OVERSEER Nutrient Budget Review

For: Environment Southland – Platinum Dairies Ltd

Prepared by: Nicky Watt, CNMA

Date: 25th January 2022

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Introduction

1. Regarding the consent application for Platinum Dairies Ltd, I have reviewed the following OVERSEER ® Nutrient Budget (OVERSEER) files:
   a) Year Ending 2021
   b) Muir Year End 21
   c) Proposed Combined

2. Along with the files I have reviewed the following accompany report: "OverseerFM farm system modelling to support a consent application for expanded dairy" prepared by Miranda Hunt, Roslin Consultancy Ltd and reviewed by Mo Topham, AgriAce. I have completed a robustness check on the file for sensibility based on data available and checked to ensure the modelling aligns with the OVERSEER Best Practice Data Input Standards for v6.4.2.

3. It must be assumed that the information provided in the OVERSEER files that the current farming system as modelled is a viable farming system, using actual stock and fertiliser inputs. Therefore, the actual and proposed scenario is also assumed to be appropriate for the location and climate.

4. A 'sensibility test' has been undertaken on the Platinum Dairies Ltd nutrient budgets with the following five output screens from OVERSEER forming the basis of the determination of the robustness of the nutrient budget:

   a) Is the nutrient loss consistent with what you would expect for an operation of this type and soils in this location?

   b) Does the summary of inputs and outputs make sense? Especially clover fixation and change in block pools?

   c) Check the 'Other values' block reports for rainfall, drainage, and PAW.

   d) Select the Scenario reports other values and check the production and stocking rate.

   e) Select the pasture production in the scenario report and check pasture growth.

5. Answers to each of these five points will be provided further in this report and then a final determination of the robustness of the nutrient loss to water will be provided at the end of this report.

OVERSEER AUDIT

Appropriateness of the Overseer inputs

1. The Overseer FM files submitted and stated in paragraph 1 of this report have been reviewed for consistency between the files and appropriateness of the inputs regarding the farming systems and the Overseer Best Practice Data Input Standard (BPDIS).

2. I concur that there are some deviations from the BPDIS. The crop rotation final month for the Muir YE model has a final month entered as 'June' and 'September' was entered for the Proposed model.

3. The YE 2021 models combined, and Proposed model have a total area of 317.7 ha with 310 ha effective. The YE 2021 combined models have a revised stocking rate of 35.7 RSU/ha for dairy

cows and the Proposed combined model have a revised stocking rate of 33.7 RSU/ha or a 5.6% decrease in RSU/ha (see Table 1 and 1a below).

4. Reviewing the NZ Dairy statistics for the 2019/2020 season, shows the average milk solids production on this property for the YE 21 model at 467.9 kgMS/cow and 1748 kgMS/ha is respectively higher than the Southland Regional average of 418 kg MS/cow and higher than the Southland Regional average of 1133 kgMS/ha. The Prop MP model at 464 kgMS/cow and 1567 kgMS/ha is respectively higher than the Southland Regional average of 418 kg MS/cow and higher than the Southland Regional average of 1133 kgMS/ha.

5. The dairy cow stocking rate for YE 21 and Prop MP model at 3.7 and 3.4 cows/ha are respectively greater than the Southland average for the 2019/2020 season of 2.76 cows/ha (Invercargill).

Table 1: Summary of Production and stocking rate

	YE 21[1]	Muir YE 21[2]	Proposed[3]
Total Ha	256.2	61.5	317.7
Effective Area (ha)	250.5	59.5	310
Effective Pasture Area (ha)	250.5	27.8	300
KgMS	437773	-	470000
MS kg/ha grazed	1748	-	1567
MS kg MS/cow	469.7	-	464
Dairy RSU	8949	-	10100
Total RSU/ha (eff pasture area)	35.9	-	33.7
Lactation Length	266	-	266
Cows/ha	3.7	-	3.4
Cows October	932	-	1000
Cows June	0	436	100
Cows July	0	460	360
Yearlings June	-	13	-
Yearlings July	-	-	-
Replacement RSU	-	-	203
Dairy Grazing RSU	-	867	755
Dairy Grazing RSU/ha (Eff past)	-	14.6	19.1
N lost kg/ha/yr	55	57	47

