

**IN THE ENVIRONMENT COURT
WELLINGTON REGISTRY**

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

UNDER	the Resource Management Act 1991
IN THE MATTER	of appeals under sch 1, cl 14(1) against the decision of Manawatū-Whanganui Regional Council on Plan Change 2 to the One Plan
BETWEEN	TE RUNANGA O RAUKAWA ENV-2021-WLG-20 NGĀTI TURANGA ENV-2021-WLG-21 ANDREW DAY ENV-2021-WLG-22 WELLINGTON FISH AND GAME COUNCIL ENV-2021-WLG-23 Appellants
AND	MANAWATŪ-WHANGANUI REGIONAL COUNCIL Respondent

**STATEMENT OF EVIDENCE OF DR JAMES ANTHONY HANLY ON BEHALF OF THE
MANAWATŪ-WHANGANUI REGIONAL COUNCIL**

SOIL SCIENCE – OVERSEER VERSION CHANGES AND TABLE 14.2

Dated: 6 October 2023



Cooper Rapley Lawyers
227-231 Broadway Avenue
PO Box 1945
Palmerston North
DX PP80001

S Johnston / A J R Sinclair
 06 353 5210
 06 356 4345
sjohnston@crlaw.co.nz

TABLE OF CONTENTS

A.	INTRODUCTION	1
B.	BACKGROUND	1
C.	CODE OF CONDUCT	2
D.	EXECUTIVE SUMMARY	2
E.	SCOPE OF EVIDENCE.....	3
F.	ASSUMPTIONS AND METHODOLOGY	4
G.	THE EXTENT TO WHICH THE TABLE 14.2 CNLM ARE AFFECTED BY OVERSEER VERSION CHANGES.....	4
H.	ASSUMPTIONS MADE ABOUT TRANSMISSIVITY OF SOLUBLE NITROGEN BETWEEN THE ROOT ZONE AND THE RIVER	7
I.	RECENT UPDATES TO OVERSEER IN TABLE 14.2	10
J.	FUTURE UPDATES TO OVERSEER	11
K.	ISSUES RAISED ON APPEAL.....	12
L.	REFERENCES	14
M.	ATTACHMENT A	15

STATEMENT OF EVIDENCE OF JAMES ANTHONY HANLY

A. INTRODUCTION

- [1] My full name is James Anthony Hanly. I am currently employed as a Senior Lecturer at Massey University. I have been in that position since 2015. Prior to that I was Senior Research Officer at Massey University.
- [2] My role involves; teaching undergraduate and postgraduate courses on soil fertility and nutrient management in agriculture and horticulture; teaching professional development courses on sustainable nutrient management, including the use of the Overseer nutrient budgeting model, farm dairy effluent management and agricultural greenhouse gas management, and supervising postgraduate student Masters and PhD research projects on soil fertility and environmental management.
- [3] I hold a Doctor of Philosophy (PhD) degree in Soil Science from Massey University. I am a member of the New Zealand Society of Soil Science.
- [4] My evidence details the approach taken by Manawatū-Whanganui Regional Council (**Horizons**) in the recalibration of the Table 14.2 Cumulative Nitrogen Leaching Maximums (**CNLM**) to reflect changes in Overseer, for the purpose of regulating intensive farming land use activities.

B. BACKGROUND

- [5] In 2018, Horizons commissioned the Fertilizer and Lime Research Centre (Massey University) to investigate the extent to which CLNM, by LUC class in Table 14.2 of the One Plan, were affected by a change in the version of Overseer. The findings of the analysis I carried out are presented in the following reports: Hanly *et al.* (2018a), Hanly *et al.* (2018b), Hanly & Horne (2018) and Hanly (2020).
- [6] The reports are attached as **Attachment A** to this evidence.
- [7] I produced a s 42A technical report for Horizons as part of the Council-level hearing on PC2, which explained the findings of those reports, and provided

the technical justification for Table 14.2 CNLM values and transmission coefficients to be updated to reflect changes in Overseer versions.

[8] There was very little concern raised around the recalibration of Table 14.2 through the Council hearing process. To the contrary, my recollection is that most submitters accepted the need and benefit arising from a recalibration of Table 14.2. As I understand it, only one of the four appellants seek relief relating to Table 14.2, with the remaining appellants supporting the recalibration of Table 14.2.

[9] My role has been and remains solely related to the recalibration of Table 14.2. While I understand that there are other consenting pathways within the version of PC2 approved by the Commissioners' decision (**DV-PC2**), and proposed since (the risk assessment tool), I have not been involved with those components of the plan change.

C. CODE OF CONDUCT

[10] I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023. This evidence has been prepared in accordance with that Code. I confirm that I have not omitted to consider material facts that might alter or detract from the opinions that I express. The evidence I am giving is within my area of expertise, except where I state I am relying on the opinion or evidence of other witnesses. I understand it is my duty to assist the Court impartially on relevant matters within my areas of expertise.

D. EXECUTIVE SUMMARY

[11] The key conclusions of my evidence are:

- (a) Overseer version changes have resulted in substantial increases in the One Plan's Table 14.2 CNLM values (Hanly et al. ,2018a; Hanly & Horne, 2018; Hanly, 2020). The updated table values, using more recent versions of Overseer, show what the CNLM values would likely have been, had these versions of Overseer been available when the original table was created.

- (b) The CNLM values relate to Overseer estimates of root zone N leaching losses. However, there are also processes that can occur after N is leached from the soil root zone that further reduce the quantity of N in drainage water before it reaches the river. These are defined using a transmission coefficient. When the Overseer estimates of root zone N leaching increase, using the same farm input information, then the transmission coefficient will be lower than previously estimated. If the estimated root zone N Leaching losses increase with an Overseer version change, then the transmission coefficient also needs to be updated, which will then show that an Overseer version change on its own does not increase the quantity of N reaching the river.
- (c) I support an approach that allows the Table 14.2 CNLM values and the transmission coefficients to be updated with changes in Overseer versions. The 'reference file' approach can be relied upon to address my recommendation that further Overseer version changes should be accounted for over time. However, I note that this approach should use the same methodology and farm information used to provide the original and recalibrated CNLM values.

[12] Mr Day, one of the appellants, has raised the specific issue in his appeal regarding the recalibration of the CNLM in Table 14.2. In particular, Mr Day seeks the *“recalibration of Table 14.2 using Overseer 6.2.3 or a subsequent version, following the same methodology as the original table”*. In my opinion, the recalibration of Table 14.2, described in Hanly *et al.* (2018a), follows closely the methodology used to derive the original CNLM values, which is the methodology described in Carran *et al.* (2007). Therefore, as I explain below, the methodology is sound and is fit for purpose.

E. SCOPE OF EVIDENCE

[13] My evidence discusses and builds upon earlier work I completed (Hanly *et al.*, 2018a; Hanly *et al.*, 2018b; Hanly & Horne, 2018; Hanly, 2020) for Horizons regarding the intensive farming land use provisions in the One Plan.

