Tabled at Hearing on 17 November 2015

BEFORE THE Canterbury Regional Council

IN THE MATTER OF Plan Change 3 to the Canterbury Land & Water Regional Plan

STATEMENT OF EVIDENCE OF DR SAMUEL JAMES DENNIS

On behalf of

BEEF + LAMB NEW ZEALAND

Dated 25 September 2015

Adopted by

Contact for service:

Matt Harcombe

beef+lamb New Zealand

0274305037

matt.harcombe@beeflambnz.com

Introduction

Qualifications and experience

1. My name is Samuel James Dennis. I hold a B.Agr.Sc (First Class Honours) and a Ph.D. (Soil Science) from Lincoln University. I have completed both the Intermediate and Advanced Sustainable Nutrient Management courses at Massey University. I am currently working as an independent agricultural environmental consultant. I have not yet sought formal certification through the Nutrient Management Adviser Certification Programme. My qualifications are in excess of what is required for certification.

2. I have been contracted by beef+lamb New Zealand to model two farms in OVERSEER in the area defined by the plan and prepare a statement of evidence.

3. My Ph.D. thesis was on nitrogen leaching losses from grazed pasture systems.

4. I previously worked as a scientist for AgResearch in the areas of farm systems, farm system modelling, precision agriculture and nutrient leaching loss. Prior to this I worked at Lincoln University as a research technician in the soil science department.

5. While at AgResearch I was a member of an internal expert OVERSEER user group. Specific areas of scientific research experience include:

    a. Nitrogen leaching losses from grazed pastures.
    b. Use of models to determine nitrogen leaching and greenhouse gas emissions from farm systems.
    c. Experimental design and data analysis.
    d. Systematic experimental design of farm system modelling studies.
    e. Pasture sensors, precision spatial management of grazed pastures.

6. Having grown up and worked on Canterbury farms in a range of industries, I am familiar with the practical realities of agriculture and am able to put scientific principles in context. In this case, my evidence focuses on the on-farm implications and difficulties of using OVERSEER to derive and monitor compliance with individual property based nitrogen discharge limits.

7. I am a member of the NZ Society of Soil Science and the International Society of Precision Agriculture.

Scope of evidence

8. My evidence covers the following matters:

    a. Practicality of generating nitrogen loss values on real farms using Overseer
    b. Natural year-to-year variability in farm systems and difficulty in modelling these
    c. Estimated Nitrogen leaching losses from two "real" farms
    d. Implications for farmers of the current approach to using OVERSEER to derive "baseline" nitrogen leaching loss
    e. The need to provide for flexibility in the plan to account for variation and complexity in farm systems and the difficulty in using OVERSEER to model this.

9. This statement of evidence does not attempt to review OVERSEER or to critique its general relevance or use as decision support software in aiding and improving on farm nutrient management. My evidence specifically relates to OVERSEER's use in setting and managing to nitrogen discharge limits with respect to how the plan was derived and how it will be implemented.

10. OVERSEER is a valuable tool for estimating nutrient losses. However it has limitations that must be carefully considered when applying it in a regulatory context.

11. It must be recognised that OVERSEER modelling is not a firm science, but rather an art which is informed by science.

12. It is a science because it is informed by scientific fact, but it is an art in that the complex system must be translated into a much simpler model, data gaps must be estimated, aspects of the farm that are not able to be directly described in the model must be substituted with alternative descriptions that the operator believes will give a similar result. When modelling a sheep and beef farm or a mixed use farm in OVERSEER there are judgement calls to be made about almost every piece of input data to enter. In most cases there is no firm, definitive true known answer, but the operator must paint the closest picture they can from the information available.

13. An OVERSEER model of a farm is like a painting of a person. A portrait that is an accurate depiction of a person can be anything from a few small lines in a caricature to a very detailed oil painting. Three different painters painting the same subject, even with the same materials, will get different results. There is no definitively "correct" answer, because the subject is a three dimensional body and can never be fully captured on paper. Yet a painting can be very useful.

14. In the same way, describing a farm in OVERSEER is an art. It is never definitively "correct", and three people modelling the same farm will get three different results. Each will probably conclude the farm leaches a different quantity of nitrogen. However any of the three models, although different, would be useful to inform farm management and decision making.

15. OVERSEER-derived nutrient leaching losses are affected by a whole host of judgement calls:

i. The level of detail the farm is modelled at. All models of a complex system are necessarily simplifications. There is no firm rule about how far to simplify the farm, it comes down to the judgement of the operator, and the information and time they have available. The implications of simplification for modelled outputs are particularly severe with crop rotations.

ii. Data availability. Trying to model a farm in the baseline years, from 2009, requires records to have been retained for six years on matters that the farmer, at the time, was never informed that they would need to retain records on. In many cases records are simply not available and data must be estimated using memories and averages.

iii. Soil types. Soils in reality are far more variable than any soil map. The soil map recommended in the OVERSEER Best Practice Data Input Standards, S-map (Landcare Research Ltd), only gives a short list of soils that may be present in that area, the precise soil type to choose out of these is still a judgement call. It may be more appropriate to use a different soil type entirely based on first-hand knowledge of the property. And as soils are infinitely variable, two different people describing the same farm will inevitably describe the soils in two different ways, neither of which is necessarily "correct".

iv. Some key aspects of farming systems are not yet described in OVERSEER explicitly, such as small seed crops, and must be substituted with something that is in the model, which is not necessarily representative. OVERSEER's feature set is and always will be limited to those features for which there has been funding to both research in the field and then build into the model, so it can never be expected to cover every eventuality. Lack of support for particular crops is not a major issue where OVERSEER is used simply to support nutrient management decisions on-farm, but becomes critical when attempting to use OVERSEER for regulatory compliance.

v. How to adjust the "real" data to a form that OVERSEER will recognise it as valid and actually run. In many cases (particularly involving fodder crops) OVERSEER will simply not recognise that the farm as accurately described is valid – particularly where forage crops are present. The operator must adjust crop yields, feeding dates, which animals feed on forage crops, and animal numbers until OVERSEER believes the farm is feasible and will calculate a result. The final farm system OVERSEER will accept may no longer represent reality, and many judgement calls must be made to ensure the final system is as close to reality as possible within the constraints of the model.

vi. How much time to spend. Any farm could be modelled for weeks to get every detail correct but ultimately the level of detail will largely be a function of time available to the modeller to assess the farm, plan how to represent it in the model, enter it into the model, and interpret the results.

16. This means that even if the calculations and science behind OVERSEER itself were inerrant, the results will still have significant uncertainty simply due to the difficulty of translating a real farm into the model.

Selection of case study properties

17. I was contracted by beef+lamb New Zealand to determine the estimated nitrogen leaching losses over the four baseline years (2009/10, 10/11, 11/12 and 12/13) on two farms.

18. The farms were selected to represent typical land uses and locations within the catchment. They are not intended to be representative of total catchment land use.

19. The farmers chosen for this process were highly motivated, with a good understanding of nutrient losses, and comparatively good record-keeping.

Definition of 'leaching loss' as presented herein

20. All values for leaching loss in this document represent OVERSEER's estimated leaching loss. Any statement that "leaching loss was X" means "leaching loss was estimated to be X using OVERSEER version 6.2.0, standalone version, using the assumptions outlined here".

21. The true nitrogen leaching losses for these farms are unknown, and the values presented here must not be misinterpreted to be the "true" leaching loss.

