BEFORE THE INDEPENDENT COMMISSIONERS

IN THE MATTER of the Resource Management Act (1991)

AND

IN THE MATTER of the proposed Waikato Regional Plan Change 1 – Waikato and Waipa River Catchments and Variation 1 to proposed Plan Change 1

AND

IN THE MATTER of the submission by Mr Micheal Joseph Peters Submitter 74197

BRIEF OF EVIDENCE OF DOUGLAS CHARLES EDMEADES

10 May 2019

QUALIFICATIONS AND EXPERIENCE

1. My name is Douglas Charles Edmeades. I hold the following qualifications: MSc (Hons) in chemistry (University of Auckland), PhD in soil science (Canterbury University) and Diploma in Management (University of Auckland).

2. Initially (1976) I was employed as a soil scientist at Ruakura Agricultural Research Centre (Research Division, Ministry of Agriculture and Fisheries). I became Group Leader (Ruakura Soils and Fertiliser) in 1988 and, with the formation of AgResearch Ltd, (1992) I was made National Science Leader (Soils and Fertiliser).

3. In 1997 I left AgResearch and established my own company agKnowledge Ltd, of which I am the Managing Director.

4. agKnowledge provides farmers with a) nutrient management and fertiliser advice (throughout New Zealand), b) publishes technical information for farmers and consultants (the Fertiliser Review) and c) undertakes research on behalf of clients. In this private capacity I continue to publish research papers in the scientific literature.

5. My speciality is soil fertility, plant nutrition and, fertiliser chemistry and agronomic effectiveness. Cumulatively I have 40 years of experience in this area of expertise and have written over 100 research papers, several book chapters and one book.

6. My full CV is annexed (Annex 1).

7. I have received the following awards: ANZAC Fellow (1985); Federated Farmers Personality of the Year (2012). Officer of the New Zealand Order of Merit (ONZM) (2013). Hamilton City Council, Kudos, Agricultural Science Award (2014).

CODE OF CONDUCT

8. I have read Schedule 4 Code of Conduct for Expert Witnesses and agree to abide by its requirements.

SCOPE OF EVIDENCE

9. I am providing expert evidence on behalf of Mr Mike Peters a farmer from Te Kauwhata

10. In particular I will be offering expert opinion on:

    a. The use of Overseer in a regulatory setting.

b. The importance of sub-catchment analysis in respect to managing water quality

c. The over-emphasis of N in the proposed PC1

d. The inappropriateness of using LUC as a means of allocating N loadings.

e. Some suggested modifications to the proposed PC1 to circumvent its' current weaknesses.

THE USE OF OVERSEER IN A REGULTORY SETTING

11. I was appointed Group Leader (Soils and Fertiliser), Ruakura, MAF Research Division in 1988 and then in 1992 became the National Science Leader (Soil and Fertiliser), AgResearch. I was instrumental in the design and development of the original OVERSEER model.

12. OVERSEER was designed as a 'Decision Support System' to enable Farm Consultants to do "what if" analysis to assess the effects (both positive and negative) of changes in farm management on the likely N leached on an average annual time- step. In the international context, and for the purpose it was designed, OVERSEER is 'leading edge technology'.

13. As with any model attempting to describe biological processes, its predicted outputs (e.g. kg N/ha/yr) are subject to 'noise' – errors. In its initial versions it was made clear that error in the estimated N leaching losses was about +/- 30%.

14. It is informative to consider the two types of error which occur when using Overseer (refer to the article "Overseer" in the Fertiliser Review 31, Annex 2).

15. Type A errors comprise all the errors associated with getting the input data correct, plus the errors due to the uncertainty per se in the models. These can be typically of the order of 40-60%. But can in the extreme be much higher (>100%) if the incorrect input data is used, inadvertently or otherwise (see examples in Fertiliser Review 31).

