BEFORE THE	Canterbury Regional Council
IN THE MATTER OF	the Environment Canterbury (Temporary Commissioners and Improved Water Management) Act 2010
AND	
IN THE MATTER OF	Submission and Further Submission on Proposed Variation 1 to the Proposed Canterbury Land and Water Regional Plan

STATEMENT OF EVIDENCE OF LIONEL JOHN HUME ON BEHALF OF THE NORTH CANTERBURY PROVINCE OF FEDERATED FARMERS OF NEW ZEALAND

Dated 29 August 2014

Introduction

Qualifications and experience

1. My name is Lionel John Hume. I hold B.Ag.Sc and M.Sc. (First Class Hons) degrees from Massey University and a Ph.D. (Plant Science) from Lincoln University. I am currently employed as a Senior Policy Advisor, by Federated Farmers, based in Ashburton. I am also a board member of Irrigation New Zealand.

2. I previously worked as a scientist for the Department of Scientific and Industrial Research (New Zealand Soil Bureau/DSIR Land Resources) in the areas of plant nutrition and soil fertility. Specific areas of scientific research experience include:
   a. nutrient uptake and use by plants – particular emphasis on nitrogen and phosphorus;
   b. nutrient availability from soils;
   c. effects of soil acidity (particularly aluminium toxicity) on nutrient uptake and symbiotic nitrogen fixation;
   d. nutrient, water and management factors affecting the growth and competitiveness of major weed species;
   e. effects of soil physical properties on plant growth; and
   f. experimental design and data analysis.

3. I am a member of the NZ Institute of Agricultural and Horticultural Science, the NZ Society of Soil Science and the Agronomy Society of NZ.

4. Currently I am a member of Federated Farmers' Regional Policy team and have ten years experience of working with regional water planning processes, including: the Natural Resources Regional Plan process (from submission through to resolution of High Court appeals); development of the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 and membership of the implementation taskforce for those regulations; the development of catchment-based flow and allocation plans for several Canterbury catchments; the development of the Canterbury Water Management Strategy; and, recently, the Regional Policy Statement and Land and Water Regional Plan processes, including several catchment based limit-setting processes.

Code of Conduct

5. Notwithstanding that this is a Regional Council hearing, I have read the Environment Court Code of Conduct for expert witnesses and agree to comply with it. I confirm that I have not omitted to consider materials or facts known to me that might alter or detract from the opinions I have expressed.

Scope of evidence

6. My evidence covers the following matters:
   a. Potential environmental impacts of farming;
   b. Soil water and water availability to plants;
   c. Reliability of water supply and its importance to efficient water use;
   d. Fluctuation of N discharge from soils in response to climatic variation and the cyclical nature of routine farming operations;
   e. Canterbury soils - the predominance of stony soils vulnerable to drainage and nutrient loss;
   f. N discharge allowance – the need to take soil type into account;
   g. Flexibility threshold – to enable low N dischargers the flexibility to carry on normal farming operations and make reasonable land use changes; and
   h. Matrix of Good Management.

Potential environmental impacts of farming

7. Potential environmental impacts of farming on water quality include loss of nutrients (particularly N and P), sediment and harmful bacteria (indicated by *E. coli*) from soils.

8. N in nitrate form is highly soluble, will move anywhere that water goes and is vulnerable to loss via drainage. Therefore, the most effective methods of minimizing N loss are to match N supply with plant demand (to minimise the pool of N vulnerable to leaching) and to minimise drainage.

9. P is less soluble and tends to move with sediment. Phosphorus and sediment risk areas (associated with heavier soils and sloping land) are identified in the LWRP Selwyn Waihora Map Series (p 6-1 to 6-15 in Proposed Variation 1). Methods to minimise sediment and P loss are to minimize surface flow of water containing suspended sediment, P and *E. coli* (where present) by avoiding over-irrigation, by

maintaining vigorous vegetation cover and via riparian management aimed at intercepting sediment and phosphorus (and *E. Coli* where present) before they enter waterways.

10. Soil is an effective filter for *E. coli*, but these organisms can occasionally enter shallow groundwater via large soil pores and other preferential pathways (such as poorly protected well-heads).