22. All input data is subject to revision, as is the OVERSEER model itself, so the values presented here may differ from any values submitted by the farmers for compliance purposes.

Modelled case study farms

23. To model the farms, I:
    a. Informed each farmer of the data needed for OVERSEER modelling of the four baseline years, for them to prepare.
    b. Visited each farmer in person, interviewing them for several hours to obtain the information needed.
    c. Personally viewed each property.
    d. Obtained soil descriptions from S-map (Landcare Research) and aligned with actual soils on the property based on farmer descriptions of soil types.
    e. Translated the available information into a form suitable for entry into Overseer.
    f. Entered the information into OVERSEER 6.2.0 in accordance with the latest version of the OVERSEER Best Practice Data Input Standards. For one farm I was provided with an existing OVERSEER model, which I reviewed then adapted. Where data was unknown OVERSEER default values were used.
    g. Consulted with farmers to clarify any issues that arose.

Farm A Mixed cropping farm, Northern Streams Area

Farm description

24. 532 hectares, flat to moderate hill. 65 hectares irrigated, with consent to irrigate the entire property (irrigation equipment yet to be installed). Arable cropping on flat and rolling country including wheat, barley, ryegrass seed, kale, and a range of specialist small seed crops such as brassica seed, with the balance of crops changing from year to year depending on market demand. Also sheep breeding (approximately 1000 ewes) and dairy grazing (approximately 150 heifers and 100 wintered dairy cows).

25. Modelled during four baseline years (2009/10 to 2012/13), and in 2013/14.

26. During this period the farm underwent several changes that influence Nitrogen leaching losses:
    i. Irrigation was installed in 2011, so two of the baseline years are unirrigated and two include irrigation.
    ii. Gradual move from full cultivation towards minimum tillage and direct drilling wherever appropriate.
    iii. Gradual increase in the variety of crops grown over time.
    iv. Gradual reduction in sheep numbers and a corresponding increase in grazed dairy cattle numbers.

Baseline N loss – simple view

27. Total farm N leaching losses over time:

	2009/10	2010/11	2011/12	2012/13	2013/14
kgN/ha	7	7	18	18	15

    i. The increase in loss in 2011/12 is due to installation of irrigation. The reduction in 2013/14 is due primarily to a different balance of crops in that year.

28. The baseline average modelled nutrient leaching loss (2009/10 – 2012/13) is 12.5 kgN/ha. At current management (2012/14) the farm is already in excess of the baseline, simply because the baseline years are averaged over before and after irrigation was installed.

Changes in N loss within current management

29. Across the farm, modelled nutrient losses varied greatly in different blocks:
    i. Pasture leached 4 – 50 kgN/ha depending on soil types and irrigation.
    ii. Wheat alone leached 3 - 22 kgN/ha in different blocks purely depending on which crops were preceding and following the wheat crop and on the wheat yield. The previous crop affects the quantity of N present in the soil and in crop residues and potentially available to be lost. The next crop affects whether the paddock is left fallow or under a cover crop in the autumn after the wheat is harvested, and what cultivation and fertiliser is used to establish that crop, affecting autumn leaching losses. Yield affects how much nitrogen is removed in grain and not available to be leached.

iii. Wheat leached from 3 – 91 kgN/ha when soil and irrigation differences are also considered. All other arable crops were also highly variable, and fell within that range

iv. Kale leached from 9 – 208 kgN/ha depending on yield, grazing species, soil type and irrigation.

30. This level of variation between crops, and the fact that the balance of crops changes from year to year depending on the markets, means that while following the exact same management system that was used during the baseline period (growing crops for market demand), in any future year leaching can be substantially higher or lower than in the baseline period, due purely to the balance of crops desired by the market, the weather in that year and the particular crop rotation on any particular soil type.

31. The fact that leaching loss varies within a particular crop type makes it very difficult to maintain compliance with regulation without heavy use of OVERSEER for forward planning. It is not possible for a farmer to use a simple rule of thumb, such as "barley leaches X kgN/ha so I must have no more than Y hectares of barley to stay under my discharge limit". Rather, the leaching loss from barley will differ depending on what crop was before or after it in the rotation and the final yield, so any future plan must be explicitly modelled in OVERSEER to determine the likely effect on OVERSEER-derived nutrient leaching estimates. This may not be possible however as the yield will be unknown until the crop is harvested, and the following crop is also unknown as that would be decided at a later date based on market conditions at the time. Even if this information were known, doing this modelling would place a major additional burden on farm decision making, particularly as a professional consultant would generally need to be engaged to use OVERSEER.

32. Leaching loss from this property, when managed in the same way that it was during the baseline period, can also increase above the baseline value by factors outside the control of the farmer. Examples of these are as follows:

i. **Wet autumns**

Most crops on this farm are sown in autumn, in order to obtain higher yields than if they were sown in spring, and to reduce erosion. This also means the crop can act as a cover crop over the winter period and reduce N leaching losses. But this is entirely dependent on weather conditions in the autumn. When the soil is too wet, crops cannot be sown in autumn, and must be sown in spring. When this occurs, nutrient loss is increased due to lack of a cover crop, and also because the crop yield is reduced (it has less time to grow before harvest) so less nutrients are removed in the crop.

To illustrate the effect of this on modelled N outputs, the farm was re-modelled assuming that the 2012 autumn had been too wet for any crops to be sown, and all crops had to be sown in spring. This affected both the 2011/12 year (no cover crops that autumn, but also fewer cultivation events) and the 2012/13 year (no cover crops in early spring, reduced yields, more cultivation events moved to this year).

Using these modelling scenarios, total N loss in 2011/12 did not change, as the increase in loss from no cover crops was balanced by the reduction in loss from less cultivation. Total N loss in 2012/13 increased by 3 kgN/ha.

kgN/ha	2011/12	2012/13
Autumn sown	18	18
Spring sown	18	21

This occurs occasionally to a greater or lesser extent, and the influence of the weather on decision making is entirely out of the control of the farmer.

ii. **Crop failure**

Inevitably some crops will fail on any property at any one time, for a wide range of reasons: hail, drought, disease, misadventure, or even markets – if the price is too low to justify harvesting so the crop is grazed or ploughed in. Whenever a crop fails, the farmer has still applied fertiliser as usual anticipating a crop, but little or no nutrients are removed in the products, leaving more nutrients available to be lost to water.

OVERSEER can simulate a crop failure by reducing crop yield to the minimum value allowed in the model (0.1 t/ha). The 2012/13 year was re-modelled assuming every single arable crop failed.

Crop failure caused nutrient loss to increase from 18 to 33 kgN/ha.

It would be unlikely for every crop to fail in a single year, however it is entirely reasonable to assume that a number of crops will fail simultaneously in some years (e.g. from hail or drought). Any such failure will increase nutrient loss above the baseline values cited above – but actually still represents "management at baseline", because everything the farmer has done is exactly the same as during the baseline period. The higher nutrient loss was unplanned and largely unavoidable.

Irrigation consent

33. This property currently has resource consent to irrigate the entire property, but has to date only irrigated part of the area because the irrigation system is still under development. As I understand it, the general principle Environment Canterbury has followed regarding large-scale irrigation schemes that were consented but not fully developed before the LWRP is to allow for additional leaching as if the scheme were already fully operational, as to not allow for this leaching would be to effectively remove the original consent. I would assume that a similar allowance would be provided for smaller-scale irrigation consents such as for this farm, to ensure the consent remains able to be implemented.