This work and related reporting involved recalculating of nitrogen (**N**) leaching maximums by Land Use Capability (**LUC**) class using Overseer.

[14] This evidence addresses the following points:

- (a) The extent to which the current Table 14.2 CNLM values are affected by Overseer version changes and the impact that this has had on the N leaching limits (including percentage changes in values between Overseer versions 6.2.3 and versions 6.3.0, 6.3.3 and 6.5.2).
- (b) Assumptions made about the transmissivity of soluble N between the root zone and the river. For example, if later versions of Overseer predict that more N is leaving from the root zone, yet the measured dissolved N load in receiving water bodies remains the same.
- (c) I provide comments on the Overseer farm 'reference file' approach in DV-PC2 for updating the CNLM values outside of the One Plan.
- (d) I also provide comments on the appeal of Mr Day against PC2, which partially relates to the methodology for the proposed changes to the N leaching CLNM in Table 14.2.

[15] In addition to my own observations, I also refer to the evidence of Professor Horne and Ms Foster and rely on that evidence in places.

F. ASSUMPTIONS AND METHODOLOGY

[16] The assumptions and methodologies used for the analysis mentioned above (E) are provided in Hanly et al. (2018a), Hanly et al. (2018b), Hanly & Hone (2018) and Hanly (2020). As noted above, these are at **Attachment A**.

G. THE EXTENT TO WHICH THE TABLE 14.2 CNLM ARE AFFECTED BY OVERSEER VERSION CHANGES

[17] For grazed pastoral farms, the Overseer model estimates the amount of N deposited in livestock urine patches and its susceptibility to be leached from the soil root zone.

- [18] These estimates rely on information from a number of sub-models in Overseer, which provide estimates of a range of factors; including: animal nitrogen intakes and partitioning of ingested N to excreta (dung and urine), soil N transformations, as well as information on climate, soil properties and soil hydrology. These sub-models are updated on a regular basis as additional information is made available from research and other sources. When changes are made to any of Overseer's sub-models then a new version of Overseer is released, which typically happens one or two times a year.
- [19] The degree to which the version change influences estimates of N leaching losses varies depending on the types of changes made to the sub-models. Since 2012, Overseer has been a web-based model (version 6 onwards) and when a new version is released it replaces the previous version so that the previous version is then no longer available for use. Simply, there is no way for users to keep or maintain access to previous Overseer versions through any downloadable software.
- [20] Hanly et al. (2018a), Hanly & Horne (2018) and Hanly (2020) reported on the extent to which the Table 14.2 CNLM values had been affected by Overseer version changes while operative in the One Plan. These reports show what the CNLM values would likely have been had the more recent versions of Overseer been available when the original table was created. The Hanly et al. (2018a) report had two main objectives:
- (a) to approximately replicate the input parameter data for each LUC class for Year 1 (One Plan Table 14.2) for use in Overseer (v5.2.6), by identifying data (known and assumed) for a base farm; and
 - (b) to use the base farm input data in the version of Overseer that was current in early-2018 (v6.2.3), to determine the updated CNLM values for each LUC class. Hanly & Horne (2018) used the same input data in the version of Overseer that was released in mid-2018 (v6.3.0) to determine the updated CNLM for each LUC class.
- [21] The CNLM values obtained with Overseer version 6.2.3 (v6.2.3) were 32.5 – 66.0% higher than the original One Plan Table 14.2 values (Table 1). Using Overseer version 6.3.0 (v6.3.0), all the CNLM values increase further for LUC

I to VII, being 41.3–69.0% higher than the original One Plan Table 14.2 values (Table 2).

Table 1: Original and early-2018 revised (v6.2.3 using v5.2.6 defaults) N leaching maximums.

kg N/ha/yr	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original (v5.2.6)	30	27	24	18	16	15	8	2
Revised (v6.2.3)	49.8	44.4	35.7	26.2	22.7	21.6	10.6	3.0*
Increase	66.0%	64.4%	48.8%	45.6%	41.9%	44.0%	32.5%	50.0%

*Native trees (pines are 2.5 kg N/ha loss to water)

Table 2: Original and mid-2018 revised (v6.3.0 using v5.2.6 defaults) N leaching maximums.

kg N/ha/yr	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original (v5.2.6)	30	27	24	18	16	15	8	2
Revised (v6.3.0)	50.7	45.1	40.4	29.4	25.0	23.8	11.3	3.0*
Increase	69.0%	67.0%	68.3%	63.3%	56.3%	58.7%	41.3%	50.0%

*Native trees (pines are 2.5 kg N/ha loss to water)

[22] Hanly (2020) used the Overseer version that was released in mid-2020 (v6.3.3) to determine the updated CNLM for each LUC class (Table 3). The version change comparison was made using v6.2.3 defaults, because the base farm files using v5.2.6 defaults (used for previous comparisons), cannot be imported into v6.3.3.

[23] Compared to the increases from using v6.3.0 (using v5.2.6 defaults, Table 2), the values from v6.3.3 represent small percentage point increases (2.3–3.3% for LUC I to VII). However, it is not possible to determine how much of the additional increase from using v6.3.3 is due to the version change (from v6.3.0 to v6.3.3) or the change in default input parameters (from v5.2.6 to v6.2.3 defaults). Future comparisons will need to use v6.2.3 defaults, because files using v5.2.6 defaults can no longer be imported into Overseer.

Table 3: Original and mid-2020 revised (v6.3.3 using v6.2.3 defaults) N leaching maximums.

kg N/ha/yr	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original (v5.2.6)	30	27	24	18	16	15	8	2
Revised (v6.3.3)	51.7	45.9	41.1	29.8	25.5	24.2	11.5	3.0*
Increase	72.3 %	70.0%	71.3%	65.6%	59.4%	61.3%	43.8%	50%

*Native trees (pines are 2.5 kg N/ha loss to water)

[24] The updates made to the CNLM table for each LUC class, described above using the same farm input, show that the changes in Overseer versions (from v5.2.6 to v6.3.3) have resulted in increases in the estimated N leaching losses from the soil root zone for most LUC classes. From early-2018 to mid-2020 (version changes from v6.2.3 to v6.3.3), the CNLM table values increased by between 0.9–5.4 kg N/ha/yr (LUC I-VII).

[25] In practice, what this means is that, as the versions of Overseer have been updated over time, the modelling of individual farms' N leaching losses through Overseer in many cases are likely to have also changed, even in circumstances where there are no changes made to the farm systems. Given Table 14.2 values have remained static over the same period, this means that more farms have experienced difficulties achieving Table 14.2 values.

[26] Further, and importantly, it is inevitable that changes will continue to occur with Overseer version changes over time. Accordingly, it is important, in my opinion, for the table values to be updated on a regular basis. I address this point further in Section J of my evidence.

