IN THE MATTER of the Resource Management Act 1991

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IN THE MATTER of submissions and further submissions by Rangitata Diversion Race Management Limited (**RDRML**) on proposed Variation 2 to the proposed Canterbury Land & Water Regional Plan

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STATEMENT OF EVIDENCE OF STUART JOHN FORD

Introduction

1. My name is Stuart John Ford.

2. I am a Director of The AgriBusiness Group and work as an agricultural and resource economist based in Christchurch. I have a Diploma in Agriculture and a Bachelor of Agricultural Commerce from Lincoln University and have undertaken post graduate studies in Agricultural and Resource Economics at Massey University. I am a member of the New Zealand Agriculture and Resource Economics Society and the Australian Agriculture and Resource Economics Society. I am also a member of the New Zealand Institute of Primary Industry Management.

3. I have spent over thirty years as a consultant in the primary industries, with the last fifteen years specialising in agricultural and resource economics and business analysis.

4. As part of my work I have been extensively involved in the calculation of nutrient discharges through the use of OVERSEER™ and the economic assessment of mitigation strategies that farmers can use to reduce their discharges and runoff. Some relevant pieces of work include "*The Impact of Water Related Management Changes*" which was written for the (then) Ministry of Agriculture and Forestry and "*Selwyn Te Waihora Nutrient Performance and Financial Analysis*" which was prepared for the Canterbury Regional Council (*the Council*) and Irrigation NZ.

5. I prepared evidence on behalf of Central Plains Water in the Variation 1 hearing and also calculated the appropriate load for Rangitata Diversion Race Management Limited (RDRML) to be used in the granting of its land use and discharge consent CRC121664 in 2014.

6. I have prepared a report “Derivation of the actual reductions possible to achieve water quality limits in Variation 2 of the Hinds Plan” for RDRML and this report is attached to this evidence.

7. I have prepared evidence and presented it to numerous District and Regional Council Hearings Panels as well as the District and Environment Courts, Board of Inquiries and Special Hearing Panels (the latter in relation to Conservation Orders) throughout New Zealand.

8. Although this is a Council hearing, I have read the Expert Witness Code of Conduct set out in the Environment Court’s Practice Note 2014. I have complied with the Code of Conduct in preparing this evidence and I agree to comply with it while giving oral evidence before the hearing committee. Except where I state that I am relying on the evidence of another person, this written evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

Scope of evidence

9. My evidence includes:

   9.1 An analysis of the Council's modelled current catchment load of 4,500 t N / ha / year.

   9.2 The process that I followed to calculate a more accurate current catchment load.

   9.3 The process undertaken to look at what reductions are realistic.

   9.4 The affordability of the land use scenarios in Table 13(h).

   9.5 Pushing out the achievement of 3,400 t N / ha / yr (Table 13(g)) to 2055.

9.6 A more appropriate figure for the new irrigation allowance.

9.7 Comment on Schedule 24c Nutrient Budget Preparation Protocol

10. I am familiar with proposed Variation 2 ('**V2**'), the RDRML's submission and further submissions to it, and the section 42a report.

11. I have also read:

11.1 Ashburton ZIP Addendum : Hinds Plain Area. March 2014.

11.2 Proposed Variation 2 to the Proposed Canterbury Land and Water Regional Plan Section 32 Evaluation Report. September 2014.

11.3 Hinds catchment nutrient and on-farm economic modelling Report No. R13/109.

11.4 Hinds/Hekeao Plains Technical Overview – Subregional Plan Development Process Report No. R14/79.

11.5 NZFARM analysis of Environment Canterbury's Hinds Catchment allocation options Report No. R14/81.

11.6 Economic impact assessments of the Hinds water quantity and quality limit setting process Report No. R14/82.

Executive summary

12. The total load from the catchment has already reached the expected peak of 5,600 tonnes N and is well above that calculated by the Council as 4,500 tonnes N. This is as a consequence of a more accurate estimate of current land use by climatic zone, soil type and irrigation type and a more accurate way of determining the current level of discharges than that used by the Council.

13. The N in the drainage at 10.3ppm is significantly less than the amount of nitrate concentration in shallow groundwater estimated by the Council as about 14ppm. In my opinion the difference is caused by the relatively large amount of Dryland (24%) in the Total Hinds Catchment.

14. The results of my modelling indicate that for the average farm it is not possible for them to experience either a drop in their Net Cash Position or deterioration in their equity without forcing them towards bankruptcy. Therefore if they were required to meet the reductions set out in Variation 2 it would cause, in my opinion and experience, quite major financial and social disruption in the Catchment because at least half of the farms would trend towards bankruptcy. There is no doubt in my mind that there will be some farms that can achieve the gains in N that are required in V2, and maintain viability but for at least half of the farms that I have considered, that is not possible.

15. There is also no doubt in my mind that there are a number of configurations of a new conversion dairy farm which will meet the financial requirements of an investor. In my considerable experience in the Hinds catchment, when they are modelled in Overseer, (I promote the use of Overseer as it is the best tool available) in an attempt to minimise the total leaching from the farm, such configurations invariably show that a minimum N leaching figure of approximately 39 kg N / ha is achievable. This casts doubt in my opinion on the figure calculated by ECan of 27 kg N / ha.

16. I have run a scenario which estimates the amount of reductions possible within the RDRML area. The scenario incorporates irrigation efficiency, more efficient cows, innovation and reduced use of supplementary feed. This scenario comes up with 30% reductions over the first 20 years. I estimate that the irrigation efficiency reductions are all achieved in the first ten years and then the other options come in over the second ten year period.

17. My preferred position is therefore that you reduce the amount of reductions to 30% for Dairy farms and 20% for Dairy Support which is both achievable and affordable by the farmers.