34. The farm was modelled as in the 2012/13 year, under full irrigation.

    i. The same irrigation system as is currently used (travelling irrigators) was used on all flat to rolling land, with a pod system used on the hills.
    ii. Livestock numbers were increased, but the current arable crops were retained for simplicity (in reality they would be also varied to take advantage of irrigation).
    iii. To offset the increase in leaching loss, a more efficient irrigation scheduling system was assumed. At present irrigation is scheduled using visual observation, it was assumed a formal soil moisture monitoring and scheduling system would be installed.

35. Modelled Nitrogen loss increased from 18 kgN/ha with 65 hectares irrigated under current management, to 23 kgN/ha with 502 hectares irrigated using soil moisture monitoring for irrigation scheduling.

Modelling methods – impact of input data and methods

Soil types

36. This property was divided into four blocks of different topography and soil type for the above modelling.

37. The preferred method of obtaining soil type data for most farms is S-map (Landcare Research Ltd). S-Map suggests a number of different soil types for each area on the property, and as the soils are variable a legitimate argument could be made for using different soil types. Most modelling was carried out assuming the dominant soil type in S-Map for the area. However a reasonable alternative soil type was also identified for each block from S-Map, as follows:
    i. Flat, poor soil (Dominant: Eyre Sib 3, Alternative: Eyre Sib 23)
    ii. Flat, good soil (Dominant: Templeton Sib 2, Alternative: Waitohi Sib 3)
    iii. Rolling (Dominant: Timaru Sib 1, Alternative: Barrhill Sib 3)
    iv. Easy Hill (Dominant: Timaru Sib 1, Alternative: Claremont Sib 1)

38. Had the farm not been covered by S-map, the OVERSEER Best Practice Data Input Standards recommend using soil order instead, a coarser classification system. The relevant soil orders are "Pallic" for most of the farm, and "Recent" for the flat, poor soil area.

39. The farm was modelled as in the 2012/13 year using the dominant and the alternative soil types from S-Map, and using soil order. In some cases the alternative soil resulted in higher leaching losses, in other cases lower. Soil order generally resulted in an intermediate leaching loss.

40. Depending on the soils data that was used, modelled farm-average N leaching loss varied from 17 to 20 kgN/ha.

Level of detail

41. The above N leaching results were determined by modelling the property at a relatively high level of detail. Each year was modelled using 15 – 24 separate "blocks" to account for different crops, soils and irrigation. For arable crops, the crops preceding and following each crop were varied to fit with the standard farm rotation.

42. The level of detail to be used is purely a judgement call on behalf of the person doing the modelling. The 2013/14 year was originally modelled as 23 blocks. While keeping the soil and irrigation zones separate, the description of the cropping rotation was simplified to represent the property in the 2012/13 year using 14 more generalised blocks instead.

43. Both the detailed and simplified models are accurate descriptions of the same farming system but to different levels of precision. Modelled N leaching loss from the simplified model was 14 kgN/Ha, in comparison to 18kg/Ha using a more fine grained approach.

44. It is estimated that to collect the data from the farmer and model this farm in a single year in a simplified fashion (resulting in the 14 kgN/ha value above) would take approximately 12 hours work, plus time for the farmer to collate the required data. Alternatively, to collect data and model in a more detailed fashion in all baseline years (resulting in all baseline values presented above) would take approximately 24 hours of work, given the complex nature of the cropping rotation.

45. It would also be possible to model this farm in much greater detail, the models used for this report still include many generalisations to make the cropping regime more manageable to enter into OVERSEER. It is generally impossible to fully capture any complex farm in OVERSEER purely for time and data availability reasons.

Seed crops

46. OVERSEER does not specifically provide for modelling nutrient losses from some crops that are grown on this farm and many others in this region, particularly small seeds. Many of the crops grown on this farm are small seeds – brassica seed, oilseed rape, carrot seed, beet seed, borage seed, plantain seed, and radish seed. As none of these crops are supported in OVERSEER, all must be simulated using the most similar crop.

47. Two small seed crops are available in OVERSEER – ryegrass and clover. Neither represents these other small seed crops well, because both grow substantially more vegetation which is generally grazed by livestock as part of the process of growing the crop. Clover is also unsuitable because it fixes atmospheric nitrogen, which these other crops do not do. Despite this limitation, all the above small seeds were simulated using ryegrass seed crops in the above models.

48. It is also possible to simulate small seeds using other crops in OVERSEER, such as barley and peas. These crops naturally grow much greater quantities of seed than the small seed crops do so are also not ideal for different reasons, and peas fix some atmospheric nitrogen also.

49. The OVERSEER Best Practice Data Input Standards offer no guidance on this issue.

50. A brassica seed crop was simulated using ryegrass, barley, or dried pea crops, with a 1.5 t/ha seed yield, and the residual herbage from each being either "grazed", "retained", "removed" or "burnt". Predicted Nitrogen loss from each of those scenarios was as follows:

kgN/ha	Grazed	Retained	Removed	Burnt
Ryegrass	15	5	5	5
Barley	35	34	34	34
Peas (dried)	34	34	32	32

51. Depending on how a small seed crop is modelled, nitrogen loss can vary as much as seven-fold, from 5 – 35 kgN/ha in this example. It is very difficult to say what value would be a "correct" prediction of actual loss.

52. The ryegrass crop with residual herbage grazed, as used in the modelling for this report, has an N loss value in the middle of the range. But this is disputable and could legitimately be modelled differently.

53. Depending on the area in small seeds in any one year, the modeller's judgement on how to model these crops can have a large effect on modelled whole-farm leaching losses.

Summary of farm

54. Baseline leaching losses are complicated by the introduction of irrigation part-way through the baseline period. They are further complicated by the uncertainty over whether the farm can be modelled as if the consented irrigation system were fully operational or not. Treatment of irrigation could result in a baseline leaching loss of:
    i. 12.5 (raw mean of baseline years)
    ii. 18 (mean of baseline years post-irrigation), or
    iii. 23 (expected N loss with full irrigation and efficient irrigation scheduling)

55. Leaching loss varies from year to year for many reasons. If the farm is managed as it were in the baseline period into the future, it is inevitable that leaching loss in some years will exceed the baseline due to many factors, including factors outside the control of the farmer.

56. None of this modelling can determine the actual leaching loss from the property. There are too many judgement calls that have to be made, the actual loss could be below or above what is quoted here, even assuming OVERSEER itself is inerrant. Another modeller would get a different result. OVERSEER is a very valuable tool, and paints a picture of a farm that can be valuable to guide management decisions, however the uncertainties inherent in using OVERSEER have obvious implications for use in a regulatory setting.

Farm B is a *Sheep & Beef breeding farm, Waihao Wainono Area*

Farm description

57. 805 hectare rolling to hill country sheep breeding farm, with cattle breeding also. Most winter feed is from forage crops (turnips, kale and rape), with silage and hay harvested for use in snows and drought.

58. Simpler than the first farm as there is no arable cropping or irrigation, and there were no major changes in management over the baseline period.

59. A previous OVERSEER file of the farm was available (from Beef + Lamb New Zealand), which was used as one source of data to inform this modelling work, and used to compare the results obtained by two different OVERSEER operators.

Baseline N loss – simplistic view

60. Total farm N leaching losses over time:

	2009/10	2010/11	2011/12	2012/13	2013/14
kgN/ha	12	11	11	11	10

61. The gradual decrease in loss over time is primarily due to differences in the area of fodder crops sown in each year.