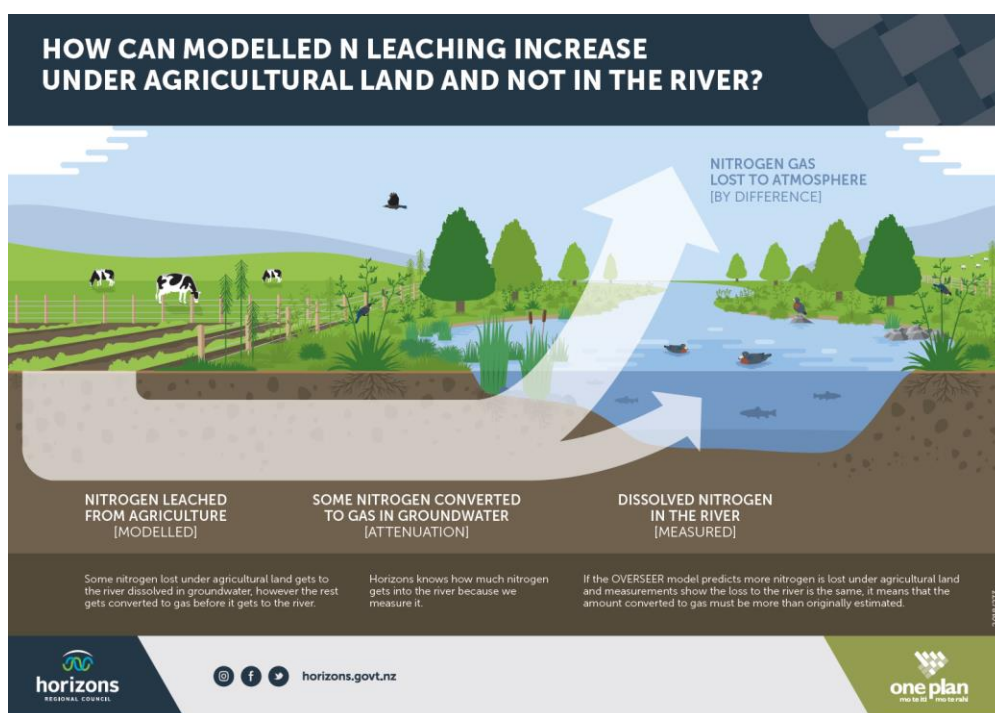
H. ASSUMPTIONS MADE ABOUT TRANSMISSIVITY OF SOLUBLE NITROGEN BETWEEN THE ROOT ZONE AND THE RIVER

[27] The Overseer version change, from version 5.2.6 (v5.2.6) to v6.2.3 (as well as later versions v6.3.0 and v6.3.3), increased the estimated quantity of N leaching from the root zone, compared to the original CNLM values. However, there are also processes that can occur after N is leached from the

soil root zone, like denitrification, which further reduce the quantity of N in drainage water before it reaches the river.

- [28] The transmission coefficient is defined as the proportion of N leached from the root zone, as estimated by Overseer, that is measured in the river. The increase in the quantity of estimated N leaching from the soil root zone, using the more recent versions of Overseer, has implications for the original N transmission coefficient derived by Clothier et al., (2007). If estimates of root zone N leaching have increased, using the same farm input information, then the transmission coefficient will be lower than previously estimated.

Diagram showing the N leaching process



- [29] Using Overseer (v5), Clothier et al., (2007) estimated that the N transmission coefficient for a 'typical' dairy and 'typical' sheep/beef farms was ~0.5 in two sub-catchments (Weber and Hopelands) of the Upper Manawatū River Catchment (Table 4). This means that approximately 50% of the N estimated by Overseer to be lost from the root zone was measured in the river.
- [30] Clothier et al. reported average per hectare equivalent values for the quantity for N measured in the river associated with either dairying farming or sheep/beef farming within a catchment, which they called 'river-based farm N fluxes'. They reported that the river-based farm N fluxes were 15.4 kg

N/ha/yr for dairy farm land and 3.9 kg N/ha/yr for sheep/beef farm land. Therefore, in the case of dairy farm land, if Overseer (v5) estimates that the root zone N leaching loss is 31 kg N/ha/year and the river-based farm N flux (i.e. the amount of N in the river attributed to dairy land in the catchment on a per hectare basis) then the transmission coefficient is $15.4/31 \text{ kg N/ha/year} = 0.5$.

Table 4: The river-based farm N fluxes, the median Overseer (v5) estimated root zone N leaching losses, and the derived transmission coefficient estimates for dairying and sheep/beef (adapted from Table 3 in Clothier *et al.*, 2007).

	River based farm N fluxes (kg N/ha/yr)	Overseer root zone N leaching losses (kg N/ha/yr)	Transmission coefficient
Dairying	15.4	31	~0.5
Sheep/beef	3.9	7	~0.5

- [31] When this same approach is used in the original analysis (Clothier *et al.*, 2007), using the same rivers N loads but with a later version of Overseer with higher estimates N leaching losses, then the transmission coefficient will need to decrease to reconcile the higher root zone N losses with the original river N load. This is because the amount of N that reaches the river from farming land is not just determined from root zone losses, but also the proportion that is transmitted from below the root zone to the river. Therefore, the N transmission coefficient should be varied with changes in Overseer root zone N leaching estimates, to provide a consistent approach for predicting the impact of changing N leaching maximums on river N loads.
- [32] Hanly *et al.* (2018b) reported on the recalculation of the N transmission coefficient using root zone N leaching loss estimates from the version of Overseer that was current in early-2018 (v6.2.3). The aim of that analysis was to determine the effect of the Overseer version change, from v5.2.6 to v6.2.3, on the derived N transmission coefficient. Changing from v5.2.6 to v6.2.3 increased the N leaching value for the 'typical' dairying farm from 31 kg to 38 kg N/ha/yr, and for the 'typical' sheep/beef farm from 7 to 13 kg N/ha/yr (Table 5). However, the river-based farm N fluxes do not change, because they are determined from the amount of N measured in the river in

the Clothier *et al.* (2007) analysis. Therefore, in the case of dairy farm land, the transmission coefficient decreases to $15.4/38 = 0.41$.

Table 5: The river-based farm N fluxes, the median Overseer (v6.2.3) estimated root zone N leaching losses, and the derived transmission coefficient estimates for dairying and sheep/beef.

	River based farm N fluxes (kg N/ha/yr)	Overseer root zone N leaching losses (kg N/ha/yr)	Transmission coefficient
Dairying	15.4	38	~0.4
Sheep/beef	3.9	13	~0.3

[33] For the above reasons, increasing the CNLM values in Table 14.2 does not necessarily imply an increased amount of N transmitted from the root zone to waterways. This is because the CNLM values are based on estimates of N leaching from the soil root zone, but other processes like denitrification can reduce the actual quantity of N in drainage water before it reaches the river. Therefore, changes in CNLM values should prompt adjustments to the transmission coefficient, which represents the proportion of N leached from the root zone and measured in the river. Here, the overall predicted N load reaching the river does not change for the base farm information used to determine the CNLM values.