18. This would, I expect, achieve the desired concentration of 9.3ppm of N in the groundwater (when considered across the Hinds catchment) and would not cause what I believe would be undue social or economic hardship. The latter is a matter that Ms Greer discusses in her evidence at paragraphs 27 to 31.

19. However it is not possible, in my opinion, to achieve the stated aim of 3,400 tonnes of total N load within the twenty year time frame set out within V2 without causing major social and economic harm in the Catchment. Having considered this matter, and again drawing on my considerable experience in the Hinds Catchment and Canterbury, I am of the opinion that a doubling of the timeframe (to 2055) is more realistic.

An analysis of the Council's modelled catchment load of 4,500 t N / ha / year

20. My first concern about the calculation of the total catchment load being 4,500 tones N / year came about when I compared it with the total load of the two RDRML schemes in the catchment (Mayfield Hinds and Valetta) and found that the amount allocated in the RDRL consent was 4197 Tonnes.[1]

21. On examining the documents which explained the methodology used I came to the conclusion that the method of calculation of the existing load of N within the catchment seriously underestimates the total load because of two factors:

    21.1 The first is the estimation of the land use within the catchment; and

    21.2 The second is the simplified means of modelling which was carried out.

22. It is apparent from the Macfarlane Rural Business (MRB) report[2] that the estimation of land use was done by:

[1] This figure was calculated while calculating the overall RDRML load to be used in its consent by calculating the individual loads of the individual schemes Mayfield – Hinds and Valetta individually and then adding them together.

[2] Macfarlane Rural Business Ltd (2013): Hinds catchment nutrient and on-farm economic modelling.

> *"To create representative farms MRB took the whole catchment and defined what they thought all the hectares of a specific range of farms would look like lumped together as one big farm of that system and then divided back by the average MPI farm area to get the representative farm for that enterprise type.*
>
> *The representative farms that are modelled are not intended to represent any one individual farm, but are intended to represent that type of farm activity over the entire catchment."*

23. This is opposed to my preferred approach which utilises existing land use data such as AgriBase mapping and local knowledge of existing land use and can lead to significant discrepancies in the land use mix. The decision to effectively lump all of the irrigation uses into one representative model also opens the methodology up to question as to its potential accuracy in terms of representing the true extent of that land use.

24. In terms of the simplified means of modelling, I had real concerns about the accuracy of the results which flows from the adoption of the practices specified in the "Overseer Best Practice Data Input Standards – August 2014". The first is the adoption of the second recommendation in the Overseer Input Standards on which method of irrigation to adopt and secondly in entering the actual number of cows present in the herd on a monthly basis rather than estimating the peak number of cows.

25. The first choice recommendation in the Overseer Input Standards is to enter the method of irrigation used and the months only (this is referred to as "method only"). This is based on the contention that it is not possible for farmers to access at least five years actual data on irrigation use which is what is required for the second option. In the justification section the Overseer Input Standards state that:

    25.1 Irrigation in addition to rainfall drives soil drainage and thus has a critically important influence on drainage and hence nutrient leaching losses.

    25.2 The three methods of data entry representing irrigation, potentially give widely different results, particularly with respect to N leaching.

25.3 Using method only, Overseer calculates the amount of irrigation water applied based on daily water balances and replacing the estimated soil water deficit. The calculated amounts are usually considerably less than actual rates applied on a long-term basis.

26. In work done for Central Plains Water[3] on over 40 farms I found that on average choosing "method only" reduced the amount of N leaching by 35%.

27. I found out that specifying the number of cows milked on a monthly basis rather than choosing to nominate the peak number of cows milked increased the amount of N leached on average by 15%. Therefore in order to calculate the total load as accurately as possible I chose to specify the number of cows milked on a monthly basis.

28. Given the foregoing, I believe that the method adopted in the Council's report would lead the Hinds Catchment to an inaccurate estimation of the total amount of N leached because of an inaccurate estimation of the land use mix and the underestimation of the amount of N leached because of the choice of practices used in the modelling.

Methodology to calculate a more accurate current catchment load

29. In order to get a more accurate estimation of the total catchment load I needed to collect information which was as accurate as possible and was across the land use and irrigation type of the catchment. DairyNZ commissioned AquaLinc to create land use maps of the area which were able to list land use by:

29.1 Farming type

29.2 Irrigation type (Border dyke, Rotorainer / K line / Lateral / Gun, Pivot / Linear, Dryland)

29.3 Soil type (Light, Heavy , Poorly Drained)

[3] The AgriBusiness Group (2014): Explanation of the variance between The AgriBusiness Group protocol and other results. A report written for Central Plains Water.

29.4 Climatic zone (650, 750, 900 mm rainfall)

30. I decided to use this information supplied by DairyNZ for a number of reasons. The prime reason was that it was the most up to date land use data and would therefore contribute to a much higher level of accuracy in the estimates. Factors which contributed to this information in achieving this status include the fact that it was comprehensive in terms of its coverage, it was able to identify farms by their climatic zones and it was able to identify the individual irrigation types.

31. I asked AquaLinc Limited (via a request made to Mr. Peter Brown, BE, PhD, IntPE, CPEng, Senior Water Resource Engineer) to provide us separate information on the same data for the area covered by the Valetta scheme and the area covered by the Mayfield Hinds scheme. It should be noted that the data supplied by DairyNZ does not differentiate between where the properties get their water. Therefore they do not exactly represent the members of the RDRML in terms of irrigated area. The DairyNZ data for the Valetta and the Mayfield Hinds schemes records higher rates of irrigated area and total area than that gained from the Farm Environment Planning (FEP) data. Therefore the AquaLinc data has been used to calculate the overall performance of the Total Catchment but the RDRML FEP data has been used to calculate the impact on the RDRML shareholders.

