the industry developed a list of 21 agreed good farming principles (see Appendix 4) which were tabled yesterday by R. Parkes. I agree that this is the best way to list the GMP's.		
What management practices are considered to be 'best management practice' or 'additional innovations' for each of the above listed intensive farming land use activities within the Horizons region?	Draft WSP CVP Memorandum of GMP and BMP attached as Appendix 1 (5-7 are the BMP) with alterations as follows for **Commercial Vegetable growing and we have also adopted these for cropping IFLU:** - Remove wording 'riparian margins' from 5.3 and 5.4 GMPs and BMPs for Beef and Sheep farming, where relevant the agreed GMPs and BMPs for cropping and dairy are the same for beef and sheep e.g. irrigation management practices, and arable management practices. In reference to Appendix 2:	All agreed.	

Issue	Statements	Agreed Position	Disagreements, with reasons
	- With the exclusion of reducing area of winter crops (4.1), cull aggressively and early in autumn (5.1), and summer crops (9.1). - Remove section 11, Herd Management.		
Which of the GMPs, BMPs and additional innovations identified above are able to have their N loss mitigation potential modelled and/or estimated and with what reliability?	<u>Dairy</u> In reference to appendix 2: - Points 2.6, 6.3, 6.4, 12.1, 14.2, 14.4, 14.5, 14.6, 14.7 are not able to be modelled for N loss mitigation. - 12.1 incorporate plantain into swards, is currently being developed for modelling. - All other points (excluding above points) can be modelled. <u>Horticulture</u> In respect to nitrogen, crop rotations, fertiliser practices, cultivation practices, irrigation practices, the use of catch crops, and the reduction of cropped area can be modelled. <u>Sheep and Beef</u> The ability to model GMPs and BMPs for beef and sheep farming, where relevant the agreed GMPs and BMPs for cropping and dairy are the same for beef and sheep e.g. irrigation management	All Agreed.	

Issue	Statements	Agreed Position	Disagreements, with reasons
	practices, and arable management practices. In reference to Appendix 2: - With the exclusion of reducing area of winter crops (4.1), cull aggressively and early in autumn (5.1), and summer crops (9.1). - Remove section 11, Herd Management. Sheep and beef farm activities that impact nitrogen loss and that can be modelled include: - Stock transactions, stock class, livestock weights, production, supplementary feed, locations, irrigation can be modelled. (along with those noted from horticulture and dairy where relevant). S.Ford notes that the some practices of vegetable cropping can and cannot be modelled, however this is reflected in the reliability of the modelling to reflect the actual results. S.McNally notes that when considering the reliability of model outputs, we need to be aware of the variations that do arise from operator competency and consistency, acceptability of the work-arounds.		

Issue	Statements	Agreed Position	Disagreements, with reasons
What range of on-farm N loss reduction should be expected to result from implementation of the (agreed above) GMPs and BMPs and additional innovations in the targeted water management sub-zones?	Experts do not consider that they can at present address this. Many experts are working on this currently and modelling will emerge from further work streams of modelling.	All agreed.	
Which of these GMPs, BMPs or additional innovations are able to be applied across all farm systems in the targeted water management subzones?	Experts note that the complexity of different systems and farm contexts is specific to individual farms. There is no ability to provide a blanket approach to GMPs and BMPs.	All Agreed.	
Should any of the GMPs, BMPs or additional innovations identified under (a) and (b) above be specified as minimum requirements for achieving consent under PC2?	Experts agreed that if this question started with "Could any of the GMPs, BMPs...." Then the answer would be yes they could and would provide certainty for those needing to apply as a discretionary activity. However the experts felt this was a question that should be directed to the Planners Caucusing session.	All Agreed.	
What are the merits and disadvantages of including a list of agreed minimum GMPs or BMPs in the proposed definition of 'good management practices'?	S.McNally notes that GMP and BMP could be useful to set minimum expectations for consideration by the planner for discretionary consent for commercial vegetable production. A.Duker notes that having a set of GMP and BMP that are available is paramount. The ability to choose from these is important, they should be a 'toolbox' of options and not mandatory requirements to implement all.	All Agreed.	

Issue	Statements	Agreed Position	Disagreements, with reasons
	J.Chrystal agrees with the above statement. R.Parkes and A.Duker note that this had the risk of becoming a checklist and not providing farm specific solutions. A.Duker notes that there needs to be a range of factors that farmers can choose from. The list is also subject to change and may block or stifle innovation. To have options with a known target is paramount, but options have to be there and ability for the farmer to choose from these options.		
What are, typically, the obstacles to farmers and growers adopting the GMPs identified under (a) above?	S.McNally notes the following as obstacles include costs, timing, capacity (technical capacity of the farmers, and financial capacity i.e. business model) J.Chrystal agrees with the above points and adds land-use change, farmer aspirations, education, and understanding of those mitigations and how to go about implementing these mitigations are to also be included. A.Duker notes existing infrastructure as an obstacle. S.Ford adds the practicality of mitigations as an obstacle. D.Horne adds the resources and climate as an obstacle. I.Kirkwood adds leased land and ownership as an obstacle.	All agreed	

Issue	Statements	Agreed Position	Disagreements, with reasons
Within what time frame is it reasonable to expect adoption and implementation by growers and farmers of the GMPs identified under (a) above?	Experts notes two to five years. A.Duker adds the availability of capital is fundamental.	All agreed	
Noting the Government's intention to introduce regulation to require 'freshwater farm plans' for intensive farming activities, how would the nutrient management plans required under the One Plan (and required by PC2) be integrated with 'freshwater farm plans'? Will it be necessary to change the name or content of nutrient management plans required by PC2?	These matters are unknown at present however, S.McNally believes that it will be highly likely Nutrient Management Plans will be a chapter in a required overall Farm Plan.	All Agreed.	
What are the particular constraints that apply to commercial vegetable growing in terms of crop rotation, leased land arrangements and location relative to markets or processing facilities?	S.Ford comments there are no particular constraints.	All Agreed.	
How many IFLUs are there estimated to be within each of the targeted water management sub-zones? How many of those have obtained consent? How many unconsented IFLUs are there estimated to be in each of the targeted water management sub-zones?	Experts agreed that this information can be obtained, it wasn't a question that they considered needing an answer in caucusing and would rather be information provided through Evidence for the hearing.	All Agreed.	
What is the best available data on the N leaching baseline for IFLUs that is closest to the time the relevant rules in the One Plan became operative?	Experts agreed that this information can be obtained, it wasn't questions that they considered needing an answer in caucusing and would rather be	All Agreed.	

Issue	Statements	Agreed Position	Disagreements, with reasons
	information provided through Evidence for the hearing.		
What is the 75th percentile number for N leaching for dairy farming activities in each of the relevant water management subzones?	Experts agreed that this information can be obtained, it wasn't questions that they considered needing an answer in caucusing and would rather be information provided through Evidence for the hearing.	All Agreed.	
How do municipal land treatment operations differ from typical GMP, BMP discussed above?	Experts agreed that this information can be obtained, it wasn't questions that they considered needing an answer in caucusing and would rather be information provided through Evidence for the hearing.	All Agreed.	
Topic 2 – Farm Systems Modelling			
Do the experts agree that the recalculation of the CNLM limit values in the recalibrated (PC2) Table 14.2 was done correctly in terms of adopting the same methodology as was adopted to calculate Table 14.2 for the One Plan and in terms of adoptiong Overseer FM as the most recent version of Overseer?	D.Horne makes reference to HRC document attached as Appendix 6.	All except G Doole could agree.	G Doole – cannot form a judgement at this point as still going through a modelling process.
What is the typical margin of error in farm system modelling under Overseer FM (and under other alternative models)? What are the uncertainties or other issues associated with using Overseer (or alternative models) for	P.Le Miere suggests the PCE report on the use of the Overseer is relevant and accepted (p.37 for the diagram).	All agreed	

Issue	Statements	Agreed Position	Disagreements, with reasons
farm system modelling in the Horizons region?			
Pre-hearing meeting discussions identified six potential uses for the Overseer FM farm systems modelling tool: (a) As a tool for calculating (permitted activity) limits in a Plan; (b) As a tool to set threshold for activity status in a Plan; (c) As a monitoring tool for compliance monitoring and enforcement; (d) As an information tool to test the efficacy of on-farm system changes to inform adaptive management (i.e. a decision support tool); (e) As an allocation tool for allocating individual shares of N or P contributed to the catchment; (f) Related to 5 above: as a basis for establishing a trading mechanism for N contamination 'rights'. Do the experts agree that these are valid uses of Overseer FM?	Experts agree this question is to be deferred to the planning caucus.	All agree.	I Kirkwood does not agree with (d) suggests it does not reflect the GMPs. There are new practices that overseer does not capture. S.McNally comments on the following modelling tools: a) It has been used b) It has been used P.Le Miere notes point c is more valid if used for relative change but not valid for enforcement. A.Duker – monitoring – must have the ability to allow for seasonal variations. S.Ford notes that this should not be used for absolute numbers (according to the PCE report) Point d has been used P.Le Miere – e and f not valid uses of Overseer FM. SF – not accurate enough S.McNally PC2 is a triggered based approach
Can N loss from commercial vegetable growing and arable intensive farming	P Le Miere and S McNally– there are issues for vegetables, arable and forage crops for modelling and is therefore	All Agreed	

Issue	Statements	Agreed Position	Disagreements, with reasons
land use activities be represented within and modelled by Overseer FM?	unreliable for depending on its use in terms of absolute numbers, but it does provide a view on trend within the same system. Yes it can but it has not been calibrated or validated against very many vegetables and arable crops, for all soil types and in all climate zones. Similarly the statement above would apply to pasture types e.g. plantain and chicory. PCE report pg.31, refer to.		
What are the current difficulties in modelling on-farm nutrient losses from commercial vegetable growing, using Overseer FM?	I.Kirkwood – there is a lack of empirical data, particularly for vegetable growing but also applies to other intensive land-uses. A.Duker - The difficulty arises when modelling is trying to achieve an absolute nitrogen number.	All Agreed.	
How can the identified difficulties be overcome? Would it be possible to develop a user guide to standardise 'work-arounds', that is tailored to the Horizons growing region, to overcome any of those difficulties?	Consistency can be achieved with the certification process, agreed industry standards for 'work-arounds' provided for use. AM.Jolly – Sector based work-arounds which provide consultants and industry groups consistency and certainty e.g. Dairy-based one pager.	All Agreed.	