I. RECENT UPDATES TO OVERSEER IN TABLE 14.2

[34] The current version Overseer was released in mid-2023 (v6.5.2). A reference file approach was used to update the CNLM table values for each LUC class (Table 6). Using Overseer v6.5.2, CNLM values (for LUC I-VII) were 26.3 - 66.7% higher than the original One Plan Table 14.2 values. Compared to v6.3.3 (mid-2020, Table 3), the v6.5.2 values were all lower for LUC I-VII, with decreases in values in the range of 1.7-8.8 kg N/ha/yr (LUC I-VII). However, compared to the version used to recalibrate the CNLM values in Table 14.2 (v6.2.3), the differences in values for v6.5.2 were smaller, ranging from a decrease of 0.2 kg N/ha/yr for LUC I to an increase of up to 3.4 kg N/ha/yr for LUC III.

Table 6: Original and mid-2023 revised (v6.5.2 using v6.2.3 defaults) N leaching maximums.

kg N/ha/yr	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original (v5.2.6)	30	27	24	18	16	15	8	2
Revised (v6.5.2)	50.0	44.2	32.3	23.8	21.0	20.0	10.1	3.0*
Increase	66.7%	63.7%	34.6%	32.2%	31.3%	33.3%	26.3%	50%

[35] I recommend that the CNLM's represented in Table 14.2 should be based on the most recent version of Overseer. As this has updated since the Commissioner's decision has released, Table 14.2 should also be updated accordingly. As noted above, the most recent version at the time of my evidence is v6.5.2, and the corresponding N leaching maximums which should, in my opinion, be included in Table 14.2 are as above.

J. FUTURE UPDATES TO OVERSEER

[36] One concern, that was also discussed at the Council level hearing, was that if the CNLM values recalibrated Table 14.2, using Overseer v6.2.3, are static then the same situation that led to the need for PC2 could recur following future changes to Overseer (At 3.225–3.228, Recommendation Report of the Independent Hearing Panel, March 2021). To overcome this, Professor Horne and Ms Foster recommended the use of a 'reference file' system, to allow the Council to update N leaching loss estimates following any significant changes in the Overseer model.

[37] I agree that there is a need for an Overseer 'reference file' system, due to the effect that ongoing Overseer changes, as a result of new research and improvements in its sub-models, can have on changes estimated farm N leaching losses. However, any use of a 'reference file' approach needs to maintain the same methodology used to create the original Table 14-2 values.

[38] While I understand the 'risk assessment tool' approach is being proposed as an alternative consenting pathway to Table 14.2, the 'reference file' system

remains an elegant solution, in my opinion, should the Table 14.2 pathway be utilised.

K. ISSUES RAISED ON APPEAL

[39] Mr Day, one of the appellants, has raised the specific issue in his appeal regarding the recalibration of the CNLM in Table 14.2. In particular, Mr Day seeks the *“recalibration of Table 14.2 using Overseer 6.2.3 or a subsequent version, following the same methodology as the original table”*.

[40] The recalibration of Table 14.2, described in Hanly et al. (2018a), uses a similar methodology as that used to derive the original CNLM values. This methodology is described in Carran et al. (2007):

For this exercise the natural capital of the soils in the catchment, is calculated from the potential stocking rate that could be sustained by a well managed legume based sward, taken from the extended legend for the LUC worksheets ‘Attainable potential livestock carrying capacity’ for the North Island. The potential livestock carrying capacities were transformed to pasture production and used in Overseer to calculate N leaching losses under a pastoral use.

[41] Hanly et al. (2018a) closely replicated the data for each LUC class for Year 1 (Table 14.2) by identifying input parameter data (known and assumed) for a base farm for use in Overseer v5.2.6, which is the same version of Overseer that was available when the Carran et al. (2007) report was published. This was the methodology used to create reference files that provided the same Overseer N leaching values for each LUC as the CNLM values in the original Table 14.2. These reference files were then used in later versions of Overseer (e.g. v6.2.3) to recalibrate the CNLM values.

[42] The only changes made to the reference files was where additional input information was required by later versions of Overseer which were not required in v5.2.6. Where additional input information was required by later versions of Overseer, then either the default value was used or the Overseer Best Practice Data Input Standards (v6.2.3) was used for guidance.

[43] In summary, the methodology used in the recalibration of Table 14.2 is as close as possible to a replication of that methodology, subject to the changes I describe above, and these differences would not result in any substantive changes to the CNLM values in the recalibration. Therefore, in my opinion the methodology is sound and is fit for purpose.

[44] I note, for completion, my recommendations in relation to the 'reference file' system above are driving at the same issue that Mr Day has addressed in his appeal. This is because I agree that updates to the CNLM should replicate, to the extent possible, how the table was developed in the first place.

6 October 2023

James Anthony Hanly

L. 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.
- Hanly (2020). Sensitivity of values in Table 14.2 of the 'One Plan' to a change in the version of OVERSEER®. *Part D: Recalculation of nitrogen (N) leaching maximums by LUC class using OVERSEER® version 6.3.3 (2020)*. A report prepared by the Farmed Landscapes Research Centre (Massey University) for Horizons Regional Council.
- Hanly J, Hedley M, Horne D (2018a). 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)*. A report prepared by the Fertilizer and Lime Research Centre (Massey University) for Horizons Regional Council.
- Hanly J, Hedley M, Horne D (2018b). Sensitivity of values in Table 14.2 of the 'One Plan' to a change in the version of OVERSEER®. *Part B: Recalculation of the nitrogen (N) transmission coefficient using N loss to water estimates from the current version of OVERSEER®(v6.2.3)*. A report prepared by the Fertilizer and Lime Research Centre (Massey University) for Horizons Regional Council.
- Hanly J, Horne D (2018). Sensitivity of values in Table 14.2 of the 'One Plan' to a change in the version of OVERSEER®. *Part C: Updating the nitrogen (N) leaching maximums by LUC class using OVERSEER® version 6.3.0 (2018)*. A report prepared by the Fertilizer and Lime Research Centre (Massey University) for Horizons Regional Council.

M. ATTACHMENT A**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). January 2018*
- *Part B: Recalculation of the nitrogen (N) transmission coefficient using N loss to water estimates from the current version OVERSEER (v6.2.3). February 2018*
- *Part C: Updating the nitrogen (N) leaching maximums of LUC class using OVERSEER version 6.3.0 (2018). July 2018*
- *Part D: Updating the nitrogen (N) leaching maximums by LUC class using OVERSEER version 6.3.3 (2020). July 2020*

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)***

Prepared for:

Horizons Regional Council
Palmerston North

January 2018

Prepared by:

Dr. James Hanly
Prof. Mike Hedley
Assoc. Prof. Dave Horne

Fertilizer and Lime Research Centre
School of Agriculture & Environment
Private Bag 11 222
Massey University
Palmerston North
<http://flrc.massey.ac.nz>

Phone: (06) 951 7854

Email: J.A.Hanly@massey.ac.nz

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

‘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

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.

