Hill, B., 2020. Comparing Tararua dairy farms ability to meet year 20 nitrogen leaching limits using Overseer 5.2.6 and table 14.2 in the one plan, with Overseer 6.3.0 and the recalibrated table. In: *Nutrient Management in Farmed Landscapes.* (Eds. C.L. Christensen, D.J. Horne and R. Singh). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 33. Farmed Landscapes Research Centre, Massey University, Palmerston North, New Zealand. 12 pages.

COMPARING TARARUA DAIRY FARMS ABILITY TO MEET YEAR 20 NITROGEN LEACING LIMITS USING OVERSEER 5.2.6 AND TABLE 14.2 IN THE ONE PLAN, WITH OVERSEER 6.3.0 AND THE RECALIBRATED TABLE

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Executive summary

The following report is an investigation into the differences in nitrogen leaching figures in kilograms of nitrogen per hectare (kgN/ha) between Overseer versions 5.2.6 and 6.3.0. It also assesses how the different nitrogen leaching figures effect the proportion of farms able to meet their Year 20 nitrogen leaching targets set by Horizons Regional Council in Table 14.2 of the One Plan and the values from recalibration of this table.

Key findings:

The percentage of farms able to meet their Year 20 nitrogen leaching limits does not change between Overseer versions and table figures.

The same proportion of farms will be able to meet their targets by either remaining the same or implementing mitigations to decrease N loss by 10%, 15% or 20%.

13% of farms will be able to meet their Year 20 nitrogen leaching target without implementing mitigations.

Nitrogen leaching numbers have increased by 64% between Overseer version 5.2.6 and 6.3.0.

Evidence in this report suggests that by increasing the numbers in table 14.2 of the One Plan, it will not result in an increase in the percentage of farms able to meet their targets. It will simply mean that farms with low leaching will once again be able to meet the One Plan limits.

Farm parameters remained the same between versions to show how these models calculated nitrogen leaching differently. The 64% increase suggests that previous Overseer versions have underestimated the amount of nitrogen being lost through the root zone and to the atmosphere.

By adopting the numbers set out in the recalibration table it will mean that farms which were considered low leachers under the old table will again be considered low leachers and will be able to gain intensive land use consents.

Introduction

The purpose of this report is to assess how the changing Overseer Versions effect the ability of farms to comply with Table 14.2 in the One Plan. Table 14.2 was calibrated using Overseer Version 5.2.6 which is now been updated and overwritten by Overseer Version 6.3.0. The table was created based on the productive potential of land based on LUC units. Water quality issues were identified in the region so the table was created to give council a way to implement nitrogen leaching reductions from intensive land uses within target catchments. It also gives

effect to the policy statement that requires Horizons Regional Council to improve water quality within the target catchments.

Since the formation of the table there has been subsequent technological improvements to the Overseer model. This has made it more difficult for intensive land users to meet the Nitrogen leaching maximums in Table 14.2, resulting in proposals to recalibrate the table using the latest Overseer version. With all things being equal this should not increase or decrease the percentage of farms able to meet the nitrogen limits. This report shows the comparison of Overseer 5.2.6 with the original table and Overseer 6.3.0 with the proposed table.

Methods

The following describes how the xml. base files from Dairy NZ were used to create new farm accounts in the 5.2.6 Overseer model. Files could not be uploaded directly into 5.2.6 as they were produced using a newer version meaning they had different formats. The change from 5.2.6 was significant as 6.3.0 provides a model that has a much larger scope of parameters, making the files much more detailed. Key information from each farm was extracted from the xml. file and entered into 5.2.6 manually. Farms were created as accurately as possible however the differences between the models lead to many assumptions being made.

The farms were named in the format of "DNZ" followed by a number which was used to identify them. This meant that the files and information within them remained confidential. A sample of 50 farms was taken from the available 95 files. These farms were chosen at random by a random number generator found on google. Some farms were not able to be transferred into 5.2.6 simply because of their complexity, these farms are outlined in appendix 1.0. Once the reports were generated the leaching number produced in 5.2.6 was compared to the 6.3.0 leaching loss. The figures produced were then compared to each individual farms year 20 target from Table 14.2 (Figure 1) and new table (Figure 2). These targets were produced based on the farms individual LUC classifications. For the calculation of the results only 47 farms were used due to limitations within the data.