32. All of the results reported in this report were calculated in Overseer Version 6.1.3. I expect that with the advent of Overseer V6.2 (which has been released with improvements to the way irrigation is calculated) that the Councils calculation of the total catchment load will increase dramatically.

33. This situation of large changes in the results of N leaching figures as a result of version changes of Overseer lead me to believe that all references to Overseer should refer to the "current" version of Overseer. In this way a problem that has occurred with Overseer in the recent past (being that when a version is superseded by a later version the old version is not available to be used) would be avoided. Should such an amendment not be made, a situation will arise whereby there is no way of referencing back to the old results when a new version of OVERSEER™ is released. Given this, a new version of the OVERSEER™ means that it is necessary to re-establishes the

Baseline for the property. If this does not occur, there will be a disconnect between the losses estimated by OVERSEER™, and the losses allowed by Variation 2. I note that changing the version of OVERSEER™ only changes the 'paper load'. In that regard, it changes the discharge of N that is estimated / modelled / projected. It does not reflect an actual increase in the amount of N that is discharged. Consequently, I can see no adverse environmental consequence of amending the reference OVERSEER™ as I am recommending.

34. In order to avoid a substantial under estimation of the amount of N leached I chose to enter an average annual amount of irrigation water applied. I then took this amount of irrigation applied from the on line tool made available by AquaLinc called "Irricalc". Irricalc is considered by many in the profession, myself included, to be the most reliable source of information on the amount of irrigation water applied in Canterbury. A table of the annual irrigation requirement used by Irricalc is in my report at P17 Table 3. I then entered these amounts into the Overseer program to represent the average irrigation requirement. I believe that the use of "Irricalc" in this way represents best practice and will ensure that the losses predicted by Overseer are as accurate as is possible.

35. Seven basic farm models were created. There were two Dairy farm models run to represent a System 3 and a System 4[4] under the DairyNZ classification. The two farms have been combined as one in the results table on a ratio that was determined from the information sourced from the RDRML farms FEP data. The data was supplied to me in Excel format by Reuben Edkins RDRML Environmental Compliance Manager. I believe that it is reliable and sufficiently accurate for the purposes which it was put to. I carried out the analysis of the data. The System 3 farms make up 78% of the total dairy farms and the System 4 farms make up 22 % of the Dairy farms.

[4] The System 3 farm is relatively lightly stocked and produces the majority of its production from pasture grown on the farm while the System 4 farm is more highly stocked and utilises feed bought in off the farm to maintain its higher level of productivity.

36. The Dairy support farm has been set up to provide silage, grazing of young stock and winter grazing of Dairy cows in accordance with the requirements of the two Dairy farms.

37. Two cropping models have been run with one representing a small seeds operation which was used on the light and heavy soils and the second one represents a process crop rotation which was used on the poorly drained soils.

38. Two sheep and beef models were run with them both being 80% sheep on a stock unit basis and 20% beef which were finishing heifers. The first is a sheep breeding operation and the second is a sheep trading operation.

39. I decided to run an Overseer model for every land use category which had over 500 ha represented. Table 1 shows the farms that were created in Overseeras individual Overseer models (green cells) and the farms that the N leaching results were derived (blue cells) by determining the mathematical relationship between the results. Areas not represented by a colour are for areas with no land use recorded.

Table 1: Models created in Overseer and Derived Results.

	Border Dyke								
	Light Soil			Heavy Soil			Poorly Drained Soil		
	650	750	900	650	750	900	650	750	900
Dairy									
Dairy Wintering									
Dairy Support									
Cropping									
Sheep and Beef									
	Rotorainer								
	Light Soil			Heavy Soil			Poorly Drained Soil		
	650	750	900	650	750	900	650	750	900
Dairy									
Dairy Wintering									
Dairy Support									
Cropping									
Sheep and Beef									
	Pivot								
	Light Soil			Heavy Soil			Poorly Drained Soil		
	650	750	900	650	750	900	650	750	900
Dairy									
Dairy Wintering									
Dairy Support									
Cropping									
Sheep and Beef									
	Dryland								
	Light Soil			Heavy Soil			Poorly Drained Soil		
	650	750	900	650	750	900	650	750	900
Dairy									
Dairy Wintering									
Dairy Support									
Cropping									
Sheep and Beef									
Created									
Derived									

40. The area in hectares for each land use was supplied by Shirley Hayward Water Quality Specialist at DairyNZ, who had commissioned AquaLinc Limited to produce the information.[5] This data is the latest available and I believe that it is the best that can be used for these purposes. All unclassified data (road towns etc) was deleted. All of the 'other' farm data which included Beef, Sheep, Deer, Goat, Pigs, Lifestyle, Mixed and Unknown were combined to be represented by the Sheep and Beef model. Table 2 represents the

[5] This was produced by Mr Peter Brown whose qualifications I have set out earlier.

summary data for the land use statistics used. It demonstrates the area of land in the Mayfield Hinds and Valetta Catchments and then in the Total Hinds Catchment.

Table 2: Land by Irrigation type. (ha)

	Mayfield Hinds	Valetta	Total Hinds Catchment
Borderdyke	4,049	405	4,652
Rotorainer	10,099	3,063	40,885
Pivot	21,559	9,207	45,679
Dryland	3,429	764	27,809
Total	39,136	13,438	119,026

41. The area in each land use was multiplied by the corresponding N leaching factor to come up with the results shown in **Table 3**.

Table 3: Results of Modelling for N Leaching and N in drainage.

	Area hectares	Total N Tonnes	Average Kg N / ha	Average N in drainage ppm
Valetta	13,438	938.1	69.81	15.9
Mayfield / Hinds	39,136	2,660	67.96	14.4
Total Hinds Area	119,026	5,625	47.26	10.3

42. When approached in the manner set out in the preceding paragraphs, it is apparent that the total load from the Total Hinds Area catchment has already reached the expected peak of 5,600 tonnes N and is well above that calculated by the Council as 4,500 tonnes N. This is a consequence of a more accurate estimate of current land use by climatic zone, soil type and irrigation type and a more accurate way of determining the current level of discharges than that used by the Council.

