OVERSEER Nutrient Budget Review

For: Environment Southland – South Dairies Ltd

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Introduction

1. Regarding the consent application for South Dairies Ltd, I have reviewed the following OVERSEER ® Nutrient Budget (OVERSEER) files:
   a) SD1 Consent Conditions AUTH-20171302-01/04
   b) SD2 APP-20147281-01-v1
   c) SD 7ha Support
   d) NB 2016-2017 Consent DSN 31827 (copy)-UPDATED (1)

2. Along with the files I have reviewed the following report:
   - Overseer Modelling Report prepared by Miranda Hunter, Roslin Consultancy Limited.

3. 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 v6.3.0.

4. It must be assumed that the information provided in the OVERSEER files that the have been modelled are a viable farming system, using actual stock and fertiliser inputs. Therefore, they are also assumed to be appropriate for the location and climate.

5. A 'sensibility test' has been undertaken on the South Dairies Ltd nutrient budgets with the following four 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.

6. 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 four XML files 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 is no deviation from the BPDIS for all predictive files.

   NB 2016 2017 Consent DSN 31827 (copy)-Updated (1), which represents original consent conditions, has not been updated (all soils not updated to the latest version, currently soils in v6.2.2). Small point to note is in table 4 of the report provided by Roslin Consultancy Ltd indicates v6.3.0 (could be written there in error as clearly states in section 7.1 that has not been updated). The key differences between this model and SD1 Consent conditions AUTH-20171302-01/04 has been clearly identified in section 7.3 of the report provided by Roslin Consultancy Ltd.

3. All models appear to have the correct area and where there are discrepancies between models this has been clearly mentioned in Section 7.3 of Roslin Consultancy Ltd report.

4. Reviewing the NZ Dairy statistics for the 2016/2017 season, shows the milk solids production on this property is in fact higher than the Southland regional average of 415kg MS/cow. The stocking rate is also higher than the Southland average for the 2016/2017 season of 2.69 cows/ha. Milk solid production per cow is the same for SD1 and SD1 2016 2017 and slightly higher for SD2. Stocking rate is similar for SD1 and SD1 2016 2017 and lower for SD2 (see Table 1).

Table 1: Summary of Production and stocking rate

	SDI*	SD1 2016 2017**	SD2***	7ha Support****
Total Ha	248.5	249.2	179.8	7.5
Effective Ha	238.1	244	173.8	6.6
MS kg/ha grazed	1480	1442	1369	-
MS kg MS/cow	451.3	451.3	462.1	-
RSU	7361	7359	5290	151
Lactation Length	268	268	268	-
Cows/ha	3.3	3.2	3.0	-
Cows June	0	0	320	200
Cows July	32	32	320	200
Peak Cows (Sept)	780	780	510	-
Bulls (Dec/Jan)	22	0	15	0
Young Stock (Aug-Dec)	197	0	130	0
N lost kg/ha/yr	58	61	58	29

*SD1= SD1 Consent Conditions AUT-20171302-01/04
**SD1 2016 2017= NB 2016-17 Consent DSN 31827 (copy) UPDATED (1)
***SD2=SD2 APP-20147281-01-v1
****7ha Support= SD 7ha Support

5. The total crop area of fodder beet is consistent between SD1 and SD1 2016 2017 as can be seen in Table 2 below. Other models have no crops modelled. Note difference in drainage area between SD1 and SD1 2016 2017 (also commented on in Section 7.3 of Roslin Consultancy Ltd report).

Table 2: Crop Details and Drainage

	SDI	SD1 2016 2017	SD2	7ha Support
Crop Effective Ha	12	12	-	-
Yield (tDM/ha)	25	25	-	-
Cultivation	Conventional	Conventional	-	-
Sown	November	November	-	-
Crop	Fodder Beet	Fodder Beet	-	-
Drainage Area (ha)	230	103	173.8	6.6

6. Supplements imported is 80 tDM/ha less for SD1 compared to SD1 2016 2017. Supplements imported for SD2 is 150 tDM/ha higher than SD1 and with 0.3 less cows/ha (see Table 3a below for supplement imported and table 1 for stocking rate).

Table 3a: Supplements imported and Harvested

	SDI	SD1 2016 2017	SD2	7ha Support
Supplements Imported (tDM)	530	610	680	30
Supplements Imported (tDM/ha)	2.21	2.49	3.91	4.55
Effective Area (ha)	238.1	244	173.8	6.6
RSU/ha	7361	7359	5290	151
N Fertiliser applied (kgN/ha)	184	186	194	97
Pasture Intake (kgDM/ha)	14846	14002	14177	3848
Silage Harvested to storage (kgDM/ha)	0	375	0	9148
Pasture Intake including supplement (kgDM/ha)	14846	14377	14177	12996

7. The SD1 Overseer model shows the pasture production is 14.85 tDM/ha and the SD1 2016 2017 is 14.38 tDM/ha or a 0.47 tDM increase in pasture production (see Table 3a above and Table 3b below). The nitrogen fertiliser used is 184 kgN/ha for SD1 and 186 kgN/ha for SD1 2016 2017 or a 0.16tDM/ha decrease in potential pasture grown through a decrease in N used. The supplement used for SD1 is 2.21 tDM/ha and for SD1 2016 2017 is 2.49 tDM/ha or 0.49 tDM/ha decrease in supplement used. Based on this information, adding the extra 80 tDM to the SD1 model will bring the two models back in line.

