BEFORE THE ENVIRONMENT COURT
AT WELLINGTON

IN THE MATTER	of appeals to the Environment Court under clause 14 of the First Schedule to the Resource Management Act 1991
AND	
IN THE MATTER	of the Proposed One Plan Consolidated Regional Policy Statement, Regional Plan and Regional Coastal Plan for the Manawatu-Whanganui Region
BETWEEN	**FEDERATED FARMERS OF NEW ZEALAND (ENV-2010-WLG-000148)**
AND	**WELLINGTON FISH AND GAME COUNCIL (ENV-2010-WLG-000157)**
AND	**HORTICULTURE NEW ZEALAND (ENV-2010-WLG-000155)**
	Appellants
AND	**MANAWATU-WHANGANUI REGIONAL COUNCIL TRADING AS HORIZONS**
	Respondent

STATEMENT OF EVIDENCE OF ANTONY ROBERTS

1. QUALIFICATIONS/EXPERIENCE

1.1 My name is Antony Hugh Coleby Roberts. I am the Chief Scientific Officer for Ravensdown Fertiliser Co-Operative Ltd, and have held that position since 2002.

1.2 I have a Bachelor of Agricultural Science degree (1st Class Honours) and a Doctor of Philosophy degree in Soil Science, both from Massey University. I obtained a Certificate of Completion for the Massey University Sustainable Nutrient Management in New Zealand Agriculture course in 2004 and one for Advanced Sustainable Nutrient Management in 2006. I am a Fellow of the New Zealand Soil Science Society and a member of the New Zealand

Institute of Primary Industry Management and the New Zealand Grassland Association.

1.3 Prior to joining Ravensdown in 2002, I was a practicing agricultural scientist for 22 years. From 1980 to 1988 I worked for the Ministry of Agriculture and Fisheries Agricultural Research Division as a District Agricultural Scientist based in Taranaki. Between 1988 and 1990 I was as the Soils and Organics Group Leader in MAFTech at Palmerston North and Flock House in Manawatu/Rangitikei. In 1990, I relocated to the Waikato (1990 to 2002) where I held the position of Group Leader of the Soils and Fertiliser Group and latterly as a Senior Scientist in the Land Management Group of the Pastoral Agricultural Research Institute of New Zealand, which trades under the name of AgResearch.

1.4 My research and consultancy interests include soil fertility (particularly in dairying), agronomy, heavy metal accumulation in agriculture, environmental performance indicator monitoring and interpretation, and waste utilisation or disposal to grazed pasture.

1.5 In addition to my work in New Zealand I have also worked in Tasmania, mainland Australia, Japan and South Africa in the area of soil fertility management on pastoral farms. I am either the senior author or a contributing author of 55 refereed scientific journal or conference papers, a further 56 scientific or extension conference papers, 4 book chapters and 4 extension booklets.

1.6 Over the past 25 years I have not only conducted many soil fertility experiments but have also had an active consultancy role, particularly with pastoral farmers throughout the country, on soil fertility management to maximise economic return, and more latterly to couple that with minimising off-farm impacts on the environment.

1.7 In my current role as Chief Scientific Officer for Ravensdown, I am responsible for managing the research and development for the cooperative, for training approximately 70 Account Managers as well as other staff in soils, fertilisers and pastoral agriculture, as well as working with many of our corporate and other farming shareholders.

1.8 I provided a statement of evidence to the Hearing Commissioners on Thursday 11th February 2010. Prior to that hearing I had caucused with Dr Alec Mackay on Monday 8th February 2010 (who has provided a statement of evidence to the Court), a copy of which I have attached to my evidence.

1.9 I had little involvement in the process leading up to the POP other than to attend invited meetings at Horizons Regional Council Offices and public meetings in Palmerston North discussing the progress of the FARMS strategy by AgResearch and case study farmers involved.

1.10 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

1.11 In preparing my evidence I have considered the following:

a. The S42A reports of Dr Alec Mackay, Supplementary Evidence of Dr Alec Mackay End of Hearing Report, Dr Grant Douglas, Dr Stewart Ledgard, and Dr Mark Shepherd.

b. The evidence of Peter Taylor, Supplemetary Evidence of Peter Taylor for the Water Hearing, Lachlan Grant, the joint evidence of Dr Jonathon Roygard, Kathryn McArthur and Maree Clark dated 14 February 2012, and the supplementary evidence of Dr Roygard and Ms Clark dated 24 February 2012.