Table 14.2 sets out the *cumulative nitrogen leaching maximum** for the *land^* used for intensive farming *land^* use activities within each specified *land use capability class**.

Table 14.2 *Cumulative nitrogen leaching maximum** by *Land Use Capability Class**

Period (from the year that the rule has legal effect[3])	*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

Figure 1 - One Plan Table 14.2 (Old Table) Horizons Regional Council, 2014

WHAT DOES THE PLAN CHANGE SAY?

PROPOSED PLAN CHANGE 2

Cross reference Operative One Plan, Chapter 5, Table 14.2, page 14-8. [2018 additions in blue and 2007 deletions in red]. Table 14.2 sets out the *cumulative nitrogen leaching maximum** for the land used for intensive farming land use activities within each specified *land use capability class**.

Table 14.2 *Cumulative nitrogen leaching maximum** by *Land Use Capability Class**
Kgs of N per hectare per year

Period (from the year that the rule has legal effect)	LUC* I	LUC* II	LUC* III	LUC* IV	LUC* V	LUC* VI	LUC* VII	LUC* VIII
Year 1	51 ~~30~~	45 ~~27~~	40 ~~24~~	29 ~~18~~	25 ~~16~~	24 ~~15~~	11 ~~8~~	3 ~~2~~
Year 5	46 ~~27~~	40 ~~25~~	35 ~~21~~	25 ~~16~~	22 ~~13~~	19 ~~10~~	8 ~~6~~	3 ~~2~~
Year 10	44 ~~26~~	37 ~~22~~	32 ~~19~~	23 ~~14~~	20 ~~13~~	17 ~~10~~	8 ~~6~~	3 ~~2~~
Year 20	43 ~~25~~	35 ~~21~~	30 ~~18~~	21 ~~13~~	19 ~~12~~	16 ~~10~~	8 ~~6~~	3 ~~2~~

Figure 2 - Recalibration of Table 14.2 in the One Plan (New Table) Horizons Regional Council, 2018

Assumptions

Key assumptions were made in order for the files to be transferred from the 6.3.0 version to the 5.2.6 version. The following is a list of the assumptions used for all of the farms, for a more in depth list of assumptions for each farm see appendix 2.0

Crop blocks had to have a value as their area so the total crop area was subtracted from the pastoral blocks in which the crop rotates, relative to their size.

If “beef or dairy grazers” were specified as being on farm in 6.3.0 then they were entered as “Other Animals” in 5.2.6. They were then modelled as being on the runoff blocks unless specified otherwise.

Decimal places were not recognised in 5.2.6 so any numbers which included a decimal was rounded using Swedish Rounding.

When supplement feed is specified to be fed out on more than one but less than the total number of blocks in 6.3.0 the supplement has to be modelled as going evenly over all blocks in 5.2.6 because there was no option to select more than one block per supplement.

Not all fertilisers were available in 5.2.6 so ones which weren’t available were entered as either soluble fertiliser or as an equivalent. The most common were “Flexi N” (entered as Urea) and “Ammo 36” (entered as a soluble fertiliser).

All turnips were modelled as “Barkant” unless the grazing occurred in winter.

In 5.2.6 all farms were assumed to have a ryegrass/clover sward over the entire farm.

If no replacements are grazed on farm then it was assumed that they leave the farm at weaning in the 5.2.6 model.

Effluent management for holding ponds was worded slightly differently in 5.2.6 to 6.3.0 so “spray infrequently” was substituted for “spray at optimum times” and “spray frequently” was substituted for “spray every day”.

Limitations

The 5.2.6 model also had some important limitations which meant that some farms couldn’t be modelled accurately or at all. These include:

The model only allows for one fodder crop per farm. This meant that farms with multiple fodder crops had to have their crops merged to produce a "fodder crop" which represented all crops on the farm. This was done by entering the first cultivation of all crops as "month cultivated", then the first month grazing of all crops entered as "first month grazed", then the last grazing of all crops entered as "final month grazed" and lastly the "month re-sown in pasture" was the last month re-sown in pasture over all crops.