[1]Year Ending 2021 – YE 21
[2]Muir Year End 21- Muir YE 21
[3]Proposed Combined – Proposed

Table 1a: Total Figures for Year End 2021 and Proposed

	Year End 2021	Proposed
Total Ha	317.7	317.7
Effective Area (ha)	310	310
Effective Pasture Area (ha)	278.3	300
KgMS	437773	470000
MS kg/ha grazed	1748	1567
MS kg MS/cow	469.7	464
Dairy RSU	8949	10100
Dairy RSU/ha (eff pasture area)	35.7	33.7
Total RSU	9867	10303
Total RSU/ Eff Pasture ha	35.5	34.3
Lactation Length	266	266
Cows/ha	3.7	3.4
Cows October	932	1000
Cows June	436	100
Cows July	460	360
Yearlings June/July	13	-
N lost kg/ha/yr	55.5	52.0

6. The YE 2021 models combined showed an area of 9.7 ha of fodder beet crop grazed in the winter 2020 and 6.2 ha of swede crop winter 2020. The area of winter 2021 crop was 12.6 ha swedes and 9.4 ha kale. The YE 2021 models had both the 2020 and 2021 wintered crops in the reporting year (due to crop final month being June). There was 10 ha Swede crop in the Proposed model (see Table 2 and 2a below).

*Table 2: Crop Details***

	YE 21	Muir YE 21	Proposed
Fodder Beet Crop (ha)	-	9.7	-
Fodder Beet Yield (tDM/ha)	-	23	-
When grazed	-	Jul/Aug 20	-
Grazed by	-	Dairy Cows	-
Swedes (ha) – Crop	-	6.2 + 12.6	10
Swedes Yield (tDM/ha)	-	12	12
When grazed	-	Jul/Aug 20 + Jun 21	Jun/Jul/Aug
Grazed by	-	Dairy Cows*	Dairy cows (3.5 ha lifted)
Kale (ha) - Crop	-	9.4	-
Kale Yield (tDM/ha)	-	12	-
When grazed	-	Jun 21	-
Grazed by	-	Dairy cows	-

*Plus 3.2 ha of swede lifted winter 20

**The crop rotation final month is June for Muir YE 21 and September for Proposed.

Table 2a: Total Crop Details for Year End 2021 and Proposed

	YE 2021	Proposed
Fodder Beet Crop (ha)	9.7	-
Fodder Beet Yield (tDM/ha)	23	-
When grazed	Jul/Aug 20	-
Grazed by	Dairy Cows	-
Swedes (ha) – Crop	6.2 + 12.6	10
Swedes Yield (tDM/ha)	12	12
When grazed	Jul/Aug 20 + Jun 21	Jun/Jul/Aug
Grazed by	Dairy Cows*	Dairy cows (3.5 ha lifted)
Kale (ha) - Crop	9.4	-
Kale Yield (tDM/ha)	12	-
When grazed	Jun 21	-
Grazed by	Dairy cows	-

*Plus 3.2 ha of swede lifted winter 20

7. The soils for YE 2021 and the Proposed models were compared as shown in Table 3 below. There is no difference between models

Table 3: Soil Details for Year End 2021 and Proposed

	YE 2021	Proposed
Pukem_6a.1	214.5	214.5
Wood_29a.1	51	51
Waiki_34a.1	38.8	38.8
Paro_4a.1	3.2	3.2
Makar_3b.1	2.5	2.5

8. Supplements are imported to meet cow demand (see Table 4 below). Pasture silage has been made where there was a surplus of pasture. The YE 2021 models have a pasture growth calculated at 18.8 tDM/ha for dairy area and the Proposed model has a pasture growth of 18.0 tDM/ha for dairy pasture. This is a decrease of 4.3% in pasture growth for the dairy pasture. The N used on all pasture blocks in the YE 2021 models combined was 217 kgN/ha for dairy and 145 kgN/ha for the dairy support compared to 189 kgN/ha for the non-effluent dairy and dairy support and 154

kgN/ha for effluent areas in the combined Proposed models. There is expected to be 5.6% less supplement imported and 92% less silage harvested in the combined Proposed model compared to the combined YE 2021 models (see Table 4 and 4a below).