2. SUMMARY OF EVIDENCE

2.1 It is my opinion that the concept of Natural Capital, the basis upon which the Land Use Classification (LUC) approach has been used to calculate the cumulative N loss maximums in Table 13.2 (DV POP), has no valid scientific basis and is still under discussion/development/debate among the international scientific community. It is a primarily a proposed mechanism for understanding among politicians and economists regarding the inherent value of soil.

2.2 The LUC system was not originally designed for the purpose of setting nutrient limits but to establish a classification system for creating an inventory of the rural land resource.

2.3 To use the LUC classification system to set N loss maximums is, in my opinion, arbitrary and inappropriate, given that it takes no account of sustainable improvements in productivity to circumvent some of the limitations imposed by a farm's physical resources.

2.4 Where this approach has been used for 9 new dairy conversions and 18 existing dairy farms, using the LUC to set cumulative N loss maximums will mean around a quarter of existing dairy farms will fail to meet their proposed cumulative N loss maximums. Others will incur considerable expense and system changes to approach their limits.

2.5 The use of the OVERSEER™ nutrient budget software to calculate the current estimated long-term annual N loss to benchmark individual dairy farms in the Water Management Sub-Zones (WMsZ) is, in my opinion, an appropriate tool to provide a basis for decision making.

2.6 In my experience, when discussing reduction in N loss from their farms using technologies such as nitrification inhibitors which can assist with this, many farmers will consider all N reduction options when they have certainty around what N loss is expected of them. This is also supported by farmer attitudes captured in catchment studies in the Waikato.

2.7 However, given the modest reductions in N losses achieved or modelled in studies of existing dairy farms, coupled with the significant barriers to adoption (e.g., mitigations must be affordable, do not affect productivity/profitability adversely, fit the farm system and are proven to work) all parties should be prepared to accept that achievement of 'stretch' water quality targets with respect to N loss will be difficult, and will certainly mean a proportion of farms will fail to meet these targets.

2.8 A significant amount of research is being done on how N losses can be minimised. For example, a three year research programme at 4 sites, funded by Fonterra, DairyNZ, MAF and Fertiliser Manufacturers Research Association, is studying the effectiveness of the nitrogen inhibitor Dicyandiamide (DCD) (marketed by Ravensdown as "EcoN") This study which began in 2009 is showing promising results, including significantly decreased N losses from urine patches and grazed pasture.

2.9 Despite these promising results (from a small sample set), it remains important to set realistic targets about N losses until much more is understood about the relationship between farm activities, N losses and effects on water quality.

2.10 Therefore, in my opinion, once the communities in each WMsZ have set acceptable N loss targets based on the target loads calculated by witnesses for the Council, farmers in each catchment should then be given the opportunity to gradually reduce their N losses over time using cost effective management practices and technologies. These reductions can be demonstrated through provision of Nutrient Management Plans to the Council, provided by accredited nutrient management advisors working with individual farmers.

2.11 If the Court wishes to impose controls in the interim while such community agreed targets are set, it is my opinion that controls based on a single number approach would be the most appropriate.

3. THE NATURAL CAPITAL CONCEPT

3.1 The decisions version (page 13.3) provides:

> **Policy 13.2C: Management of dairy farming land uses**.
>
> When making decisions on resource consent applications, and setting consent conditions for dairy farming as a land use, the Regional Council must:
>
> a. Have regard to Policy 6.7.
>
> b. …..

c. ensure that nitrogen leaching from new dairy farming land uses does not exceed nitrogen leaching rates based on the natural capital of each LUC class of land used for dairy farming.(my emphasis)[1]

3.2 The reference to 'natural capital' is repeated in the 'Proposed Changes' version of the plan suggested by the Council on 21 December 2011 as Policy 13.2C (e).

3.3 The concept of natural capital has been developed from the thinking of soil and environmental science groups, both in New Zealand and worldwide, in part as a metaphor to assist the understanding and decision making of economists and politicians. One of the drivers for this concept is the fact that central government science funding for soils research has been eroding for several decades in most OECD countries and this is an attempt to reinforce to decision makers the critical 'value' of soil.

3.4 Natural capital is not 'real' – it is a concept, and as yet is not universally embraced by the science community either, but is a metaphor to liken natural resources to other forms of capital such as manufactured capital (e.g., tractors, buildings) or human capital (e.g., skills, knowledge) that economists, accountants and policy makers are usually more familiar with. However, I consider that extending this beyond a qualitative metaphor is very difficult, as is judging qualitatively whether one soil has a higher natural capital than another, except in the most obvious cases.

3.5 In his Section 42A report, Dr Alec Mackay discusses the use of the natural capital approach to assist in determining the permitted N loss for farms in the Horizons water management zones.