11. Farm Environment Plans (FEP's) are a powerful tool for addressing the loss of nutrients (mostly N and P), sediment and harmful bacteria (indicated by *E. coli*) from soils because they are able to address these issues in the context of particular land uses in particular farming environments. However, FEP's come with a cost and capacity to produce them is limited (because of a limited number of suitably qualified personnel). Therefore, their use as a regulatory tool is best focused on properties where significant nutrient, sediment or *E. Coli* discharge issues are likely to arise.

Soil water and water availability to plants

12. Water is crucial for plant growth and to sustain agricultural production. An understanding of how water is stored in soils and its availability to plants is essential in order to be able to manage it effectively, to optimize plant growth, and minimize drainage and consequent dissolved nutrient loss.

13. Field capacity has been defined as the amount of water that a well drained soil holds against gravitational forces, when downward drainage is markedly decreased. However, it is recognized that field capacity is an imprecise term and that true equilibrium is never reached. Although it varies with both soil type and conditions such as temperature, field capacity is often estimated to be the water held at a soil water potential (or suction) of -33 kPa. This is a measure of the energy that has to be used to extract water from the pores in a soil.

14. As soils dry out, the energy required to extract water increases to a point where plants wilt and do not recover overnight. This is known as permanent wilting point and generally occurs at about -1500 kPa. The water held in a soil between field capacity and permanent wilting point is known as plant-available water. However, water is not equally available over this entire range and extraction becomes increasingly difficult as permanent wilting point is approached. Once about the first half of plant-available water

is used, the increasing energy required to extract further water results in decreased plant growth and decreased crop yield. In order to optimise plant growth, irrigation needs to be scheduled to keep plant available water above the 50% mark. Obviously there is less margin for error in this regard on soils with less plant available water.

15. The quantity of plant-available water is dependent on soil type, including factors such as:
    - Soil texture – fine textured soils tend to retain more water than coarse textured soils.
    - Soil structure – the degree of aggregation of primary soil particles into structural units. Organic matter assists with the development and maintenance of good soil structure and increased plant available water.
    - Stones – stony soils retain less water than soils without stones (because of lesser soil volume). This is an important issue for Canterbury soils where some horizons may contain more than 50% stones.
    - Soil depth – deep soils retain more water than shallow soils (because of greater soil volume).
    - Impermeable or slowly-permeable layers – may prevent or reduce water movement through the soil profile and therefore drainage from it.

16. Soils which have the capacity to store less plant available water are more vulnerable to loss of water (and dissolved nutrients) via drainage compared with soils which have greater plant available water. The reason for this is that there is less 'buffering capacity' in soils with less water storage and therefore less capacity to store incoming rainfall without drainage losses. On soils which are irrigated, there is less capacity to deficit irrigate (leaving capacity to store incoming rainfall by not watering up to field capacity) where there is less water storage.

17. Therefore, irrigating little-and-often, using soil moisture monitoring, is likely to result in more efficient use of irrigation water for plant uptake and less potential for soils to exceed field capacity and leach nutrients, compared with less frequent application of greater quantities.

Reliability of water supply

18. Access to a reliable water supply is crucial to efficient water use, especially on the moderate to very light stony soils in Canterbury which tend to have low water storage

and moderate to rapid permeability. A constantly available, reliable water supply encourages investment in modern irrigation technology and enables little-and-often approaches to the application of irrigation water (referred to previously). It also removes the need for use-it-or-lose-it approaches to irrigation which are encouraged by intermittent and unreliable supply. If it is known that water will be available when it is needed, the appropriate amount can be applied when it is needed ('just in time' rather than 'just in case'). Reliability of supply also encourages the use of deficit irrigation (e.g. to leave storage capacity for expected rainfall) by providing the assurance that further water will be available if the expected rainfall does not eventuate.

19. Reliable water supply enables communities to maximise the benefits from irrigation. For example, it enables the development of high value arable and horticultural production systems where crop loss (decrease in yield or quality) or failure could occur if water is not available in the right quantity at the right time.

20. When irrigators have less reliability they tend to use greater quantities of water when it is available, hoping that will provide sufficient soil moisture and plant growth to minimise the impacts of possible future shortage (such as restrictions on takes related to minimum flows).