Table 4: Supplements imported and Harvested

	YE 21	Muir YE 21	Proposed
Supplements Imported (tDM)	1130	88	1150
Supplements Imported Effective Area (tDM/ha)	4.51	1.48	3.83
Silage Harvested (tDM)	-	367	31
Silage Harvested Pasture (tDM/ha)	-	6.17	0.10
Total Area (ha)	256.2	61.5	317.7
Effective Area (ha)	250.5	59.5	310
Effective Pasture Area (ha)	250.5	27.8	300
RSU/ha (effective pasture area)	35.9	31.2	34.3
Peak Cows/ha	3.7	-	3.4
Dairy RSU	8949	-	10100
Dairy RSU/ha (Eff past)	35.7	-	33.7
N Fertiliser applied non -effluent area(kgN/ha)	217	-	189
N Fertiliser applied effluent Area (kgN/ha)	217	-	154
N Fertiliser applied to support area (kgN/ha)	-	145	-
Pasture Growth support area (tDM/ha)	-	17.8	-
Pasture Growth dairy area (tDM/ha)	18.8	-	18.0

Table 4a: Total Supplement for Year End 2021 and Proposed

	YE 2021	Proposed
Supplements Imported (tDM)	1218	1150
Supplements Imported Effective Area (tDM/ha)	3.92	3.83
Silage Harvested (tDM)	367	31
Silage Harvested Pasture (tDM/ha)	1.18	0.10
Total Area (ha)	317.7	317.7
Effective Area (ha)	310	310
Effective Pasture Area (ha)	278.3	300
Peak Cows/ha	3.7	3.4
Total RSU	9867	10303
Total RSU/ Eff Pasture ha	35.5	34.3
Dairy RSU	8949	10100
Dairy RSU/ha (eff pasture area)	35.7	33.7
N Fertiliser applied non -effluent area(kgN/ha)	217	189
N Fertiliser applied effluent Area (kgN/ha)	217	154
N Fertiliser applied to support area (kgN/ha)	145	-
Pasture Growth support area (tDM/ha)	17.8	-
Pasture Growth dairy area (tDM/ha)	18.8	18.0

Overseer Outputs

9. The combined N lost to water for the YE 2021 models was 55.5 kgN/ha/yr (17642 kgN/annum) compared to 52 kgN/ha/yr (16541 kgN/annum) for the Proposed model which is an 6.2% reduction in total N loss. The combined P lost for the YE 2021 models was 1.3 kgP/ha/yr (419 kgP/annum) compared to 1.9 kgP/ha/yr (399 kgP/annum) for the Proposed model which is a 4.8% reduction in total P loss (see Table 5 below). It is assumed that the information provided in this farming system is modelled as a viable farming system, using actual stock and fertiliser inputs.

Table 5: OVERSEER outputs

Overseer v6.4.2	YE 21	Muir YE 21	Proposed
N lost to water kg/ha/yr	55	57	52
Total N lost kg/farm	14125	3517	16541
P lost kg/ha/yr	1.4	1	1.3
Total P lost kg/farm	358	61	399
Other sources – N	916	17	1110
Other sources – P	171	13	190

Table 5a: Total OVERSEER outputs between Year End 2021 and Proposed

Overseer v6.4.2	YE 2021	Proposed
N lost to water kg/ha/yr	55.5	52
Total N lost kg/farm	17642	16541
P lost kg/ha/yr	1.3	1.3
Total P lost kg/farm	419	399
Other sources – N	933	1110
Other sources – P	184	190

Change in block pools

10. The organic pool for N indicates the amount of N that is being either immobilized as seen by a 'positive' Organic pool N value or being mineralized as seen by a 'negative' Organic pool N value. N being immobilized is being used for increased biological activity and temporarily locked up. Once the microorganisms die the organic N in their cells is converted by mineralization and nitrification to plant available nitrate. It appears N is potentially being immobilized in all models (see Table 6 below).

11. The inorganic soil pool for P indicates the amount P that exceeds soil P maintenance as seen by a 'positive' inorganic soil P value or is less than the soil P maintenance requirements as seen by a 'negative' inorganic soil P value. Above maintenance P was applied to YE models and slightly above maintenance levels for the Proposed model (see Table 6a below).