62. The baseline average nutrient leaching loss (2009/10 – 2012/13) is 11.1 kgN/ha. At current management (2013/14) the farm is just under the baseline.

Alternative judgement calls when modelling

63. The values above do not represent the actual nutrient leaching losses, but only the nutrient loss if modelled one way. As for Farm 1, many judgement calls had to be made in order to derive the above leaching values. Some have a major effect on N loss.

Soil type

64. Soils were defined in three different ways for the 2012/13 year:

   a. As in the B+LNZ nutrient budget. Soils were defined using soil order.
   b. By the author, using soil order and some additional modifications to the soil profile based on a farm visit and discussion with the farmer.
   c. Using dominant soil types for each area of the farm from S-Map.

65. Nutrient leaching losses calculated using each set of soil definitions were:

2012/13	B+LNZ soils	Author's soils	S-Map
kgN/ha	8	14	11

66. Without a detailed, professional farm specific soil survey, there is no way of knowing which of these sets of soil definitions, if any, are the most correct way to represent the farm in OVERSEER. S-Map claims the western end of the farm has heavier soils than the eastern end, which appears incorrect as it conflicts with both the farmer and the author's observations. However the soil descriptions by both the author and B+LNZ modeller are far less detailed than S-Map and also based on limited observations.

67. For the purposes of this report, the S-map soils have been used for all modelling, simply because they gave an intermediate N leaching loss value, not because there is any reason to believe they are more accurate than the other options.

Simplified crop modelling

68. Forage crops can be defined in two separate ways in OVERSEER – as "arable crop blocks" or as "fodder crop blocks".

69. Arable crop blocks allow more detailed information to be entered, but are more complex to use. They must be fully defined as a separate farm block (including soil types etc), and require detailed information to be entered on crops, fertilisers and grazing for two years, the previous year and the year being assessed.

70. Fodder crop blocks are simpler to use as they require only information on a single crop to be entered and assume this crop is sown on an existing pasture block. However they assume every crop is cultivated out of pasture and re-sown back into pasture, and there can only be one crop in the rotation, which is limiting and does not necessarily represent the true crop rotation.

71. For the 2012/13 year, crops were defined using either "arable crop blocks" or "forage crop blocks".
    i. Arable crop blocks: 11 kgN/ha average farm leaching loss
    ii. Forage crop blocks: 8 kgN/ha average farm leaching loss

72. In this case the arable crop blocks are likely to be a more accurate representation than the forage crop blocks, because the crop rotation generally includes more than one crop. However if no information were available to define the crop rotation used in the baseline years, a model user would be likely to define these crops using the "forage crop block" option, which would be in accordance with the OVERSEER Best Practice Data Input Standards as the fodder crop area is less than 25 percent of the block the crop rotates through. In this case the level of information and time available for modelling can have a large effect on predicted farm nutrient loss.

73. These results are surprising. In previous OVERSEER versions the author has noted that forage crops modelled using "forage crop blocks" have consistently higher leaching losses to the same crop modelled as an "arable crop block". It appears that with the latest model this has been reversed, and now "forage crop blocks" are giving lower leaching losses. There were rational reasons for a "forage crop block" to give higher losses to an "arable crop block", but lower losses are surprising and unjustifiable in the author's view. This means that this is likely to be changed again in a future model update. This does illustrate another difficulty of using OVERSEER for compliance purposes, as the calculated N leaching losses can change without warning with model updates.

74. Unfortunately previous OVERSEER versions are unavailable so this observation cannot actually be confirmed. The unavailability of previous OVERSEER versions means the model has very little transparency and it is impossible to replicate past work. For instance, if an OVERSEER-derived nutrient leaching value is ever challenged by the council or in court, it may be impossible to replicate the original modelling work because the version used is no longer available. The author has actually assisted users in the past to run old versions of OVERSEER 5 to replicate past work that had been challenged, this would be impossible with OVERSEER 6 without working directly with the OVERSEER owners. This severely limits the usefulness of OVERSEER for both research and regulatory uses.

Other factors

75. Many other judgement calls had to be made, that did not have as large an effect on modelled nutrient losses on this particular property, but would affect nutrient losses from others.

76. The type of pasture can be defined as "ryegrass / white clover", "browntop" or "unimproved". Each has a different nitrogen content and quality, so will affect nutrient leaching losses. Although farmers sow "ryegrass / white clover" or similar pasture mixes, these often revert back towards native grasses, making it difficult to know how to classify the average pasture on a block. In this case, defining pasture on the main pasture areas as "browntop" rather than "ryegrass / white clover" increased the nutrient leaching from that pasture area from 7 to 8 kg DM/ha, however did not substantially alter the total farm nutrient leaching loss due to the quantity of forage crops and other pasture also contributing to modelled leaching. On a farm with fewer forage crops this would have a greater effect.

77. Livestock numbers through the year were not available in the data presented to the author, only numbers at the start and end of the year and total numbers of lambs and calves born. It would have been possible to determine monthly numbers precisely by trawling through every single livestock sale or purchase transaction recorded in the farm accounting data, but this would be extremely time consuming and is not generally worthwhile in terms of return on time invested. Instead, in line with how most modelling would be conducted, the monthly numbers had to be estimated, which was done in two different ways:
    i. The author's best judgement, entered in detail for every stock class.
    ii. Converting the stock numbers into approximate "relative stock unit" values for total sheep and cattle, and allowing OVERSEER to use a default pattern of monthly livestock numbers. This is a highly simplistic option that is not recommended in the OVERSEER Best Practice Data Input Standards, but is available for use when monthly stock numbers are not available.
    iii. The input and mix of livestock classes and numbers in any one month made no substantial difference to leaching losses, because this is a breeding farm that has similar management to OVERSEER's default assumptions (this is also why it is not generally worthwhile to use accounting data on stock sales and purchases for a farm such as this). This would make more of a difference on a property with large numbers of trading or dairy grazing livestock or different patterns to those assumed within the default pattern.

78. A periodically wet area, growing rushes, is present on the property. It is difficult to know whether to call it a "wetland" or not. This is a question that arises on many farms. If the area were to be called a wetland, it is difficult to know how to define it in the model, as several different descriptions could reasonably be applied to it, and the description makes a large difference to the amount of N extracted by the wetland. In this case, because the area and its catchment are small, classifying it as a wetland using any reasonable description made no substantial difference to leaching losses. However had the wet area been larger this would have likely affected predicted N loss.

79. Data was available on what livestock would be expected to graze each type of forage crop as a general rule, but not a detailed account of what livestock actually did graze each crop. The type of livestock grazing crops may affect nutrient leaching loss because different animals have different urine characteristics. However in this particular case changing which crops were fed to which livestock did not substantially alter N loss.

Farm summary

80. This farm is simpler than farm 1, so fewer decisions need to be made when modelling it. Some of the decisions that had to be made however can have a large effect on nutrient leaching loss. Simply using different soil types could result in losses ranging from 8 to 14 kgN/ha – an almost two-fold difference. Defining crop blocks differently could alter N loss from 8 to 11 kgN/ha – an almost 50% difference.

81. Many other judgement calls had to be made that had a smaller impact on nutrient leaching loss.

82. This farm happens to be under stable management at present so modelled losses do not vary greatly from year to year, and recent losses appear to be below the average of the baseline years. However recent management may not reflect long-term management

Long-term management implications for the use of OVERSEER as a means of compliance with discharge limits

83. Farm 1 is in the process of being handed over from an older generation, who still manage the livestock operation, to a younger generation, who have responsibility for the arable cropping. As a result, over the baseline period, the arable cropping intensified, irrigation was installed, while livestock numbers gradually declined. Farm 1 is intensifying because that is the stage of life the owners are at.