Animal distribution on farm could not be specified by different proportions or by month. Only one animal group could be on any one block at any one time and they must be on the block for the entire season. This was also the same for the grazing of the fodder crop.

Pasture production was calculated to be significantly lower in 5.2.6 than the pasture production in 6.3.0 which caused problems with the supplements harvested. This was overcome specific to each farm specified in appendix 2.0.

Fertiliser application to pastoral blocks were not specified my month only by application rate.

5.2.6 does not have the option to have in shed feeding. This meant the supplements had to be modelled as being fed on the feed pad or on blocks if there was no feed pad.

Results

After comparing 47 farms Overseer results with table 14.2 and the values produced from the calibration, the following results have been extracted. For the purposes of this investigation reduction in nitrogen leaching by 10%, 15% and 20% has been assessed as a type of sensitivity. It has been assumed that these farms could meet these leaching reductions by implementing best on farm practices and mitigations for reducing nitrogen leaching.

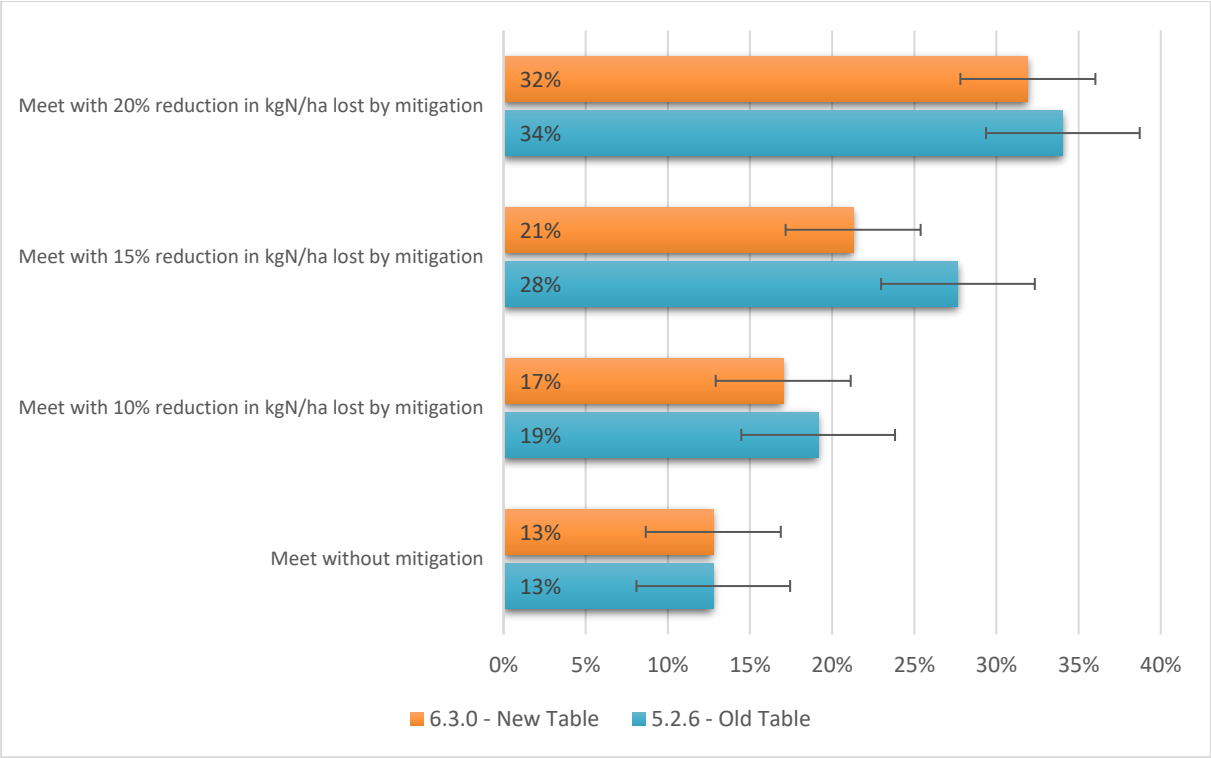

Figure 3 - Percent of Farms that are Likely to Meet the Year 20 Target N Leaching Limit Set Out in Table 14.2 in Horizons Regional Council's One Plan and the Recalibration Values Based on Overseer Versions 6.3.0 and 5.2.6