Table 3b: Comparison of actual and proposed feed availability

(tDM/ha)	SD1	SD1 2016 2017	Difference
Pasture Intake	14.85	14.38	0.47
Supplements Imported	2.21	2.49	-0.49
Pasture Growth from N fertilizer*	1.84	1.86	-0.02

**Pasture growth from N fertilizer have assumed an average 10:1 response*

8. The N lost to water and P loss is similar for the SD1, SD1 2016 2017 and SD2 models, keeping in mind SD1 2016 2017 is modelled with v6.2.2 so is likely to have a much higher N loss than that shown below (see Table 4 below). It must be assumed that the information provided in all the models are farming systems is modelled as a viable farming system, using actual stock and fertiliser inputs and are also assumed to be appropriate for the location and climate.

Overseer Outputs

Table 4: OVERSEER outputs

Overseer v6.3.0	SDI	SD1 2016 2017	SD2	7ha Support
N lost to water kg/ha/yr	58	61	58	29
Total N lost kg/farm	14333	15287	10414	218
P lost kg/ha/yr	1.4	1.4	1.3	0.6
Total P lost kg/farm	338	340	230	5
Other sources – N	788	624	480	4
Other sources – P	133	131	91	1

Change in block pools

9. It appears N is potentially being immobilized for both SD1 and SD1 2016 2017 models. This is observed with a positive value in the Organic pool for N. This value shows no change for SD2 and SD 7ha support.

Table 5: Change in block pool (N)

	SDI	SD1 2016 2017	SD2	7ha Support
Plant Material	-6	-5	0	0
Organic Pool	92	88	119	142
Inorganic Material	0	0	0	0
Inorganic Soil Pool	2	4	0	0

10. Phosphate added to SD1 2016 2017 was between 32-42 kgP/ha where maintenance P requirements were 20-25 kgP/ha which has resulted in the organic P soil P increasing (see table 6 below). The phosphate added to the SD1 and SD2 models was 25-26 kgP/ha which met P maintenance requirements resulting in little to no change the inorganic soil pool for changing. SD 7ha support shows is receiving maintenance P.

Table 6: Change in block pool (P)

	SDI	SD1 2016 2017	SD2	7ha Support
Plant Material	-1	-1	0	0
Organic Pool	15	15	16	15
Inorganic Material	2	1	2	2
Inorganic Soil Pool	-1	10	1	0

Rain/clover N Fixation

11. The average Biological fixation for 7ha support and SD2 are 8% and 56% less respectively when compared to the SD1 and SD1 2016 2017 models (see table 7 below).

12. N added is reasonable consistent for the 3 dairy farm models and half for the support block. In all cases (for the dairy farm models as shown below in table 8) consideration has been given to effluent being applied (less N on effluent blocks).

13. The small decrease in biological fixation for SD2 compared to SD1 and SD1 2016 2017 will likely be due to the increase in average N applied. This is deemed to be an acceptable variance and within the limitations of the model.

Table 7: Biological fixation

	SDI	SD1 2016 2017	SD2	7ha Support
Biological Fixation	95	96	87	42
Average N applied to whole farm kg/ha/yr	184	186	194	97

14. It is not known if the decrease in N applied and slight decrease in biological fixation for SD1 when compared to SD1 2016 2017 will be able to maintain the pasture production modelled for SD1.

Pasture Production

15. The effluent N inputs for SD1 are 66% less compared to SD1 2016 2017 which is due to the increase in effluent area, in SD1, (32% increase in area) being applied (see table 8 below). Important to note N loading from effluent at 165 kgN/ha/annum for SD1 2016 2017 exceeds consent conditions ie 'Nitrogen loading from effluent not to exceed 150 kgN/ha/annum'

16. Fertiliser inputs of N vary across the 3 models with 7% more N fertiliser being applied to the SD1 effluent area and 9% more to the non-effluent area compared to SD1 2016 2017. SD2 model has similar input to SD1.

17. Pond solids, separate solids and solids from the wintering pad area, are all applied to all blocks in all models. Liquid effluent, using <12 mm), is applied for SD1 and a Low application method is applied to SD1 2016 2017.

18. Long term pasture growth in Southland between 1979 and 2012 indicated that average pasture growth for newer pastures was 12.7T DM/ha/yr. The pasture production on this property is higher than the long-term growth. This has been explained by Roslin Consultancy Ltd in Section 4.2.