84. Farm 2 has been managed by the same owner for many years, has reached a stable management system, and is very gradually declining in intensity and N loss. It is reaching a relatively low level of potential N loss for this property, as the current owner can afford to manage it this way. When the next generation inevitably takes over management they will undoubtedly need to intensify again in order to provide for the greater financial needs of their younger family and increased debt levels. There is a risk that if Farm 2 were capped at current levels of N loss it may be not financially viable for a new generation to take on the property, with potentially far-reaching economic and social consequences.

85. It is my opinion that OVERSEER modelled outputs should not be used to determine compliance with fixed discharge limits. It is my view that the outputs simply tell a story, and must be considered within a long-term context of farm management and systems. Defining "Baseline management" using only four years gives only a very brief snapshot and does not necessarily represent the actual long-term management of the property.

"Baseline" will actually force farmers to reduce loss to comply

86. Estimated leaching losses do vary from year to year, particularly on mixed cropping farms, and in these cases they did vary over the baseline period (noting the limitations on the accuracy of these values as described above). If a farm is run

exactly as it was during the baseline period, it will theoretically exceed the baseline nutrient leaching losses every second year.

87. To stay below the baseline, a farmer will have to reduce average leaching losses. Farm 1 for example leached 7 - 18 kgN/ha in the four baseline years, and as explained previously in any particular year loss could fluctuate substantially higher due to factors outside the control of the farmer. Such fluctuations will always occur and cannot be eliminated. So, if required to stay below the mean of the baseline years, even if that is taken as the mean of only the last two years when irrigation was used (18 kgN/ha), this farm would have to reduce leaching losses to ensure that years of peak loss do not exceed 18.

88. A four-year rolling average does not in itself provide for this variation, as will be shown below.

Demonstration using simulated farms

89. To illustrate the difficulty of managing and modelling at a determined baseline I also simulated theoretical farms that are maintained at the same farming practices as in the baseline years, but with year-to-year variation in N loss. I generated random N leaching values between 12 and 15 kgN/ha for 2000 modelled farms over 100 years, calculated the baseline (being the average of the first four years), and the rolling averages for all subsequent years. This simulation was run in the statistical software R, using normally distributed randomised N leaching values.

    a. In any individual year, the leaching loss exceeded the baseline 49 – 51% of the time.

    b. In any set of four years (i.e. when using a rolling average), the average leaching loss also exceeded the baseline 49 – 51% of the time.

    c. The only difference was that the individual year differed from the baseline by 0.8 kg N/ha on average, while the rolling average differed by 0.5 kg N/ha on average.

    d. The rolling average reduces the amount the baseline is exceeded by, but doesn't change the fundamental problem that the farm will still breach their baseline leaching losses 50% of the time, even without intensifying the system at all.

    e. However if the maximum year in the first four years was taken as the baseline, rather than the mean, the farms only exceeded this 19% of the time on an individual year basis, or 9% as a rolling four year average.

90. I then determined how much these farmers would have had to reduce their leaching loss in order to comply with their baseline leaching caps.

    a. If the baseline is the mean of the four baseline years, they would have to reduce average loss by 1.5 kgN/ha, or 10%, to not exceed it in any one year. If assessed on a 4 year rolling average basis they would have to reduce mean loss by 1.0 kgN/ha, or 7%.

b. If instead the baseline is the maximum of the four baseline years, they would have to reduce average loss by 0.6 kgN/ha, or 4%, to not exceed it in any one year. If assessed on a 4 year rolling average basis they would have to reduce mean loss by 0.1 kgN/ha, or 0.5%.

91. Capping the baseline at the mean of the 4 baseline years would in practice require all farmers to reduce average leaching losses by possibly up to 10%, depending on how this is assessed and the level of year-to-year variability in their particular farming system.

92. Only capping losses at the maximum year in the baseline period and assessing this on a rolling average basis would allow farmers to continue with current management, with negligible requirement to reduce losses.

Providing for operating flexibility to account for model estimates and farm management

93. It is not realistic to expect all farms to reduce leaching losses. Low leaching loss farms may already be doing all reasonable practices that minimise loss, and may have little ability to reduce loss further. It is essential that year-to-year variability in loss is allowed for to ensure low loss farms can at least continue to operate within current management practice.

94. In addition, the modelled leaching loss for a farm is likely to change with the release of new versions of OVERSEER as it has with past updates, and the plan needs to allow for this. Updates to OVERSEER do not change the actual loss from the farming system, just improve our understanding of this loss.

95. As described above, the baseline could be calculated as the maximum rather than the mean of the four baseline years.

96. It is important to note that changing the baseline to the maximum rather than the mean would not increase losses, so does not affect current modelling of catchment loads. This change in calculation method would simply allow farmers to maintain current farming practices, to allow farmers to operate at baseline leaching losses.

   a. The mean of the baseline years is a valuable figure to calculate catchment loads. However if used as a regulatory tool it could have the unintended consequence of requiring all farmers to reduce N loss irrespective of their current practice or their practical ability to do so.

   b. The maximum of the baseline years is more appropriate to use on an individual farm basis to define nitrogen loss limits.

   c. Both values are complementary; they just need to be used in the correct context.

97. In my opinion using the maximum number to calculate the baseline on a rolling four year average is the minimum flexibility the plan should provide for in terms of the changes in modelled outputs by Overseer. However this will still result in challenges

in managing to limits for those farmers with relatively lower estimated N losses.

98. This will also only work for farms where enough data is available to model the baseline years in enough detail to get an accurate assessment of year-to-year variation. Where the baseline years are modelled in a more generalised fashion (due to data non-availability, time constraints, or operator error) some variation may not be captured, and the maximum loss from that modelling exercise may not give sufficient flexibility for long-term management.

99. Providing for flexibility up to a limit also overcomes some of the current limitations in managing to baseline numbers:

    a. For some farms, the baseline years are not representative of long-term financially viable management.

    b. For farms of particularly low N loss, it is debatable whether the high cost of compliance with the regulation would deliver meaningful results for the catchment.

Proposed flexibility caps

100. The current proposed "flexibility caps" given in Table 15 (m) of the proposed variation 3 are too low to offer these farms any flexibility at all.
    a. Farm 1 is primarily rolling topography, so it is unclear whether it falls into the Northern Streams "Plains" or "Hill" category. The flexibility cap is 15-17 for Plains and 5 for Hill. This farm was already leaching 18 kgN/ha during the baseline period, so regardless of how it is categorised it is in excess of the cap, and possibly over three times the flexibility cap.
    b. Farm 2 is in the "Waihao – Wainono Hill" region, with a flexibility cap of 5. Regardless of the soil type used, Farm 2 is well in excess of this value, leaching 8 – 14 kgN/ha according to Overseer.

101. It is important to note that Farm 2 is a low intensity farm that would be expected to have relatively low nutrient losses. If Farm 2 is well above the flexibility cap it is reasonable to assume that the vast majority of other farms in this region will also be over this cap.