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)'

Current

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)

Non-effluent block

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

Effluent block

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"

Case study farm - LUC II (differences from LUC I – base):

Overseer 5.2.6 file: 'LUC II (v5.2.6)'

Current*Dairy animals*

- Dairy cows (/ha): 3.1 cows
- Milk solids (kg/ha): 1150 kg MS/ha

Non-effluent block*Soil*

- Soil order: Brown

Effluent block*Soil*

- Soil order: Brown

Case study farm - LUC III (differences from LUC I – base):

Overseer 5.2.6 file: 'LUC III (v5.2.6)'

Current*Dairy animals*

- Dairy cows (/ha): 2.7 cows
- Milk solids (kg/ha): 1020 kg MS/ha

Non-effluent block*Block general*

- Topography: Rolling

Soil

- Soil order: Pallic

*Fertiliser***Effluent block***Block general*

- Topography: Rolling

Soil

- Soil order: Pallic

Case study farm - LUC IV (differences from LUC I – base):

Overseer 5.2.6 file: 'LUC IV (v5.2.6)'

Current*Dairy animals*

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

Non-effluent block*Block general*

- Topography: Rolling

Soil

- Soil order: Pallic

Effluent block*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)'

Current*Dairy animals*

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

Non-effluent block*Block general*

- Topography: Easy hill

Soil

- Soil order: Pallic

Effluent block*Block general*

- Topography: Easy hill

Soil

- Soil order: Pallic

Case study farm - LUC VI (differences from LUC I – base):

Overseer 5.2.6 file: 'LUC VI (v5.2.6)'

Current*Dairy animals*

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

Non-effluent block*Block general*

- Topography: Easy hill

Soil

- Soil order: Pallic

Effluent block*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)'

Current*Dairy animals*

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

Non-effluent block*Block general*

- Topography: Easy hill (instead of Steep hill)

Soil

- Soil order: Pallic

Effluent block*Block general*

- Topography: Easy hill (instead of Steep hill)

Soil

- Soil order: Pallic

Case study farm - LUC VIII:

Overseer 5.2.6 file: 'LUC VII(v5.2.6)'

Current*Block setup*

- Block areas: 109 ha Trees, 1 ha Pasture

Other animals

- SU/ha beef: 1

Trees block*Block general*

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

Pasture block*Block general*

- Topography: Steep hill

Soil

- Soil order: Pallic

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'

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:** 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**

Non-effluent block

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

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

Effluent block*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**)

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)

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)

Case study farm - LUC VI (differences from LUC I – base):

Overseer 6.2.3 file: 'LUC VI (v6.2.3) – v5 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) – v5 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)

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

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)

- 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**)

Case study farm - LUC II (differences from LUC I – base):

Overseer 6.2.3 file: 'LUC II (v6.2.3) – v6 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) – v6 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)

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)

•

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)

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

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

***Part B: Recalculation of the nitrogen (N) transmission coefficient
using N loss to water estimates from the current version of
OVERSEER®(v6.2.3)***

Prepared for:

Horizons Regional Council
Palmerston North

February 2018

Prepared by:

Dr. James Hanly
Prof. Mike Hedley
Assoc. Prof. Dave Horne

Fertilizer and Lime Research Centre
School of Agriculture & Environment
Private Bag 11 222
Massey University
Palmerston North
<http://flrc.massey.ac.nz>

Phone: (06) 951 7854

Email: J.A.Hanly@massey.ac.nz

Introduction

Horizons Regional Council commissioned the Fertilizer and Lime Research Centre (Massey University) to investigate the extent to which cumulative N leaching maximums in Table 14.2 of their One Plan are affected by OVERSEER[®] version changes. The results of that analysis, reported in Hanly *et al.*, (2018), showed that the N leaching maximums obtained with OVERSEER[®] (v6.2.3) were 32.5 - 66.0% higher than the original One Plan Table 14.2 values (Table 1).

Table 1: Original and revised (OVERSEER[®] v 6.2.3 using v5.2.6 defaults) cumulative N leaching maximums (Hanly *et al.*, 2018).

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original	30	27	24	18	16	15	8	2
Revised (v 6.2.3)	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)

The increase in the quantity of estimated N leaching from the soil root zone, using the current version of OVERSEER[®] (v6.2.3), has implications for the original N transmission coefficient derived by Clothier *et al.*, (2007) and used in Carran *et al.*, (2007). The transmission coefficient is defined as the proportion of N leached from the soil root zone, as estimated by OVERSEER[®], that is measured in the river. Using OVERSEER[®] (v5), Clothier *et al.*, (2007) estimated that the N transmission coefficient for a ‘typical’ dairying and ‘typical’ sheep/beef farms was ~0.5 in two sub-catchments (Weber and Hopelands) of the Upper Manawatu River Catchment. In other words, approximately 50% of the N estimated by OVERSEER[®] to be lost from the root zone was measured in the river.

With the OVERSEER[®] estimates of N leaching from the root zone increasing with the current version (v6.2.3, Table 1), then the N transmission coefficient will also be lower than previously estimated because the river N load is a measured value. Therefore, the N transmission coefficient should be varied with changes in OVERSEER[®] N leaching estimates, to provide a consistent approach for predicting the impact of changing N leaching maximums on river N loads.

The aim of the analysis presented in this report was to determine the effect of the OVERSEER[®] version change, from v5.2.6 to v6.2.3, on the derived N transmission coefficient. In addition,

this exercise explored the relationship between the revised N leaching maximum values for each LUC class (Table 1), and the revised N transmission coefficients and the implications for river N loads using the same approach as presented in Carran *et al.*, (2007).

Methods

Farm input parameters for the ‘typical’ dairy farm and ‘typical’ sheep/beef farm were obtained from Clothier *et al.*, (2007). For input parameters that were not provided by Clothier *et al.*, (2007), then default or assumed values were used to complete the farm files in OVERSEER® (v5.2.6). The OVERSEER® (v5.2.6) N leaching values were then compared with those reported for the two farm systems in Clothier *et al.*, (2007).

The equivalent input data, to that used in OVERSEER® (v5.2.6), was then entered into OVERSEER® (v6.2.3). As reported in Hanly *et al.*, 2018, there were two main considerations that needed to be addressed when changing versions. The first consideration was that some of the default values used in OVERSEER® v6.2.3 varied from those in OVERSEER® v5.2.6. In such cases, the v5.2.6 default values were used (as indicated in Appendix 2). The other consideration was that v6.2.3 has more options for entering input information compared to 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. Full details of the OVERSEER® input parameters used for the farm files are provided in Appendices 1 and 2.

