BEFORE THE HEARING PANEL OF SOUTHLAND REGIONAL COUNCIL

In the matter of sections 88 to 115 of the Resource Management Act 1991

And

In the matter Applications for resource consents by:

WOLDWIDE FOUR LIMITED, WOLDWIDE FIVE LIMITED,
Applicants

BRIEF OF EVIDENCE OF ANTHONY HUGH COLEBY ROBERTS

16 September 2019

QUALIFICATIONS AND EXPERIENCE

1. My full name is Antony Hugh Coleby Roberts.

2. I am the Chief Scientific Officer at Ravensdown. Ravensdown is an agricultural servicing co-operative, owned by the shareholding farmers who purchase Ravensdown's products and services. Its business includes manufacturing, importing and selling fertilisers, ground and aerial spreading, and selling seed, animal health and agrochemical products. Ravensdown employs over 100 qualified staff who provide nutrient and environmental management advice to its shareholders and customers. Ravensdown also operates a subsidiary called Analytical Research Laboratories Limited (**ARL**), a commercial soil, plant and water testing laboratory.

3 I have a Bachelor of Agricultural Science (1st Class Honours) and a Doctor of Philosophy in Soil Science, both from Massey University, Palmerston North. 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. I am a Certified Nutrient Management Advisor.

4 Prior to joining Ravensdown in 2002, I was a practicing agricultural scientist for 22 years working for the Ministry of Agriculture and Fisheries, Agricultural Research Division. Initially I was a District Agricultural Scientist based in Taranaki from 1980 to 1988, and then I took a role as the Soils and Organics Group Leader in MAFTech at Palmerston North and Flock House in Manawatu/Rangitikei (1988 to 1990). I transferred 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 **AgResearch**).

5 My research and consultancy interests have included soil fertility, agronomy, heavy metal accumulation in agriculture, environmental performance indicator monitoring and interpretation, and waste utilisation or disposal to grazed pasture. I have also worked in Tasmania, mainland Australia, Japan, Niue, Chile and South Africa in the area of soil fertility management on commercial farm businesses.

6 I am the senior or a contributing author of 65 refereed journal articles or conference papers, and a further 70 scientific or extension conference papers. I have also authored chapters in 5 books, and 4 extension booklets.

7 Over the past 39 years I have conducted many soil fertility experiments and had an active consultancy role, particularly with pastoral farmers throughout the country, on soil fertility Over the past 39 years I have conducted many soil fertility experiments and 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.

8 In my current role, I am responsible for managing agronomic research and development for Ravensdown, training approximately 70 Agri Managers and other staff in soils, fertilisers and pastoral agriculture, as well as working with many of our Corporate and other farming shareholders.

9 I was one of the 5 scientists from AgResearch, who in 1993 under contract to the Ministry of Agriculture and Fisheries, conceived the original development of the model which is now known as OVERSEER. In 2012 I managed, on behalf of the Fertiliser Association of New Zealand (FANZ), a project to develop the Best Practice Data Input Standards (BPDIS) manual for users of OVERSEER. This was first published in 2013. Subsequently I chaired a multi-stakeholder BPDIS committee to ensure the Standards document kept pace with model changes, until the committee's dissolution in 2017. I was also on the Science Advisory Group (SAG) for OVERSEER until that group was also dissolved in 2018. Both these dissolutions have occurred because the structure of OVERSEER management has changed.

10 I have read, and agree to comply with, the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. Other than where I state that I am relying on the evidence of another person, I confirm that the issues addressed in this evidence are within my area of expertise. I have not omitted to consider material facts known to me that alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

11 This evidence is presented on behalf of the two applicants for consent at the dairy platforms known as Woldwide Four and Woldwide Five.

12 This evidence addresses the following issues:

12.1 Whether or not the OVERSEER nutrient budget model accounts for the cracking/swelling behaviour of Braxton soil siblings.

12.2 The 'uncertainty' of OVERSEER nutrient budget estimates of N loss below the root zone.

12.3 The appropriateness of OVERSEER for use in the current consent application.

13 The evidence that I will give on these issues is within my area of expertise.

BACKGROUND

Site visit

14 I have not visited the site nor am I personally acquainted with the Braxton soil siblings in the field but neither of these facts detract from the evidence and opinions I will present.

Other sources of information

15 I have also obtained and viewed the following information:

15.1 The Hearings Report of Ms Aurora Grant.

15.2 A Brief of Evidence by John Scandrett, dated 20th March 2019 which was presented in support of an effluent application consent for the De Wolde farm Woldwide One Ltd.

15.3 Report by Michael Killick appended in the Hearings Report, pages 901-915.

15.4 Statement of Evidence of Ms Belinda Meares appended in the Hearings Report, pages 235-253.

15.5 Water Quality Assessments report by Landpro in the Hearings Report (WW1&2) , pages 750-800.

15.6 Resource Consent Application to Southland Regional Council for Woldwide Four Limited and Woldwide Five Limited (prepared by Landpro Ltd.)