Figure 3 produces a graph which shows the proportion of farms which could meet the Year 20 nitrogen leaching limits set out in Table 14.2. The orange bars reflects the comparison between the N loss numbers produced by Overseer version 6.3.0 and the proposed recalibrated table. The blue bars reflects the N loss numbers produced by the 5.2.6 Overseer version compared to the original table in the One Plan.

It is clear to see that there is no statistical difference between these comparisons, supported by the overlap between error bars. 13% of farms in both scenarios can meet the table without implementing mitigation, 17-19% of farms can meet the tables when decreasing N loss numbers by 10%, 21-28% of farms could meet their targets by decreasing N leaching by 15% and 32-34% of farms could meet the table by decreasing N loss by 20%.

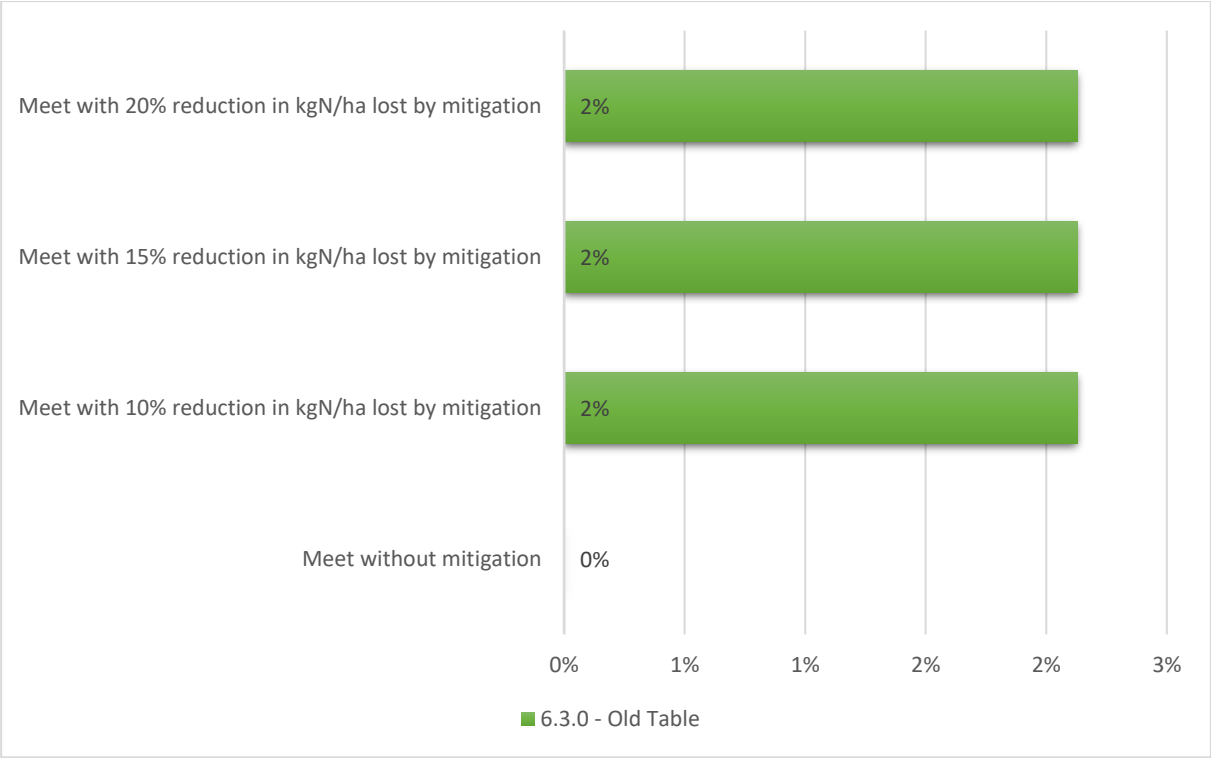

Figure 4 - Percentage of Farms that Could Meet the Nitrogen Leaching Limits in the One Plan, Table 14.2 Based on the Overseer Version 6.3.0