3.6 Dr Mackay acknowledges (Paragraph 30: page 8 TEB) that as it is so 'new' there no method to calculate the soil's natural capital and suggests a proxy measure. He suggests that this proxy is the "ability of a soil to sustain a legume-based pasture that fixes N biologically under optimum management and before the introduction of additional technologies" (Paragraph 31; page 8/9 TEB).

[1] This is repeated in Policy 6.7 (page 6-18) of the Council's decision version.

3.7 In my opinion, this approach is flawed. That is because published DSIR trials by Sears et al. 1965[22] in the Wellington region showed legumes (white clover) fixed 680 kg N/ha with grass and clover clippings returned on a Judgeford subsoil (B horizon) where the topsoil had been removed. Legumes will grow very well in soils of 'poor natural capital' because the N status of these soils (in unimproved state) is low and the legume has the ability to supply its own N requirement through symbiotic nitrogen fixation.

3.8 Dr Mackay suggests (Paragraph 29; page 8 TEB) that N loss should be linked to natural capital estimates and LUC classes. I address what I consider to be the shortcomings of using LUC later in my evidence. In brief, while using LUC classes makes greater sense to estimate P loss risk because of the processes engendering P loss, N loss from grazed pasture systems is directly linked to biological productivity. Biological productivity is not linked to LUC class where productive constraints are overcome by introducing technological advances including improved farm management practices. Dr Mackay acknowledges (Paragraph 21; page 6 POP Supplementary Evidence for End of Hearing Report – Water) that the natural capital approach (and by implication the LUC methodology used) does not reflect farm productivity of intensive pastoral systems. The annual productivity of grass/legume based pastures, all other things being equal, is directly linked to the amount of N cycling through the soil/plant/animal/atmosphere system, and so is N loss risk.

3.9 In my opinion, the use of the concept of 'natural capital' is unhelpful and does not accurately reflect current agricultural practice and understanding. Even if the use of LUC were to be retained in the plan provisions, I consider that the reference to 'natural capital' should be removed because it is unnecessary and confusing.

4. THE USE OF LAND USE CLASSIFICATION AS A BASIS FOR SETTING N LOSS LIMITS

4.1 In my opinion the Land Use Classification (LUC) system is not appropriate to be used to determine the allowable current and future allowable N losses from farms. That is because the LUC system was not designed for this purpose and leads to distortions in allowable N losses. As Mr Grant explains in his

[2] NZ Journal of Argicultural Research 8: 270-283

evidence (Paragraph 9; page 2 TEB), the LUC system "was not originally designed for the purpose of setting nutrient limits but to establish a rigorous classification system for creating an inventory of the rural land resource."

4.2 The LUC system has been well described in the Section 42A report of Dr Douglas and again in Mr Grant's evidence. I agree that the LUC is, as explained, a classification of the *suitability* of land for one or more productive uses after consideration of the land's physical limitations, rather than its productive potential in either an unimproved or improved state.

4.3 The classification takes into account the physical resources of the land such as rock type, soil type, slope, erosion type and severity and vegetation cover. Climate and previous land use effects are also assessed. The physical resources are used to divide land into 8 classes – the eight classes used by Horizons to allocate allowable N loss. However, there is no objective assessment of the actual productivity of the land within the eight classes.

4.4 The LUC then divides each class into a subclass identifying the dominant physical limitation such as erodibility, wetness (poor drainage or flooding risk), soil (shallow soil, pans, stoniness, low water holding capacity, low fertility etc.) and climate (summer drought, excess rainfall, frost, snow, wind and salt spray). Again, no objective assessment of actual productivity is used in the sub class, even though logic suggests that many of the potential limitations described above will impact on productivity. However, modern agricultural technology allows land managers to overcome some of these physical limitations through flood protection, drainage, enhancing soil properties through soil management techniques such as building organic matter, fertiliser use and introducing irrigation – all of which can be successfully undertaken where the economics of the enterprise allows.

4.5 I have no issue with either the Dr Douglas's report or Mr Grant's evidence with respect to the how the LUC system was created and the manner in which it has been updated.

4.6 In a caucusing meeting between Dr Mackay and myself on 8 February 2010, (a copy of the notes of which is provided as Appendix A), we were able to largely agree on the above points, including that "Modern technology allows

managers to overcome some of the identified physical limitations. LUC assessment can also be adjusted by major schemes that permanently change the degree of the limitation, such as large-scale irrigation, drainage or flood control schemes. The classification of LUC is independent of such factors as location, distance from markets, processing facilities, land ownership, or the skills of individual farmers." (Paragraph 11; page 2 Report of a Meeting between Experts, Appendix A)

4.7 In my opinion, the Council have already recognised that the above is possible through the acknowledgement that irrigating the Manawatu sand country permanently increases the productive capacity of that land class. In fact, Mr Grant's evidence to this Court discusses the processes involved in reclassifying the irrigated sand country to a higher LUC class (paragraphs 43-68; pages 11-22).