Results

The estimated OVERSEER® N leaching values obtained in the current analysis for the ‘typical’ dairy farm and ‘typical’ sheep/beef farm using v5.2.6 were 31 and 7 kg N/ha/yr, respectively, which were the same values report in Clothier *et al.*, (2007) (Table 2).

Table 2: The river-based farm fluxes q , the median of OVERSEER[®] (v5) calculations q^* , and the derived transmission coefficient estimates for dairying and sheep/beef (adapted from Table 3 in Clothier *et al.*, 2007).

	q (Eq5) kg N/ha/yr	q^* (Eq5) kg N/ha/yr	Transmission coefficient
Dairying	15.4	31	~0.5
Sheep/beef	3.9	7	~0.5

Changing from v5.2.6 to v6.2.3 increased the ‘typical’ dairying farm N leaching value by 22.6%, from 31 kg to 38 kg N/ha/yr (Table 3). This percentage increase is smaller than the 32.5–66.0% increase range obtained for the farm files when OVERSEER[®] (v6.2.3) was used to revise the One Plan Table 14.2 (Hanly *et al.*, 2018). The reasons for this discrepancy relates to differences in the predictions of N leaching by the two versions of OVERSEER[®] when nitrogen fertiliser is used. When the OVERSEER[®] versions are compared when no N fertiliser is used (i.e. as was the case with the farm files used to derive the One Plan Table 14.2 values) then the ‘typical’ dairy farm N leaching loss value increased by 45.8%, from 24 to 35 kg N/ha/yr. However, the ‘typical’ dairying farm in Clothier *et al.*, (2007) used urea fertiliser at a rate of 100 kg N/ha/yr. For some reason, v6.2.3 predicts a smaller increase in estimated N leaching from the use of N fertiliser than v5.2.6. Accordingly, there is a larger difference in N leaching losses between the two versions of the farm scenarios that use no N fertiliser.

Changing from v5.2.6 to 6.2.3 increases the ‘typical’ sheep/beef farm N leaching loss value by 85.7%, from 7 to 13 kg N/ha/yr. This farm uses urea N fertiliser at a low rate of 7 kg N/ha/yr.

Table 3: The river-based farm fluxes q , the median of OVERSEER[®] (v6.2.3) calculations q^* , and the derived transmission coefficient estimates for dairying and sheep/beef.

	q (Eq5) kg N/ha/yr	q^* (Eq5) kg N/ha/yr	Transmission coefficient
Dairying	15.4	38	~0.4
Sheep/beef	3.9	13	~0.3

The N transmission coefficient of ~0.5 was used by Carran *et al.*, (2007) to estimate the total N loading in the river (kg N/yr) for the Upper Manawatu River Catchment, which was 767,541 kg N/yr (Table 4). This estimated value is close to the measured load of 744,000 kg N/yr (Clothier *et al.* 2007). Carran *et al.*, (2007) found that “*when the fraction of potential production is limited to 75% on all LUC classes, the N at farm scale and the resulting N loading in the river are very close to the present loading*”. They go on to say that “*if the short-term goal was to prevent any further increase in the N loading in the river the N loss values in column 5 provide an N loss limit, before requiring the introduction of a mitigation practice.*”

Table 4: Area of each LUC class in the Upper Manawatu River Catchment, calculated N loss associated with the potential productivity of the soil in each LUC class (using OVERSEER® v5) and the contribution of the soils in each LUC to the N loading of the Upper Manawatu river when each LUC is farmed at 75% of potential (values from Carran *et al.*, 2007).

LUC Class	Area (ha)	N loss based on potential production (kg N/ha/yr)	Fraction of potential	N loss limit (kg N/ha/yr)	Transmission coefficient	Total N loading in the River (kg N/yr)
II	12424	27	0.75	20.6	0.5	127790
III	20257	23	0.75	17.6	0.5	178315
IV	11508	18	0.75	13.1	0.5	75608
V	907	16	0.75	12.3	0.5	5555
VI	57254	15	0.75	10.9	0.5	311580
VII	22108	8	0.75	6.2	0.5	68693
VIII	5180	0	0.75	0	0.5	0
Total	129638					767541

A simplified approach was used to allocate the revised dairy N transmission coefficient and the revised sheep/beef N transmission coefficient to the different LUC classes. The dairy coefficient of ~0.4 was applied to the lowest LUC classes based on the area of land in dairying, and then the sheep/beef coefficient of ~0.3 was applied to the remaining LUC classes. Clothier *et al.*, (2007) estimated that approximately 16% of the catchment was in dairy farming at that time. Therefore, 0.4 was used for all of the LUC Class II land and half of the LUC Class III land, which resulted in transmission coefficient of 0.35 for LUC Class III. When the N leaching losses, based on potential production for each LUC class, and the N transmission coefficient were revised using OVERSEER® (v6.2.3), the N river load is estimated to be 758,775 kg N/yr (Table 5). This revised value is close to the value estimated using the earlier version of OVERSEER® (Table 4).

Table 5: Area of each LUC class in the Upper Manawatu River Catchment, calculated N loss associated with the potential productivity of the soil in each LUC class (using OVERSEER® v6.2.3) and the contribution of the soils in each LUC to the N loading of the Upper Manawatu river when each LUC is farmed at 75% of potential.

LUC Class	Area (ha)	N loss based on potential production (kg N/ha/yr)	Fraction of potential	N loss limit (kg N/ha/yr)	Transmission coefficient	Total N loading in the River (kg N/yr)
II	12424	44.4	0.75	33.3	0.4	165488
III	20257	35.7	0.75	26.8	0.35	189833
IV	11508	26.2	0.75	19.7	0.3	67840
V	907	22.7	0.75	17.0	0.3	4633
VI	57254	21.6	0.75	16.2	0.3	278254
VII	22108	10.6	0.75	8.0	0.3	52728
VIII	5180	0*	0.75	0.0	0.3	0
Total	129638					758775

*A value of zero was used for LUC VIII to be consistent with the approach by Carran *et al.*, 2007.

The original cumulative N leaching maximums by LUC Class from Table 14.2 of Horizons Regional Council's One Plan for Years 1, 5, 10 and 20 are presented in Table 6. The percentage decreases in values in each of the subsequent years after Year 1, in Table 6, were identified. These percentage decreases were then applied to the revised Year 1 values (using OVERSEER v 6.2.3) to obtain revised values for Years 5, 10 and 20 for comparative purposes (Table 7).

Table 6: Original cumulative N leaching maximums (kg N/ha/yr) by LUC Class from Table 14.2 of Horizons Regional Council's One Plan.

	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
Year 5	27	25	21	16	13	10	6	2
Year 10	26	22	19	14	13	10	6	2
Year 20	25	21	18	13	12	10	6	2

Table 7: Revised cumulative N leaching maximums (kg N/ha/yr) by LUC Class, revised using OVERSEER® v6.2.3.