102. Flexibility caps are an excellent concept, but the proposed values have been set far too low to be useful, as it is likely that they will apply to very few farms. This is because of many critical flaws in how they have been calculated. The Overseer models used to define the flexibility caps, as provided by ECan in the online FAQ on variation 3, are overly simplistic and do not reflect real-world farming systems.

    a. Most critically, the "Dryland beef", "Irrigated sheep" and "Sheep/Beef" models are pasture-only, with no forage crops. Although some farms do run pasture-only systems, this is not normal, and not at all representative of an "average" farm. The losses from the pasture areas of Farm 2 in this report are comparable to those derived from the models used for the baseline, but the total farm loss is considerably higher because of the use of forage crops – which is a very normal practice.

b. Furthermore, the Overseer models behind the flexibility caps also have livestock numbers defined using RSU rather than monthly numbers (which is not recommended in the OVERSEER Best Practice Data Input Standards as discussed above, but can be useful sometimes). In effect, this means that every model is assuming the farm is a breeding operation. No model simulates a lamb or beef finishing, dairy heifer, or dairy cow wintering block (except where dairy cows are wintered on a milking platform). This again makes the models completely unrepresentative of many farming systems, and biases the nutrient loss downwards by completely ignoring the large numbers of additional cows and heifers that are routinely wintered on sheep & beef and arable farms throughout the region.

c. The soils used in these Overseer models are simply defined using "soil series", without any further modification to the soil profile description to define whether they are stony, have impeded rooting depths, artificial drainage, or any other such feature. On a real farm most soil profiles will be defined more precisely than this, and most such soil profile adjustments will increase nutrient leaching loss (few adjustments allowed in the model may decrease loss, most will increase it, due to the way the data input screens are set up). This means that the current way soil types are defined in these models minimises nutrient loss below that which would be expected on a real farm, even a real farm with the same soil type as used in the model.

d. The pastures in these Overseer models are all defined as "ryegrass / white clover", the pasture option that in practice has the lowest nutrient leaching losses. On real farms it will generally be more realistic to define at least some pastures as "browntop" or "unimproved", which will again increase leaching loss.

e. No supplements are used on these Overseer models. This is unrealistic. Supplements again tend to increase nutrient loss.

f. Very low levels of nitrogen fertiliser are used on these Overseer models, which are not at all realistic. Some dairy models receive no nitrogen at all (which looks like an error). Otherwise irrigated dairy receives 150 kgN/ha, irrigated sheep 30 kgN/ha, dryland sheep & beef 15 kgN/ha, all of which look on the low side of normal (in my opinion). Furthermore all nitrogen on sheep & beef farms, and most on dairy farms, is applied in spring. No or minimal N is applied in autumn, when it is more likely to contribute to nutrient loss. This again is not realistic.

103. The Overseer models behind the flexibility caps are therefore completely unsuitable and need to be, at the very least reviewed, to ensure they are actually representative of real-world farming systems.

104. I would recommend that the flexibility caps be based on a pool of models of real farms rather than a set of hypothetical, simplified systems. Real farms are always more complex than hypothetical systems, and complexity tends to increase nutrient leaching losses.

105. It must also be noted that, as currently worded, flexibility caps apply to "farms" but do not apply to "farming enterprises" (compare 15.5.2(1) and 15.5.6(3)). Farming enterprises by definition are "an aggregation of land parcels held in single or multiple ownership that constitute a single operating unit, to address farming businesses that involve multiple leases or encompass a number of properties", which is broad wording that may apply to any farm that encompasses multiple separate properties, which would apply to a large proportion of farming operations, including Farm 1. Even if the flexibility caps were set to a useful number, the treatment of "farming enterprises" would need to be altered in order for flexibility caps to actually be applicable to many farms within a farming enterprise.

Tabled at Hearing on 17 November 2015

17 November 2015

TO:

Canterbury Regional Council

ON:

Plan Change 3, Canterbury Land and Water Regional Plan

BY:

Beef + Lamb New Zealand Ltd

Hearing statement

1. My name is Matt Harcombe. I am the Environment Programme Manager for Beef + Lamb New Zealand.

2. B+LNZ is an industry-good body funded under the Commodity Levies Act through a levy paid by producers on all cattle and sheep slaughtered in New Zealand. Its mission is to deliver innovative tools and services to support informed decision making and continuous improvement in market access, product positioning and farming systems.

3. B+LNZ have developed an approved Farm Environment Plan template for use within the Canterbury planning framework and in implementing the plan. B+LNZ is committed to supporting farmers in their adoption of the FEP and most importantly implementation of the actions that may result from that FEP, to manage and reduce the loss of contaminants from their farm systems.

4. In addition B+LNZ developed, supports, promotes and invests in the adoption by farmers of Land and Environment Plans (LEP). The LEP programme is entirely voluntary. It is delivered through a series of facilitated workshops, where farmers are assisted to identify environmental risk on their individual properties and to put in place a set of agreed actions to manage this risk. These actions are prioritised and given a budget allocation from year to year. The identification of these risks and agreed actions is undertaken in a whole farm systems approach to managing the effect of the operation on the environment and optimal resource use, by matching appropriate land use to different areas of the farm while achieving production and development goals for the property.

5. B+LNZ considers that farmer led, farm specific and industry supported initiatives and actions are the most effective method to achieve practice change that results in long term sustainable management of natural resources.

6. B+LNZ made a submission on plan change 3.

Sheep and Beef farming in Waimate District

7. The following is a summary of data from Beef+Lamb New Zealand's Economic Service that collects annual data from just over 500 farms throughout the country. It has been included in our hearing statement to help paint a picture of sheep and beef farming in the zone but the data relates only to the Waimate District territorial boundaries.

8. There were 180 commercial sheep and beef farms in Waimate district in 2013-14

9. The Waimate district accounts for about 9% of the total stock units and 9% of grazable/land area of Canterbury regional council.

10. In the last 10 years, the number of sheep nearly halved (-44%) to just under 400,000, primarily as a result of the conversion of that land to dairy farming. The number of dairy cattle increased (+77%). Beef cattle numbers increased slightly (+2%) over the same period of time.

11. In 2013-14, 31% of the commercial sheep and beef farms in Waimate own less than 1,000 stock units, primarily these are likely to represent the mixed cropping models

outlined in Dr Dennis evidence. 69% of the commercial sheep and beef farms in Waimate own at least 1,000 stock units,

12. Nearly 60% of commercial sheep and beef farms in Waimate district were class 6 Finishing and Breeding farms in 2013-14. Canterbury regional level data is used to inform data on class 6 farms in the Waimate District. Class 6 farms are South Island finishing-breeding farms. A more extensive type of finishing farm, sometimes encompassing some irrigation and frequently with some cash cropping. Carrying capacity ranges from six to 11 stock units per hectare on dryland farms and over 12 stock units per hectare on irrigated units. These farms systems are more like those of Mr Gardner's property, also modelled in the evidence of Dr Dennis.

13. On average in 2013-14, class 6 finishing and breeding farms in Canterbury owned 3,280 stock units – up 8% compared with 1990-91.

14. The stocking rate averaged 8.5 stock units per hectare in 2013-14, compared with 8.0 in 1990-91 (+6%).

15. The farm profit before tax per farm averaged $81,300 in 2013-14. But it got as low as $6,200 in 2006-07, which is the lowest level of farm profit in the last 24 years. This highlights the volatility in farm profit before tax and the importance of maintaining land use flexibility for low N emitters.

16. The gross output at the farm gate of the sheep and beef sector in Waimate district was estimated at $101million in 2013-14 and the total impact of this activity in the economy is estimated at $262million.