Table 6: Change in block pool (N)

	YE 21	Muir YE 21	Proposed
Organic Pool	141	-1	109
Inorganic Mineral	0	0	0
Inorganic Soil Pool	0	36	4

Table 6a: Change in block pool (P)

	YE 20	Muir YE 21	Proposed
Organic Pool	15	-5	13
Inorganic Mineral	2	2	2
Inorganic Soil Pool	19	41	4

Rain/clover N Fixation

All plants, including forage crops, need relatively large amounts of nitrogen for growth and development. Biological nitrogen fixation is the term used for a process in which nitrogen gas (N2) from the atmosphere is incorporated into the tissue of certain plants. Only a select group of plants can obtain N this way, with the help of soil microorganisms. Among forage plants, the group of plants known as legumes (predominantly Clover in NZ pastures) are well known for being able to obtain N from air N2. The OVERSEER Technical Manual – Characteristics of Pasture, April 2015 indicates that biological N fixation is based on total pasture production and includes the fertiliser induced reduction in N fixation.

12. The Biological fixation for the combined YE 21 Models is 101 compared to the Proposed model at 122 (see table 7a below).

13. The N added to pasture for the combined YE models was 210 kgN/ha compared to 164 kgN/ha for the combined Proposed models (a 21.9 % drop in N used).

14. The increase in biological fixation in the Proposed model can be explained by the almost 22% decrease in N fertiliser applied.

Table 7: Biological fixation

	YE 21	Muir YE 21	Proposed
Biological Fixation (kg/ha/yr)	104	74	122
Average N applied to whole farm kg/ha/yr	212 (217 to all pasture)	106 (145 to all pasture)	157 (189 to non-effluent and 154 to effluent pasture)

Table 7a: Biological fixation between Year End 2021 and Proposed

	YE 21	Prop MP
Biological Fixation (kg/ha/yr)	101	122
Average N applied to pasture kg/ha/yr	210	164

Pasture Production

15. The average effluent N inputs for the YE 2021 models was 52kgN/ha from liquid to 212.6 ha of pasture and 6 kgN/ha from solid effluent to 250.5 ha pasture (see table 8 below). The average effluent N inputs for Proposed model was 56 kgN/ha from liquid to 212.6 ha of pasture and 6 kgN/ha from solid effluent to 300 ha pasture.

16. Fertiliser inputs of N, for the YE 2021 models combined, to effluent and non-effluent pasture was 217 kgN/ha (see Table 8 below). The combined fertiliser inputs of N to pasture onto effluent and non-effluent area was 169 kgN/ha pasture in the Proposed model (see Table 7a above).

17. Liquid effluent is applied onto pasture block for all the models was applied all year-round using a <12 mm application method. Solids effluent from pond is applied in Jan for all the models.

Table 8: Pasture production and N inputs (fertiliser and effluent)

	YE 2021	Proposed
Effluent Liquid Area (ha)	212.6	212.6
Effluent Solids Area (ha)	250.5	300
Pasture Growth (tDM/ha/yr)		
Effluent	18.8	18.0
Non-Effluent	18.8	18.0
Support	17.8	18.0
N Fertiliser inputs (kg/ha/yr)		
Effluent	217	154
Non-Effluent	217	189
N Effluent Inputs (kg/ha/yr)		
Effluent	52	56
Non-effluent (includes solids)	6	6
Total N Inputs (kgN/ha/yr)		
Effluent	269	210
Non-Effluent	223	196

18. The pasture production for all models have been modelled as varying based on topography, climate, and development status.

19. Fertiliser inputs of N are high for the YE 2021 models compared to moderate for the Proposed Model (see Tables 7a and 8).

20. It is assumed the YE 2021 models represent the actual farm system with actual stock, crop area and fertiliser inputs, it is assumed that the pasture production is accurate and reasonable.

21. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr.

22. The dairy pasture production for the YE 21 model was 18.8 tDM/ha compared to 18.0 tDM/ha for the Proposed models which is respectively 32.4% and 29.4% higher than the Southland average (see Tables 4, 4a and 8 above).