Issue	**Statements**	Agreed Position	Disagreements, with reasons
	P.Le Miere – we are not overcoming the difficulties. The work-arounds are standardising practice and reducing the variations associated with input data.		
How many currently unconsented IFLUs will comply with Table 14.2 limits by implementing good management practices? How many will not?	Preliminary work has started and more work needs to be done. D.Horne noted that around 65% unconsented dairy farmers are estimated to meet the table (11kg/ha/yr). Nearly all sheep and beef will meet the table, and currently working on arable. Based on 2012. D.Horne – it is a suite of mitigation measures to meet the reduction. S.McNally noted that under the modelling been done, potatoes will be a controlled activity. AM.Jolly noted that excluding potatoes, five out of nine commercial vegetable rotations would be controlled activities when applying GMP, one additional passes the table with BMP. The rest follow discretionary pathways. G.Doole - Additional modelling scenarios will show different impacts, reflecting different models and assumptions used for all land-uses.	All Agreed.	
What alternative N loss modelling tools are available (e.g. APSIM) and what are	Experts note that APSIM is available, and has some comparability and have	All Agreed	

Issue	Statements	Agreed Position	Disagreements, with reasons
their benefits and disadvantages compared to Overseer FM?	highlighted the following disadvantages and advantages: Disadvantages: - Established modelling tool more commonly used in research. It is not a farm advisor tool. - Crop based, not pasture based - Need to develop a user interface - Large data inputs for the user Advantages: - More accurate than what is already been used for cropping or horticulture. - Greater granularity e.g. daily input. Very much a crop based system compared to overseer, which is more suitable for pasture. Other tools available for pastoral farming: - MitAgator tool is available through Ballance. - LUCI (Land-Use Capability Indicator) model available through Victoria University. - LUCIAG available Ravensdown Applicability of these tools are not nitrogen focused, but are whole farm systems models. D. Horne SPASMO exists for most land-uses through Plant and Food. It is a		

Issue	Statements	Agreed Position	Disagreements, with reasons
	research grade tool and does not have a user interface.		
What should be included, as a minimum, in the nutrient management plan accompanying applications for consent for each of the listed intensive farming land use activities? Is there an appropriate nutrient management plan template available that could be adopted?	S.McNally – Definition of nutrient management plan in the plan change is considered to be wrong. The description of this in the plan change is more akin to a farm environmental management plan. A nutrient management plan is a component of a farm plan, and will deal with all nutrients of which nitrogen is one. The current Horizons template exists, but this is very out of date and not adequate. It is likely that there will need to be four different templates for each IFLU, refer to question 10 of this statement. Overseer provides a nutrient budget which feeds into the nutrient plan, but this is a starting point. A. Duker - Dairy has existing templates which describe the nutrient budget and associated scenarios for evidence of reduction in application. J.Chrystal and R.Parkes – Farm plans template exist for Beef and Lamb NZ, and within that there is a nutrient management component. A significant farm planning programme. AM.Jolly – Nutrient management, nutrient budget (current status, and future status), critical source risk	All Agreed.	

Issue	Statements	Agreed Position	Disagreements, with reasons
	assessment, management plan, and timeframes.		
What should be the minimum qualifications of a person compiling a nutrient management plan? If this is different for different farm systems, please explain.	I.Kirkwood notes that horticulture training is essential to upskill the advisors. I. Kirkwood also notes that the CNMA may not be adequate cover for horticulture. S.McNally and AM.Jolly both note that this requires broader and more consistent training. A.Duker, J. Chrystal, and AM.Jolly note a minimum qualification CNMA (Certified Nutrient Management Advisor). This qualification requires the course to be completed and ongoing professional development in the farm systems. S.McNally notes that at current capacity this is low, but may drive training. A.Duker - Reasonable consideration should be given to alternate and suitable qualifications and experience.	All Agreed.	
What are the expected impacts on Overseer modelled N loss for intensive farming land use activities, when combined with land treatment activities (the irrigation of treated municipal wastewater to land)?	Experts note that effluent applied to a dry stock farm will trigger the requirements of an IFLU. J.Feltham and D.Horne note land treatment is likely to increase nitrogen leaching for that property and may not conform to all GMPs.	All Agreed.	

Issue	Statements	Agreed Position	Disagreements, with reasons
	Extremely difficult to get to the table, as leaching losses are likely to exceed the table 14.2. This discretionary pathway is available.		
What are the key causes of these impacts (if any) from municipal land treatment activities?	Experts note that effluent applied to a dry stock farm will trigger the requirements of an IFLU. J.Feltham and D.Horne note land treatment is likely to increase nitrogen leaching for that property and may not conform to all GMPs. Extremely difficult to get to the table, as leaching losses are likely to exceed the table 14.2. This discretionary pathway is available.	All Agreed.	
Do the impacts (if any) of municipal land treatment have implications for intensive farming land use compliance with the recalibrated (PC2) Table 14.2?	Experts note that effluent applied to a dry stock farm will trigger the requirements of an IFLU. J.Feltham and D.Horne note land treatment is likely to increase nitrogen leaching for that property and may not conform to all GMPs. Extremely difficult to get to the table, as leaching losses are likely to exceed the table 14.2. This discretionary pathway is available.	All Agreed.	
What options are available to address the expected impacts of municipal land treatment on N loss (3.f.) for municipal land treatment/intensive farming land use operators?	Experts note that effluent applied to a dry stock farm will trigger the requirements of an IFLU. J.Feltham and D.Horne note land treatment is likely to increase nitrogen	All Agreed.	

Issue	Statements	Agreed Position	Disagreements, with reasons
	leaching for that property and may not conform to all GMPs. Extremely difficult to get to the table, as leaching losses are likely to exceed the table 14.2. This discretionary pathway is available.		
Do experts agree, based on items (u) to (x), that the control of intensive farming practices in combination with municipal land treatment activities under the recalibrated (PC2) Table 14.2 may restrict or otherwise penalise these activities?	Experts note that effluent applied to a dry stock farm will trigger the requirements of an IFLU. J.Feltham and D.Horne note land treatment is likely to increase nitrogen leaching for that property and may not conform to all GMPs. Extremely difficult to get to the table, as leaching losses are likely to exceed the table 14.2. This discretionary pathway is available.	All Agreed.	
Topic 3 – Farm-Scale Economics			
What are the typical on-farm costs and benefits of adopting the range of GMP, BMP or additional innovations identified under (a) to (e) above within Horizons region for the four types of intensive farming land use – under the following scenarios: (a) Under the operative (pre-PC2) One Plan, assuming compliance is required with Table 14.2 and N leaching loss from no ~~unconsented~~			

Issue	Statements	Agreed Position	Disagreements, with reasons
IFLUs exceed the operative Table 14.2 limits; (b) Under PC2, assuming compliance is required with recalibrated Table 14.2 and N leaching loss from no IFLUs exceed the recalibrated Table 14.2 limits; (c) Under PC2, assuming N leaching from some ~~unconsented~~ IFLUs (those who cannaot achieve the Table 14.2 limits using GMP) exceeds the recalibrated Table 14.2 limits in the following scenarios: i. All those above Table 14.2 limits reduce N leaching by 10% from the baseline agreed in the Farming and Growing Management Practices joint witness statement (question (k) above). ii. All those above Table 14.2 limits reduce N leaching to 75th percentile number for each target water management subzone as identified in the Farming and Growing Management Practices joint witness statement (question (n) above) iii. All those above Table 14.2 limits reduce N leaching by 10% or reduce to the 75th			

Issue	Statements	Agreed Position	Disagreements, with reasons
percentile (whichever results in the lowest N leaching rate) iv. All those above Table 14.2 limits adopt GMP (but are not required to do any additional or further N reduction) (Please specify the assumptions made for each scenario)			
How do these costs vary across the diverse farms found within each intensive land use?			
An important part of agriculture is financial returns from capital gain. How are asset values affected under different regulatory approaches?			
Agricultural production typically requires high debt loads for a business due to the high price of land. How are the debt to asset ratios of diverse farms affected by different regulatory approaches within each intensive land use?			

Appendix 1

Memorandum

To	Horizons Regional Council
Copy	Farm Modelling experts as identified in PC2 pre-hearings
From	Anne-Maree Jolly, Stephen McNally
Office	Palmerston North
Date	17 July 2020
File/Ref	
Subject	Draft Horticulture GMP and BMP

WSP has investigated available industry information, previous reports and submissions and meet with industry participants in gathering the following list of management practises. We have not attempted to develop new management practices. The list is therefore a compilation of several sources but with some attempt to give a prioritisation under GMP and BMP.

Most of the practices defined by WSP have already been outlined as either a GMP or BMP in the Horticulture New Zealand Code of Practice for Nutrient Management 2014. Time has also been spent with Dan Bloomer to get a better understanding of the work Page Bloomer Associates has completed with the Levin growers. Additionally, key industry operators provided a grower's opinion to the mix. Finally, several GMPs and BMPs outlined in the NZ GAP FEP template have been adopted.

For the purpose of our brief we have considered GMP and BMP to be defined below;

- GMP is defined as practices that are well known and tested under recent operational and market conditions, that can be readily adopted within a reasonable expectation of capability and resourcing.
- BMP are management systems that are available but may require a more substantial capital and/or operational financing consideration or require a higher degree of management capability and expertise.

The ability to apply GMP and/or BMP may be a function of the scale of the operation concerned which impacts labour capacity, funding capacity and the time frame for implementation. Many can be applied simultaneously while others may be incrementally adopted as operational constraints allow. For example, this is especially the case with controlled traffic farming that has a high capital requirement that may suit a timed approach to equipment retirement. All are accepted to be positive actions in terms of reducing the impact of intensive land use operations in particular improved nutrient and sediment control.

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150 YEARS IN AOTEAROA

1. **GMP soil**
    1.1. Soil type, structure, texture and profile is assessed
    1.2. Identify site specific risks of each paddock (e.g. soil type, slope, proximity to waterways, critical source areas)
    1.3. Cultivation of soil when soil moisture conditions are appropriate
    1.4. Minimise soil tillage as much as practicable
    1.5. Minimise cultivation passes
    1.6. Minimise fallow periods between crops
    1.7. Only cultivate on days when the weather conditions are suitable: not when there are high winds
    1.8. Planting catch crops in between vegetable rotations where fallow period is more than 12 weeks
    1.9. Incorporate crop residual where possible
    1.10. Understand how surface water enters and leaves each paddock
    1.11. Ensure access ways into paddocks are not at the lowest point
    1.12. Grassing of riparian margins or buffer strips at the sides of each paddock (1.5 m)
    1.13. Grassing of riparian margins or buffer strips at the bottom of each paddock (5 m)
    1.14. Have appropriate infrastructure in place to prevent sediment losses (culverts, interception drains, bunds)
    1.15. Retire or actively manage marginal land to ensure soil conservation measures are in place
2. **GMP nutrients**
    2.1. Soil testing for base fertiliser every two years including trace elements, organic carbon and organic matter
    2.2. Soil testing for nitrogen using quick N test before every planting of crop
    2.3. Yearly deep nitrogen test (600 mm) to determine the level of residual nitrogen remaining in the soil
    2.4. Plan fertiliser inputs for each crop taking into account all nutrient inputs (nutrient balance)
    2.5. Matching soil testing results to plant requirements
    2.6. Split fertiliser application
    2.7. Using most suitable types of fertiliser for crops
    2.8. Applying fertiliser only where it is required, follow instructions for application, avoid waterways
    2.9. Managed applications of fertiliser taking into account weather and soil conditions
    2.10. Avoid broadcast fertiliser application where it can be
    2.11. As much harvestable crop as possible is removed
    2.12. Fertiliser to be stored and loaded to avoid spillages into waterbodies or transfer into waterbodies
    2.13. Yearly calibration of fertiliser spreading equipment
3. **GMP water and irrigation**
    3.1. Yearly calibration of irrigators' application rates and uniformity checked
    3.2. Irrigation applied allows achievement of the yield target for fertiliser applied
    3.3. On site soil moisture monitoring is conducted on crops that require/prefer 'wet' soils
    3.4. Irrigation scheduling is tied to the soil moisture monitoring
    3.5. Irrigation is applied to maintain soil moisture between wilting point and field capacity where possible
    3.6. Water usage is metered
    3.7. Non-irrigation water is used efficiently (e.g. wash water)
4. **GMP other**
    4.1. Maintain records of activities and applications undertaken
    4.2. Provide training to all operators: Soil testing, irrigation and fertiliser equipment
    4.3. Develop short and long-time environmental objectives

JF

5. **BMP soil**
    5.1. GPS map of soil testing locations and use same locations for each soil test
    5.2. Yearly soil assessment for compaction (e.g. using penetrometer)
    5.3. Planting or grassing of riparian margins or buffer strips at the sides of each paddock (3 m)
    5.4. Planting or grassing of riparian margins or buffer strips at the bottom of each paddock (10 m)