The above graph shows that by using the new Overseer version 6.3.0 2% of farms could meet the nitrogen leaching levels set out in the original table in the One Plan (Figure 1). This therefore suggests that 98% of farms, regardless of the mitigations put in place will not be able to meet table 14.2 in the One Plan.

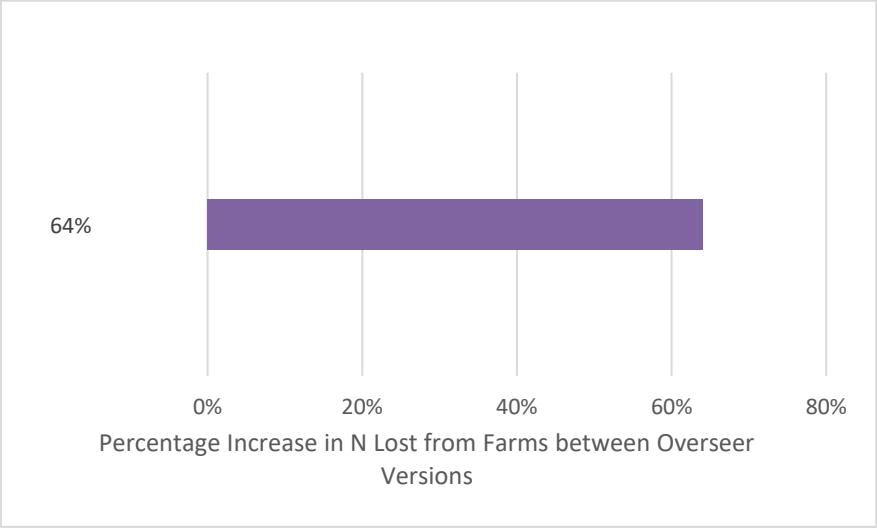

Figure 5 - Average Increase in Nitrogen Leaching Figures between Overseer Versions 5.2.6 and 6.3.0

From the 50 farms that were modelled in 5.2.6 there was an average increase of 64% in kg N/ha lost over the whole farm. The majority of this increase can be put down to the upgrade in

Overseer version as the farm files between versions were as close to the same as physically possible with some assumptions being made.

Discussion

All the assumptions and limitations show how different the two models are and how far the technology has progressed from 2007 to 2019. It is important to understand how these limitations effect the overall nitrogen leaching produced by each of the models. This has led to the evaluation between the two models for the purpose of assessing the differences between the models and how this impacts dairy farm compliance.

From these results it is clear that there is no difference in the percentage of farmers able to meet the nitrogen leaching limits in the one plan table 14.2 and the recalibration of these numbers. There is no significant evidence to suggest that by increasing the table numbers to match those in the recalibration table, that any more or less farmers could meet the new targets. By increasing the table numbers it is updating the policy to reflect the updates in technology. There has been a significant increase in technology upgrades between the two versions which has influenced how the inputs are used to produce estimations on nitrogen leaching.

As stated in Hanly *et al.* 2018, default values are different between the two versions and there is a greater number of options when inputting information into version 6.3.0. This supports the idea that the two versions produce different end results. This is also supported by the 64% increase in N loss figures between the two versions shown in figure 5. With the increase in research and technology behind the 6.3.0 model it can be assumed that this version would produce a much more accurate representation of the farms actual nitrogen leaching amount. The increase in N loss numbers could simply mean that nitrogen loss has been underestimated in previous Overseer versions, potentially due to the limited modelling capacity on N loss through the production of gas in the soil (Horizons Regional Council, 2018).