23. YE 21 model: Allowing for the Overseer model assuming an average metabolisable energy (ME) value of 10.5 MJME/kgDM for pasture and South Island pastures have a ME value closer to 11 MJME/kgDM the models output of pasture growth would drop by 4.5%. Also, the YE 21 model has used actual data and is assumed that pasture renewal has occurred, and new pasture can account for a 15-20% improvement in pasture growth. Also 2.6 tDM/ha would come from the high N fertiliser applied (217 kgN/ha X 12 kgDM/kgN applied). This more than accounts for the high pasture growth.

24. Proposed model: The drop in pasture growth can be accounted for in the large drop in N fertiliser applied, decrease in pasture harvested and decrease in RSU/ha.

25. The animal distribution is modelled as 'No difference between blocks' and 'Same ratio of animal intake' with 'Default Grazing Months' for all models.

Mitigations Modelled

26. Reporting out lined the following: As described in the Nutrient Budget Report for Platinum Dairies Ltd prepared Miranda Hunt, Roslin Consultancy Ltd (page 5 of the 'OverseerFM farm consultancy modelling to support a consent application for expanded dairy' document), there are several mitigation measures indicated to mitigate N loss that have been included in the Proposed modelling. The below table details if the mitigation measures have been included in the proposed scenario and if they are accurately modelled.

Table 9: Mitigation option for Proposed scenario

Reduced area of winter crop	Yes, the area of winter crop has decreased from 22 ha of Swedes/Kale in the YE 21 models to 10 ha of Swedes in the Proposed model. Note that we are not comparing the same 'Crop Rotation Final Month'. Muir 2 YE21 model had the month of 'June' entered and the Proposed had 'September'.
Decrease in N applied	Yes, N fertiliser applied to pasture decreased from 210 kgN/ha for the YE 21 models combined compared to an average of 164 kgN/ha for the Proposed model (a 21.9 % decrease).

Reduction in cows wintered	Yes, the cows wintered have dropped from 436/460 cows June/July in the muir YE Model compared to 100/360 cows June/July for the Proposed model.
Removal of jersey bulls	Yes, there are no Jersey Bulls in the Proposed model
Reduced young stock numbers	Yes, the calves in the Muir YE 21 were 287 (October to early Dec), this is reduced to 265 (Aug to mid Dec) in the Proposed model
Reducing the farm average Olsen P to 30	Yes, the drop in Olsen P to 30 has been modelled.

27. All mitigations identified in the OverseerFM report have been modelled correctly.

28. I have added 'change in fertiliser timing' and 'imported supplement', which are mitigations I have added and not mentioned as mitigations in the OverseerFM Modelling Report, as they can have an impact on N loss.

29. It is important that these mitigation measures are measured and monitored as if they are not adhered to the N loss reductions proposed may not occur.

30. Some good management practices assumed in Overseer are maintain accurate and auditable records of annual farm inputs, outputs and management practices (Overseer output is only as good as the data entered); Fertiliser is being applied according to the Fertmark and Spreadmark Codes of Practice; Feed is stored to minimise leachate and soil damage; Compliant effluent systems as defined by DairyNZ; Stock exclusion from water ways; Irrigation efficiency greater than 80%; farm race and bridge/culvert nutrient runoff is directed to paddocks; grazing managed to minimise losses from critical source areas.

31. Overseer will account for bad practices such as nitrogen (N) applied that exceeds the plants' ability to absorb the excess N, application of N in the winter, high stocking rates, land left fallow between crops and irrigating high water application rates causing N drainage to name a few.

32. The Overseer modelling completed for this farm does not have any of the 'Bad Practices' as suggested in paragraph 31, and it would be assumed the FEMP would cover any good management practices (not limited to) outlined in paragraph 30.

CONCLUDING COMMENTS

Determination of the robustness of the nutrient loss to water

33. The questions below were described at Paragraph five of this report. Whilst these have been answered throughput this report, this section summarizes the answer to each question to make an overall conclusion about the robustness of the nutrient budgets.

Is the N loss consistent with what you would expect for an operation of this type and soils in this location?

34. Based on my experience, the N loss estimates are reasonably consistent with an operation of this scale and soil types present.