5.5. Implement controlled traffic farming where appropriate

6. **BMP nutrients**
   6.1. Soil testing for base fertiliser every year including trace elements, organic carbon and organic matter
   6.2. Soil testing for nitrogen using quick N test before every nitrogen side dressing
   6.3. Soil nitrogen quick test results to be calibrated against laboratory testing until confident in field data
   6.4. GPS monitoring all fertiliser applications: proof of placement
   6.5. The use of current smart fertilisers where appropriate
   6.6. Spreadmark accredited fertilizer application contractors are used
   6.7. Machinery is upgraded to be more efficient/accurate
   6.8. Leaf tests are conducted to determine nutrient levels in relation to fertiliser plans
   6.9. Nutrient levels are managed and informed by soil tests to match rainfall/irrigation and yields
   6.10. Obtain advice from a nutrient advisor or agronomist
   6.11. Fertiliser plans receive annual audits

7. **BMP water and irrigation**
   7.1. Variable rate irrigation application within the paddock to maximise efficiency were appropriate
   7.2. Adopt automated irrigation systems that allow more frequent applications of less water
   7.3. Irrigation efficiency is measurable at greater than 80% (water stays in topsoil)

8. **BMP other**
   8.1. Planting of native vegetation in riparian areas where appropriate

Appendix 2

Proposed list of GMP

1. A nutrient management plan (based on a tool such as Overseer)

2. Effluent management

2.1 Adequate storage (as defined by Horizons use of the FDESC)

2.2 Application depths of 12 mm, or less, in winter/spring

2.3 Limit applications of all forms of N to FDE blocks to 150 kg N/ha/yr

2.4 Approved scheduling technique for day to day management of FDE irrigation (moisture monitoring or water balance)

2.5 Ponds solids applied in low risk period (runoff unlikely)

2.6 Three- yearly calibration of irrigators' application rates and uniformity

3 Fertiliser management

3.1 Remove all N fertiliser application from high risk period (April to August)

3.2 Limit single applications to 40 kg N/ha

3.3 Limit annual N fertiliser application to 190 kg N/ha

4 Crops

4.1 Remove winter crops

5 Herd management

5.1 Cull aggressively and early in autumn

6 Irrigation management

6.1 Improve scheduling (moisture monitoring or water balance)

6.2 Modify 'trigger' and 'target' values in scheduling regime (as 'dry' as practicable)

6.3 Yearly calibration of irrigators' application rates and uniformity

6.4 Water use is metered

7 Protect soil structure and infiltration rates

7.1 Have strategies in place to minimise pugging/treading damage

Proposed list of BMPs

8 Supplement management

8.1 Replace N boosted pasture with low CP content supplements

9 Crops

9.1 Reduce area of summer crops (grass to grass, replace with other supplements)

9.2 Use minimum tillage

TF

Ross Monaghan's list 2009

A nutrient management plan (based on a tool such as Overseer)

Effluent management
Adequate pond storage
low depth applications
Low rate applications
Improved scheduling of FDE irrigation
Stock exclusion from streambank riparian margins

Fertiliser management
Timing (avoid high risk periods)
Form
Rate

Supplement management
Low N feed in diet (e.g. maize, cereal silage)

Use of standoff facilities
Particularly in summer/autumn

Edge of field techniques
Constructed wetlands
grass buffer strips
nutrient adsorbing materials in flow pathways
harvest of nutrients in water crops (e.g. watercress)
Impoundment structures

10 Use of standoff facilities

10.1 Where standoff facilities are in place, practise standoff (e.g. overnight) during late summer autumn

10.2 Where standoff facility is not in place then look to install over the next 5 years

11 Herd management

11.1 Increase number of cows grazed off farm over winter

11.2 Dry cows off earlier (shorten lactation period)

11.3 Graze dry cows off in autumn

11.4 Reduce/optimise cow numbers/herd size

12. Emerging technology

12.1 Incorporate Plantain into swards

Systems interventions and edge of field techniques

13 Systems interventions

13.1 Larger reduction in herd size/stocking rate

13.2 Build animal shelters (such as a barn)

13.3 Fence off less productive areas and retire

13.4 Organic farming

14 Edge of field techniques

14.1 Constructed wetlands

14.2 Bioreactors

14.3 Grass buffer strips

14.4 Nutrient adsorbing materials in flow pathways

14.5 Harvest of nutrients in water crops (e.g. watercress) in internal surface drains on farm

14.6 Impoundment structures such as Detainment bunds

14.7 Controlled drainage

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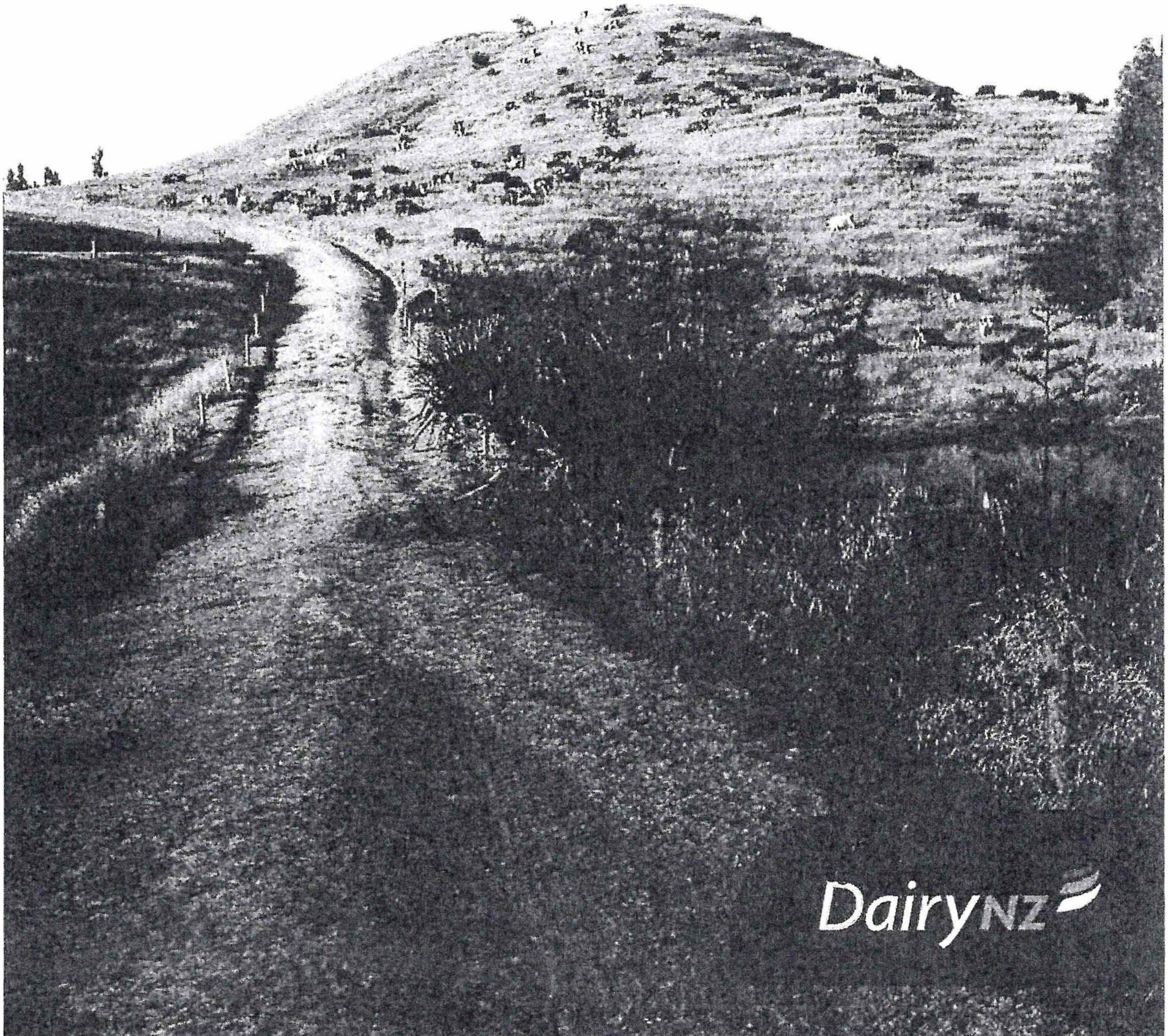
Appendix 3

Good management practices

A guide to good environmental management on dairy farms



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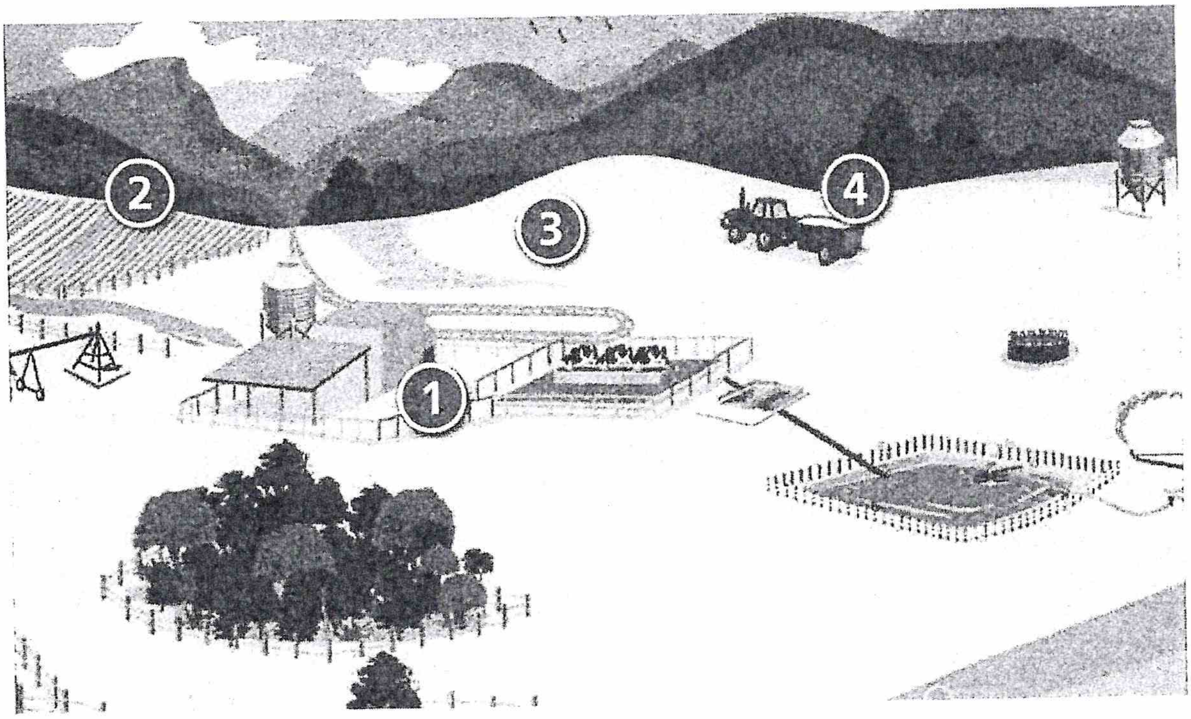
Nutrients

Good management practices



Why is this important?

Nutrients come from multiple sources on farm such as fertiliser, effluent, fixation, supplementary feed and irrigation water. Having a good understanding of where nutrients are coming from and going to on your farm means you will be able to make better decisions around purchasing and applying fertiliser. Applying the right amount of fertiliser in the right place, at the right time, will ensure that you get the best possible response and return on investment, and will minimise the risk of losses to water.

After investing significant time and money into managing your nutrients and making the best decisions about what to apply, when and where, it is important the equipment can deliver what you need. Over-application of nutrients will increase the risk of leaching or runoff, wasting money and in some cases breaching rules. Under-application of necessary nutrients will result in plants and animals with reduced performance.