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Year 1	50	44	36	26	23	22	11	3
Year 5	45	41	32	23	19	15	8	3
Year 10	43	36	29	20	19	15	8	3
Year 20	42	34	27	19	17	15	8	3

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.
- Hanly J, Hedley M, Horne D (2018). Sensitivity of One Plan Table 14.2 values to OVERSEER version change. Part A: Recalculation of nitrogen (N) leaching maximums by LUC class using OVERSEER versions 5.2.6 (2007) and 6.2.3 (2017). A report prepared by the Fertilizer and Lime Research Centre (Massey University) for Horizons Regional Council.

Appendix 1 - Overseer 5.2.6

'Typical' dairy farm (Bold denotes assumed input parameters)

Overseer 5.2.6 file: 'Typical dairy (v5.2.6)'

Current

Farm

- Region: East Coast North Island

Block setup

- Block areas: 99 ha Non-effluent, 11 ha Effluent (spray effluent)
- Relative productivity: **No difference between blocks**

Dairy animals

- Dairy cows (/ha): 2.5 cows
- Breed: **Friesian x Jersey**
- Milk solids (kg/ha): 1000 kg MS/ha
- Average weight: **478 kg/animal**
- Replacements grazed off: **Weaning**
- Effluent disposal system: **Holding pond**
- Pond treatment method: **Spray at optimum times**
- Block (solid) effluent distrib: **Effluent block (pond sludge)**

Supplements added

- Quantity: Total 110 T DM (70% silage); **Good quality pasture silage 77 T DM, Good quality pasture hay 33 T DM**
- Destination: **Paddocks**

Non-effluent block

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: Olsen P = 30, **Organic S = 8**, QT K = 8, QT Ca = 12, QT Mg = 10, QT Na = 3

Fertiliser

- Fertiliser rates: 217 kg urea/ha; 322 kg SSP/ha (Maintenance P)

Effluent block

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: Olsen P = 30, **Organic S = 8**, QT K = 8, QT Ca = 12,
QT Mg = 10, QT Na = 3

Fertiliser

- Fertiliser rates **No fertiliser**

‘Typical’ sheep & beef farm (Bold denotes assumed input parameters)

Overseer 5.2.6 file: ‘Typical sheep & beef (v5.2.6)’

Current*Farm*

- Region: East Coast North Island

Block setup

- Block areas: 400 ha Pasture

Other animals

- Sheep (SU/ha): 7
- Beef (SU/ha): 3
- Wool (kg/ha): 38.5
- % beef as males 33

Pasture block*Block general*

- Topography: **Rolling**
- Distance from coast: **50 km**
- Rainfall: 1200 mm

Animals and pasture

- Development status: Developing (not default)
- Pasture type: Browntop

Soil

- Soil order: **Pallic**
- Soil texture: Silt loam
- Soil tests: Olsen P = 14, **Organic S = 8**, QT K = 10, QT Ca = 12,
QT Mg = 20, QT Na = 5

Fertiliser

- Fertiliser rates 15 kg urea/ha; 180 kg SSP/ha

Appendix 2 – Overseer 6.2.3 using v5.2.6 defaults

‘Typical’ dairy farm (Bold shows additional input parameters compared to v5.2.6)

Overseer 6.2.3 file: ‘Typical dairy (v6.2.3) – v5 defaults’

Farm scenario

Farm

- Location By Region - East Coast North Island

Block setup

- Block areas: Total 110 ha: 99 ha Non-effluent, 11 ha Effluent
- Relative productivity: No difference between blocks

Dairy animals

- Peak cow numbers: 275 cows **(breeding numbers NOT constant)**
- Breed: Friesian x Jersey
- Milk solids (kg/ha): 1000 kg MS/ha
- Average weight: 478 kg/animal (default for 5.2.6)
- Replacement rate: 25% (default for 5.2.6)
- Milk solids (kg/ha): 1000 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**

Supplements imported

- Quantity Total 110 T DM (70% silage); Good quality pasture silage 77 T DM, Good quality pasture hay 33 T DM
- Destination Paddocks
- Utilisation **Average**

Non-effluent block

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

Soil

- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile:** **Medium**
- Soil tests: Olsen P = 30, Organic S = 8, QT K = 8, QT Ca = 12, QT Mg = 10, QT Na = 3
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 58 tonnes (dry weight basis) (automatic in 5.2.6)
- Destination: Non-effluent block

Fertiliser

- Fertiliser rates: 217 kg urea/ha (**Split Aug, Sep, Oct**); 322 kg SSP/ha (Maintenance P) (**Mar**)

Effluent block*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

Soil

- Soil order: Recent
- Top soil texture: Silt loam
- **Lower profile:** **Medium**
- Soil tests: Olsen P = 30, Organic S = 8, QT K = 8, QT Ca = 12, QT Mg = 10, QT Na = 3
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 6 tonnes (dry weight basis) (automatic in 5.2.6)
- Destination: Effluent block

Effluent

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

'Typical' sheep & beef farm (Bold shows additional input parameters compared to v5.2.6)

Overseer 6.2.3 file: 'Typical sheep & beef (v6.2.3) – v5 defaults'

Farm scenario*Farm*

- Location: By Region - East Coast North Island

Block setup

- Block areas: **Total 400 ha:** 400 ha Pasture

Other animals

- Sheep (RSU): 2486 (7 SU/ha x 400 ha x 88.8%*)
*(5775 SU/6500 RSU = 88.8%; convert from SU to RSU)
- Beef (RSU): 1066 (3 SU/ha x 400 ha x 88.8%*)
- Wool (kg): 15400 kg (38.5 kg/ha)
- % beef as males: 33

Non-effluent block*General*

- Topography: Rolling
- 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: Browntop
- Specify pasture quality: Default from v5.2.6, see table below

	Digestibility (%)	ME (MJ ME/kg DM)
January	61	9.1
February-March	57	8.4
April	60	8.9
May	66	9.8
June-July	71	10.4
August	74	10.9
September-Oct	75	11.1
November	71	10.5
December	66	9.8

Soil

- Soil order: Pallic
- Top soil texture: Silt loam
- Soil tests: Olsen P = 14, Organic S = 8, QT K = 10, QT Ca = 12,
QT Mg = 20, QT Na = 5
- **Susceptibility to pugging:** **Occasional**

Supplements made

- Category: Silage
- Weight: 38 tonnes (dry weight basis) (default from 5.2.6)
- Destination: Pasture block

Fertiliser

- Fertiliser rates 15 kg urea/ha (**Sep**); 180 kg SSP/ha (**Mar**)



11-15 Victoria Avenue
Private Bag 11 025
Manawatu Mail Centre
Palmerston North 4442

T 0508 800 800
F 06 952 2929
help@horizons.govt.nz
www.horizons.govt.nz

Sensitivity of values in Table 14.2 of the ‘One Plan’ to a change in the version of OVERSEER[®]

***Part C: Updating the nitrogen (N) leaching maximums by LUC
class using OVERSEER[®] version 6.3.0 (2018)***

Prepared for:

Horizons Regional Council
Palmerston North

July 2018

Prepared by:

Dr. James Hanly
Assoc. Prof. Dave Horne

Fertilizer and Lime Research Centre
School of Agriculture & Environment
Private Bag 11 222
Massey University
Palmerston North
<http://flrc.massey.ac.nz>

Phone: (06) 951 7854

Email: J.A.Hanly@massey.ac.nz

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[®], from v5.2.6 (2007 version) to v6.2.3 (2017 version), which was reported in Hanly et al., (2018a). This current report updates these values using OVERSEER[®] v6.3.0 (2018 version).