43. The N in the drainage at 10.3ppm is significantly less than the amount of nitrate concentration in shallow groundwater estimated by ECan as about 14 ppm. I believe that the difference is primarily caused by the relatively large amount (23%) of Dryland in the Catchment.

The process undertaken to look at what reductions are realistic

44. N leaching occurs as a result of N built up in the soil profile in the autumn months which is leached out during the winter period when typically soil moisture levels are very high, plant uptake is low and rainfall is high.

45. The mitigation options which I tested are those that are designed to address the nature and timing of N leaching. The mitigation options discussed here are each designed to address one of the causes of high nutrient leaching. They address each option with a degree of restraint on the main cause of N leaching from that activity. In many of the cases the mitigation could be adopted with a lesser or greater degree of restraint on the activity according to the requirements of the property. Therefore these should be considered as examples of the degree with which a mitigation activity will address the issue.

46. The mitigation options tested by me are:

46.1 **Original** – which is the current operation of the farm.

46.2 **Increase Irrigation Efficiency** – conversion from low efficiency Borderdyke (40%) to higher efficiency pivot type irrigators (90%). Improvements in Rotorainer, gun and k-line efficiency (50%-75%) and eventual conversion to pivot irrigation.

46.3 **More efficient animals** – doing the same production from less cows (having all cows producing at their genetic capability).

46.4 **Less supplementary feed / less cows** – decrease in the amount of feed purchased and a corresponding reduction in the number of cows.

46.5 **Innovation** - a number of innovative techniques already exist but can't be modelled in Overseer, and others will be developed. DCD use, which is the application of DCD in May and August, which is used in this case as an example, can be modelled in Overseer.

46.6 **Reduced Autumn N** – reduce N application to half the normal rates from January to March with complete reduction of the April application.

46.7 **Supplementary feed pads –** the use of supplementary feed pads with urine being collected and spread through the farms effluent system (dairy farms only).

46.8 **On / off Autumn Grazing** – which restricts the herd's access to pasture during the Autumn period with urine being collected and spread through the farms effluent system (dairy farms only).

46.9 **Top 5% of Pastoral Only Farms –** adopting a best practice system of very little supplementation of the farm operating at 3.5 cows / ha producing 500 kg / cow using only 150 kg N and 300 kg supplements.

47. This is in my opinion a comprehensive list of the available mitigations available to reduce N leaching. The only one which I have missed out that I have analysed in previous exercises is the option of ‘housing’ the cows in a shed over autum / winter / spring to avoid periods of high leaching. I did not trial that mitigation option here because in all previous exercises it has failed to mitigate sufficient N leaching to justify the considerable expenditure required to house the cows. Consequenrtly, I believe that the list of mitigations that I have trialled in this exercise is a complete list of the mitigation options which are open to farmers in the catchment.

48. In earlier work carried out as part of the contribution to Variation 1,[6] I found that there is a great deal of potential for improvements in N leaching performance through making improvements in irrigation efficiency. Border systems which at present are modelled at 40% efficiency will only achieve an efficiency of greater than 80% once they are converted across to Pivot irrigation. In order for Gun and K Line systems to make the necessary changes to their systems to achieve efficiency targets of greater than 80% efficiency additional expenditure of capital will be needed.

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[6] The AgriBusiness Group 2013: Selwyn Te Waihora Nutrient Performance and Financial Analysis.

49. Across the two schemes approximately 4,454 ha is in Borderdyke irrigation which is 9% of the area and approximately 13,162 ha is in gun irrigation which is 27% of the total area.

50. However with conversion across to a more efficient irrigation system the results in the RDRML area of interest are as follows:

Table 4: Gains to be made from improvements in Irrigation Efficiency.

	Mayfield Hinds	**Valetta**
Border (kgN)	4,049	405
Gun (kgN)	10,099	3,063
Pivot (kgN)	21,559	9,207
Dryland (kgN)	3,429	764
Kg N pre (kgN/ha)	67.97	69.8
Kg N post (kgN/ha)	55.0	60.9
N in drainage pre (ppm)	14.4	15.9
N in drainage post (ppm)	14.5	16.0

51. So although there is a considerable reduction in the total tonnage the concentration in the drainage doesn't alter. This is because by achieving the desired efficiency gains much less water will be applied so the N concentration in the drainage will not substantially change. That is, the concentration of N that is leached will have much higher concentrations than presently occurs.

52. The impacts of each of the mitigations as modelled are shown in **Table 5**.

Table 5: Impacts of Mitigation techniques.

	Original	**Efficient Animals**	**Less Supplements**	**Innovation**	**Reduced N**	**Feedpads**	**On / Off Grazing**	**Top 5%**
N result (kg n / ha)	54	50	46	46	51	50	46	50
Change from original		4	8	8	3	4	8	4
Percentage change.		7%	15%	15%	6%	7%	15%	7%

53. As can be seen from **Table 5** the effectiveness of each mitigation technique as modelled varies considerably from a 6% impact to a 15% reduction in the amount of N leached.

The affordability of the land use scenarios in Table 13(h)

54. The financial models that I used to determine the affordability are based on the 2012 MPI Farm Monitoring models. These report an average farm operation and therefore variation from farm to farm should be expected and individuals will differ considerably from the average both in their likely response in terms of the mitigation responses which are appropriate and the likely financial impacts of those mitigation options on their individual financial performance. Nevertheless the use of average models are sufficient to represent what will happen to the average farm, which is, in my opinion, the most useful measure to assess what is affordable and what is not.