Nitrogen and phosphorus losses to waterways can cause undesirable plant or algal growth. This can make the waterway unsuitable for aquatic life, recreational activities and requires additional maintenance.

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1 General nutrient management

PRACTICE

	YES	NO
Soil-test each year for each different management block	☐	☐
Soil-test well before crops are planted to identify nutrient levels	☐	☐
Use a nutrient budget to help fertiliser decision-making	☐	☐
Supply farm nutrient information to your milk company at the end of each season	☐	☐

EVIDENCE

- Soil test results
- Nutrient budget
- Milk company nitrogen report
- Nutrient management plan

2 Monitor and maintain P levels at the economic optimum | GMP 9

PRACTICE

	YES	NO
Monitor Olsen P trends of successive years	☐	☐
Maintain Olsen P in optimum range	☐	☐
Tailor fertiliser applications for different management blocks	☐	☐

EVIDENCE

- Soil test results
- Fertiliser recommendations
- Fertiliser invoices

3 Fertiliser application matches plant requirements and minimises losses | GMP 10

PRACTICE

	YES	NO
Record all fertiliser applications – product, rate, date, location (If using contractors get the information from them)	☐	☐
Assess soil temperature and moisture levels before applying fertiliser (i.e. avoid winter months)	☐	☐
Avoid fertiliser application:		
- When heavy rainfall is forecast and runoff is likely	☐	☐
- Close to waterways	☐	☐
Apply N – 'little and often' and when pasture is actively growing	☐	☐
Assess pasture or crop growth and feed requirements before applying N	☐	☐

EVIDENCE

- Fertiliser proof of placement records – product, rate, date, location
- Pasture walk data / Feed wedge

4 Fertiliser spreading equipment is well maintained and calibrated | GMP 12

PRACTICE

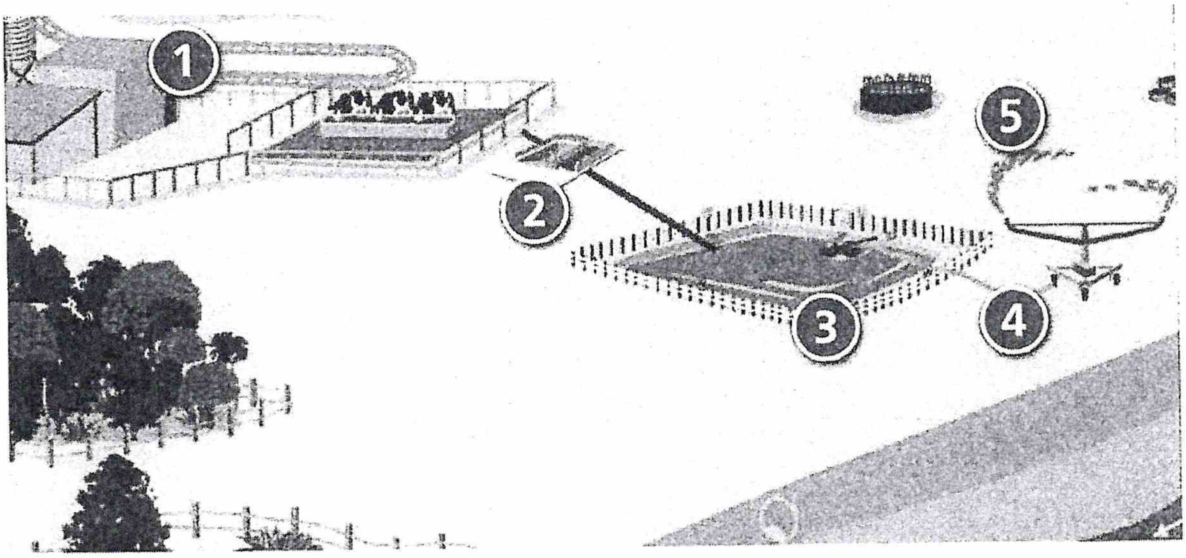
	YES	NO
Calibrate farm spreading equipment regularly – check spreading width and volume	☐	☐
Clean and grease spreaders routinely	☐	☐
Check for 'paddock stripes' after spreading	☐	☐
If using contractors: Make sure they are Spreadmark accredited	☐	☐

EVIDENCE

- Calibration information
- Maintenance records
- Contractor invoice

Effluent

Good management practices



Why is this important?

Effluent loss to waterways is a major risk to water quality because of the nutrients and faecal bacteria it contains. All milk companies require effluent systems to be fit for purpose and be able to achieve 365-day compliance with the rules.

Having a system that is designed to the 'Farm Dairy Effluent Design Standards and Code of Practice' provides this certainty and peace of mind.

Having sufficient effluent storage will allow you to store effluent when soil or weather conditions do no suit application and provide flexibility during summer months, allowing you to apply effluent at times that suit you.

Ensuring effluent is applied to pastures and crops, at the appropriate depth, rates and times, reduces the risk of nutrient loss through leaching and runoff and maximises the value of effluent in terms of nutrient uptake.

1 All effluent systems

PRACTICE

	YES	NO
Understand and comply with effluent consent conditions and regional rules	☐	☐
Have an effluent management plan	☐	☐
Record all effluent applications	☐	☐
Train staff on how to operate and maintain the effluent system	☐	☐

EVIDENCE

- Regional council compliance record
- Effluent management plan
- Effluent application records
- Staff training records
- Operations manual

Have you considered

Getting a Dairy Effluent Warrant of Fitness (WOF) is a simple way of checking if your system is up to scratch, and covers the above areas. For more information go to effluentwof.co.nz

2 Effluent system meets code of practice | GMP 16

PRACTICE

	YES	NO
Effluent is collected from all sources: dairy sheds, yards, feeds pads, underpasses	☐	☐
System design is appropriate for the soil type, topography, and climate	☐	☐
For new systems: use an accredited designer	☐	☐

EVIDENCE

- Effluent WOF assessment
- Effluent system design plans
- Commissioning report

3 Sufficient suitable storage available | GMP 17

PRACTICE

	YES	NO
Use the Dairy Effluent Storage Calculator to work out storage needs	☐	☐
If building new storage, use an accredited effluent designer	☐	☐
Apply effluent whenever possible to keep storage low	☐	☐
Ensure storage facilities are sealed	☐	☐
Routinely remove effluent solids that accumulate	☐	☐
Have safety barriers, equipment and signage	☐	☐

EVIDENCE

- Dairy Effluent Storage Calculator report
- Storage design plans
- Pond or tank liner specifications and warrantees
- Compaction/seepage test data
- Pond leakage test – approved method by your regional council

4 Spreading equipment is well maintained and calibrated | GMP 18

PRACTICE

	YES	NO
Calibrate effluent irrigator/spreading equipment	☐	☐
Inspect and maintain effluent equipment regularly	☐	☐
Service effluent pumping equipment routinely	☐	☐

EVIDENCE

- Effluent calibration results – bucket test
- Maintenance schedule/records
- Servicing invoice

5 Effluent applied at correct depth, rate and time | GMP 19

PRACTICE

	YES	NO
Adjust effluent application timing and rates based on soil moisture levels	☐	☐
Spread nutrient load evenly across the largest area practical	☐	☐
Test for high potassium (K) levels on effluent block to avoid animal health issues	☐	☐
Adjust fertiliser application to effluent areas based on soil tests	☐	☐
Identify and record risk areas for effluent application on map	☐	☐
Consider odour impact during application	☐	☐

EVIDENCE

- Soil test results
- Nutrient budget – effluent report
- Effluent application area risk map
- Rainfall/soil moisture records

PLM

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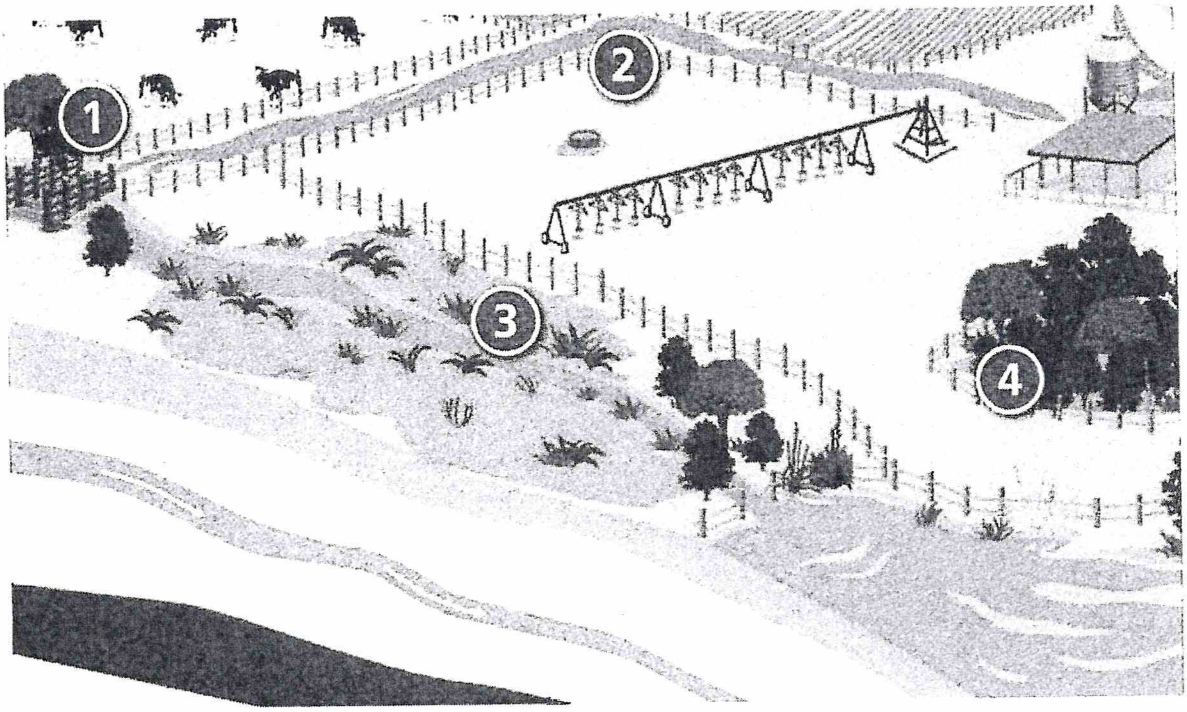
Waterways and biodiversity

Good management practices



Why is this important?

Keeping stock out of waterways ensures stock stay safe and waterways stay healthy. Stock in waterways deposit dung and urine which increase nutrient and bacteria levels in the water. It also causes erosion and disturbance of stream banks and beds. Stock exclusion is one of the best things you can do to improve water quality.

Sediment, faecal bacteria and phosphorus can also enter waterways by overland flow. The use of buffer strips and riparian planting not only reduces overland flow of nutrients and sediment, it also provides shade and habitat for aquatic life.

Wetlands and areas of native vegetation are important natural filters and habitat for plants and animals. Protecting these areas from stock access and weed growth can have significant benefits.