21. Reducing the reliability of water supply for irrigators from 90% to 85% in Proposed Variation 1 reduces the allocated annual volume by up to 13% (depending on soil type and type of irrigation)[1]. In my opinion this discourages the efficient use of irrigation water that is crucial in a catchment which is deemed to be over-allocated for both water quantity and water quality.

Fluctuation of N discharge

22. N discharge will fluctuate from year to year under constant land use (farming activity). Fluctuations result from:

- Climatic variation, especially rainfall[2]:
    - Variation in drainage and consequent N loss (e.g. resulting from heavy rainfall events). This will be more pronounced on soils with relatively less plant available water.

[1] Aqualinc Research Ltd Memorandum, July 2014: Modelled irrigation demand changes – 90th percentile vs 85th percentile.
[2] http://resources.ccc.govt.nz/files/NaturalHazards_1758_AnnualRainfall-docs.pdf

- Surface flow events where incoming rainfall exceeds the infiltration capacity of the soil. This may result in loss of sediment and P, as well as dissolved N.
- Variation in plant growth (crop yield), plant N uptake and urine deposition (in the case of livestock farming) as influenced by varying conditions for plant growth, availability of animal feed etc.

- Cyclical variation in farming operations, including:
  - Crop rotations.
  - Livestock changes in response to market signals.

23. In order to be workable, any regulatory regime to manage N loss should recognise the seasonal fluctuations which occur as part of biophysical systems and in response to market signals. Such fluctuations may occur over an extended period, longer than four years (being the duration of the 2009-2013 "nitrogen baseline" period and the 4 year rolling average "nitrogen loss calculation" period). These fluctuations in N loss are conceptually different from the sort of change which arises from a radical change of land use, from one with inherently low rates of N loss to another with substantially greater (perhaps several fold) rates of N loss (such as a change from dry-land sheep and beef farming to irrigated dairy farming). It is these gross changes in land use and associated N loss that will have the greatest long-term impact on water quality.

Canterbury soils

24. Soil type is a key factor influencing drainage and the loss of soluble nutrients (especially N) in Canterbury. Canterbury has 890,000 ha of stony soils (soil depth less than 45 cm to gravels), which are classified moderate, light or very light (in terms of their primary soil class)[3]. These soils occupy 64% of the total land area in Canterbury that could potentially be used for intensive agriculture (less than 15 degree slope). They have moderate to rapid permeability, and a large proportion have low water storage (less than 60 mm or 60-90 mm for very light and light soils respectively). Therefore, these soils are vulnerable to drainage and consequent loss of soluble nutrients. In 2012, 143,000 ha of Canterbury's stony soils were used for dairy farming and 196,000 ha were under irrigation. While the numbers quoted refer to the whole of Canterbury, in percentage

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[3] Carrick, S.; Palmer, D.; Webb, T.; Scott, J.; Lilburne, L. 2013: Stony Soils are a Major Challenge for Nutrient Management Under Irrigation Development. In: Accurate and efficient use of nutrients on farms. (Eds L.D. Currie and C.L. Christensen). Occasional Report No. 26. Fertiliser and Lime Research Centre, Massey University, Palmerston North, New Zealand.

terms they are equally true for Selwyn Waihora, where shallow stony soils occupy most of the land area north-west of State Highway 1.

25. The contrast between very light to moderate stony soils and heavier soils is stark. In a study of nitrate leaching from cow urine patches in Canterbury, leaching from a Lismore shallow and stony soil (at the better end of stony soils in terms of its water storage capacity) was double that from a stone-free Templeton soil[4&5].

26. Therefore, it is crucial that soil type is taken into account when establishing N discharge limits or thresholds in a planning context.

N discharge allowance

27. If the vision to be achieved is to "restore the mauri of Te Waihora while maintaining the prosperous land-based economy and thriving communities", a large proportion of the productive potential of Selwyn Waihora (and the wider Canterbury region) and its soils will need to be maintained. In order for the productive potential of soils to be expressed, it will need to be accepted that, even with a high standard of management, there will be greater drainage of water and soluble nutrients (especially N) from some soils than others. Therefore, if we wish to maintain the productive potential of soils in the Selwyn Waihora catchment, it is important for Variation 1 to allow for greater rates of N discharge from those soils with a greater vulnerability to drainage (i.e. the stony soils classified very light through to moderate, discussed previously). These soils have the potential to be highly productive and make up approximately 64% of the area of the land with potential for intensive land use in Canterbury. Again, while this percentage refers to the whole of Canterbury, it is at least equally true for Selwyn Waihora where shallow stony soils occupy most of the land area north-west of State Highway 1.