B+LNZ submission

17. It is important to note that B+LNZ submission was developed not because we are an industry body representing sheep and beef farmers, but in response to serious concerns from sheep and beef farmers in South Canterbury about their future. The most powerful aspects of those concerns have already been expressed to you, collectively and individually by the low emitters group. B+LNZ strongly support those submissions and worked closely with those farmers during the course of the plan change.

18. I have with me today Dr Samuel Dennis, Mr David Gardner and Mr Roger Small. B+LNZ lodged a statement of evidence from Dr Dennis, outlining some of the challenges in using Overseer. Dr Dennis will provide a summary of his evidence and I encourage you to explore with him some of the challenges in using Overseer, in setting and managing to Nitrogen Discharge Limits, particularly as they relate to sheep and beef and mixed cropping and livestock farms. Mr Gardner's farm was one of the farms that Dr Dennis modelled in Overseer as part of his evidence. You are welcome to ask additional questions of Mr Gardner that relate to Dr Dennis evidence, where his property is modelled in Overseer.

19. I would like to strongly acknowledge the degree to which the commissioners have listened and responded to the concerns of the lower emitters group and individual sheep and beef farmers represented to you in the first week of hearings. Beef + Lamb New Zealand will actively participate in the caucusing process.

20. The context and drivers for successful long term sustainable management and practice change on farms is an incredibly important consideration for you as decision makers. This hearing statement, as our submission did, focusses almost solely on the impact on sheep and beef farmers of the proposed Nitrogen allocation method. It is our submission that the proposed plan change will not incentivise long term sustainable management from sheep and beef farmers, at the very least in respect to the management and discharge of Nitrogen.

Nutrient User Groups

21. I would like to briefly touch on nutrient user groups and what value they might provide to the low emitter groups.

22. In my view there would be no incentive or no value in a farmer with lower Nitrogen losses being part of or going to the effort to form a Nutrient user group. Based on the allocation to individual farmers and what we know from modelling these farms through Overseer, there is no flexibility to be able to move nutrient losses between farms or farm enterprises because there is no spare nutrient capacity to do so. Any that is available within their allocation will be too valuable to that farmer to provide for yearly variation and for some (if any) limited continued development.

23. Further it is my understanding that Nutrient User Groups as provided for in the plan are:
    a. Not required to comply with either nutrient baseline or flexibility caps. Only required to submit a management plan outlining how losses will be managed and accounted for, and in some limited areas must comply with maximum N losses per soil type. A "nutrient user group" can be given permission to do basically anything, including increase N loss.
    b. A "discretionary" activity, but nowhere are the terms of this "discretion" defined or limited. So the decision to grant the consent may be made considering any or as few factors as the council desires.
    c. <u>So a nutrient user group can be given permission to do basically anything, for any reason.</u>

24. It is my submission that this approach is flawed. It basically allows higher N loss activities to join together, purchase farms that are capped at their low baseline and transfer N discharge to those properties. This is putting all the incentives in all the wrong places in my view.

25. While this might be perceived as providing for flexibility for a group of low emitters, there will be no flexibility for that group unless the council in granting a consent, provides additional N allocation to that group. If they applied for a consent to operate such a scheme now, there will be no additional N allocation available to them and no benefit to them of doing so.

Nitrogen Allocation, flexibility of land use and the role and use of Overseer

26. B+LNZ submission sought changes to the proposed definition of Nitrogen baseline and proposed an alternative Nitrogen allocation method. The basis of the submission was that if the plan proposed to use the allocation of Nitrogen to property level, or to impose a Nitrogen discharge limit, as a method of achieving good water quality, then the allocation method chosen should not be short term in its view of possible land use within the catchment and should allow and promote land use flexibility and

transition over an extended period of time to a state where land use within the catchment would be optimised, encouraging intensive land use activities on to soils that have the greatest productive capacity, while providing the ability to manage environmental risk.

27. Providing for flexibility in land use is not only important for sheep and beef farmers, it's important for the local community and for the economy. Locking farmers into one land use, influencing property values through N allocation and making presumptions about future land use through allocation methods will stifle farmers ability and response to what is the best use of that land to grow which product to respond to higher value markets.

28. Our submissions and the supporting evidence of Dr Dennis, are presented on the continued basis that the overall approach to allocating Nitrogen, as proposed in Plan Change 3, is fundamentally flawed.

29. For the majority of sheep and beef farmers in south Canterbury, the allocation framework is inequitable, will not be effective in achieving improved water quality directly from practice change on those farms and places significant operating constraints on land uses that already have relatively low N losses.

30. It is our submission that the plan is overly reliant on Overseer, both as a model to estimate existing N loss within the catchment and to understand compliance with it at a property level.

31. Criticising the reliance on Overseer is not a criticism of the model itself, rather the way that it is being used within the proposed plan.

I will now call on Dr Dennis to summarise his evidence and take any questions on his evidence statement before concluding our hearing statement

Conclusion

32. It is the submission of B+LNZ that the evidence presented by Dr Dennis strongly supports significant changes to the proposed allocation framework, that are strongly supported by lower emitters.

33. The proposal for an increased flexibility cap up to 15kgN/Ha for low emitters as a permitted activity and up to 20kgN/Ha as a controlled activity, would in most cases overcome some of the issues in respect to Overseer use in the plan, in the short term and provide for flexibility of operation on a year to year basis for those properties, without a significant, if any impact on managing total Nitrogen load within the catchment.

34. I would like to conclude by saying that while a proposal to allow low emitters, across the entire zone, to discharge up to 15kg as a permitted activity and up to 20kg through a resource consent process, is strongly supported, as referred to above, B + LNZ submits that this is only making the best of a flawed allocation approach, that will likely result in perverse behaviour, actions and market disturbance. It is our submission that just like the mentality of paint by numbers, stifles creativity in children, so farming by numbers will stifle creativity and innovation by sheep and beef farmers.

35. I would also like to stress that our submissions, evidence and hearing statements are not be interpreted as an avoidance of environmental responsibility by farmers, nor an ignorance of the requirement to regulate to achieve behaviour change to meet community outcomes for water quality. However we do have a fundamental disagreement with the Nitrogen allocation approach taken to get us there. ENDS

Table at Hearing on 17 November 2015

BEFORE THE	Canterbury Regional Council
IN THE MATTER OF	Plan change 3 to the Canterbury Land & Water Regional Plan

SUMMARY OF EVIDENCE OF DR SAMUEL JAMES DENNIS

On behalf of BEEF + LAMB NEW ZEALAND

Hearing date: 17 November 2015

Key points from full evidence statement:

1. Overseer modelling is an art, not a firm science. Translating a real farm into Overseer is as much a simplification as translating a person into a pen-and-ink caricature. Two newspaper cartoonists will draw two completely different caricatures of John Key – yet both will be recognisable as him. Two modellers will make two different models of the same farm, with two different N leaching results – yet both will be recognisable as accurate depictions of that farm and useful to inform management.
    a. Just as the degree to which John Key's hairline is receding may differ between caricatures by two artists, and you could never know the actual quantity of hair on his head by looking at caricatures, you can never know the true N loss from a farm by looking at Overseer models.
    b. However, just as caricatures by the same artist over time may give an informative record of whether John Key's hairline has receded or not over the course of his political career, Overseer models by the same modeller of the same farm over time or under different management options may indicate whether and in what direction N loss is likely to change when the farm is managed differently.
    c. This makes Overseer a valuable tool to inform management decisions, but not to quantify actual environmental losses.