1 Identify areas where runoff may occur and manage to avoid runoff entering waterways | GMP 6

PRACTICE	YES	NO
Identify risk areas where surface runoff may enter waterways	☐	☐
Leave a grass buffer strip or riparian plantings between waterway and fence	☐	☐
If cultivating paddocks leave an uncultivated buffer strip between cultivation and waterway (the steeper the land the wider the buffer strip needs to be)	☐	☐
Ensure bridges and culverts have raised sides or mounds to stop runoff entering waterway	☐	☐
If the track is beside a waterway, slope the track in the opposite direction to avoid effluent and sediment flowing into the waterway	☐	☐
Maintain track cut-outs to appropriately direct track runoff	☐	☐

EVIDENCE

- Risk areas identified on farm map
- Record any riparian fencing, planting or buffer strips on farm map
- Cropping / pasture renewal policies and procedures
- Culvert or bridge design plans
- Track maintenance records

2 Tracks, feed areas, gateways and troughs are located away from waterways | GMP 7

PRACTICE	YES	NO
Locate tracks away from waterways if practical	☐	☐
Feed out supplement away from waterways	☐	☐
Locate water troughs away from waterways in a dry area of paddock	☐	☐
Ensure gateways are in a dry point and are wide enough for good cow flow to reduce pugging	☐	☐

EVIDENCE

- Farm map identifying tracks, feed areas, and troughs

3 Stock are excluded from waterways | GMP 8

PRACTICE	YES	NO
Fence all permanently flowing waterways (including wetlands)	☐	☐
Bridge or culvert across regular stock crossings	☐	☐
Temporarily fence any temporary streams if grazing while water is flowing	☐	☐
Develop a riparian management plan (include any plantings)	☐	☐
Ensure drains are well managed	☐	☐

EVIDENCE

- Farm waterway map with fencing and crossings shown
- Riparian management plan

4 Areas of native plants or significant biodiversity are protected

not relevant?

PRACTICE	YES	NO
Identify areas on farm map	☐	☐
Fence stock out of the area	☐	☐
Control weeds within the area	☐	☐
Trap or poison animal pests	☐	☐

EVIDENCE

- Farm map
- Weed and pest management records

PLM

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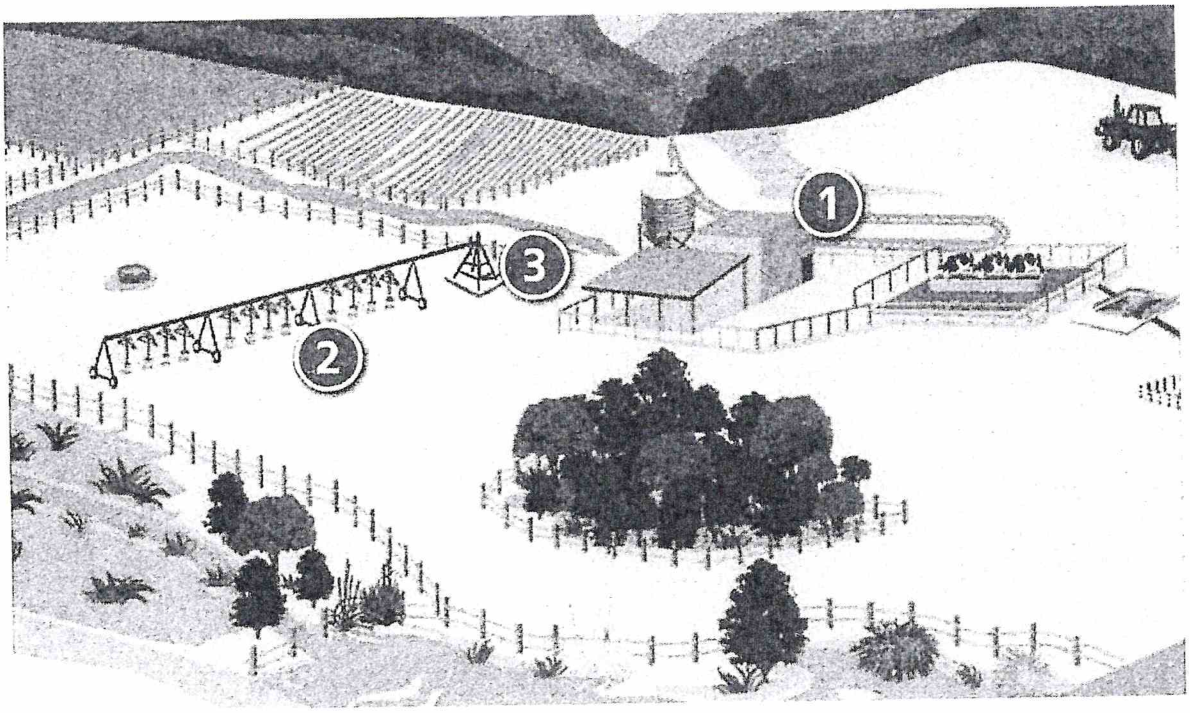
Water and irrigation

Good management practices



Why is this important?

Water is arguably the most important resource on farm, even more so on irrigated farms. Often there is limited water available and costs associated with pumping it around the farm. Water taken for farming is removed from the natural cycle and may reduce stream flows or groundwater levels. Ensuring water is not wasted will save money and benefit the environment.

A well-designed irrigation system is easier to manage and more reliable. Managing well is still key to ensuring the system operates efficiently and that water is applied at the right depth across the farm. This will result in more even pasture growth and easier pasture management. An efficient irrigation system also allows you to better match water application to soil, plant and production requirements. This will maximise efficiency within the farm system in terms of production, electricity usage, and wear and tear on equipment. It also means that excess water is not draining the soil of nutrients or resulting in runoff that may contaminate groundwater and waterways.

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1 Water use for the dairy shed and stock water is efficient

PRACTICE

Practice	YES	NO
Measure all water use on farm (water meters)	☐	☐
Minimise water wastage from the dairy shed	☐	☐
Ensure all leaks are fixed as soon as possible	☐	☐
Check water troughs daily where animals are grazing	☐	☐

EVIDENCE

- Water meter and telemetry records
- Maintenance records

2 Irrigation rates and timing match plant requirements | GMP 13

PRACTICE

Practice	YES	NO
Irrigate to replace soil moisture deficit only	☐	☐
Assess soil moisture levels and weather when scheduling irrigation by: - Estimate soil moisture levels with a soil water budget or - Monitor soil moisture levels with real time soil moisture equipment	☐	☐
Measure all water use on farm (water meters)	☐	☐
Monitor large water takes (telemetry)	☐	☐
Record irrigation events - when, where, amount	☐	☐

EVIDENCE

- Soil water budgets, moisture trace or data
- Irrigation scheduling – rainfall records, soil tapes/probes/sensors
- Water efficiency calculations
- Water meter and telemetry records
- Irrigation event and location records

3 Design, calibrate and operate irrigation systems to use water efficiently | GMP 14

PRACTICE

Practice	YES	NO
Use an accredited design and installation company – "Blue tick" for new irrigation system or upgrades	☐	☐
Evaluate irrigation system annually to check application efficiency and performance (consider using a skilled professional to assess)	☐	☐
Carry out routine bucket tests to assess performance	☐	☐
Inspect and maintain regularly	☐	☐
Train all staff using the system (Consider Irrigation NZ's operator and manager training)	☐	☐

EVIDENCE

- Irrigation system design plans
- Commissioning report
- Calibration results – bucket test
- Maintenance schedule/records
- Servicing invoice
- Training records

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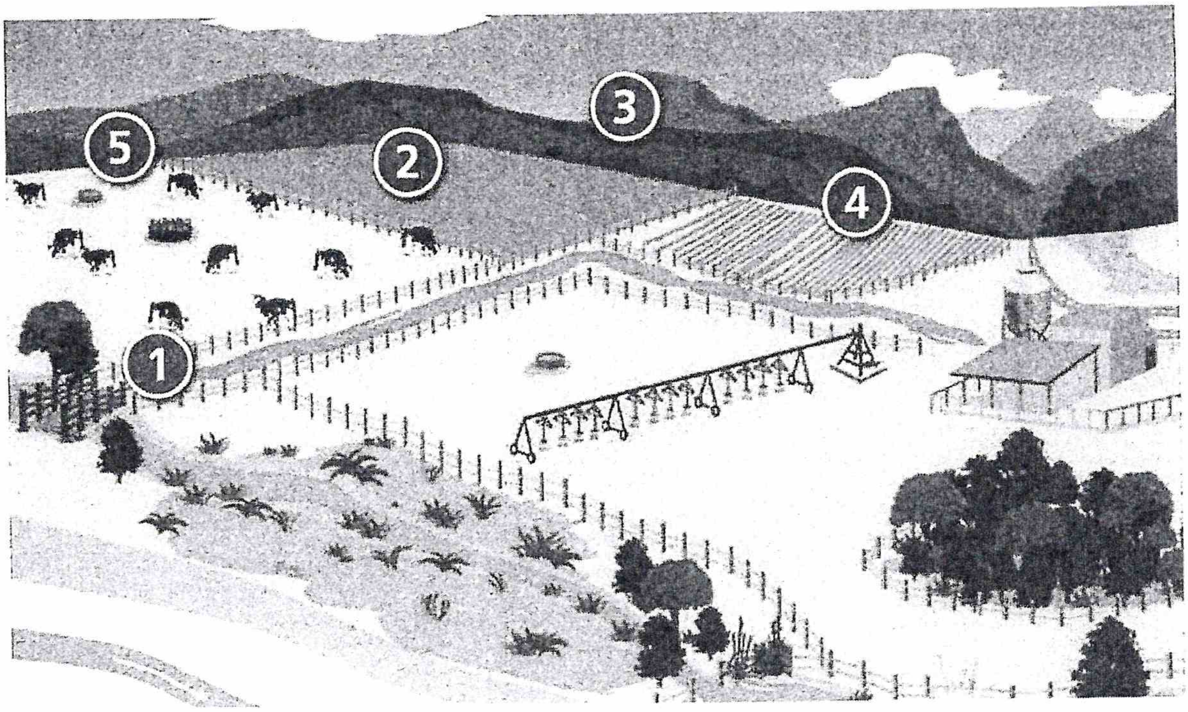
Land and soil

Good management practices



Why is this important?

Land and more specifically the soils are the fundamentals of a productive dairy farm. Management practices which result in pugging, compaction, extended periods of bare soil and grazing unsuitable land will all result in top soil damage, erosion and loss of production.

Topsoil is nutrient rich and losing it into waterways is not only expensive to the farm in terms of replacement nutrient costs, it is also damaging to the waterway.

Sediment can be a limiting factor to water quality as it will discolour the water and silt up stream beds which damages aquatic habitat.

Nutrients, most notably phosphorus attached to the sediment, can cause undesirable plant and algal growth which harms aquatic life. Sediment accumulation also has downstream impacts on rivers, estuaries and harbours.