55. Revenue has been adjusted to allow for a long term average expectation of product prices. This is taken from the MPI report Situation and Outlook for New Zealand Agriculture and Forestry (2014) and averages the actual product prices for the previous four years and MPI's estimate of the likely prices for the next four years. In the case of Arable farming the product prices are the average of the last five years. The figures used are as displayed in **Table 6**.

Table 6 : Price Series

Item	Price
Milksolids Price ($/ kg milksolids)	6.50
Lamb Price ($/kg)	5.39
Wool Price ($/kg)	3.50
Beef Price ($/kg)	3.61
Dairy Support ($ / kg DM)	0.23

56. The farm expenditure is taken from the farm monitoring model and adjusted according to the changes in activities required for each mitigation option.

57. The asset values used in the analysis are taken from the asset values used in the MPI Farm Monitoring reports. The value per hectare used in those reports is multiplied by the area of each farm to give the total asset value.

58. Similarly the debt structures adopted are the same as those used in the Farm Monitoring reports. If the productivity of the farm is altered by any of the mitigations used then the asset value of the farm is changed accordingly. If

there is the necessity to enter into more debt as a result of the adoption of mitigation then the debt is altered accordingly.

59. The full impacts of the various mitigation options are shown in Table 12 and Table 13 which can be found on Page 28 of the attached report and in Appendix 1.

60. The first point to note is the financial performance of the **Original** farm. Although the Cash Farm Surplus is reasonably healthy the majority of this is then taken up with the necessary expenditure to maintain the operation resulting in a much lower Net Cash Position. It should be noted that there is no Principal Repayment budgeted so one could safely assume that the surplus would all go into debt repayment. From a cash perspective the average farm is basically at a break even situation in an average year. From a Capital perspective the farm is in a relatively healthy position with 50% debt.

61. The more **efficient animals** option is a good one for the farm with an increase in cash and the capital position. This is because the same amount of output is achieved with less cows meaning that expenditure stays the same but per cow costs decrease therefore the Total Farm Working expenses decrease leaving a higher Cash Farm Surplus. The Capital position improves because the amount of capital tied up in cows is reduced.

62. The **less supplements** feed option results in about the same Net Cash Position of the farm but the capital position deteriorates markedly by increasing debt levels to nearly 60%. This is because the farms are valued on their productivity and the productivity in this case deteriorates quite considerably.

63. The modelling of the use of DCD’s as a means of showing the impact of **innovation** is excellent for the farm with very little impact on the cash position and a positive impact on the capital position. This is because the use of DCD’s lifts productivity slightly and therefore lifts both the Income and Capital position of the farm. The cost of applying it is priced at about the advantage which it gives. While DCD’s are not presently a measure that can be employed in New Zealand, I have used them in this analysis as an indication of what can be achieved via innovation and enhancements in technology. I

expect that there will be other innovations developed which have a similar impact on the nitrogen leaching performance of the farm but are not cash neutral. For example the research farm at Lincoln University has the objective *"To develop practical dairy farming systems that combine high production and profit with lower nitrate leaching*." They are currently trialling different stocking rates and the performance of different feed types and their impact on N leaching.

64. **Reducing N** usage in the autumn has a minor negative impact on both the cash and the capital position. This because the farm as modelled was already lighter in its application of N in the Autumn period. Therefore the relatively small reduction in N application during this period has a minor negative impact on productivity and therefore the Net Cash Position and on the Capital structure of the farm.

65. The adoption of a **feedpad** has a major negative impact on both the cash position and the capital position. This is because there is a major capital cost of installing a feedpad. For the System 3 farm there is very little supplements used and in the System 4 farm the majority of the extra feed is fed in the dairy shed. So in both cases there is a considerable capital expenditure which increase both the debt servicing costs and the annual repairs and maintenance expenditure with no additional productivity gains.

66. **On / off grazing** in the autumn has a major negative impact on both the cash and the capital position. This mitigation option is designed to minimise the amount of cow grazing in the Autumn to prevent the deposition of high concentrations of N. It requires considerable extra expenditure on sufficient housing of the cows to allow them to be held off the pasture for up to 20 hours per day. This requires extra expenditure on the supplementary feed required to feed them during this period of time. These both cause the Net Cash Position to deteriorate with no additional income.

67. Achieving the performance of the **top 5%** of farms has a major positive effect on both the cash and the capital position. This brought about by achieving a combination of the previous mitigation techniques with higher performance per cow coupled with a lower number of cows per ha which is achieved by using a lower amount of Nitrogen fertiliser and less supplements. This results in higher productivity with lower per cow costs including Nitrogen fertiliser and

supplementary feed costs resulting in a much higher Net Cash Position. The capital position is also improved by the increased value of the farm as a result of the higher productivity.

68. In order to display the relative financial performance of each of the options it is displayed in Table 14 (which is on Page 28 of the attached report and in Appendix 1) as the cost to the Net Cash Position divided by the amount of N that each option reduces. If each farmer were able to make a rational choice of options which they would, in my opinion and experience, choose they would start with those with the highest return and then go down the list until they had made sufficient savings in N. It should be pointed out that the three options (namely Lees Supplements, Reduced N and Innovation) which are relatively inexpensive also have a negative impact on the farm's capital position. The two which entail infrastructure costs are the most expensive and cause a deterioration in the capital position as well.

69. This makes it very difficult to achieve the Council's aim of achieving a 45% reduction in N leaching by Dairy Farms and a 25% reduction in those of Dairy Support operations. The Dairy Support mitigations are relatively simple, increasing the area of grass in the wintering grazing mix from that provided currently they can relatively simply reduce the amount of N leaching from their average operations by increasing the area over which the cows graze by offering them more grass and less crop. This will, however, increase the cost of dairy wintering which they will pass on to the Dairy Farms which will further increase the cost to the Dairy Farmers. The Dairy Farmers are, in my experience and opinion, price takers and must absorb whatever price that they receive from the market into their own operation and therefore cannot pass the cost onto the consumer. As a consequence they will be forced to absorb the additional cost themselves which will inevitably cause a deterioration in their Net Cash Position.