Methods

Details of the methods and assumptions used in the original analysis are provided in Hanly et al., (2018a). The same OVERSEER[®] files that were used to provide the N leaching maximums with OVERSEER[®] v6.2.3, using the v5.2.6 defaults, were opened with v6.3.0 to provide the new N leaching maximums for each LUC Class.

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 v6.3.0 all the leaching maximums increased for LUC I to VII (Table 3). The largest increases were for LUC III to LUC VI, ranging from 4.7 kg N/ha for LUC III to 2.2 kg N/ha for LUC VI.

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	3.0*
Increase	66.0%	64.4%	48.8%	45.6%	41.9%	44.0%	32.5%	50.0%

*Native trees (pines are 2.5 kg N/ha loss to water)

(Correction: previous values were incorrectly reported as 3.3 kg N/ha for native trees and 2.7 kg N/ha for pines; Hanly et al. 2018a, 2018b)

Table 3: Original and revised (v6.3.0 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 6.3.0) V5.2.6 defaults	50.7	45.1	40.4	29.4	25.0	23.8	11.3	3.0*
Increase	69.0%	67.0%	68.3%	63.3%	56.3%	58.7%	41.3%	50.0%

*Native trees (pines are 2.5 kg N/ha loss to water)

References

- Hanly J, Hedley M, Horne D (2018a). 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)*. A report prepared by the Fertilizer and Lime Research Centre (Massey University) for Horizons Regional Council.
- Hanly J, Hedley M, Horne D (2018b). Sensitivity of values in Table 14.2 of the 'One Plan' to a change in the version of OVERSEER®. *Part B: Recalculation of the nitrogen (N) transmission coefficient using N loss to water estimates from the current version of OVERSEER®(v6.2.3)*. A report prepared by the Fertilizer and Lime Research Centre (Massey University) for Horizons Regional Council.



11-15 Victoria Avenue
Private Bag 11 025
Manawatu Mail Centre
Palmerston North 4442

T 0508 800 800
F 06 952 2929
help@horizons.govt.nz
www.horizons.govt.nz



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

***Part D: Updating the nitrogen (N) leaching maximums by LUC
class using OVERSEER® version 6.3.3 (2020)***

Prepared for:

Horizons Regional Council
Palmerston North

July 2020

Prepared by:

Dr. James Hanly

Farmed Landscapes Research Centre
School of Agriculture & Environment
Private Bag 11 222
Massey University
Palmerston North
<http://flrc.massey.ac.nz>

Phone: (06) 951 7854

Email: J.A.Hanly@massey.ac.nz

Introduction

Horizons Regional Council commissioned the Farmed Landscapes 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 from v5.2.6 (2007 version) to v6.2.3 (2017 version) and v6.3.0 (2018 version), which was reported in Hanly et al., (2018a) and Hanly & Horne (2018), respectively. This current report updates these values using Overseer v6.3.3 (2020 version).

*(Previously called the Fertilizer and Lime Research Centre)

Methods

Details of the methods and assumptions used in the original analysis are provided in Hanly et al., (2018a). The same Overseer files that were used to provide the N leaching maximums with Overseer v6.2.3, using the v6.2.3 defaults, were opened with v6.3.3 to provide the new N leaching maximums for each LUC Class. In the Hanly & Horne (2018) report, the version change comparison was made using v5.2.6 defaults, however, these files could not be imported into v6.3.3.

Results

The N leaching maximums obtained with Overseer v6.3.3, using the v6.2.3 defaults, were 43.8 – 72.3% higher than the original One Plan Table 14.2 values (Table 1).

Table 1: Original and revised N leaching maximums

	LUC I	LUC II	LUC III	LUC IV	LUC V	LUC VI	LUC VII	LUC VIII
Original (a) (v 5.2.6)	30	27	24	18	16	15	8	2
Revised (b) (v 6.3.0) <i>v5.2.6 defaults</i>	50.7	45.1	40.4	29.4	25.0	23.8	11.3	3.0
Increase from (a) to (b)	69.0%	67.0%	68.3%	63.3%	56.3%	58.7%	41.3%	50%
Revised (c) (v 6.3.3) <i>V6.2.3 defaults</i>	51.7	45.9	41.1	29.8	25.5	24.2	11.5	3.0
Increase from (a) to (c)	72.3%	70.0%	71.3%	65.6%	59.4%	61.3%	43.8%	50%

*Native trees (pines are 2.5 kg N/ha loss to water)

(Correction: previous values were incorrectly reported as 3.3 kg N/ha for native trees and 2.7 kg N/ha for pines; Hanly et al. 2018a, 2018b)

Compared to the increases from using v6.3.0, using v5.2.6 defaults, the values from v6.3.3 represent small percentage point increases (2.3-3.3% for LUC I to VII). However, it is not possible to determine how much of the additional increase from using v6.3.3 is due to the

version change (from v6.3.0 to v6.3.3) or the change in default input parameters (from v5.2.6 to v6.2.3 defaults). However, future comparisons will need to use v6.2.3 defaults, because files using v5.2.6 defaults can no longer be imported into Overseer.

References

- Hanly J, Hedley M, Horne D (2018a). 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)*. A report prepared by the Fertilizer and Lime Research Centre (Massey University) for Horizons Regional Council.
- Hanly J, Hedley M, Horne D (2018b). Sensitivity of values in Table 14.2 of the ‘One Plan’ to a change in the version of OVERSEER®. *Part B: Recalculation of the nitrogen (N) transmission coefficient using N loss to water estimates from the current version of OVERSEER®(v6.2.3)*. A report prepared by the Fertilizer and Lime Research Centre (Massey University) for Horizons Regional Council.
- Hanly J, Horne D (2018). Sensitivity of values in Table 14.2 of the ‘One Plan’ to a change in the version of OVERSEER®. *Part C: Updating the nitrogen (N) leaching maximums by LUC class using OVERSEER® version 6.3.0 (2018)*. A report prepared by the Fertilizer and Lime Research Centre (Massey University) for Horizons Regional Council.