1 Minimise losses of sediment and nutrient to water, and maintain soil structure | GMP 3

PRACTICE

	YES	NO
Avoid pugging and compaction of soils	☐	☐
Consider no tillage or low impact cultivation methods and timing	☐	☐
Locate supplement feed-out areas away from waterways	☐	☐
Leave riparian margins or buffer strips beside waterways and other areas where sediment and nutrients may flow such as gullies or swales.	☐	☐

EVIDENCE

- Wet weather management policies
- Cropping / pasture renewal policies and procedures
- Record retired, fenced and erosion-planted areas on farm map

2 Reduce periods of bare soil between crops and pasture to reduce erosion and leaching | GMP 4

PRACTICE

	YES	NO
Re-sow bare paddocks as soon as practical	☐	☐
Rest and re-sow erosion damaged areas	☐	☐
Subsoil, rip or cultivate compacted soils	☐	☐
Use cover crops (e.g. oats, mustard) to reduce losses and increase soil organic matter	☐	☐

EVIDENCE

- Cropping / pasture renewal policies and procedures
- Sowing and grazing dates recorded in farm diary

BMP

3 Retire all LUC 8 land and retire LUC 7e land or ensure that it has soil conservation measures in place | GMP 5

PRACTICE

	YES	NO
Identify any LUC 8 and 7e land on the property	☐	☐
Permanently fence off LUC 8 and 7e land areas	☐	☐
Plant areas to protect from erosion if practical	☐	☐

Note: LUC means land use capability

EVIDENCE

- LUC map of farm
- Record retired, fenced and planted erosion-risk areas on farm map

4 Use appropriate paddocks for intensive grazing | GMP 20

PRACTICE

Select low risk paddocks for intensive grazing that are ideally:

	YES	NO
- Further away from waterways	☐	☐
- With soils least likely to pug and compact	☐	☐
- Flatter with as few gullies and swales as possible	☐	☐

EVIDENCE

- Winter crop paddock selection tool
- Map winter cropping areas

5 Manage grazing to minimise nutrient loss from risk areas | GMP 21

PRACTICE

	YES	NO
If paddocks near waterways have to be used during wet periods, fence off a buffer strip beside the waterway	☐	☐
Offer more feed in cold conditions when demand is high and utilization low	☐	☐
When break feeding:		
- Feed towards the waterway	☐	☐
- Move fences daily rather than offering a few days feed at a time	☐	☐
- Back-fence land that has already been grazed	☐	☐
Crops:		
- Offer long narrow breaks rather than wide breaks	☐	☐
- Sow crops across slopes not up and down where practical	☐	☐

EVIDENCE

- Winter management plan
- Wet weather management policies

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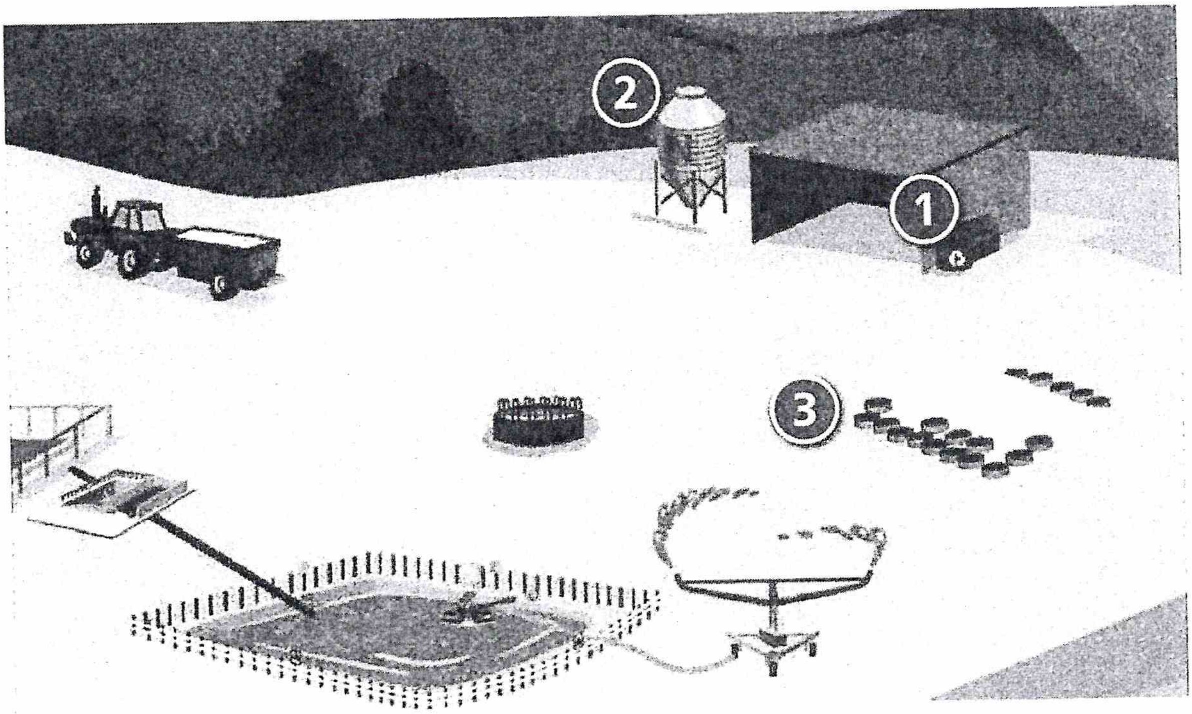
Storage infrastructure and waste

Good management practices



Why is this important?

Feed and fertiliser are significant financial investments and a major source of nutrients into the farm system. Make sure you are getting maximum value from your investment by ensuring that storage and loading is carried out correctly to avoid wastage and reduce the chances of any nutrients entering and contaminating waterways.

Waste including farm waste, household waste and dead stock pose the risk of contamination of waterways, groundwater and land. Appropriate management reduces this risk.

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out of scope

1 Farm waste is minimised and managed properly

PRACTICE

	YES	NO
Recycle waste where possible	☐	☐
Contain and remove waste from farm where feasible	☐	☐
Send dead animals for processing or correctly dispose on-farm	☐	☐
Any on-farm waste pits are small, away from waterways, and above the water table	☐	☐
Control pests	☐	☐

EVIDENCE

- Refuse transfer receipts/invoices
- Dead stock collection invoices

2 Store and load fertiliser with minimal spillage and leaching | GMP 11

PRACTICE

	YES	NO
Follow 'Fertiliser Industry - Code of Practice' for fertiliser handling, storage and use	☐	☐
Locate storage sites away from waterways	☐	☐
Ensure stored fertiliser is covered	☐	☐

EVIDENCE

- Farm map with storage sites identified
- Fertiliser storage and handling policy

3 Store, transport and distribute feed with minimal wastage, leachate and soil damage and leaching | GMP 15

PRACTICE

	YES	NO
Locate feed storage areas away from waterways	☐	☐
Store silage and other feeds on hard-sealed areas and collect leachate	☐	☐
Divert overland flow and rain water away from feed storage area	☐	☐
Ensure silage has been sufficiently wilted before being put into stack	☐	☐
Ensure silage remains sealed while stored to prevent rotting	☐	☐
Permanent feed-out areas / facilities are sealed and effluent is collected	☐	☐

EVIDENCE

- Farm map identifying feed storage and feed out areas
- Feed out area design plans

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For more information visit
dairynz.co.nz

DairyNZ
Corner Ruakura and Morrinsville Roads
Private Bag 3221
Hamilton 3240

Phone 0800 4 DairyNZ (0800 4 324 7969)

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Appendix 4

Promoting good farming practices

At the national level, the Governance Group will promote the Good Farming Practice Principles outlined below.

AGREED NATIONAL GOOD FARMING PRACTICE PRINCIPLES

GENERAL PRINCIPLES

1. Identify the physical and biophysical characteristics of the farm system, assess the risk factors to water quality associated with the farm system, and manage appropriately.
2. Maintain accurate and auditable records of annual farm inputs, outputs and management practices.
3. Manage farming operations to minimise direct and indirect losses of sediment and nutrients to water, and maintain or enhance soil structure, where agronomically appropriate.

NUTRIENTS

4. Monitor soil phosphorus levels and maintain them at or below the agronomic optimum for the farm system
5. Manage the amount and timing of fertiliser inputs, taking account of all sources of nutrients, to match plant requirements and minimise risk of losses.
6. Store and load fertiliser to minimise risk of spillage, leaching and loss into water bodies
7. Ensure equipment for spreading fertilisers is well maintained and calibrated.
8. Store, transport and distribute feed to minimise wastage, leachate and soil damage.

WATERWAYS

9. Identify risk of overland flow of sediment and faecal bacteria on the property and implement measures to minimise transport of these to water bodies.
10. Locate and manage farm tracks, gateways, water troughs, self-feeding areas, stock camps, wallows and other sources of run-off to minimise risks to water quality.
11. Exclude stock from water bodies to the extent that is compatible with land form, stock class and stock intensity. Where exclusion is not possible, mitigate impacts on waterways.

LAND AND SOIL

12. Manage periods of exposed soil between crops/pasture to reduce risk of erosion, overland flow and leaching.
13. Manage or retire erosion prone land to minimise soil losses through appropriate measures and practices*
14. Select appropriate paddocks for intensive grazing, recognising and mitigating possible nutrient and sediment loss from critical source areas
15. Manage grazing to minimise losses from critical source areas.

EFFLUENT

16. Ensure the effluent system meets industry specific Code of Practice or equivalent standard.
17. Have sufficient, suitable storage available for farm effluent and wastewater.
18. Ensure equipment for spreading effluent and other organic manures is well maintained and calibrated.
19. Apply effluent to pasture and crops at depths, rates and times to match plant requirements and minimise risk to water bodies.

WATER AND IRRIGATION

20. Manage the amount and timing of irrigation inputs to meet plant demands and minimise risk of leaching and runoff.
21. Design, check and operate irrigation systems to minimise the amount of water needed to meet production objectives.

**Implementing this principle may mean that Class 8 land is not actively farmed for arable, pastoral or commercial forestry uses as this land is generally unsuitable for these activities as described in the Land Use Capability Handbook.*

Appendix 5

MASSEY UNIVERSITY

FERTILIZER & LIME RESEARCH CENTRE

Sensitivity of values in Table 14.2 of the 'One Plan' to a change in the version of OVERSEER®

Part A: Recalculation of nitrogen (N) leaching maximums by LUC class using OVERSEER® versions 5.2.6 (2007) and 6.2.3 (2017)

horizons

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Introduction

Horizons Regional Council commissioned the Fertilizer and Lime Research Centre (Massey University) to investigate the extent to which cumulative N leaching maximums, by Land Use Capability (LUC) Class in Table 14.2, of their One Plan, are affected by a change in the version of OVERSEER®. The Year 1 numbers in Table 14.2 appear to have been derived directly from values calculated using OVERSEER® version 5.2.6 (2007 version) or earlier (Carran *et al.*, 2007). The first step to re-calibrating the Table 14.2 values is to assess the impact that the current version of OVERSEER® (v6.2.3) has on the N leaching losses by LUC class for Year 1 (Table 1).

Table 1: One Plan Table 14.2 Cumulative N Leaching Maximums for Year 1 (kg N/ha)

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Year 1	30	27	24	18	16	15	8	2

This report has two objectives. Firstly, to approximately replicate the data for each LUC class for Year 1 (One Plan Table 14.2) by identifying input parameter data (known and assumed) for a base farm for use in OVERSEER® (v5.2.6). Secondly, the input parameter data is used in the current version of OVERSEER® (v6.2.3) to determine the new cumulative N leaching maximums for each LUC class.

Methods

The main initial assumptions used to develop the base farm file for use in OVERSEER® (v5.2.6) include the following:

- a legume based pasture receiving no N fertiliser,
- seasonal supply dairy farm, not carrying any replacements,
- 1200 mm annual average rainfall,
- soil orders used: Class I = Recent Soil, Class II = Brown soil, Class III - VII Pallic soil.
- the appropriate slope class and erosion potential solely dictate the choice of topography, and
- distance from the coast of 50 km
- A total of 9% of the farm area is used for spray application of farm dairy effluent (Holding ponds are used to store effluent, which is 'sprayed at optimum times').

Full details of the input parameters for the base farm file are provided in Appendix 1. The approach used to develop the base farm file was to first set up the farm for LUC I. To do this, the 'attainable physical potential' grazing carrying capacity was obtained from the NZLRI Land Use Capability Extended Legend for the Manawatu/Taranaki Region. For LUC I, the

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'attainable physical potential' is 30 stock units (SU)/ha, while the 'present average' value provided is 20 SU/ha. Cow stocking rate and milksolids production were increased in OVERSEER® v5.2.6 until a pasture intake corresponding to a stocking rate of approximately 30 SU/ha (16,500 kg DM/ha; assumes 550 kg DM/SU) was achieved. The milksolids (MS) production was maintained at 370 kg MS/cow, which was the average value provided in Clothier *et al.*, (2007).

