Irricon resource solutions

OVERSEER Nutrient Budget Review

For: Environment Southland – Capil Grove Ltd

Prepared by: Nicky Watt, CNMA

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Introduction

1. Regarding the consent application for Capil Grove Ltd, I have reviewed the following OVERSEER ® Nutrient Budget (OVERSEER) files:
   a) Stage 0 – Baseline -All farms (v1) (Environment Southland)
   b) Stage 3 – Proposed Dairy Milking w/lease (v1) (Environment Southland)
   c) Stage 4 -Proposed Dairy Milking w/o lease (v1) (Environment Southland)

2. Along with the file I have reviewed the following accompany reports: Overseer modelling reports from OverseerFM. No accompanying Modelling Report prepared. Overseer modelling prepared by Miranda Hunter. I have completed a robustness check on the files for sensibility based on data available and checked to ensure the modelling aligns with the OVERSEER Best Practice Data Input Standards for v6.4.3.

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 Capil Grove 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. There is no mean calving or dry off date for the Prop w and Prop wo models. The drawn area for the Base model differ to that of the Prop w and Prop wo models. Barley has not been harvested in March in the Prop wo model. The soil area and type varies between all models.

3. The Base model and both Prop w and Prop wo models had a total area of 340.1 ha with 313.4 ha effective. The Base model had a revised stocking rate of 25.1 RSU/ha for all animal and the

Prop w model and Prop wo model had a respective revised stocking rate of 28.1 RSU/ha and 30.3 RSU/ha or a respective 10.7% and 17.2% increase in RSU/ha (see Table 1 below).

4. Reviewing the NZ Dairy statistics for the 2020/2021 season, shows the average milk solids production on this property for the Prop W model at 550 kgMS/cow and 1067 kgMS/ha is respectively higher than the Southland Regional average of 424 kg MS/cow and lower than the Southland Regional average of 1,208 kgMS/ha. The Prop wo model at 550 kgMS/cow and 1311 kgMS/ha is respectively higher than the Southland Regional average of 424 kg MS/cow and higher than the Southland Regional average of 1,208 kgMS/ha.

5. The dairy cow stocking rate for Prop w and Prop wo model at 1.9 and 2.4 cows/ha are respectively lower than the Southland average for the 2020/2021 season of 2.79 cows/ha (Southland).

Table 1: Summary of Production and stocking rate

	Base[1]	Prop w[2]	Prop wo[3]
Total Ha	340.1	340.1	340.1
Effective Area (ha)	313.4	313.4	313.4
Effective Pasture Area (ha)	262.4	260.4	268.4
KgMS	-	277750	352000
MS kg/ha grazed	-	1067	1311
MS kg MS/cow	-	550	550
Dairy RSU	-	6207	7870
Total RSU	6581	7313	7896
Total RSU/ha (eff pasture area)	25.1	28.1	30.3
Lactation Length	-	335	335
Cows/ha	-	1.9	2.4
Cows October	-	505	640
Dairy Cows June	400	505	640
Dairy Cows July	400	505	640
Dairy Grazing RSU	-	247	261
Beef RSU	3334	-	-
Sheep RSU	3247	859	-
Dairy Grazing RSU/ha (Eff past)	-	0.95	0.97
N lost kg/ha/yr	34	29	28

[1]Stage 0 – Baseline – All Farms (v1) (Environment Southland) - Base
[2]Stage 3 – Proposed Dairy Milking w/lease (v1) (Environment Southland) - Prop w
[3]Stage 4 - – Proposed Dairy Milking w/o lease (v1) (Environment Southland – Prop wo

6. The Base Model showed an area of 18 ha of swedes grazed by beef animals in the winter with a yield of 15 tDM/ha and the 17 ha of swede grazed by sheep in the winter with a yield of 12 tDM/ha. The Prop w Model had 8 ha of kale grazed in the winter by sheep with a yield of 12 tDM/ha. Both the Prop w and Prop wo had 45 ha of barley sown in Oct and harvested with a yield of 8 tDM/ha and residual grazed by dairy cows. The grain was harvested in March for the Prop w model but no harvest date for the Prop wo model (see Table 2 below).
7.

Table 2: Crop Details

	Base	Prop w	Prop wo
Barley Grain (ha)	-	45	45
Barley Yield (tDM/ha)	-	8	8
When harvested	-	March	? no harvest date
Grazed by	-	Dairy cows	Dairy cows
Swedes (ha) – Crop	18	-	-
Swedes Yield (tDM/ha)	15	-	-
When grazed	June-Sept	-	-
Grazed by	Beef	-	-
Swedes (ha) – Crop	17	-	-

Swedes Yield (tDM/ha)	12	-	-
When grazed	June-Aug	-	-
Grazed by	Sheep	-	-
Kale (ha) - Crop	-	8	-
Kale Yield (tDM/ha)	-	12	-
When grazed	-	June-Aug	-
Grazed by	-	Sheep	-

8. The soils for each of the models were compared as shown in Table 3 below. There is a difference between models for Temar_3a, Brax_4a and Kau_7a soils.