70. Dairy farming provides both Total Revenues and Net Cash Positions which are far superior to any of the alternative land uses even considering the relatively high additional cost of achieving them. Therefore once they have invested the additional capital there is little likelihood of them adopting one of the alternative land uses as a means of reducing their total N leaching because of the requirement of paying back the capital borrowed. Changing

land use would be an option for a Dairy farmer who didn't have any debt but they would suffer a notable drop in their Net Equity position. There would be reductions in returns to the Canterbury economy from the higher returning land uses being replaced by lower returning land uses.

71. The average farm cannot afford to experience either a drop in their Net Cash Position or deterioration in their equity. This is because at present the average farm in an average year is only able to generate sufficient surplus to pay off a relatively small amount of debt. A deterioration in their ability to generate surpluses will put them in a situation where they are steadily going backwards in both their cash position and their capital positions. There will be, I expect, some farms which can achieve the gains in N that are required and maintain viability because of lower debt levels but for at least half of them that is not possible.

Pushing out the achievement of 3,400 t N / ha / yr in Table 13 (g) to 2055

72. As can be seen from the preceding section of this brief, it is very difficult to choose mitigation options which aren't going to unacceptably adversely affect the viability of at least half of the farming families associated with the RDRML. Having considered this matter, I think that this is likely to be the case for those dairy and dairy support families that are not associated with the RDRML, but that rely on irrigation.

73. The issue then becomes what is a realistic proportion of reduction which was available to famers in the catchment.. In my opinion there are only four mitigations which I consider can be done without unacceptably harming the current level of farm viability either through reducing the net cash position of the farm into a loss making position or reducing the Net Equity to a position where they are unable to recover. They are:

73.1 Achieving Irrigation Efficiency

73.2 Achieving higher productivity with lower livestock

73.3 Adoption of innovations

73.4 More efficient farming.

74. Achieving Irrigation Efficiency requires quite a considerable amount of expenditure either through replacing the border dyke system with a Pivot irrigator or in upgrading their Gun system to achieve the 80% efficiency.

75. In the case of Borderdyke irrigation the expenditure can range from approximately $4,000 / ha for a simple change of irrigation system through to upwards of $9,000 / ha for a full remodelling of the farm and its infrastructure, so it cannot be expected to occur over a short time period. In my opinion the majority of the area in Borderdyke irrigation is currently in several larger blocks or is held in relatively small blocks of land. Therefore, for the conversion to occur it will depend on the current financial position of the current land owners. It is reasonable to expect that it will occur at a rate of half the conversions occurring over the next 20 years.

76. In the case of gains in Rotorainer irrigation efficiency because of the combination of the range of expenditures required (which range from $500 / ha for adoption of a soil moisture system through to $6,500 / ha for a full system refit) to achieve the 80% efficiency raning from relatively small adjustments available to improve the way that they irrigate through to large investments in capital to convert to pivot technology I believe that it is reasonable to assume that half of this conversion will occur over the next twenty years.

77. Achieving Higher Productivity with Lower Livestock is theoretically possible however my experience is that this mitigation takes a long time with breeding gains possible of up to 1 to 2 % per generation. It would be relatively simple to achieve if the quality of livestock were available on the market but if they were available it would be in very small numbers and they would be very expensive. The only option is for them is to breed up to achieve the quality of stock required and this will take a long time. However I believe that it would be reasonable to expect that there will be a 3.5% reduction in the N leaching figure over the next twenty years (by 2025).

78. Adoption of DCD's or other Innovations depends upon the return of DCD's which at this stage is uncertain (noting that the Council has included it in its

calculation of possible mitigation techniques) and any new innovations are, I understand from attending field days at the Lincoln University Research farm where they are trialing various new technologies to reduce N leaching at least five years from being considered as suitable for wide spread use. However some of the fertiliser companies are working on quite promising techniques to reduce losses of Nitrogen. I have assumed that 5% gains can be made over the next twenty years from the adoption of innovations. The gains that will be made in this area are much more likely to be "lumpy". For example if the use of DCD's becomes available that could immediately result in a 15% reduction in N leaching.

79. More Efficient Farming relies on the fact that there is a natural lag of time between when something is proven as worthwhile and when it is taken up by the industry as a whole. This is for a number of reasons which include a requirement for a lot of extension activity which requires the techniques to both be demonstrated that it works in a farming situation and to be taught to the individual farmer in order for people to take up the new methods on their farms and in some cases this takes a generational change in the management structure before they are fully taken up.

80. Capital and financial restrictions and implications, as illustrated in my financial modelling results (which are attached to this evidence), also require that the implementation of mitigations can only occur viably over an extended period.

81. The most cost effective and productive mitigation options for % N loss reduction over 20 years, from my analysis are:

81.1 Irrigation Efficiency 8%

81.2 Higher Productivity 3.5%

81.3 Innovation 5%

81.4 More Efficient Farming 4%

82. My work shows that it is not possible to achieve the Variation 2 target of 3,400 tonnes of N load by 2035 without causing considerable hardship to a

significant proportion of the farming sector. Therefore I believe that the total N load should reduce by 1% per year over the next 20 years for a total gain of a 20 % reduction in total N leaching.

83. Although some of the mitigations will maintain or slightly increase the amount of Nitrate in the water, others are quite effective in reducing the Nitrate concentration in the water. I believe that it is appropriate to maintain the target reductions at 9.6 ppm by 2035 but to monitor this and review it when other factors (the success of MAR) are more obvious.