OVERSEER MODELLING

Braxton soil siblings

16 Ms Grant asserts in the Hearing Report section 1.1.10 (page 3) that "The dairy platform is located partly on the Central Plains physiographic zone with Braxton soils that have 'swell-crack' characteristics. Overseer (*sic)* does not accurately model nutrient losses from cracked soil which adds uncertainty to the accuracy of the Overseer (*sic*) modelling results and may mean calculated nutrient losses are underestimated."

17 I can confirm that OVERSEER not only does not, but cannot, include the cracking behaviour of the Braxton soil siblings for reasons that have been well documented in the evidence of Ms Belinda Meares paragraphs 60-63 (p250 in Hearings Report). To reiterate: OVERSEER is a long term annual average model using long term average annual rainfall data and long-term average monthly rainfall distribution data. The cracking propensity of the Braxton soils is a within year, short term rainfall affected occurrence which OVERSEER cannot model, and as noted in

both Ms Meares' and Mr Killick's evidence the cracking behaviour does not occur uniformly in terms of frequency, depth and length on soils prone to this behaviour.

18 The soil properties which OVERSEER uses, from the S map database for Braxton soil siblings, is appended (Appendix 1). There are no parameters available regarding the cracking/swelling behaviour of these soils.

19 The major mechanism of N loss from a dairy farm system is driven by N in urine patches of grazing animals and soil drainage. Urine contains urea produced by the animals from the ingested plant protein excess to requirement for growth and production. The soil cannot retain the large amount of urine N (equivalent to 700-1000 kg N/ha) once it has been converted by soil bacteria to nitrate and the pastures cannot utilise all the N either. When soils reach field capacity and further rainfall (or irrigation) occurs the soils will drain carrying the nitrate down the soil profile.

20 Ms Meares, in her evidence in paragraphs 19-26 (pp.240-242 in Hearings Report) has given a very detailed and clear explanation of the soil and hydrological factors which are important for solute movement i.e., matrix, preferential and overland flow. Essentially, for all these processes of solute movement to occur the soil needs to be either at or above field capacity, and then further water added (by rainfall or irrigation). In my opinion, this set of circumstances is highly unlikely to occur in dry summers when the cracking soils are most likely to exhibit that behaviour.

21 It is my opinion that the cracking nature of the Braxton soil siblings is of little consequence to the issue of N loss from urine spots and P loss as particulate P. This is because the cracking will occur when the soils are extremely dry i.e., over summer/autumn when soil drainage down macropores (i.e., the cracks) does not occur unless there is an episodic high intensity rainfall event. Both N and P (P attached to fine clay particles or dissolved P in solution) require soil water drainage to transport these nutrients down the soil profile.

22 Clearly, this could be a risk for the proposed slurry addition during the summer period. The dry matter (DM) % of the slurry averages around 8% and will be applied at approximately 2mm or 20000 l/ha (A de Wolde, *personal communication)* while the DM% of FDE is typically 1-2% (Professor K Cameron, *personal communication).* Ms Meares discusses the risks around FDE application on cracked soils in her evidence (paragraphs 44-47, pp.247-248 in Hearings Report). Despite the fact that slurry has a higher DM content than FDE there is still some risk of slurry also entering soil cracks. I support a precautionary approach to slurry application when these soils are cracked.

23 Mr Killick made the comment in parenthesis on page 909 of the Hearings Report that "The depth of the cracks could not otherwise be ascertained as it was not visible from the surface and the

soil structure and cracks collapsed easily with digging". This suggests, in my opinion, that even if a summer/autumn high intensity rainfall event occurred on cracked Braxton soil siblings it is likely that the cracks would rapidly collapse and be sealed with soil material by the energy of the rainfall.

The 'uncertainty' of the OVERSEER nutrient budget estimates of N loss below the root zone

24 Ms Grant, in paragraph 1.1.10. under the title "Uncertainty around relevance and accuracy of modelled losses shown by Overseer (*sic*)…." appears to be using this as one of the reasons for rejecting the application.

25 The question of OVERSEER uncertainty was, in my opinion, fully addressed in the Landpro report appended in the Hearings Report (pages 790-791). Paragraphs 7.5 to 7.10 provide useful information for the Hearing to consider but this appears to have not been accepted by Ms Grant.

26 In paragraph 7.8 of the Landpro report (p791 of Hearings Report) the uncertainty (or error) of OVERSEER is quoted as probably greater than 30%, but also points out the uncertainties are currently not able to be quantified. This figure of 30% is often quoted in the public domain and has its origins in the mid-1990s.