Table 3: Soil Details for Year End 2021 and Proposed

	Base	Prop w	Prop wo
Pukem_6a.1	185.5	191	184.9
Makar_3b.1	83.9	82.4	88.5
Temar_3a.1	19.2	24.7	31.3
Brax_4a.1	16.1	6.6	-
Kau_7a.1	8.7	8.7	8.7

9. Supplements are imported to meet cow demand (see Table 4 below). Pasture silage has been made where there was a surplus of pasture. The Base model had pasture growth calculated at 14.7 tDM/ha for the sheep grazed area and 17.2 tDM/ha for the beef grazed area dairy area. The Prop w model had a pasture growth of 11.8-11.9 tDM/ha for dairy pasture and 15.1 tDM/ha for the sheep grazed area. This is a slight increase of decrease of 2.6% in pasture growth for the sheep grazed area. The Prop w model had a pasture growth of 12.3 tDM/ha for dairy pasture. The decrease in the pasture growth in the dairy area for both the proposed models can be account for in the large increase in supplement imported and 100% wintering in the barn for 5 months. The N used on all pasture blocks in the Base models was 58-152 kgN/ha compared to 74-106 kgN/ha for the Prop w and 55-87 kgN/ha for the Prop wo. There is expected to be 79.6% and 89.4% more supplement imported, respectively, for the Prop w and Prop wo models when compared to the Base model. The silage harvest is expected to increase by 88.5% and 91.1% respectively for the Prop w and Prop wo models when compared to the Base Model (See Table 4 below).

Table 4: Supplements imported and Harvested

	Base	Prop w	Prop wo
Supplements Imported (tDM)	200	981	1880
Supplements Imported Effective Area (tDM/ha)	0.64	3.13	6.00
Silage Harvested (tDM)	75	650	850
Silage Harvested Pasture (tDM/ha)	0.24	2.07	2.71
Total Area (ha)	340.1	340.1	340.1
Effective Area (ha)	313.4	313.4	313.4
Effective Pasture Area (ha)	262.4	260.4	268.4
Total RSU	6581	7313	7896
Total RSU/ha (effective pasture area)	25.1	28.1	30.3
Peak Cows/ha	-	1.9	2.4
N Fertiliser applied non -effluent area(kgN/ha)	-	74	55
N Fertiliser applied effluent Area (kgN/ha)	-	74-118	55-118
N Fertiliser applied to support area (kgN/ha)	58-152	-	-
Pasture Growth sheep area only (tDM/ha)	14.7	15.1	-
Pasture Growth support area (tDM/ha)	17.2	11.8-11.9	12.3
Pasture Growth dairy area (tDM/ha)	-	11.8-11.9	12.3

Overseer Outputs

10. The N lost to water for the Base model was 34 kgN/ha/yr (11629 kgN/annum) compared to 29 kgN/ha/yr (9907 kgN/annum) for the Prop w model and to 28 kgN/ha/yr (9620 kgN/annum) for the Prop wo model which is, respectively, a 14.8 % and 17.3% reduction in total N loss. The P lost to water for the Base model was 1.9 kgP/ha/yr (633 kgN/annum) compared to 1.9 kgP/ha/yr (646 kgN/annum) for the Prop w model and to 1.9 kgP/ha/yr (648 kgN/annum) for the Prop wo model which is, respectively, a 2.1% and 2.4% increase 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 v6.4.3	Base	Prop w	Prop wo
N lost to water kg/ha/yr	34	29	28
Total N lost kg/farm	11629	9907	9620
P lost kg/ha/yr	1.9	1.9	1.9
Total P lost kg/farm	633	646	648
Other sources – N	172	316	364
Other sources – P	61	97	110

Change in block pools

11. 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 not being immobilized or mineralised for all models (see Table 6 below).

12. 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 all models (see Table 6a below).

Table 6: Change in block pool (N)

	Base	Prop w	Prop wo
Organic Pool	47	77.1	61
Inorganic Mineral	0	0	0
Inorganic Soil Pool	15	0	36

Table 6a: Change in block pool (P)

	Base	Prop w	Prop wo
Organic Pool	7	13.3	8
Inorganic Mineral	1	1	1
Inorganic Soil Pool	21	11.1	19

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.