84. Having said that, I believe that the target should be for a much longer time frame and again believe that it should be set over the next forty years (2055). This is purely because the gains that can be made in the first twenty years are substantial, but once that range of mitigation factors have been utilised there is very little left in terms of available mitigation options which are both effective and affordable. Therefore I believe, that at this place in time, any further gains will be relatively slow in their impact without causing social and economic harm on the community. That is why I believe that it is necessary to plan for a much slower reduction time frame encompassing the whole of the second twenty years.

85. In my opinion I have demonstrated that it is not possible to achieve the stated aim of 3,400 tonnes of total load within the twenty year time frame suggested without causing major social and economic harm in the Catchment. This is because of the financial stress that achieving it would put on at least half of the Dairy farmers (because the only way that they could achieve the reductions that are required would be through mitigation options which would adversely affect both their Cash position and their Capital position). I also believe that the amount of mitigation which they would have to achieve is much more than that calculated by the Council because the current load is much higher than that calculated by the Council.

86. In my opinion a doubling of the timeframe is more realistic which would mean that it would be achieved in forty years' time (2055). I believe it is important (as stated in Nigel Bryce's evidence) that the figure stated is used as a target and is not treated as a firm limit. There are, in my opinion, considerable uncertainties around the effectiveness of the various mitigation techniques

that are available at present but I am positive that further alternative or new mitigation techniques will be developed in this timeframe that will provide us sufficient reductions to achieve the target.

87. In the case of RDRML there is the potential for a more aggressive scenario of reductions than that possible for the general catchment. That is because there is, I understand, a good possibility that within the next ten years the Mayfield Hinds scheme will convert its delivery system to a piped scheme. This automatically precludes continuation of borderdyke irrigation.

88. The gains that are made in N reduction as a result of achieving irrigation efficiencies (conversion from borderdyke to pivot and the improvement of the performance of guns to 80% efficiency) will be very property dependant. The remainder of the reduction will, in my opinion and experience, be achieved by the rest of the farmers achieving a range of reductions. In the end what options farmers choose to reduce N leaching will be entirely up to them but they will be worked out in the FEP process and then individual targets will be set.

89. In order to model this process I have gone through the mitigation options from the least cost first.

90. The first option is for RDRML to achieve the irrigation efficiency gains that are available through conversion of borderdyke irrigation to spray and improvements to gun efficiency. This will require that the borders are all gone in ten years and that via the FEP process the farmers get their guns up to 80% efficiency. It is assumed that the borders will convert across with their current land use. This will give the irrigators in total a 17% reductions in N leaching over the first ten years. The cost is in capital expenditure so that is shown as an increase in the debt servicing across the land uses.

91. I have modelled an increase in animal efficiency which reflects improving productivity with a corresponding reduction in cows milked as productivity improves. This keeps revenue the same but reduces expenditure. This reduces N leaching by 3% over twenty years.

92. Innovation, which is effectively the use of DCD's, adds to costs and reduces N leaching by 5% over the twenty year period.

93. The final method used is to reduce the amount of silage purchased. This reduces both revenue and expenditure as a proportion of cows is reduced at the same time to reflect the reduction in silage purchases. This will reduce the amount of N leached by 5% over twenty years.

94. This scenario comes up with 30% reductions over the first 20 years. I estimate that the irrigation efficiency reductions are all achieved in the first ten years and then the other options take effect over the second ten year period.

95. I have created financial models for the area covered by the RDRML consent for three scenarios:

95.1 Without Variation 2

95.2 With Variation 2

95.3 RDRML Management.

96. These models were given to Glen Greer for her to calculate the flow on impacts.

A more appropriate figure for the new irrigation allowance

97. Currently the allowance calculated for new irrigation is set at 27 Kg N / ha. As I have previously stated, I believe that this is taken from modelling which over simplified what was possible and missed out the two important factors of the impact of irrigation and the impact of specifying the number of cows. Therefore I believe that this number puts real restraint on the ability to convert anything across to irrigated agriculture.

98. Therefore I am of the opinion that the adoption and application of this number will impose a very real restraint on the ability of a farmer to convert from an existing dryland operation to irrigated agriculture. This is because of the relatively poor financial results which can be achieved with such a restrictive amount of N allowed. This, in my opinion, would be a sub-optimal outcome, and one that I believe needs to be avoided.

99. I have modelled a Dairy system which meets the requirement of an N leaching figure of 27 kg N / ha and achieves an N in the drainage of 9.9 ppm in Overseer. This level of nutrients has been achieved by reducing all supplementary feeding, cutting out all of the applications of Nitrogen and reducing the number of cows by 24% to 517 but maintaining the per cow performance at 410 Kg MS / cow.

100. When this model is run through my financial model it comes up with the results as shown in **Table 7**. The detailed budget is in Appendix 5 Page 55 the report which is attached to this evidence. What this data shows is that on a straight cash basis the returns are relatively low but acceptable.

Table 7: Financial performance of new Conversion Farm

	$ / farm
Total Revenue	1,452,770
Total Farm Working Expenses	782,211
Cash Farm Surplus	670,559
Net Cash Position	28,567

101. The conversion costs are taken as $19,332 / ha and the purchase of Fonterra shares are taken as $5,511 / ha. The full breakdown of conversion costs and the financial performance are available in Appendix 5 of the attached report.