4.8 Additionally, in Mr Peter Taylor's Supplementary Evidence (paragraphs 3 and 4; page 1), four of the 21 FARM strategy case study farms were reviewed to assess the effects of suggestions by farmers or consultants related to mitigations to reduce N loss and/or adjustments to the LUC class for permanently irrigated sand country (e.g., Johnson Farm).

4.9 Mr Taylor concludes (paragraph 5; page 1) that an adjustment to the LUC class for irrigated sand country can be justified.

4.10 However, this adjustment to the LUC class did not address the difference between the current estimated N loss (25 kg N/ha) and the proposed year 1 N loss of 17.2 kg N/ha.

4.11 In my opinion, this demonstrates the inadequacy of the LUC system to correctly assign productivity to farm systems where technology improvements have been implemented, and hence equitably assign fair permitted N loss.

4.12 It is only when the LUC unit, the most detailed level of the classification, is arrived at that a productivity index is considered. The LUC unit describes land which is homogenous with respect to management requirements, conservation treatment and suitability for the same type of crops, pasture or

forestry with similar potential yields. With respect to pastoral use this is based on stock carrying capacity.

4.13 Stock carrying capacity is itself a moving target as technology, knowledge and experience allows land managers to improve pasture productivity and hence either carry more animals per hectare or increase per animal performance (both of which equate to an increase in stocking rate or carrying capacity).

4.14 In the February 2010 caucus meeting, Dr Mackay and myself could not agree that the productivity assessment i.e., the potential carrying capacity should be adjusted to take account of the points made in paragraph 4.13 above. Dr Mackay stated that "The productivity indices (i.e. attainable potential carrying capacity) listed in the extended legend of the LUC worksheets, are based on the capability for long-term sheep and beef livestock production from back in the late 1970's. The attainable potentials were based on a well-managed legume based pasture system. This has not changed". (Paragraph 18; page 3 Report of a Meeting between Experts, Appendix A).

4.15 This is exactly my point – i.e., that these historic assessments (many of them qualitative expert opinions of MAF and private agricultural consultants) should be changed to reflect the current potential carrying capacities.

4.16 Dr Mackay also contended in the caucusing meeting that "There is strong evidence that the productive levels of a legume based pasture have changed little over 40 years. The data in the extended legend LUC classification system is therefore suitable to be used as a proxy method for assessing the soil's natural capital - ultimately the best way of assessing land capability and setting nutrient loss allowances". (Paragraph 18; page 3 Report of a Meeting between Experts, Appendix A).

4.17 I do not agree and provide the following 4 reasons for my opinion. Firstly, in the sheep/beef industry alone it would be difficult to explain how the national lamb kill today is approximately the same numerically as it was several decades ago with less than half the national breeding ewe flock than in those past decades and with significantly less land area now devoted to sheep farming. Improved animal genetics explains some of the increases in lambs/per ewe but these highly fecund ewes still need to be fed to

requirement through an increase in feed quantity and quality engendered by improvements to farm feed supply.

4.18 Secondly, in a paper published in the New Zealand Grassland Association Conference Proceedings[3] in 1999, the author Dr Derek Woodfield demonstrated the genetic gains made in plant breeding in white clover. Between the mid-1950s to 2000, the genetic gain in white clover cultivars (relative to the standard Huia cultivar) was 1.49%/year and 1.21%/year under sheep and cattle grazing respectively. Significantly, low annual improvements occurred over the years mid-1950s to the late 1980s i.e., 0.4 and 0.6% under sheep and cattle grazing respectively. The rate of gain increased dramatically post the late 1980s to 4.4 and 2.5% annually under sheep and cattle grazing. This points to significant improvements in potential productive levels of well managed legume based pastures on sheep and beef livestock production systems post the original assessments in the 1970s.

4.19 Thirdly, farmlet trials at the formerly MAF and now AgResearch Ballantrae Research Station at the southern end of the Ruahine Ranges were established in 1973. The farmlets were 'balanced' as much as possible for important factors such as slope, aspect, topography and so it would be safe to assume that the LUC classifications of the farmlets were also similarly 'balanced'.