Some suggestions for this increase could be due to the addition of being able to model multiple fodder crop rotations within one farm, the ability to graze animals and different animal classes over multiple blocks and at specific times of the years, specifying when fertiliser is applied to pastoral blocks and having a much more comprehensive model for estimating pasture production in the 6.3.0 version. These however have not been fully investigated in this report.

Conclusion

The results show that with the increase in research and technological development, the numbers in table 14.2 of Horizons Regional Councils One Plan should be updated to reflect the changes in the Overseer model. From evaluating the results of the comparisons between each Overseer version and table version, it can be concluded that there would be no impact on dairy farm compliance. The proportion of farms that are able to meet the year 20 targets will remain the same.

Farm parameters remained as close to identical as possible between versions however, an average increase of 64% for nitrogen leaching numbers was seen. The model treats parameters differently and produces figures which reflect a higher number for nitrogen leached from the farm and the soil. These higher nitrogen values suggest that N leaching has been underestimated in the past. This will prevent farmers from gaining intensive land use consents under the old One Plan rules, simply because technology has improved.

By adopting values from the recalibrated table it will mean that farms which were considered to be low leaching under the old table will be able to once again be classified as low leachers and meet the targets set in the One Plan. This will therefore mean that farmers with acceptable leaching figures can meet the table and gain intensive land use consents.

References

Hanly, J., Hedley, J., Horne, D. (2018). *Sensitivity of Values in Table 14.2 of the 'One Plan' to a change in the version of OVERSEER.* Part A & B. Retrieved from http://www.horizons.govt.nz/publications-feedback/one-plan-reviews-changes/nutrient-management

Horizons Regional Council. (2014). *One Plan – The Consolidated Regional Policy Statement, Regional Plan and Regional Coastal Plan for the Manawatū-Wanganui Region.* Report No. 2014/EXT/1338. Retrieved from http://www.horizons.govt.nz/CMSPages/GetFile.aspx?guid=ad4efdf3-9447-45a3-93ca-951136c7f3b3

Horizons Regional Council. (2018). *Proposed One Plan Change 2 – Recalibration of Nitrogen Leaching Numbers.* Retrieved from https://www.horizons.govt.nz/HRC/media/Media/One%20Plan%20Documents/One%20Plan%20Reviews%20and%20Changes%20Documents/Proposed-One-Plan-Change-2.pdf

Appendix

Excluded Farms

Farm Identifier DNZ	**Reason for Exclusion**
26	Farm system had multiple crops which had effluent applied to them but nowhere else, 5.2.6 would not allow effluent to me applied to crops so had no way of distributing effluent.
47	Had two fodder crops within the system, one crop was grazed by the dairy animals and the other crop was grazed by the beef/dairy grazer animals. 5.2.6 does not allow you to input split grazing's between animal classes.
80	System had four different fodder crops, no way of accurately modelling this in 5.2.6.
48	Seven different fodder crops on the farm. Impossible to model in 5.2.6.
88	The fodder crop was spread over who seasons. Only fodder crops with one season rotations could be entered into 5.2.6.
8	Seven different fodder crops on the farm. Impossible to model in 5.2.6.
66	Crops are grazed 50/50 by beef and dairy animals, cant model this in 5.2.6.
49	Runoff block is split 50/50 between replacement animals and beef grazing animals. The way the 5.2.6 models replacements means that you cannot separate the two animal classes or add replacements into the dairy grazing category.

42	Two crops on farm, Kale and Turnips. Beef graze the Kale and Dairy graze the Turnips, cant split the grazing of animals on the fodder crop.
106	4 fodder crops all with rotations that spread over 2 seasons.
40	Two crops on farm, Kale and Turnips. Beef graze the Kale and Dairy graze the Turnips, cant split the grazing of animals on the fodder crop.
84	Two fodder crops within the system, one crop was grazed by the dairy animals and the other crop was grazed by the beef/dairy grazer animals. 5.2.6 does not allow you to input split grazing's between animal classes.
117	Kale grazed by Beef, Turnips grazed by Dairy, when merging the two only one group of animals can eat the crop so couldn't be entered into 5.2.6.
32	Crops rotate over 2 seasons, can't be modelled in 5.2.6.
79	Kale, turnips and fodder beet all grazed by different stock classes and can't be modelled in 5.2.6.