2. Overseer does not, and will never, contain enough options to truly represent every aspect of a farm correctly. The modeller must simplify reality to squeeze it into Overseer. This involves judgement calls.
    a. Small seed crops are not available in Overseer at all, and are a major component of many arable rotations. Representing them in different approximated ways can result in a seven-fold difference in leaching loss depending on the judgement call made.
    b. Soils are highly variable and not mapped in detail on most farms, so all soil type inputs are a rough approximation, even using S-map. Representing soils differently can result in vastly different nutrient leaching losses.
    c. Arable and forage crop rotations are generally far more complex than can fairly be represented in Overseer, and unless every paddock is modelled as a separate block (which is generally impractical) all crop rotations must be simplified to be modelled. The level and method of simplification used can greatly affect leaching losses.
    d. Other judgement calls that can affect losses include pasture type, monthly livestock numbers, whether wet areas are "wetlands" or not, which livestock grazed crops and when, and forage crop yields (generally unmeasured so must be guessed).

3. The Overseer Best Practice Data Input Standards do not say how to make these decisions, just limit the possible options. Removing the judgement calls would remove Overseer's ability to represent reality, and would produce consistent yet meaningless results. Judgement calls will always be necessary.

4. The level of detail a farm is modelled at is defined by the time and money available for the modelling. When I ask farmers what they were charged for modelling (i.e. the time the consultant spent on the work) and what farm information was requested, there is a wide range. Some Overseer models produced for compliance are clearly very generic and have been produced in bulk using little real farm data (and cheaply, indicating little time was spent on them), while others are more comprehensive (more farm data and more money / time, likely more accurate). The level of detail can make a major difference to modelled leaching losses.
    a. How much detail should I model a farm at for compliance purposes? I could take four hours or 24 hours, producing farm models at completely different levels of detail. What would satisfy ECan? What can the client afford to pay for? What should I be willing to put my name to as "accurate", knowing I could keep refining it for ever and the estimate of the actual N loss will always be wrong anyway? These are serious questions for any consultant.

5. I modelled two farms for the purposes of developing my statement of evidence. Farm A had irrigation installed part-way through the baseline period, and has a consent to irrigate more area that is yet to be developed. Baseline average loss (12.5kgN/ha) is lower than loss with irrigation (18kgN/ha) as the baseline includes dryland years.
    a. Will this farm be forced to reduce loss to the baseline average (12.5 kgN/ha)? This would require severe and expensive changes.
    b. Can it use the loss during the irrigated baseline years only as the "baseline" (18 kgN/ha)? This would allow management as at present but make the consent to irrigate the rest of the property invalid.
    c. Can the consented irrigation be installed, increasing loss above baseline (23 kgN/ha), as is allowed for properties in consented irrigation schemes?

   The answer will have major practical and financial implications.

6. "Management as in the baseline years" and "baseline nutrient leaching losses" are two different things. Farm A's baseline management can be summarised as "grow whatever crops there is a market demand for, to the highest yields possible". But applying this management strategy in future years may result in completely different leaching losses. For instance:
    a. The proportion of different crops is heavily influenced by the market.
    b. Crop failure (e.g. from hail) increases leaching loss.
    c. Wet weather preventing autumn sowing and requiring spring sowing of crops increases leaching loss.
    d. Crop leaching varies greatly depending on what crop preceded or followed it, so the same crop mixture in two different years may give two different leaching losses.
    e. The same crop grown in different paddocks (in a crop rotation) may leach differently due to different soil types etc.

7. It is difficult to plan management that will keep losses below baseline, on a farm including reasonable areas of arable cropping.

a. As loss from the same crop will differ between paddocks and years, it is impossible to define simple "rules of thumb" such as "barley leaches X so have no more than Y hectares of barley to stay below baseline".
b. This means that potential management in each year must be modelled as scenarios in Overseer, in advance, to determine whether the planned management is compliant. This would add additional complexity and expense to an already complex decision-making process – and may be impossible in the timeframes available in which to make decisions.
c. But in advance it is impossible to know what contracts will be obtained for autumn-sown crops and therefore what crops will be sown in the modelled year. The weather is unknown – so sowing dates and yields are unknown. The farm cannot be accurately modelled in advance anyway.
d. In practice, the loss will be unknown until the year is complete, and the farmer finds out whether they stayed below baseline or not.

8. This year-to-year variation means that inevitably all farms, even if managed exactly as in the baseline period, would exceed the baseline nutrient leaching loss approximately every second year.
    a. The only way to stay below the baseline is to reduce average loss to below that in the baseline period, to try and ensure that years of peak loss do not exceed baseline.
    b. This means that "baseline" nutrient losses, if calculated as an average of the baseline years, do not allow a farm to continue operating as in the baseline years. They actually require all farms to reduce loss to comply.
    c. Calculating losses as rolling averages alone does not solve this issue. Only also using the maximum rather than the mean loss in the baseline period as the limit would allow farms to continue to operate as in the baseline period.
    d. But this would still unfairly limit farms that had uncharacteristically low losses during the baseline period due to their stage of development during those years.

9. Flexibility is necessary to allow low leaching loss farms to continue to operate as normal with minimal additional expenses for regulatory compliance. Flexibility also will help ensure that the attention of regulators is focussed on those farms that may actually be causing environmental problems and have the potential to reduce losses – making the regulations more likely to actually help the environment.

10. However the proposed flexibility caps are so low that almost no farms will be below them, making them unusable. This is because the Overseer models that were used to derive them are greatly simplified and completely unrepresentative of real farming systems – and not compliant with the Overseer Best Practice Data Input Standards. In particular, these models ignore:
    a. Arable and forage crops
    b. Dairy heifers, wintered dairy cows, beef and lamb finishing
    c. Supplementary feed
    d. Real-world soil descriptions (soils are exceedingly simplified)
    e. Pasture type variations
    f. Real-world N fertiliser application rates (N applications are very low)

    Real farms all include at least some of these factors, most of which increase nutrient leaching losses. Real farms will generally exceed the proposed "flexibility caps".

11. Minor correction: In my evidence, I erroneously state (point 100) that Farm 2 is in the "Waihau-Wainono Hill" area, with a flexibility cap of 5 kgN/ha, when in fact it is in the "Waihau-Wainono Plains" area, with a flexibility cap of 10 - 17 kgN/ha, and that it is unclear which region Farm 1 is in, when it is actually in the "Northern Streams Plains" area. This error arose from the confusing use of the term "plains" in the area names, when both farms are dominated by rolling to hilly topography.

12. However even with this correction, both farms baseline nutrient leaching losses exceeded their respective caps – Farm 1 exceeds the cap under all circumstances, while Farm 2 exceeds it with no augmentation but would be slightly under cap with augmentation - even though neither is particularly intensive. I can see no realistic, economically viable way to ensure either farm remains under these caps.

13. In my view the "flexibility caps" need to be completely recalculated, based on data from real farms, in close consultation with industry.

14. Farming enterprises:
    a. Technically, any farm with multiple physically separate blocks may be classed as a "farming enterprise".
    b. Flexibility caps do not apply to "farming enterprises".
    c. Many, if not most, farms have multiple physically separate blocks.
    d. Therefore many, if not most, farms may not be able to take advantage of the flexibility caps even if they are recalculated, based on current wording of the legislation.

Summary

15. Overseer does not determine actual leaching losses, just direction of change.
16. Year-to-year variation in N loss means flexibility is vital, even if farms continue to be run as they were during the baseline period.
17. Currently proposed flexibility caps are vastly inappropriate and need to be recalculated, using a completely different approach.