4.20 These farmlets have had continuous treatments applied to 3 of the farmlets, namely: no fertiliser (Control), 125 kg/ha superphosphate (LF) annually and 375 kg/ha superphosphate annually (HF). In 1973, data produced from Ballantrae shows that the initial stocking rates were 6 stock units (su)/ha. These increased until by 1982 they had stabilised at around 10 su/ha for the LF farmlet and 16 su/ha for the HF farmlet until 1992.

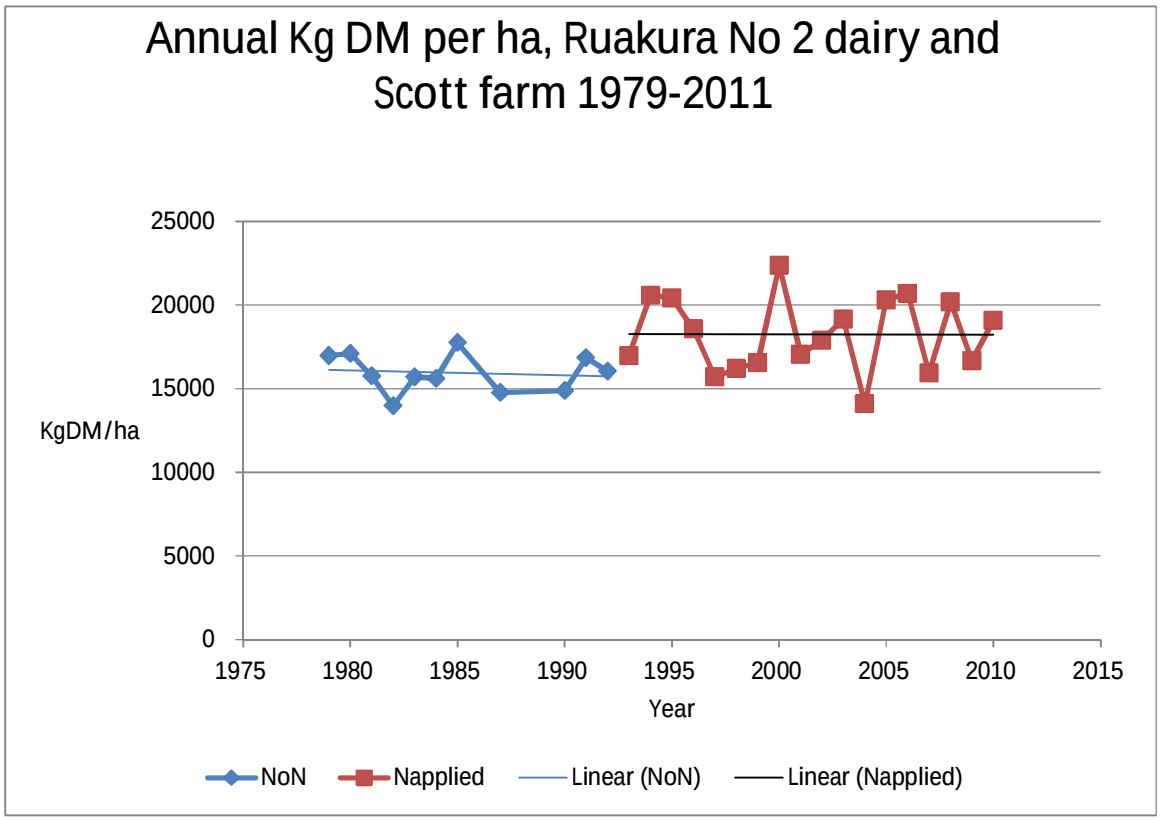
4.21 The point here is that for the same LUC, the addition of more nutrients important to pasture productivity has led to a sustainable increase in potential carrying capacity. Given that the HF farmlet has more legume than the LF farmlet which has more than the Control farmlet, it would be fair to assume that there will be considerably more N cycling in the HF farmlet and hence more N loss risk. Using the LUC system to set the permissible N loss based

on 1970 productivity estimates will limit those farmers who have raised their productivity beyond that designated for their farm based on their LUC.

4.22 Finally, Dr Mackay provides a graph from Deane (1999) which shows a clustering of annual pasture production taken from "research stations in Taranaki and Waikato, and from top farms in the main North Island dairying areas" (Paragraph 16, Supplementary Evidence of Dr Alec Mackay for End of Hearing Report – Water). He provides Deane's conclusion that little has changed in terms of annual pasture production from 1960 to around 1996.

4.23 In my opinion, data for well-developed dairy farms does not provide evidence that " ..the estimates of potential productive capacity of a legume-based pasture, fixing N biologically under a typical sheep and beef farming system …are still very relevant today". Moreover, recent data from Dairy NZ contradicts Deane's assertions.

