Notes on the derivation of One Plan Table 14.2

PURPOSE

1. This is a short paper to examine how the values for the cumulative nitrogen leaching maximums in Table 14.2 of the One Plan were developed and whether there is any benefit in recalibrating Table 14.2 after changes in Overseer versions.

SCOPE

2. These notes focus on how the values in Table 14.2 were derived. The advantages and disadvantages of using the natural capital approach for nitrogen allocation, or consideration of alternatives to allocation by natural capital are not within scope.

DEFINITIONS

3. Measured SIN annual load - the quantity of SIN passing a point on the river, in kg/year or tonnes/year, calculated from a river flow statistic and water quality data collected at that location.

4. Target SIN annual load - the quantity of SIN passing a point on the river, in kg/year or tonnes/year, calculated from a river flow statistic and One Plan Schedule E water quality target for that location.

5. QUICK CONCLUSIONS

6. The year 1 cumulative nitrogen leaching maximums in Table 14.2 appear to be directly linked to OVERSEER outputs and would change according to OVERSEER version.

7. The year 20 cumulative nitrogen leaching maximums in Table 14.2 were set at a level to manage nitrogen leaching in over-allocated catchments after weighing up the environmental, economic and social consequences of doing so. They are therefore policy decisions related to, but not determined by the OVERSEER outputs.

8. The year 5 and 10 targets appear to be stepdown modifications of the year 1 nitrogen leaching maximums and could change should the year 1 cumulative nitrogen leaching maximums change.

BACKGROUND

9. During development of the One Plan, Horizons identified that the measured annual loads of **soluble inorganic nitrogen (SIN)** in some **Water Management Sub-zones (WMSZs)** exceed the target SIN annual loads derived to safeguard the life supporting capacity of waterways and provide for the surface water management values identified for those WMSZs (Table 1).

10. Resource accounting showed that over 90% of SIN was derived from non-point source run-off. The non-point source contributions were estimated as 50% from sheep and beef (which makes up 84% of the land use) and 50% from dairy (which makes up 16% of the land use).

11. It was decided that the most effective approach was to manage N from intensive farming land uses because this would be the most cost effective option and there were more mitigations available for this class of land use, e.g., dairy farming.

12. One Plan Table 14.2 specifies cumulative nitrogen leaching maximums according to **Land Use Capability (LUC)**. It is used in the One Plan as a tool to allocate nitrogen leaching loads amongst intensive farming land users.

13. OVERSEER was used during development of the cumulative nitrogen leaching maximums in Table 14.2 and this has lead to the perception that the N leaching numbers in the table are affected by version changes. It is argued that the calculations should be re-run and Table 14.2 recalibrated to take account of OVERSEER version changes.

DISCUSSION

14. The Manawatū River at Hopelands and Mangatainoka River at S.H. 1 were used as case studies in development of the cumulative nitrogen leaching maximums in Table 14.2. The case study information is repeated below to help demonstrate how the values in Table 14.2 were derived.

<u>Over-allocation and target SIN annual loads in the rivers</u>

15. The measured and target SIN annual loads for the case study catchments are presented in Table 1.

Table 1: Target and measured SIN annual loads in case study rivers

	Manawatū River at Hopelands	Mangatainoka River at S.H. 1
One Plan Schedule E target for SIN (g/m^3)	0.444	0.444
Target SIN annual load (calculated from river flow statistic and Schedule E target (kg/year)	**364,000**	**264,000**
Measured SIN annual load as at 2012 (kg/year)	**762,000**	**542,000**
Identified **over-allocation** of SIN in catchment (kg/year)	398,000 (209%)	278,000 (205%)

16. The comparison of measured and target SIN annual loads identifies over-allocation in both catchments and supports the case for managing nitrogen discharges, including non-point discharges to these rivers.

17. The annual target SIN annual loads are reference points toward which efforts, including allocation of nitrogen leached from intensive farming activities, are directed.

<u>Allocation using the natural capital approach</u>

18. There are a number of methods available for allocation of nitrogen. It was decided that the natural capital approach developed by a project team contributing to the Sustainable Land Use Research Initiative for Horizons Regional Council would be the most appropriate allocation method (Curran et al, 2007).

19. The approach derives N leaching limits using LUC as a proxy for the natural capital of soils. The process can be summarized as follows:

    a. Estimate the potential productive capacity of a legume-based pasture fixing nitrogen biologically under a typical sheep and beef system for each LUC unit from the extended legends of LUC worksheets;

    b. Transform the average attainable potential livestock carrying capacity into pasture production.

    c. Use pasture production values in OVERSEER to calculate nitrogen leaching losses from a legume based pasture under optimum management of a dairy farm for each LUC Class.

20. The calculated nitrogen losses rank soils on the basis of their natural capital stocks or productive capacity for legume-based pasture. There are some challenges in doing this modelling.

21. Modelling nitrogen leaching in OVERSEER for each LUC Class involves choosing a set of characteristics to represent the sub-classes of the LUC Class, e.g., a representative livestock

carrying capacity. This is challenging because there is a considerable range within a LUC Class, reflecting the different soil versatilities, variability associated with the LUC Subclass limitations, and the variations in landform and slopes, soil parent materials, degree of soil development, soil depth, stoniness, drainage, texture, and climate.

22. Another underlying assumption is that higher (lower number) LUC Class soils can achieve higher production with lower inputs and have less potential for nitrogen leaching than poorer (higher number) LUC Class soils. However, like the considerable variation in the livestock carrying capacities within an LUC Class, there is also considerable variability in the tendency of soils to leach within each LUC Class.