28. If the very light, light and moderate soils are unable to be used to their reasonable potential, this would potentially have a major adverse social and economic impacts on Selwyn Waihora and the wider region. This was highlighted in 'scenario 3' of the Selwyn Waihora limit-setting process where measures required to reduce the trophic level index of Te Waihora to 6.0 were explored. This scenario featured very low

[4] Di, H.J. and Cameron, K.C. 2005: Reducing environmental impacts of agriculture by using a fine particle suspension nitrification inhibitor to decrease nitrate leaching from grazed pastures. Agriculture, Ecosystems & Environment 109, 202-212.

[5] Di, H.J. and Cameron, K.C. 2007: Nitrate leaching losses and pasture yields as affected by different rates of animal urine nitrogen returns and application of a nitrification inhibitor – a lysimeter study. Nutrient Cycling in Agroecosystems 79, 281-290.

intensity sheep and beef farming on the extensive areas of light to extremely light soils, with no irrigation and no N fertiliser application. Under this scenario, most income was generated from very intensive dairying, on good soils (with less vulnerability to drainage), using advanced mitigation. While, under this scenario, the regional contribution to GMP was greater than the 'current' situation, it was considerably less than 'scenario 2' where a lesser level of intensification, with less advanced mitigation, was assumed across the whole catchment. 'Scenario 3' also involved considerable capital costs of transition and considerable social disruption.

Flexibility threshold

29. The purpose of a flexibility threshold is to allow low N dischargers the flexibility to carry on with their normal farming operations, which are typically cyclical in nature and to make reasonable changes in land use (without converting to a high N discharge land use) in response to market signals. For the reasons stated previously, the proposed 15 kg/ha/yr threshold gives greater flexibility to those on deep, fine textured soils or poorly drained soils (which have less vulnerability to drainage) than to those on shallow, coarse textured soils (which have greater vulnerability to drainage).

30. Recognising the linkage between soil type and potential N loss will enable the management of N loss in a way that is more equitable to land users. If the thresholds are set appropriately, this will enable reasonable flexibility of land use on all soil types, without allowing for conversion to high N loss activities without further scrutiny. In my opinion, a tiered approach based on soil types, of 15 kg/ha/yr for heavy and medium soils and 20 kg/ha/yr for light and very light soils would help to achieve that outcome.

Matrix of Good Management

31. The Matrix of Good Management (MGM) project is currently being undertaken by Environment Canterbury in partnership with the primary sector. The main purpose of the project is to quantify and benchmark nutrient (especially N) losses from farms across Canterbury's soils and climates. It will define what can reasonably be expected in terms of nutrient discharges from various combinations of land use, soil type, climate and topography, and identify a range of management practices designed to minimise nutrient discharge.

32. The MGM project should provide a great deal of useful information to assist with managing N loss, setting catchment limits and establishing N reduction regimes where these are required. It will provide key information about which combinations of land use and land use practices are likely to meet various N loss targets and, therefore, about the likely social and economic effects of different catchment limits and N reduction regimes.

33. The MGM benchmarks should provide an ideal basis for planning rules which:
- Recognise the investment in existing land use.
- Enable the productive potential of all land to be expressed – within the constraints of soil type, climate and topography, recognizing that water and nutrient deficiencies can, and mostly will, be overcome.
- Allow for nutrient discharge only where it cannot be avoided without frustrating reasonable land use.
- Assume an appropriate level of good management practice.
- Facilitate flexibility of land use and enable regional economic wellbeing.
- Assist with achieving the stated vision for the Te Waihora/Lake Ellesmere catchment.

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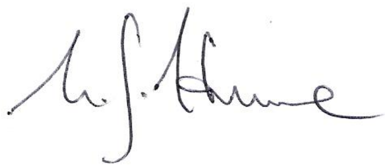

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