4.24 Information from pasture growth measurements at the old Ruakura No. 2 Dairy farm and the DairyNZ Scott farm (both located in the Waikato just outside Hamilton – a matter of kilometres from each other) would suggest that while there is year to year variation in annual pasture production, there has been an increase in productivity. Over the years 1979-1992 average annual production was around 16t DM/ha (blue data on graph), but from 1992 to present, this average annual production has risen to around 18t DM/ha (red data on graph), albeit with the use of N fertiliser to assist in this.



Graph supplied by Mr Chris Glassey, Scientist, DairyNZ

4.25 Additionally, within each land class, subclass and unit will be land managers who have a range of skills and abilities which will enable the best ones to exceed the stock carrying capacity allocated, while others will not be able to approach this figure - yet under the current proposal all will be treated the same with respect to allowable N loss.

4.26 Mr Taylor's evidence shows that for nine new farms converted to dairy pursuant to Rule 13-1B, all are able to meet their cumulative N loss limits (as calculated using the LUC approach) with only 3 identifying specific N loss mitigation in the NMPs (Table 1). Mr Taylor did also record, in the footnote to the Table, that some mitigations i.e., no winter applied N, would be applied by all farms and two farms achieved their leaching maximum through farm management design.

4.27 While these farms are at or below their N loss limit, according to the analysis in Table 1, this does not vindicate the calculation of the N loss limits using the

LUC approach. When starting from a non-dairy situation the farmers and their advisors have the opportunity to design the whole farm system to comply with this requirement along with all other conditions.

4.28 However, the opportunities to 're-engineer' the farm infrastructure and management systems to the same degree does not occur on existing dairy farms. In Mr Taylor's evidence, 10 of the 18 FARM strategy dairy farm test farms need to reduce N leached under the proposed rule (paragraph 32) and for half the 10 farms (~28%) it would be moderately difficult to very difficult to reduce N loss.

4.29 In my opinion, the above demonstrates that using the LUC system (at the class level) to arbitrarily calculate a cumulative N loss target is setting up 28% of existing dairy farms to fail to meet the required loss estimate. The LUC approach does not correctly attribute allowable N losses to farms within each class because it takes little or no account of actual productivity differences either within or between classes.

4.30 Additionally, the proposal that those existing dairy farms in high rainfall areas (>1500mm) with >50% of LUC classes 4-8 (paragraph 31 of Mr Taylor's evidence) should be exempt the current proposal underpins the very point I am making about the inadequacy of the proposed methodology. Under the proposal of Ms Barton (as stated in paragraph 31 of Mr Taylor's evidence) the exempted farmers will be allowed, by employing best management practices, to work more gradually to achieving their N loss maximum.

4.31 In my opinion, if this proposal is acceptable to Council for the high rainfall/high LUC class farmers then, I see no reason why it should not also be granted to all existing dairy farmers.

5. AN ALTERNATIVE APPROACH TO DETERMINING N LOSS TARGETS

5.1 Other regional councils have approached the issue of N loss in different ways. For example, in the Waikato Regional Council's Variation 5 for the Western Taupo catchment the Council has adopted a grand parented cap and trade policy, while Environment Canterbury has set N concentration limits for drainage water leaving the plant root zone.

5.2 I agree that it would be helpful to set clear nutrient loss targets for farmers to give them a degree of certainty for their businesses and so they could consider what infrastructure and/or management changes they might need to adopt to meet the required N loss targets. Whether this is better done in the POP or by non regulatory methods is outside my expertise.

5.3 In the Waikato Regional Council study *"Evaluation of the Integrated Catchment Management Pilot Project – final report June 2009"*, which involved farms from the Little Waipa and Waipapa catchments, the lack of clear nutrient targets and guidelines for some of the actions required were barriers to adoption i.e., farmers needed to know not only what was required but perhaps more importantly – how to get there. The study also found that one-on-one farm planning advice by skilled people was effective in encouraging on-farm change.

5.4 I understand that there are 24 Water Management sub-Zones (WMsZ) identified in the Horizons region. For each sub-zone the current water quality has been assessed and what would be desirable in the future has been determined. From this the soluble inorganic nitrogen (SIN) loadings required to achieve the desired water quality for each WMsZ has been determined.