Does the summary of inputs and outputs make sense? Especially clover fixation and change in block pools?

35. The Biological fixation for the combined YE 21 Models is 101 compared to the Proposed model at 122.

36. The N added to pasture for the combined YE models was 210 kgN/ha compared to 164 kgN/ha for the combined Proposed models (a 21.9 % drop in N used).

37. The increase in biological fixation in the Proposed model can be explained by the almost 22% decrease in N fertiliser applied.

Check the 'Other values' block reports for rainfall, drainage, and PAW.

38. The rainfall and soil information have been entered based on protocols for the location and soil type selected. YE 2021 model's soils areas are within 5% of Proposed models soils.

Production and stocking rate

39. The YE 2021 combined models have a revised stocking rate of 35.7 RSU/ha for dairy cows and the Proposed combined model have a revised stocking rate of 33.7 RSU/ha or a 5.6% decrease in RSU/ha.

40. Based on my experience and reviewing the NZ Dairy statistics for the 2019/2020 season, shows the average milk solids production on this property for the YE 21 model at 467.9 kgMS/cow and 1748 kgMS/ha is respectively higher than the Southland Regional average of 418 kg MS/cow and higher than the Southland Regional average of 1133 kgMS/ha. The Prop MP model at 464 kgMS/cow and 1567 kgMS/ha is respectively higher than the Southland Regional average of 418 kg MS/cow and higher than the Southland Regional average of 1133 kgMS/ha.

41. The stocking rate for YE 21 and Proposed models at 3.7 and 3.4 cows/ha are respectively greater than the Southland average for the 2019/2020 season of 2.76 cows/ha (Invercargill).

42. It is assumed that the YE 2021 models are based on actual year end information.

Select the pasture production in the scenario report and check pasture growth.

43. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr.

44. The dairy pasture production for the YE 21 model was 18.8 tDM/ha compared to 18.0 tDM/ha for the Proposed models which is respectively 32.4% and 29.4% higher than the Southland average.

45. YE 21 model: Allowing for the Overseer model assuming an average metabolisable energy (ME) value of 10.5 MJME/kgDM for pasture and South Island pastures have a ME value closer to 11 MJME/kgDM the models output of pasture growth would drop by 4.5%. Also, the YE 21 model has used actual data and is assumed that pasture renewal has occurred, and new pasture can account for a 15-20% improvement in pasture growth. Also 2.6 tDM/ha would come from the high N fertiliser applied (217 kgN/ha X 12 kgDM/kgN applied). This more than accounts for the high pasture growth.

46. Proposed model: The drop in pasture growth can be accounted for in the large drop in N fertiliser applied, decrease in pasture harvested and decrease in RSU/ha.

47. The animal distribution is modelled as 'No difference between blocks' and 'Same ratio of animal intake' with 'Default Grazing Months' for all models.

48. I have assumed an adequate level of robustness around the YE 2021 Models of actual Overseer Modelling as it is based on an actual farming system, and with that, I have assumed actual stock and fertiliser inputs used.

    The data input protocols have been followed with some deviations. This leads to medium-high level of robustness for the relevant input data for example, climate, soils, and pasture type. Based on this, I consider that the robustness of the nutrient loss estimates for the Proposed model to be **medium-high,** this is due to the following:

Summary of Mitigations to address:

- Please explain why: The crop rotation final month for the Muir YE model has a final month entered as 'June' and 'September' was entered for the Proposed model.

References:

New Zealand Dairy Statistics 2019/2020. Produced by LIC and DairyNZ 2020.
https://www.dairynz.co.nz/publications/dairy-industry/new-zealand-dairy-statistics-2019-20/

Overseer Definition of Terms, previously Technical Note 6. May 2016
Overseer Technical Manual – Characteristics of Pasture, April 2015

Smith. L. C. 2012. Proceedings of the New Zealand Grassland Association 74: 147-152 (2012) *Long Term pasture growth patterns for Southland New Zealand: 1978-2012.* www.grassland.org.nz/publications/nzgrassland_publication_2284.pdf

https://www.dairynz.co.nz/media/5793235/average-pasture-growth-data-south-island-2020-v1.pdf