Individual Farm Assumptions

Farm Identifier DNZ	**Assumptions for 5.2.6**
3	Turnip and Kale crop merged together, all fertiliser applications included.
111	Barley can't be modelled so it was merged into one crop rotation with the turnips. Both were modelled as "leafy turnips" with all fertiliser applications included.
114	"Herb Mix" crop modelled as "Oats leafy" with a yield of 8t/ha assuming that the sward is predominately Chicory based.
105	"Organic Jungle" modelled as "leafy oats with yield of 8t/ha.
57	Barley grain is meant to me fed in the milking shed but fed on the feed pad in 5.2.6.
105	Maize and turnips fodder crops merged together and destination "fed on farm" with all fertiliser applications added.
62	Barley and canola is fed on the feed pad in 5.2.6 when it should be fed in the milking shed. Barley, Rape and Turnips merged into one fodder crop with pasture resown in august.
18	Minimum till substituted for direct drill in 5.2.6.
69	Oats and Rape crop merged together with all fertiliser applications included.
16	"Ammo 33" substituted for a soluble fertiliser. Amount of Hay harvested from the blocks was halved to meet the models pasture production estimation.
107	Turnips and Kale crops merged together. Note: the crops are modelled as being grazed for 7 months when in reality it is only 4 months.
93	"N-rich ammo 36N, Cloverking & Dairyking" fertilisers not in 5.2.6 so were substituted for soluble fertiliser.

11	Chicory crop modelled as “leafy oats”. Direct drill used instead of minimum till. Chicory is meant to me irrigated but there is not this option in 5.2.6.
109	“MP Trees” is less than 1ha so it was joined with the riparian block since all tree blocks are modelled the same. “Flexi N” is added as the equivalent amount of urea and “Cropmaster DAP Boron plus” added as soluble fertiliser.
95	0.5 hours on the feed pad is rounded up to 1 hour per day. “Ammo 33” is added as the equivalent amount of urea and “Cropmaster DAP Boron plus” added as soluble fertiliser.
43	"Cropmaster Brassica" entered as soluble fertiliser”.
34	Molasses fed on the feed pad instead of in the milking shed.
15	Three fodder crops merged into one with the month re sown being pushed back a month to allow for the model to work sacrificing one month of fallow. "Internal calculation problem, not balancing for block 0 nut: N, K," but a report is generated.
116	Hay and silage "from storage" is modelled as being "supplements added" and supplements made on the runoff blocks are exported. Dairy animals are not recorded as being on the farm from june-july so modelled as being wintered off farm in 5.2.6. "Pasturezeal G2 impact" can’t be found in 5.2.6 so added as a soluble fertiliser. "N-rich 25K" substituted for urea and KCl in equivalent amounts. Can’t specify what months the beef are grazing on the runoff (dry cows). No option to just graze the dairy replacements so 100% of grazing animals are grazed on the "runoff easy hill Matamau" & "RO Easy Hill Maharahara". The supplements removed on from "RO Flat SH2 Kopua" was greater than 8t/ha so decrease the supplements by 7 tonnes for each supplement. Supplement harvested on the "RO Flat SH2 Kopua" had to be halved for the model to work. Also an internal calculation error occurred but report has been generated.
56	Added the MgO as a dusting regime and the MgCl as a drenching regime. Maize grain should be fed in the milking shed but feed on the feed pad in 5.2.6. Can’t apply effluent solids to chicory crops. Chicory modelled as oats leafy with 8t/ha. Should be grazed in November but model won’t allow grazing within one month after cultivation so first grazing is in December.
67	PKE and Molasses are feed in the milking shed in 6.3 but modelled as being fed on the paddocks in 5.2.6 as there is no fed pad. “Ammo36” substituted for soluble fertiliser. Pasture production estimated in 6.3 for RO Flats is 11.5 but in 5.2.6 its only 4.7 so supplements harvested had to be reduced from 100TDM of bailage to 35TDm.
52	Wheat grain fed in the milking shed but no option in 5.2.6 modelled as being spread over paddocks as no feed pad. Sulphur application exceeds the 5.2.6 model so maxi sulphur super so application was decreased to meet the sulphur requirements then added RPR to get the correct amount of P. “Cropmaster Brassica” made to be soluble fertiliser.