13. The Biological fixation for the Base Model is 83 compared to the Prop w model at 94.2 and Prop wo model of 85 (see table 7a below).

14. The increase in biological fixation in the Prop w and Prop wo models can be explained by the large increase in pasture silage harvested and use of the Wintering Barn which offsets the increase in N fertiliser applied.

Table 7: Biological fixation

	Base	Prop w	Prop wo
Biological Fixation (kg/ha/yr)	83	94.2	85
Average N applied to whole farm kg/ha/yr	50 (47.9 to all pasture)	106 (74 to non-effluent & 100 to effluent pasture)	87 (55 to non-effluent and 83 to effluent pasture)

Pasture Production

15. The average effluent (liquid and solids) N inputs for the Prop w model was 80 kgN/ha to 259.7 ha of pasture (see table 8 below). The average effluent N inputs (liquids and solids) for Prop wo model was 107 kgN/ha to 259.7 ha of pasture.

16. Fertiliser inputs of N, for the Prop w model to effluent and non-effluent pasture was 88 kgN/ha and 55 kgN/ha respectively (see Table 8 below). The combined fertiliser inputs of N to pasture onto effluent and non-effluent area was 157-186 kgN/ha and 74 kgN/ha respectively to pasture. Fertiliser inputs of N, for the Prop wo model to effluent and non-effluent pasture was 100 kgN/ha and 74 kgN/ha respectively (see Table 8 below). The combined fertiliser inputs of N to pasture onto effluent and non-effluent area was 143-194 kgN/ha and 55 kgN/ha respectively to pasture.

17. Liquid effluent is applied onto pasture block for all the models was applied September to May and December to February on the barley crop using a <12 mm application method. Solids effluent from pond was applied to pasture only blocks in December and February in the Prop w model and December and March to the Prop wo model.

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

	Prop w	Prop wo
Effluent Liquid Area (ha)	259.7 + 45 ha crop	259.7 + 45 ha crop
Effluent Solids Area (ha)	259.7	259.7
Pasture Growth (tDM/ha/yr)		
Effluent	11.8-15.1	12.3
Non-Effluent	11.8	12.3
N Fertiliser inputs (kg/ha/yr)		
Effluent	100 (74-106)	83 (55-87)
Non-Effluent	74	55
N Effluent Inputs (kg/ha/yr)		
Effluent	80	88-107
Non-effluent (includes solids)		
Total N Inputs (kgN/ha/yr)		
Effluent	154-186	143-194
Non-Effluent	74	55

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 all the models would be considered moderate.

20. It is assumed the Base model 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 pasture production for the Base model ranged from 14.7 tDM on the sheep only grazed pasture and was 17.2 tDM/ha for the beef only grazed pasture. The Prop w model pasture production was 11.8-11.9 tDM/ha for the dairy/ dairy grazed pasture and 15.1 tDM/ha for the sheep grazed pasture. The Prop w model pasture production was 12.3 tDM/ha for the dairy/ dairy grazed pasture. The sheep grazed pasture production in the Prop w model is consistent with the Base model sheep grazed pasture production. The pasture production for the Base Model is respectively 13.6% and 26.2% higher than the Southland average (see Tables 4, 4a and 8 above). The Prop w and Prop wo models for dairy/dairy grazed pasture production is respectively 6.7% and 3.1% less than the Southland average.

23. Base 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 Base 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. This accounts for the high pasture production on the sheep grazed area but not the high pasture harvest for the beef grazed pasture.

24. Prop w model: The drop in pasture growth can be accounted for in the large increase in supplement imported (79.6%) and animals being wintered in the Wintering Barn for 5 months but is offset by the large increase in pasture silage harvested (88.5%).

25. Prop wo model: The drop in pasture growth can be accounted for in the large increase in supplement imported (89.4%) and animals being wintered in the Wintering Barn for 5 months but is offset by the large increase in pasture silage harvested (91.2%).

26. The animal distribution is modelled as 'No difference between blocks' and 'Based on animals present on block' with 'Default Grazing Months' for Base and Prop w models but 'Same as ratio of total animal intake' was used for the Prop wo model (no impact on N loss).