To derive the stocking rate values for the other LUC classes (LUC II-VII), the stocking rate and milksolids production were decreased until the N loss to water values were the same as those provided in the One Plan Table 14.2 for Year 1 (Table 1). The pasture intakes for each LUC class, as estimated by OVERSEER® v5.2.6, were then compared with the 'attainable physical potential' grazing carrying capacity, provided in the NZLRI Land Use Capability Extended Legend. This was done to ensure that the values obtained using OVERSEER® v5.2.6 for each LUC class were within the expected range provided in the LUC Extended Legend. The stocking rates, milk solids production, soil order and topography used in OVERSEER® v5.2.6 for each LUC class are provided in Table 2. Although LUC VII is classified as having 'Steep' topography, 'Easy' was used instead because a N loss to water below 9 kg N/ha could not be achieved with OVERSEER® v5.2.6 when 'Steep' topography was used.

Table 2: Summary of main input parameter changes for each LUC class

LUC	Stock Units (SU/ha)	Stocking rate (cows/ha)	Milksolids (kg/ha)	Soil Order	Topography
I	29.9	3.4	1275	Recent	Flat
II	27.1	3.1	1150	Brown	Flat
III	23.8	2.7	1020	Pallic	Rolling
IV	16.6	1.9	700	Pallic	Rolling
V	14.0	1.6	590	Pallic	Easy
VI	13.1	1.5	555	Pallic	Easy
VII	4.4	0.5	185	Pallic	Easy**
VIII	Trees	-	-	-	

*Assumes 550 kg DM/SU intake. **Used Easy rather than Steep.

For each LUC class, the equivalent input data to that was used in OVERSEER® v5.2.6 was then entered into OVERSEER® v6.2.3. There were two main considerations that needed to be addressed when changing versions. The first consideration was that some of the default values

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used in OVERSEER® v5.2.6 varied from OVERSEER® v6.2.3. Therefore, two sets of results from OVERSEER® v6.2.3 are provided; one using the v5.2.6 default values (Appendix 2) and the other using the v6.2.3 default values (Appendix 3). The other consideration was that v6.2.3 has more options for entering input data than v5.2.6. Therefore, in most cases where additional input information was required by v6.2.3, then either the default value was used or the OVERSEER®Best Practice Data Input Standards (v6.2.3) were used for guidance.

Results

The N leaching maximums obtained with OVERSEER® v6.2.3, using the v5.2.6 defaults, were 32.5 - 66.0% higher than the original One Plan Table 14.2 values (Table 2). Using the v6.2.3 defaults instead of the v5.2.6 defaults made minimal difference to the N leaching maximums obtained (Table 3).

Table 2: Original and revised (v 6.2.3 using v5.2.6 defaults) N leaching maximums

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original (v 5.2.6)	30	27	24	18	16	15	8	2
Revised (v 6.2.3) ***v5.2.6 defaults***	49.8	44.4	35.7	26.2	22.7	21.6	10.6	3.3*
Increase	66.0%	64.4%	48.8%	45.6%	41.9%	44.0%	32.5%	65.0%

*Native trees (pines are 2.7 kg N/ha loss to water)

Table 3: Original and revised (v6.2.3 using v6.2.3 defaults) N leaching maximums

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original (v 5.2.6)	30	27	24	18	16	15	8	2
Revised (v 6.2.3) ***v6.2.3 defaults***	49.4	44.0	35.5	26.0	22.6	21.5	10.6	3.3*
Increase	64.7%	63.0%	47.9%	44.4%	41.3%	43.3%	32.5%	65.0%

*Native trees (pines are 2.7 kg N/ha loss to water)

The pasture intakes provided for each LUC class by OVERSEER® v6.2.3, using the v5.2.6 defaults, were close to those obtained with v5.2.6 (Table 4). When the v6.2.3 default values were used instead, the difference in pasture intakes between v6.2.3 and v5.2.6 increased. Therefore, it is recommended that comparisons of the N losses to water between the two OVERSEER® versions are best made using the v5.2.6 defaults for both versions.

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Table 4: Stock units and OVERSEER® pasture intakes* for each LUC class

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Stock units** (SU/ha)	29.9	27.1	23.8	16.6	14	13.1	4.4	-
v5.2.6 Pasture Intake (kg DM/ha)	16,448	14,930	13,108	9,123	7,683	7,216	2,406	-
v6.2.3 Pasture Intake *v5.2.6 defaults* (kg DM/ha)	16,265	14,742	13,179	9,144	7,784	7,319	2,440	-
v6.2.3 Pasture Intake *v6.2.3 defaults* (kg DM/ha)	16,977	15,395	13,748	9,543	8,130	7,636	2,545	-

*Assumes that pasture intake is 85% of pasture production. **Based on an intake of 550 kg DM/SU

References

Carran A, Clothier B, Mackay, Parfitt R (2007). *Appendix 6: Defining nutrient (nitrogen) loss limits within a water management zone on the basis of the natural capital of soil in Farm Strategies for Contaminant Management.* A report prepared by the Sustainable Land Use Research Initiative (SLURI) for Horizons Regional Council.

Clothier B, Mackay A Carran A, Gray R, Parfitt R, Francis G, Manning Maitland, Duerer M, Green S (2007). *Farm Strategies for Contaminant Management.* A report prepared by the Sustainable Land Use Research Initiative (SLURI) for Horizons Regional Council.

Appendix 1

Case study farm - LUC I (base)

Overseer 5.2.6 file: *'LUC I(v5.2.6)'*

<u>Current</u>

Farm

- Region: East Coast North Island

Block setup

- Block areas: 100 ha Non-effluent, 10 ha Effluent (spray effluent)
- Relative productivity: No difference between blocks

Dairy animals

- Dairy cows (/ha): 3.4 cows
- Breed: Friesian
- Milk solids (kg/ha): 1275 kg MS/ha
- Replacements grazed off: Weaning
- Effluent disposal system: Holding pond
- Pond treatment method: Spray at optimum times
- Block (solid) effluent distrib: Effluent block (pond sludge)

<u>Non-effluent block</u>

Block general

- Topography: Flat
- Distance from coast: 50 km
- Rainfall: 1200 mm

Animals and pasture

- Development status: Highly developed (not default)
- Pasture type: Ryegrass/white clover

Soil

- Soil order: Recent
- Soil texture: Silt loam
- Soil tests: "Click if missing soil test data"

Fertiliser

<u>Effluent block</u>

Block general

- Topography: Flat
- Distance from coast: 50 km
- Rainfall: 1200 mm
- Effluent application rate: Medium

Animals and pasture

- Development status: Highly developed (not default)
- Pasture type: Ryegrass/white clover

Soil

- Soil order: Recent
- Soil texture: Silt loam
- Soil tests: "Click if missing soil test data"

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Case study farm - LUC II (differences from LUC I – base):
Overseer 5.2.6 file: *'LUC II (v5.2.6)'*
<u>Current</u>
Dairy animals
- Dairy cows (/ha): 3.1 cows
- Milk solids (kg/ha): 1150 kg MS/ha

<u>Non-effluent block</u>
Soil
- Soil order: Brown

<u>Effluent block</u>
Soil
- Soil order: Brown

Case study farm - LUC III (differences from LUC I – base):
Overseer 5.2.6 file: *'LUC III (v5.2.6)'*
<u>Current</u>
Dairy animals
- Dairy cows (/ha): 2.7 cows
- Milk solids (kg/ha): 1020 kg MS/ha

<u>Non-effluent block</u>
Block general
- Topography: Rolling

Soil
- Soil order: Pallic

Fertiliser
<u>Effluent block</u>
Block general
- Topography: Rolling

Soil
- Soil order: Pallic

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Case study farm - LUC IV (differences from LUC I – base):
Overseer 5.2.6 file: *'LUC IV (v5.2.6)'*
<u>Current</u>
Dairy animals

- Dairy cows (/ha): 1.9 cows
- Milk solids (kg/ha): 700 kg MS/ha

<u>Non-effluent block</u>
Block general

- Topography: Rolling

Soil

- Soil order: Pallic

<u>Effluent block</u>
Block general

- Topography: Rolling

Soil

- Soil order: Pallic

Case study farm - LUC V (differences from LUC I – base):
Overseer 5.2.6 file: *'LUC V (v5.2.6)'*
<u>Current</u>
Dairy animals

- Dairy cows (/ha): 1.6 cows
- Milk solids (kg/ha): 590 kg MS/ha

<u>Non-effluent block</u>
Block general

- Topography: Easy hill

Soil

- Soil order: Pallic

<u>Effluent block</u>
Block general

- Topography: Easy hill

Soil

- Soil order: Pallic

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Case study farm - LUC VI (differences from LUC I – base):
Overseer 5.2.6 file: *'LUC VI (v5.2.6)'*
<u>Current</u>
Dairy animals

- Dairy cows (/ha): 1.5 cows
- Milk solids (kg/ha): 555 kg MS/ha

<u>Non-effluent block</u>
Block general

- Topography: Easy hill

Soil

- Soil order: Pallic

<u>Effluent block</u>
Block general

- Topography: Easy hill

Soil

- Soil order: Pallic

Case study farm - LUC VII (differences from LUC I – base):
Overseer 5.2.6 file: *'LUC VII(v5.2.6)'*
<u>Current</u>
Dairy animals

- Dairy cows (/ha): 0.5 cows
- Milk solids (kg/ha): 185 kg MS/ha

<u>Non-effluent block</u>
Block general

- Topography: Easy hill (instead of Steep hill)

Soil

- Soil order: Pallic

<u>Effluent block</u>
Block general

- Topography: Easy hill (instead of Steep hill)

Soil

- Soil order: Pallic

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Case study farm - LUC VIII:
Overseer 5.2.6 file: *'LUC VII(v5.2.6)'*
<u>Current</u>
Block setup

- Block areas: 109 ha Trees, 1 ha Pasture

Other animals

- SU/ha beef: 1

<u>Trees block</u>
Block general

- Distance from coast: 50 km
- Rainfall: 1200 mm

<u>Pasture block</u>
Block general

- Topography: Steep hill

Soil

- Soil order: Pallic

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Appendix 2 – Overseer 6.2.3 using v5.2.6 defaults

Case study farm - LUC I (base): Bold denotes additional input information required by v6.2.3

Overseer 6.2.3 file: *'LUC I (v6.2.3) – v5 defaults'*

<u>Farm scenario</u>

Farm

- Location — By Region - East Coast North Island

Block setup

- Block areas: — **Total 110 ha:** 100 ha Non-effluent, 10 ha Effluent
- Relative productivity: — No difference between blocks

Dairy animals

- **Peak cow numbers:** — 374 cows **(breeding numbers NOT constant)**
- Breed: — Friesian
- **Average weight:** — 534 kg/animal (default for 5.2.6)
- **Replacement rate:** — 25% (default for 5.2.6)
- Milk solids (kg/ha): — 1275 kg MS/ha
- **Lactation length:** — 271 (default for 5.2.6)
- Replacements grazed off: — Weaning
- Effluent disposal system: — Holding pond;
- **Pond solids:** — **Solids spread on selected blocks; ponds empty every 1 year**
- **Liquid effluent:** — **Spray regularly**

<u>Non-effluent block</u>

General

- Topography: — Flat
- Distance from coast: — 50 km

Climate

- **Daily rainfall pattern:** — **731-1450 mm, low**
- Rainfall: — 1200 mm
- **Temperature:** — 12.6 °C (default for 5.2.6)
- **PET:** — **Use default PET (801-950 mm/yr)**
- **PET seasonal variation:** — **Moderate**

Pasture

- Development status: — **No input for development status**
- Pasture type: — Ryegrass/white clover
- Specify pasture quality: — default from v5.2.6, see table below

	Digestibility (%)	ME (MJ ME/kg DM)
January	75	11.1
February-April	73	10.8
May-August	74	10.9
September	77	11.4
October	79	11.7
November	78	11.5
December	77	11.4