115	Soils defined in Smaps so substituted for soil order.
20	"Cropmaster Brassica + boron" substituted for soluble fertiliser.
46	Supplements removed exceeded the model, had to decrease the amount harvested from the RO block 120t down to 20t for bailage and 66t down to 15t for hay.
104b	PKE fed in the milking shed put onto the blocks in 5.2.6.
24	Dairy animals and beef grazers are grazed on all blocks but you can only graze 1 stock class on each block. The "beef/dairy grazers" have then been removed as they only equated to 123 SU. Supplements removed on "Effluent Flat Kairanga" halved to meet the model.
54	5.5ha of turnips rounded up to 6ha. Barley grain fed on the feed pad (instead of being fed in the milking shed). Silage and hay from storage is imported on farm as supplements imported. “Sulphur super gain, phased N, N-rich ammo 30N and cropzeal boron boost” added as soluble fertiliser
83	Effluent block is only 0.3ha so must be rounded up to 1 ha so 0.7ha has removed from Milking Platform - tukituki. “Ammo 31” replaced as soluble fertiliser. Dairy animals should be grazed on the RO over June and July but you can’t split the animals based on month so it is modelled at the dairy stock only being grazed on the milking platform. Dairy animals are only supposed to be on the river bank block over June and July so assumed they are on there the whole year. RO split 50% sheep and 50% Beef to make the model work.
61	MP Matamau and Support block had split % of animals on each block which you can’t do in 5.2.6 so removed the stock class with the lowest %.
108	Chicory modelling as oats leafy in 5.2.6 with a yield of 8t/ha. 9.5ha will be rounded up to 10ha so 0.5 was taken off another block which the fodder crop rotates through. 20 steers are removed from the model as they are grazed on the whole farm and you can’t split the animal distribution on the blocks.
19	7.5ha rounded up to 8ha of turnips. 0.5 subtracted from another block rotated through the crop rotation. “Cropmaster brassica + boron” added as soluble fertiliser.
38	Both dairy grazers and beef animals are grazed on the runoff however you can’t split animal distribution on blocks so it has been assumed that only the beef animals are grazed on the runoff blocks. "Turnips leafy" replaced with rape. Supplements removed from the RO blocks had to be halved.
30	MP Matamau has 50% split between dairy animals and beef grazers, cant model this in 5.2.6 so had assumed its only dairy animals on this block. On the MP Railway Matamau block animals are grazed off this block in the winter but you can’t specify animal distribution in 5.2.6 so animals are just assumed to graze over the entire year.
41	Replacement animals have been modelled as dairy/beef grazers in 5.2.6, these animals are then only grazed on the "effluent raumati"

	block. This then means that the dairy animals do not go on this block.
14	Crop rotation goes through two years but it is the same each year so just input the data from 1 month. The crops are not resown back in pasture but for the 5.2.6 model it must be so pasture is re sown in March, when the last grazing occurs. Crop modelled as oats leafy.
59	Dairy animals are grazed on the support block in June & July but animal distribution by month cant modelled in 5.2.6 so only beef animals are grazed on this block. Supplements removed are halved to meet the model.
78	Two crops on the farm, one maize silage and one turnips. The maize is exported and then brought back on the farm, can't split the "final destination of crops" in 5.2.6 so instead of exporting the crop it is modelled as being fed on farm with the turnips and the imported supplement is removed, modelled as triticale. Instead of the maize (which has been removed) being fed on the feed pad I have modelled the palm kernel as being modelled on the feed pad. 2.5ha of turnips will round up to 3ha. On the Wonderland block 40% of replacements are grazed but this can't be modelled ion 5.2.6 so they are removed from the block.
17, 6, 29, 91, 104a, 92, 7, 74 & 70	No individual assumptions made.