19. The animal distribution is modelled the same in all scenarios.

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

	SDI	SD1 2016 2017	SD2	7ha Support
Effluent Area (ha)	183	121	105.4	0
Pasture Growth (tDM/ha/yr)				
Effluent	17.5	16.8	16.7	
Non-Effluent	17.5	16.8	16.7	
N Fertiliser inputs (kg/ha/yr)				
Effluent	187	174	183	
Non-Effluent	231	210	227	
N Effluent Inputs (kg/ha/yr)				
Effluent	56	165	68	
Non-effluent (includes solids)	33	87	42	
Total N Inputs (kgN/ha/yr)				
Effluent	243	339	251	
Non-Effluent	264	297	269	

Changes Modelled

20. As described in the report provided by Roslin Consultancy Ltd, Section 7.3, on a comparison between SD1 and SD1 2016 2017 there are several changes that have been included in the SD1 model that differs from the SD1 2016 2017 model. The table below details if the changes have been included in the SD1 model and shows has been accurately modelled.

Table 9: Changes to SD1

Total Area changed	Yes (249.2 to 248.5 ha)
Effective area changed	Yes (245.2 to 239.3
Increased Effluent area	Yes (121 to 183 ha)
Change application depth effluent applied	Yes. Changed from low application depth to <12mm depth
Months Solids applied	Yes (changed from Dec and Jan to Jan only)
Changed from wintering pad to feedpad and times on	Yes, changes proposed made
Topography changes	Yes (all flat to some areas rolling)
Drainage changes	Yes (103 to 230 ha mole/tile drained)
Animal changes	Yes (cow weight now default, drying off 31st May, bulls included, replacement calves on farm)
Supplement changes	Yes (less supplement imported and no silage harvested however to keep pasture harvest consistent similar supplement should be imported – this will drop N loss further)
Fertiliser and Nitrogen	Yes (less P fertiliser applied to maintain Olsen P levels, slightly less N applied over all farm)

21. Most of the changes look reasonable and are robust.

22. It is important that these changes are measured and monitored as if they are not adhered to the N losses proposed may not occur.

CONCLUDING COMMENTS

Determination of the robustness of the nutrient loss to water

23. 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?

24. 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?

25. There was a small decrease in biological fixation for SD2 compared to SD1 and SD1 2016 2017 will likely be due to the increase in average N applied. This is deemed to be an acceptable variance and within the limitations of the model.

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

26. The rainfall and soil information have been entered based on protocols for the location and soil type selected.

Production and stocking rate

27. Based on my experience as well as reviewing NZ Dairy statistics for the 2016/2017 season the stocking rate and milk solid production are higher than the Southland Region average in the 2016/2017 season.

28. The milk solids production per cow modelled for SD1 and SD1 2016 2017 at 451.3 kgMS/cow/annum and SD2 at 462.1 kg MS/cow/annum is higher than the Southland regional average of 415kg MS/cow.

29. The stocking rate, for all dairy farm models, is higher than the Southland average for the 2016/2017 season of 2.69 cows/ha.

30. It is assumed that all the models are based on actual information and all scenarios represent viable production and stocking rates.

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

31. A detailed explanation of the pasture production has been outlined in the above sections.

32. There is an increase in pasture production between the SD1 2016 2017 and the SD1 models and a corresponding small decrease in N applied and decrease in supplement being imported. The pasture production of SD2 and SD 7ha seems in line with expectations.

33. There is a shortfall of either supplement imported and/or nitrogen applied to cover the extra pasture production of the SD1 model and it is therefore unlikely that the modelled increase in pasture production in the SD1 model could occur. This would indicate that supplements imported and/or N fertiliser would need to increase to cover the increase in pasture production.

34. An increase in N fertiliser to grow the additional feed modelled in the SD1 model would likely see an increase in N lost than is currently modelled.

35. An increase in supplements imported on farm to cover the shortfall in feed is unlikely to have a significant impact on the N leaching and would be in line with what was modelled in SD1 2016 2017.

36. I have assumed an adequate level of robustness for all scenario Overseer Modelling as it is based on an actual farming system, and with that, I have assumed actual stock and fertiliser inputs used.

37. The data input protocols have been followed for all scenarios with no deviations. This leads to a high level of robustness for the relevant input data for example, climate, soils, and pasture type.

38. Based on the above information, I consider that the robustness of the nutrient loss estimates for models to be as follows:

    a) SD1 **medium-high**
    b) SD2 **high**
    c) SD 7ha Support **high**
    d) SD1 2016 2017 as a model originally produced for consent **medium**

39. The area of concern in the SD1 model is: the increase in pasture production and the reduction in supplements imported, however increasing the supplement, in SD1 to get the pasture covers back in line, will result in a slightly lower N loss.

40. The area of concern around the SD1 2016 2017 model is: the robustness of the model where farm area; topography; soil areas; drainage; animals on farm; effluent; fertiliser all have had to be changed to meet what happened on farm.

41. It is vital that the proposed plans for the farm system are effectively measured and monitored as if these are not adhered to then the proposed N losses may not occur.

References:

New Zealand Dairy Statistics 2016/2017. Produced by LIC and DairyNZ 2014. https://www.dairynz.co.nz/media/5788533/nz-dairy-statistics-2016-17-web.pdf

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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