27 The Fertiliser Association of New Zealand (FANZ), at the time known as FertResearch, contracted Dr Stewart Ledgard, the original progenitor of the N sub model of OVERSEER, to define the error associated with the N leaching estimate from one of the very early versions of OVERSEER. Dr Ledgard reported that his estimate of error was $\pm$ 25%. This error estimate appeared (as a foot note in small print) on nutrient budget reports for several years after. Over time this estimate morphed to 30%.

28 Since then the way OVESEER calculates N leaching, by estimating soil drainage rather than leaching being driven by rainfall/irrigation volumes, changed between earlier versions (i.e., OVERSEER 5 and its predecessors) to OVERSEER 6. There have been several suggested attempts to try to quantify OVERSEER uncertainties but to date, none have borne fruit.

29 No models give certain answers and OVERSEER is no exception. Believing that the N loss numbers estimated by OVERSEER are what actually leaves the root zone is a common mistake that has been made by regulators up and down the country. The certainty of OVERSEER estimates is compromised by limitations in accurate input parameters, in scientific knowledge as well as the ability of mathematical modelling to fully describe biological processes.

The appropriateness of OVERSEER for use in the current consent application

30 Despite the foregoing discussion of OVERSEER uncertainties, in terms of estimating relative nutrient losses over time for grazed pastoral farm systems at quasi-equilibrium the OVERSEER model is currently the best we have and when used appropriately is fit for purpose as one tool to help both landowners and councils inform actions to reduce nutrient loss from the root zone.

31 The model is not at fault when the outputs from the model are used for a purpose that ignores the limitations associated with the ability to obtain accurate input data and the science used to build the algorithms. The biggest error is to use the estimated N loss figure as an absolute value (for consent purposes) for all the reasons explained regarding uncertainty and because that estimate has and will change as new science is added to OVERSEER (i.e., version change). When the N loss estimate from OVERSEER changes from one value to another, due to version change, for the same property with all the same inputs this simply means that the estimate of what leaves the root zone has changed not that more or less N reaches receiving waters – that amount is still the same, whatever it is. Of course, with version change it is hoped that the estimate of N loss from the root zone is improved to more closely reflect the actual value.

32 Both the Landpro report (paragraph 7.10, p791 in Hearing Report) and Ms Meares (paragraph 59, p250 in Hearing Report) advocate that in essence it is the N loss relativity between different scenarios or the N loss trend over time for the same property that is a key strength of OVERSEER in providing information for landowners and regulators to judge progress in reducing loss of N to the receiving environment.

33 In the case of this consent application, the Hearing has been provided with OVERSEER output from the existing Woldwide farm systems and then new scenarios which are the subject of these consent applications.

34 It is my professional opinion that this is a valid way of showing the differences in N loss estimates between the existing and new dairy farm systems despite the expressed concerns by Ms Grant and Ms Meares, regarding such matters as the inability of OVERSEER to account for localised effects such as cracking soils and by pass flow.

35 The reason for this professional opinion is because the existing and new scenarios are modelled with exactly the same soil and climatic input information. In other words, you are comparing apples with apples with respect to the important properties which will affect solute movement on both these systems. What has changed between the scenarios are the farm management factors. While (as already discussed) the OVERSEER estimates of N loss cannot quantitatively estimate the absolute N loss from the root zone, the quantitative <u>difference</u> between the existing and new scenarios can be treated with confidence. By this I mean if the new scenario shows a similar or decreased N loss then this should be accepted as a fair and reasonable effect of the changed system.

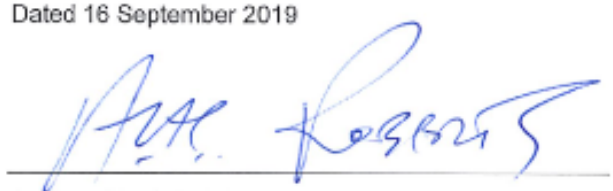
CONCLUSION

36 The OVERSEER nutrient budget model does not, and indeed cannot, account for the cracking/swelling behaviour of the Braxton soil siblings. The long-term quasi equilibrium nature of the model using long term average annual and monthly climate data does not allow for the model to accommodate short term, ephemeral within season weather induced soil property changes. It is unlikely that soil drainage occurs to any great extent in dry summers when the cracking may be evident.

37 The output estimates of the OVERSEER model have inherent uncertainties. There are multiple factors why this is, not least of which is the certainty of the input data, the gaps in scientific knowledge and the ability of mathematical algorithms to replicate biological systems. There is no measure of this uncertainty for the current OVERSEER version.

38 The fact that OVERSEER cannot replicate the cracking behaviour of Braxton soil siblings and that there is uncertainty around the N loss estimates produced by the model in no way invalidates its use in this Consent application. This is because it is the difference in N loss between the existing and proposed farm systems that is the important consideration because both scenarios are modelled with the identical soil and climate input data. Whether the actual N loss estimates are correct or not (and most certainly are not) is not the issue.

Dated 16 September 2019



Anthony Hugh Coleby Roberts