5.5 As this is not my area of expertise, I am not able to comment on the evidence of Dr Roygard, Ms McArthur and Ms Clark on the state and trends in water quality across the region as presented in their Joint Technical Expert Statement (14 February 2012) and their earlier Section 42A and Supplementary reports (Roygard: pages 193-500 TEB v1; Clark pages 501-582 TEB v 2; MacArthur; pages 591 – 928 TEB v 2). Similarly, I am not able to comment on the appropriateness of the 'target loads' of SIN presented in Table 6 of the Joint Technical Expert Statement and the methodologies used to derive the target SIN concentrations (Schedule D of the DV POP) to achieve the water body values described by Ms McArthur in her S42A evidence. Nor do I comment on the adequacy of the procedure outlined by Dr Roygard translating target concentrations into target loads (Section 6.14.2 of his S42A evidence).

5.6 I therefore make no comment on the appropriateness of the target loads presented in Table 6 of the Joint Technical Expert Statement (14 February 2012) and the repeated on page 23 of the Supplementary Statement of Dr Roygard and Ms Clark dated 24th February 2012.

5.7 I am aware of, and accept, the average attenuation factor of 0.5 that is being used to link the amount of SIN leaving the root zone (as estimated using the OVERSEER model) and the quantity of SIN reaching the river. This factor was determined in a study by Dr Clothier for two sub-catchments (S42A Report, paragraph 110, Figure 10.4). However, this attenuation factor is no more than a regional wide estimate. I anticipate that greater future understanding of the processes of attenuation of SIN between the bottom of the root zone and receiving waters will enable more explicit attenuation factors for different land uses and sub-catchments in the region. In my opinion, that work remains to be done.

5.8 I understand that Professor Tillman will say in his evidence that based on the scenarios in the Joint Technical Expert Statement the application of N loss limits by whatever method still leaves considerable differences between estimated modified SIN load and the target loads presented in Table 6. Given this, I believe that a process involving the Council and the communities within the relevant WMsZs needs to be undertaken, similar to that which is currently being undertaken by the Water Management Zone Committees in the Canterbury region (e.g., the Hurunui Catchment). This process would involve the community, in conjunction with the Council, deciding on an acceptable (and practically achievable) water quality standard relative to the ideal 'target loads' presented in Table 6, and the timeframe over which to achieve this standard.

5.9 Once that is done, then within each WMsZ, the N loss for each individual farm should be estimated by using the OVERSEER™ programme. Modelling N loss is necessary because neither farmers nor the Regional Council have the ability to directly measure N loss from grazed farmland.

5.10 Once the long term average N loss has been calculated for each farm, then farm management practices and technologies to progressively reduce N loss from all farms within each WMsZ. This, in my view, is not materially different

to what Ms Barton has proposed for the farms in the high rainfall/high LUC areas.

5.11 To assist the Council in ensuring that progress is being made in reducing N loss from dairy farms within each WMsZ, farmers would be required to provide to Council or to make available on request, a Nutrient Management Plan showing what N loss mitigation strategies have been put in place and the outcome of this on farm N loss as modelled annually.

5.12 A significant amount of research is being done on how N losses can be minimised. For example, a three year research programme at 4 sites, funded by Fonterra, DairyNZ, MAF and Fertiliser Manufacturers Research Association, is studying the effectiveness of the nitrogen inhibitor Dicyandiamide (DCD) (marketed by Ravensdown as "EcoN") This study is showing promising results, including decreased N leaking from urine patches by around 40% and in grazed pasture by 21%.

5.13 Despite these promising results (from a small sample set), it is important to set realistic targets about N losses.

Appropriate interim controls on N loss

5.14 I have been asked by counsel for Ravensdown to comment on what I consider would be appropriate controls on N loss in the interim if the Court were to decide such controls are necessary now and not wait for the sort of analysis I have suggested in paragraph 5.8. Dr Roygard, Ms McArthur and Ms Clark suggest three possible approaches in this regard: a “do nothing” approach, the use of "LUC approaches" or using "single number limits approaches". (Table 7 page 5058 TEB).

5.15 Obviously, given the justifiable concern about water quality in the Manawatu Region the 'do nothing' approach is not acceptable.

5.16 For the reasons I have discussed in section 4 of my evidence, I consider that the "LUC approaches" are flawed and unhelpful.

5.17 In the interim, the Council could base N loss limits on the 'single number' approach using DairyNZ/FertResearch aggregated figures on estimated N loss on a regional basis rather than trying to do this on a subcatchment/WMZ basis.

6. USE OF THE OVERSEER MODEL

6.1 In my opinion, the use of the OVERSEER programme to estimate N losses from pastoral farms is valid and will assist farmers to adopt management practices and technologies which will assist them in achieving N loss reductions on their farms.

6.2 As explained in Dr Stewart Ledgard's Section 42A report the OVERSEER programme is based on sound science and is regularly updated to reflect both advances in scientific understanding and also the requirements of describing complex and evolving farm systems.