102. When the cost of conversion is considered from either a Sheep and Beef Farm or an Arable farm, and one assumes that the starting debt is the same as what is assumed for the average farm, the capital position is as shown in **Table 8.**

Table 8: Capital Position of new Conversion Farm

	Sheep and Beef	**Arable**
Total Farm Assets	8,362,217	8,362,217
Total Liabilities	5,440,009	5,980,009
Total Equity	2,922,208	2,382,208

103. What this data shows is that the debt positions of the average farms is quite poor with the addition of the conversion debt. The conversion from Sheep and beef has a total debt of 65% and the conversion from Arable has a total debt of 72%. These two figures are both outside the lending ranges of the banks which tend to, in my experience, stop at about 60%.[7] As I understand that the Committee is to hear from Mr. George Lumsden, a banking representative on behalf of RaboBank, I have not discussed this further with him. Therefore the opportunity to take up new irrigation is only open to those with much higher equity positions than that modelled here as the average situation.

104. Stopping conversion means that there is lost opportunity and reduced benefits for the Canterbury economy and this is not optimal

105. In order to calculate the return on investment I have taken the Cash Farm Surplus from each of the conversion options and deducted it from the Cash Farm Surplus of the new conversion option. I have then calculated the Return on Investment created by each option by dividing that figure by the total cost of the conversion. The results of this exercise are shown in **Table 9**.

Table 9: Return on Investment

	Sheep and Beef	**Arable**
Cash Farm Surplus prior to conversion.	325395	422130
Dairy Cash Farm Surplus minus prior.	345,164	248,429
Return on Investment	6.6%	4.8%

106. The Returns on Investment at 6.6% for the Sheep and beef conversion and 4.8% for the Arable conversion are relatively poor returns for such an investment and do not exceed the cost of borrowing the money. Again it indicates that it would only be an attractive proposition for an investor with a lot of capital and low expectations of returns. In my experience rural investors do not meet this description.

107. There is no doubt that there are a number of configurations of a new conversion dairy farm which may meet the financial requirements of an investor. When a new conversion to both irrigation capability and Dairy

[7] George Lumsden Agribusiness Manager Rabobank Ashburton. Pers Comm.

farming is modelled with the dual aim of achieving a viable business model and to minimise the amount of leaching that can occur in my experience it requires a stocking rate of approximately 3.5 cows / ha producing 500 kg milksolids / cow, feeding grain in the shed and a small amount of silage in the shoulders of the season. This system is reliant on very high annual pasture growth and is a very high performing farming operation and this is required to justify the expenditure that is required on the conversion costs (approximately $19,000 / ha). When modelled in Overseer (using the methods of Overseer modelling discussed in my evidence) this farming configuration which works financially comes out at about 39 kg / ha of N. Any less and it fails to meet the financial requirements of an investor.

Comment on Schedule 24c Nutrient Budget Preparation Protocol

108. The RDRML submission on Variation 2 sought to insert a schedule to define Nutrient Budget Preparation Protocol. The reason being that without a consistently used protocol the results from the nutrient budgets will vary from farm to farm. Given the need for equity and consistency, it is fundamentally important, in my opinion, that all nutrient budgets are comparable, and are produced using a common methodology / protocol. For this reason I developed the Schedule 24c that was suggested in RDRML's submission.

109. Since lodging the RDRML submission, a new version of OVERSEER has been released, Version 6.2, which in my opinion largely deals with the majority of the issues which lead to my proposal of Schedule 24c. In my opinion this will provide adequate protocols for consistent and equitable nutrient budget preparation. The officer has recommended a change in Schedule 24a (a) Nutrient Management (i) of *“latest version of the”* OVERSEER Best Practice Data Input Standards. I accept this change.

110. In my opinion, there is no longer any need to insert a schedule for Nutrient Budget Preparation Protocol proposed by RDRML and in that respect I agree with the reporting officer.

Summary

111. I believe that the Total Catchment Load is much greater than that calculated by the Council as a result of having more up to date information on the current land use and using my preferred method of modelling which I believe results in a far more accurate estimate of the N leaching.

112. The average dairy farmer is not able to afford the percentage reduction proposed by the Council and would become bankrupt if they were forced to adopt them.

113. I believe that the proposed reductions of 30% for Dairy farming and 20% for Dairy Support over the next twenty years are both feasible and affordable for farmers.

Name: Stuart John Ford
Date: 15th May 2015

Appendix 1 Tables referred to from the report.

Table 10: Financial Impacts of Mitigation Techniques ($ /farm).

	Original	Efficient Animals	Less Supplements	Innovation	Reduced N	Feedpads	On / Off Grazing	Top 5%
Total Revenue	1,910,800	1,908,850	1,644,300	1,965,166	1,875,440	1,910,800	1,910,800	2,048,600
Farm Working Expenses	1,151,840	974,351	895,020	1,211,840	1,128,720	1,171,340	1,263,920	1,060,720
Cash Farm Surplus	758,960	934,499	749,280	753,326	746,720	739,460	646,880	987,880
Net Cash Position	93,568	240,395	91,024	89,061	83,776	60,288	- 55,147	276,704
Change		146,827	- 2,544	- 4,507	- 9,792	- 33,280	- 148,715	183,136

Table 11: Capital Impacts of Mitigation Techniques ($ /farm).

	Original	Efficient Animals	Less Supplements	Innovation	Reduced N	Feedpads	On / Off Grazing	Top 5%
Total Farm Assets	10,998,660	10,986,825	9,381,210	11,328,620	10,784,052	10,998,660	10,998,660	11,835,000
Total Liabilities	5,550,000	5,427,000	5,450,000	5,550,000	5,550,000	5,890,000	6,685,600	5,550,000
Total Equity	5,448,660	5,559,825	3,931,210	5,778,620	5,234,052	5,108,660	4,313,060	6,285,000

Table 12: Relative Financial Impacts of Mitigation Techniques ($ /unit of N loss reduction).

	Original	Efficient Animals	Less Supplements	Innovation	Reduced N	Feedpads	On / Off Grazing	Top 5%
Cost / Unit N		175	- 2	- 3	- 16	- 40	- 89	218