23. The calculated nitrogen losses and the cumulative nitrogen leaching maximums are compared in Table 2. The nitrogen leaching values calculated using OVERSEER appears to form the basis for the year 1 leaching maximums in Table 14.2. Since these are based on OVERSEER outputs, it follows that these values would change according to the OVERSEER version used.

Table 2: OVERSEER derived nitrogen leaching based *attainable potential livestock carrying capacity* as a proxy for natural capital and year 1 values in Table 14.2

	LUC Class							
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**
N leaching based on *attainable potential livestock carrying capacity* (kg/ha/year)	**30**	**27.4**	**23.5**	**17.5**	**16.3**	**14.5**	**8.3**	**0**
Table 14.2 Year 1 cumulative nitrogen leaching maximum for comparison (kg/ha/year)	**30**	**27**	**24**	**18**	**16**	**15**	**8**	**2**

Derivation of year 5, 10 and 20 cumulative nitrogen leaching maximums

24. The Manawatū River at Hopelands and Mangatainoka River at S.H. 2 were used as case study catchments in Curran et al (2007). Two scenarios were modelled in which 90% and 75% of the nitrogen leaching based on the *attainable potential livestock carrying capacity* were used to estimate the total nitrogen loadings in the case study WMSZs. The scenarios were based on:

   a. The estimated area for each LUC class in the catchment; and

   b. An average land to water transmissivity of 0.5.

25. The scenario results were then compared against the measured (as at 2012) and target SIN annual loads in the case study (Table 3).

Table 3: Nitrogen leaching based on 90% and 75% of nitrogen leaching based on *attainable potential livestock carrying capacity* and year 5 and 20 values in Table 14.2

	LUC Class							
	I	II	III	IV	V	VI	VII	VIII
N leaching based on 90% of *attainable potential livestock carrying capacity* (kg/ha/year)	**27**	**25**	**21**	**16**	**15**	**13**	**7**	**0**
Table 14.2 Year 5 nitrogen leaching maximum for comparison (kg/ha/year)	**27**	**25**	**21**	**16**	**13**	**10**	**6**	**2**
N leaching based on 75% of *attainable potential livestock carrying capacity* (kg/ha/year)	**23**	**21**	**18**	**13**	**12**	**11**	**6**	**0**
Table 14.2 Year 20 nitrogen leaching maximum for comparison (kg/ha/year)	**25**	**21**	**18**	**13**	**12**	**10**	**6**	**2**

26. The scenario modelling carried out by Curran et al (2007) can be repeated for the Table 14.2 nitrogen leaching maximums in Table 14.2 (See Table 3) to check how the modelled annual nitrogen loads relate to the measured and target annual loads in the case study rivers. The modelling for the Manawatū River at Hopelands shows that application of the year 20 cumulative nitrogen leaching maximums in Table 14.2 would hold SIN annual loads in the catchment at the 2012 measured levels, but would make very little progress toward the target SIN annual loads needed to address over-allocation.

27. The modelling for the Mangatainoka River at S.H.2 shows that application of the year 20 cumulative nitrogen leaching maximums in Table 14.2 would make substantial progress in reducing SIN annual loads in the river toward the target SIN annual load needed to address over-allocation.

28. The case study differences show how the variability of soils, landscape units and rainfall affect the OVERSEER outputs. The topography, soil types and average annual rainfall in the Upper Manawatu vary significantly from those in the Mangatainoka catchment and these differences affect nitrogen leaching loss and nitrogen loading.

Table 3: Modelled annual nitrogen loads in two case study catchments using Table 14.2 nitrogen leaching maximums

Modelled total annual nitrogen loading in river (kg/year)	**Manawatū River at Hopelands**	**Mangatainoka River at S.H. 1**
Year 1 cumulative nitrogen leaching maximums (consistent with the OVERSEER derived nitrogen leaching calculated for *attainable potential livestock carrying capacity*)	1044653	410123
Year 5 cumulative nitrogen leaching maximums (consistent with 90% of the OVERSEER derived nitrogen leaching calculated for *attainable potential livestock carrying capacity*)	823732	334351
Year 10 cumulative nitrogen leaching maximums	773331	310914
Year 20 cumulative nitrogen leaching maximums (consistent with 75% of the OVERSEER derived nitrogen leaching calculated for *attainable potential livestock carrying capacity*)	**750783**	**301452**
Measured SIN annual load as at 2012	762,000	542,000
Target SIN annual load to address over-allocation	**364,000**	**264,000**

CONCLUSIONS

29. The year 1 cumulative nitrogen leaching maximums in Table 14.2 appear to be based on the unmodified OVERSEER derived nitrogen leaching rates presented in Curran et al (2007). The values for these cumulative nitrogen leaching maximums are likely to change according to OVERSEER version.

30. The year 20 cumulative nitrogen leaching maximums are consistent with 75% of the year 1 cumulative nitrogen leaching maximums. It is clear from the case study modelling that these values would not achieve the target SIN annual loads. The year 20 cumulative nitrogen leaching maximums in Table 14.2 were set at a level to manage nitrogen leaching in over-allocated catchments after weighing up the environmental, economic and social consequences of doing so. They are policy decisions related to, but not determined by the OVERSEER outputs. They are, therefore, unlikely to change according to OVERSEER version.

31. The year 5 and 10 targets appear to be step-down modifications of the year 1 nitrogen leaching maximums. They are linked to both the year 1 and year 20 values. In general, the year 5 nitrogen leaching maximums appear to be about 90% of the year 1 values and the year 10 values appear to be about 80% of the year 1 values.

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