6.3 Fertiliser Industry staff now use this programme as a matter of course on all dairy farms and larger sheep and beef properties as part of the matrix of tools and techniques to assist their land manager shareholders to manage nutrient flows into and out of their properties.

Use of OVERSEER by trained persons

6.4 OVERSEER should be used by properly trained and qualified people using long term average data appropriate to the regional or sub-regional area in which the farm lies. University graduates in agriculture will have had an introduction to the theory behind and use of OVERSEER but further training is provided by the Massey University professional development courses including the Intermediate and Advanced Sustainable Nutrient Management courses. These courses are open to anyone who wishes to gain knowledge and experience with the tool and the wider issues of nutrient cycling on grazed pastoral farms.

6.5 An independently run nutrient management accreditation scheme is currently being developed by DairyNZ, the Fertiliser Industry and other stakeholders to give assurance of the credibility of 'nutrient management advisors' who

prepare OVERSEER analyses of farm businesses. It is expected that attendance at and qualification in the two Sustainable Nutrient Management courses will form part of the necessary requirements for accreditation as a 'nutrient management advisor'. This scheme will hopefully be in place in the next 12-18 months.

Auditing OVERSEER nutrient budgets

6.6 Furthermore, as a further assurance of credibility and transparency an OVERSEER analysis is auditable by third parties provided an Input Parameter Report is supplied with the output reports. The Parameter Report would then allow a qualified third party to recreate the OVERSEER analysis to check compliance with proper use of the OVERSEER programme.

6.7 The overall objective of using OVERSEER should be to establish a benchmark N loss figure for a property and over time with management and technology changes, demonstrate a long term reduction in N loss.

6.8 Caution should be exercised in terms of both the quantum of N loss reduction and time frame over which this is required to occur.

6.9 For example, in the previously referred to Waikato Integrated Catchment Management study (paragraph 5.56), in the Little Waipa 20 dairy farms reduced N loss by 4 kg N/ha (from 42 to 38 kg N/ha), and in the Waipapa a 'modelled' reduction of 9 kgN/ha (37 to 28 kg N/ha) was achieved. There was still a 'gap' of 4 to 8 kg N/ha between what was achieved and what was deemed to be sufficient to have *"no net change in water quality"*.

6.10 Furthermore, in the Section 42A report of Dr Mark Shepherd, Dr Shepherd reports that five case study farms were chosen, by Horizons staff, which were thought to struggle to meet the allowable N loss limits proposed in the One Plan. This same difficulty, in at least 28% of farms being able to easily meet the N loss maximums calculated using the LUC approach, was also highlighted in paragraph 4.28.

6.11 In Dr Shepherd's evidence, The OVERSEER modelling for each farm showed this largely to be the case, especially for the dairy farms. The two non-dairy

farms (irrigated beef, intensive cropping) met the proposed initial N loss, but 2 of the 3 dairy farms needed to reduce N loss by 9 kg N/ha immediately. The third dairy farm had a large non-dairy area which offset the dairy platform losses.

6.12 Importantly, the FARMS reports investigated good fertiliser and effluent management, nitrification inhibitors and stock exclusion in autumn/winter as potential mitigations. Some of these mitigations (or good environmental practices) bore significant cost and were insufficient to meet the targets.

6.13 The study reported by Dr Shepherd supports the findings of both the Integrated Catchment Management Study and Nutrient Efficiency Study from the Waikato.

7. CONCLUSION

7.1 In my view, the use of the LUC system to set allowable N loss targets is inappropriate, because it is arbitrary and as such, is not fit for purpose. It unfairly penalises farm businesses who have introduced technologies and developed skills and abilities to farm productively, despite the limitations imposed by the physical resources of the land area involved.

7.2 While land managers must know what N loss limits they need to strive for, setting unrealistically achievable reductions will not, in my view, lead to compliance by even the most willing land manager.

7.3 Given the modest reductions in N losses achieved or modelled in studies of existing dairy farms discussed above coupled with the significant barriers to adoption (e.g., mitigations are affordable, do not affect productivity/profitability adversely, fit the farm system and are proven to work) all parties should be prepared to accept that achievement of ‘stretch’ water quality targets with respect to N loss will be difficult and will certainly mean a proportion of farms will fail to meet these targets.

7.4 Therefore, in my opinion, once the communities in the WMsZ have set acceptable N loss targets, then farmers in each catchment be given the opportunity to gradually reduce their N losses over time using cost effective

management practices and technologies to assist them, and demonstrating this through provision of Nutrient Management Plans to the Council, provided by accredited nutrient management advisors working with individual farmers.

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