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Soil

- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile:** **Medium**
- Soil tests: "Replace missing test data with typical values"
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 80 tonnes (dry weight basis) (automatic in v5.2.6)
- Destination: Non-effluent block

<u>Effluent block</u>

General

- Topography: Flat
- Distance from coast: 50 km

Climate

- **Daily rainfall pattern:** **731-1450 mm, low**
- Rainfall: 1200 mm
- **Temperature:** 12.6 °C (default for v5.2.6)
- **PET:** **Use default PET (801-950 mm/yr)**
- **PET seasonal variation:** **Moderate**

Pasture

- Development status: **No input for development status**
- Pasture type: Ryegrass/white clover
- Specify pasture quality: Default from v5.2.6

Soil

- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile:** **Medium**
- Soil tests: "Replace missing test data with typical values"
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 8 tonnes (dry weight basis) (default from 5.2.6)
- Destination: Effluent block

Effluent

- Effluent application rate: **12-24 mm**
- Solids effluent application: Pond solids/sludge **(December)**

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Case study farm - LUC II (differences from LUC I – base):
Overseer 6.2.3 file: *'LUC II (v6.2.3) - v5 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 341 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 1150 kg MS/ha

Non-effluent block

Soil

- Soil order: *Brown*

Supplements made

- Category: Silage
- Weight: 73 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

- Soil order: Brown

Supplements made

- Category: Silage
- Weight: 7 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC III (differences from LUC I – base):
Overseer 6.2.3 file: *'LUC III (v6.2.3) – v5 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 297 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 1120 kg MS/ha

Non-effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 64 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 6 tonnes (dry weight basis) (automatic in v5.2.6)

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Case study farm - LUC IV (differences from LUC I – base):
Overseer 6.2.3 file: *'LUC IV (v6.2.3) – v5 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 209 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 700 kg MS/ha

Non-effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 45 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC V (differences from LUC I – base)
Overseer 6.2.3 file: *'LUC V (v6.2.3) – v5 defaults'*

Farm scenario

Dairy animals

- Peak cow numbers: 176 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 590 kg MS/ha

Non-effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 38 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

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Case study farm - LUC VI (differences from LUC I – base):
Overseer 6.2.3 file: *'LUC VI (v6.2.3) – v5 defaults'*

<u>Farm scenario</u>

Dairy animals

- Peak cow numbers: 165 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 555 kg MS/ha

<u>Non-effluent block</u>

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 36 tonnes (dry weight basis) (automatic in v5.2.6)

<u>Effluent block</u>

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC VII (differences from LUC I – base):
Overseer 6.2.3 file: *'LUC VII (v6.2.3) – v5 defaults'*

<u>Farm scenario</u>

Dairy animals

- Peak cow numbers: 5 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 185 kg MS/ha

<u>Non-effluent block</u>

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 12 tonnes (dry weight basis) ((automatic in v5.2.6)

<u>Effluent block</u>

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 1 tonnes (dry weight basis) (automatic in v5.2.6)

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Case study farm - LUC VIII:

Overseer 6.2.3 file: *'LUC VIII (v6.2.3) – v5 defaults'*

Farm scenario

Beef/dairy grazers

- Block areas: 1 RSU

Block setup

- Block areas: 109 ha Trees, 1 ha Pasture

Trees

General

- Bush type Native

Pasture

Block general

- Topography: Steep hill

Soil

- Soil order: Pallic

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Appendix 3 - Overseer 6.2.3 using v6.2.3 defaults

Case study farm - LUC I (base): Bold denotes additional input information required by v6.2.3

Overseer 6.2.3 file: *'LUC I (v6.2.3) – v6 defaults'*

Farm scenario

Farm

- Location — By Region - East Coast North Island

Block setup

- Block areas: — **Total 110 ha:** 100 ha Non-effluent, 10 ha Effluent
- Relative productivity: — No difference between blocks

Dairy animals

- **Peak cow numbers:** — 374 cows **(breeding numbers NOT constant)**
- Breed: — Friesian
- **Average weight:** — Default reading falsely as 462 kg/animal, actual 525 kg/animal (default for 6.2.3)
- **Replacement rate:** — Default 23% (default for 6.2.3)
- Milk solids (kg/ha): — 1275 kg MS/ha
- **Lactation length:** — 270 (default for 6.2.3)
- Replacements grazed off: — Weaning
- Effluent disposal system: — Holding pond;
- **Pond solids:** — **Solids spread on selected blocks; ponds empty every 1 year**
- **Liquid effluent:** — **Spray regularly**

Non-effluent block

General

- Topography: — Flat
- Distance from coast: — 50 km

Climate

- **Daily rainfall pattern:** — **731-1450 mm, low**
- Rainfall: — 1200 mm
- **Temperature:** — Default 12.3 °C (default for 6.2.3)
- **PET:** — **Use default PET (801-950 mm/yr)**
- **PET seasonal variation:** — **Moderate**

Pasture

- Development status: — **No input for development status**
- Pasture type: — Ryegrass/white clover
- Specify pasture quality: — Not specified (defaults for 6.2.3 are different to defaults for v5.2.6, but are not shown)

Soil

- Soil order: — Recent
- Top soil texture: — Silt loam
- **Lower profile:** — **Medium**
- Soil tests: — "Replace missing test data with typical values"
- **Susceptibility to pugging:** — **Occasional**

Supplements made

- Category: — Silage
- Weight: — 80 tonnes (dry weight basis) (automatic in v5.2.6)

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- Destination: Non-effluent block

Effluent block

General

- Topography: Flat
- Distance from coast: 50 km

Climate

- **Daily rainfall pattern:** **731-1450 mm, low**
- Rainfall: 1200 mm
- **Temperature:** Default 12.3 °C (default for 6.2.3)
- **PET:** **Use default PET (801-950 mm/yr)**
- **PET seasonal variation:** **Moderate**

Pasture

- Development status: **No input for development status**
- Pasture type: Ryegrass/white clover
- Specify pasture quality: Not specified (defaults for 6.2.3 are different to defaults for v5.2.6, but are not shown)

- *Soil*
- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile:** **Medium**
- Soil tests: "Replace missing test data with typical values"
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 8 tonnes (dry weight basis) (automatic in v5.2.6)
- Destination: Effluent block

Effluent

- Effluent application rate: **12-24 mm**
- Solids effluent application: Pond solids/sludge **(December)**

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Case study farm - LUC II (differences from LUC I – base):
Overseer 6.2.3 file: *'LUC II (v6.2.3) – v6 defaults'*
<u>**Farm scenario**</u>
Dairy animals

- Peak cow numbers: 341 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 1150 kg MS/ha

<u>**Non-effluent block**</u>
Soil

- Soil order: Brown

Supplements made

- Category: Silage
- Weight: 73 tonnes (dry weight basis) (automatic in v5.2.6)

<u>**Effluent block**</u>

- Soil order: Brown

Supplements made

- Category: Silage
- Weight: 7 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC III (differences from LUC I – base):
Overseer 6.2.3 file: *'LUC III (v6.2.3) – v6 defaults'*
<u>**Farm scenario**</u>
Dairy animals

- Peak cow numbers: 297 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 1120 kg MS/ha

<u>**Non-effluent block**</u>
General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 64 tonnes (dry weight basis) (automatic in v5.2.6)

<u>**Effluent block**</u>
General

- Topography: Rolling

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 6 tonnes (dry weight basis) (automatic in v5.2.6)

JF

Case study farm - LUC IV (differences from LUC I – base):
Overseer 6.2.3 file: *'LUC IV (v6.2.3) – v6 defaults'*
Farm scenario
Dairy animals
- Peak cow numbers: 209 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 700 kg MS/ha

Non-effluent block
General
- Topography: Rolling

Soil
- Soil order: Pallic

Supplements made
- Category: Silage
- Weight: 45 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block
General
- Topography: Rolling

Soil
- Soil order: Pallic

Supplements made
- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC V (differences from LUC I – base):
Overseer 6.2.3 file: *'LUC V (v6.2.3) – v6 defaults'*
Farm scenario
Dairy animals
- Peak cow numbers: 176 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 590 kg MS/ha

Non-effluent block
General
- Topography: Easy hill

Soil
- Soil order: Pallic

Supplements made
- Category: Silage
- Weight: 38 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block
General
- Topography: Easy hill

Soil
- Soil order: Pallic

Supplements made
- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

JF

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Case study farm - LUC VI (differences from LUC I – base): *Italics denotes changes from the previous LUC value file*
Overseer 6.2.3 file: '*LUC VI (v6.2.3) – v6 defaults*'

Farm scenario

Dairy animals

- Peak cow numbers: 165 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 555 kg MS/ha

Non-effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 36 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 4 tonnes (dry weight basis) (automatic in v5.2.6)

Case study farm - LUC VII (differences from LUC I – base):
Overseer 6.2.3 file: '*LUC VII (v6.2.3) – v6 defaults*'

Farm scenario

Dairy animals

- Peak cow numbers: 5 cows (breeding numbers NOT constant)
- Milk solids (kg/ha): 185 kg MS/ha

Non-effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 12 tonnes (dry weight basis) (automatic in v5.2.6)

Effluent block

General

- Topography: Easy hill

Soil

- Soil order: Pallic

Supplements made

- Category: Silage
- Weight: 1 tonnes (dry weight basis) (automatic in v5.2.6)

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Case study farm - LUC VIII:
Overseer 6.2.3 file: *LUC VIII '(v6.2.3) – v6 defaults'*

Farm scenario

Beef/dairy grazers

- Block areas: 1 RSU

Block setup

- Block areas: 109 ha Trees, 1 ha Pasture

Trees

General

- Bush type Native

Pasture

Block general

- Topography: Steep hill

Soil

- Soil order: Pallic

JF

Appendix 6

WSP Brief

- Develop a financial farm scale model to compare all of the following scenarios for Intensive Land Use
- We commenced with the least documented and complex of these, commercial vegetable growing under all four
- And, Scenario 2 and 3 for the remaining three intensive land uses that had already been analysed
  - Baseline: Comply with current Table 14.2 (controlled pathway)
  - Scenario 1: Comply with revised Table 14.2 (controlled pathway)
  - Scenario 2: Substantial compliance with 14.2 revised, with remainder rapidly moving towards compliance before year 20 (discretionary pathway)
  - Scenario 3: Substantial compliance with Table 14.2 revised, with those not complying being on an improving trend using GMP (discretionary pathway)

JF

Methodology

Apply a cost of change to farm level input cost activities, productivity and revenue streams to determine a change in financial viability

As representative farms are difficult to define due to the significant variability in farming systems and geographical features an activity gross margin approach has been adopted.

This allows a NPV measure to be used to compare system impacts rather than determine individual business viability (which is subject to further variabilities such as financial structuring).

- To do this we needed to define Good Management Practices and Best Management Practices
- Model practice change in Overseer and compare N outputs against Table 12.4 (current and revised)
- Develop Gross Margins and Net Present Values
- Apply a sensitivity through a Monte Carlo approach

JF

LUC Nitrogen Allocation Table 14.2

Period	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Year 1	30	27	24	18	16	15	8	2
	51	45	40	29	25	24	11	3
Year 5	27	25	21	16	13	10	6	2
	46	42	35	26	20	16	8	3
Year 10	26	22	19	13	13	10	6	2
	44	37	32	23	20	16	8	3
Year 20	25	21	18	12	12	10	6	2
	43	35	30	21	19	16	8	3

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Provisional analysis

- Verification of financial models is underway and is subject to final access to cross refenced data from farmers and growers
- The information presented in later slides is related to Commercial Vegetable Production.
- Dairy systems examples are being built off prior reports but adopting the new discretionary pathway. These results will be documented and circulated.