Mitigations Modelled

27. No report was provided (other than the Overseer FM reports). Overseer modelling was prepared by Miranda Hunter and Victoria. There are several mitigation measures that have been modelled 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: Mitigations for Proposed scenarios

Presence of a wintering barn	There is a covered wintering pad/shelter in both the proposed models May to September
Wintering barn minimizes environmental impacts over winter	N loss is less in proposed models. The model has limitations in accounting for E coli or other pathogens and Critical Source areas.
High FDE application area	FDE application area is 259.7 ha for both proposed models, and 103 ha for Prop w and 139 ha for Prop wo is required to ensure N loading is less than 150 kgN/ha/annum,
FED low application rate	Application depth is proposed to be less than 12mm in both proposed models
No dairy cow winter grazing on crop	There is kale in the Prop w model but being grazed by sheep, all stock feed 100% in the wintering barn over winter

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

29. I have added the mitigation as no report was provided with the application other than the reports produced from Overseer FM.

30. 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.

31. 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.

32. 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.

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

CONCLUDING COMMENTS

Determination of the robustness of the nutrient loss to water

34. 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?

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

36. There are a couple of discrepancies between the models. The drawn area for the Base Model differs to that of the proposed models. Also there is no harvest date for the Barley in the Prop wo model.

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

37. The Biological fixation for the Base Model is 83 compared to the Prop w model at 94.2 and Prop wo model of 85 (see table 7a below).

38. The increase in biological fixation in the Prop w and Prop wo models can be explained by the large increase in pasture silage harvested and use of the Wintering Barn which offsets the increase in N fertiliser applied.

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

39. The rainfall information have been entered based on protocols for the location and soil type selected. The soils do vary between the models and will need addressing.

Production and stocking rate

40. The Prop w model and Prop wo model had a respective revised stocking rate of 28.1 RSU/ha and 30.3 RSU/ha or a respective 10.7% and 17.2% increase in RSU/ha.

41. Based on my experience and reviewing the NZ Dairy statistics for the 2020/2021 season, shows the average milk solids production on this property for the Prop W model at 550 kgMS/cow and 1067 kgMS/ha is respectively higher than the Southland Regional average of 424 kg MS/cow and lower than the Southland Regional average of 1,208 kgMS/ha. The Prop wo model at 550 kgMS/cow and 1311 kgMS/ha is respectively higher than the Southland Regional average of 424 kg MS/cow and higher than the Southland Regional average of 1,208 kgMS/ha.

42. The dairy cow stocking rate for Prop w and Prop wo model at 1.9 and 2.4 cows/ha are respectively lower than the Southland average for the 2020/2021 season of 2.79 cows/ha (Southland).

43. It is assumed that the Base model is based on actual year end information. Please note in both the proposed models there is no mean calving or dry off date for the dairy cows.

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

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

45. The pasture production for the Base model ranged from 14.7 tDM on the sheep only grazed pasture and was 17.2 tDM/ha for the beef only grazed pasture. The Prop w model pasture production was 11.8-11.9 tDM/ha for the dairy/ dairy grazed pasture and 15.1 tDM/ha for the sheep grazed pasture. The Prop w model pasture production was 12.3 tDM/ha for the dairy/ dairy grazed pasture. The sheep grazed pasture production in the Prop w model is consistent with the Base model sheep grazed pasture production. The pasture production for the Base Model is respectively 13.6% and 26.2% higher than the Southland average (see Tables 4, 4a and 8 above). The Prop w and Prop wo models for dairy/dairy grazed pasture production is respectively 6.7% and 3.1% less than the Southland average.

46. Base 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 Base 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. This accounts for the high pasture production on the sheep grazed area but not the high pasture harvest for the beef grazed pasture.

47. Prop w model: The drop in pasture growth can be accounted for in the large increase in supplement imported (79.6%) and animals being wintered in the Wintering Barn for 5 months but is offset by the large increase in pasture silage harvested (88.5%).

48. Prop w model: The drop in pasture growth can be accounted for in the large increase in supplement imported (89.4%) and animals being wintered in the Wintering Barn for 5 months but is offset by the large increase in pasture silage harvested (91.2%).

49. The animal distribution is modelled as 'No difference between blocks' and 'Based on animals present on block' with 'Default Grazing Months' for Base and Prop w models but 'Same as ratio of total animal intake' was used for the Prop wo model (no impact on N loss).

50. I have assumed an adequate level of robustness around the Base Model 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 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 models to be **medium,** this is due to the following:

- Please explain why there is no mean calving or dry off dates for dairy cows
- Please explain why there is no harvest date for the barley crop in the Prop wo model
- Please explain why the drawn area for the Base model differs to that of the proposed models
- Please explain why the soil areas/types vary between the Baseline and the proposed models and between the proposed models
- Please explain the high pasture harvest in the Base model for the beef area

Note: There is a small increase in P loss for both proposed models when compared to the Base model. Overseer does/can't show all P loss mitigations but these should be identified in the properties FEMP.

References:

https://www.dairynz.co.nz/publications/dairy-industry/new-zealand-dairy-statistics-2020-21/

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