16. Type B errors comprise all the variability associated with measuring nitrate leaching in the field (+/- 20-30%).

17. PC1 proposes (Rule 3.11.5.3 (1)) to set *absolute* discharge limits for N (Nitrogen Reference Points, NRP) for each farm. The 'errors' in Overseer mean that there will always be considerable uncertainty as to whether the specific NRP is met or otherwise. Litigation is a likely outcome.

18. There is no consideration about the management of the errors in the estimates of nitrate leaching from Overseer in either in PC1 or the Section 32 Evaluation Report. Indeed the Section 32 Evaluation Report (page 148) states that having an "absolute" number (for the NRP) has the advantages of providing "the community with the sense of a clear quantum of N being capped….!"

19. The uncertainty in the predicted N losses is exacerbated because Overseer undergoes version changes over time. These changes are necessary to remove 'bugs', improve its functionality and importantly, to incorporate new science. The consequence is that for a given set of input data, the predicted nitrate leaching can change, either up or down, depending on which version of Overseer is used. This is one of the problems that beset the implementation of Horizons 'One Plan'. There are methods to minimize the effects of version changes on prescribed NRP levels but none are currently included in PC 1.

20. PC1 proposes to use 'grandparenting' to allocate N loadings at the farm level. (Schedule B). These will be based on the predicted N leaching losses estimated by Overseer for the two seasons 2014/15 and 2015/16, taking the higher of the two estimates. This system is crude, unfair and inequitable because it rewards in perpetuity the least efficient N users and punishes the most efficient users.

21. The problems identified above are dismissed in the Section 32 Evaluation Report (page 148) because solving them "would require additional resources" and that the "…..public perception could be that landowners are not complying with property limits if nitrogen leaching limits change."

22. In my opinion:

    a. Overseer should not be used in a regulatory setting. It is best used for qualitative analysis where the concern in not the absolute number but the effect of changing farm management practices can have on the likely trends (either up or down) in N leaching (see para 55)

    b. Overseer can properly be used to undertake qualitative what-if-analyses, if required, for a given sub-catchment where N is identified as a limiting nutrient in a given sub-catchment.

c. When Overseer is used to estimate rates of N leaching, an estimate of the error should also be given.

d. 'Grandparenting' should not be used to set NRPs

e. That other methods should be explored to allocate N losses to given farms within sub-catchments (see para 54 and 55).

f. That, when used, the predicted N leaching losses from Overseer are expressed as qualitative ranges (e.g. 10-20, 20-30, 30-40 etc.) to reflect the uncertainty in such estimates.

SUBCATCHMENT MANAGEMENT (THE NEED FOR FORENSIC ANALYSIS)

23. PC1 proposes (3.11.3 Policy 9) that "…. a prioritized and integrated approach to sub-catchment water quality management…. " will be adopted. Then at "Implementation 3.11.4.5" it states that the "Waikato Regional Council will work with others to develop sub-catchment scale plans…."

24. The purpose for these sub-catchment plans appears to be (see sections a-g), although it is not made clear, to prioritize which of the 4 contaminants, or combination of contaminants, is the cause for the poor water quality and plan the appropriate mitigation options reflecting the biophysical properties of the sub-catchment.

25. To emphasise this point the Land & Water Forum 3rd Report is clear:

26. "Regional Councils should ensure freshwater objectives and limits are achieved through the following steps in the regional planning process:

    a. Identify the contaminants of concern in the catchment.

    b. Identify the total load of each contaminant of concern and all sources by way of a catchment contaminant account.

    c. Identify the respective contributions to the load from natural background and human induced sources.

    d. Consider temporal and spatial aspects of contaminant management.

e. Consider the inter-relationship between hydrology and water quality."

27. Applying these recommendation from the 3rd Land & Water Report to the subcatchment approach proposed in PC1 appears to be contradictory to the pan-regional approach embedded in the proposed PC1, which currently attempts to mitigate the losses of all 4 contaminants, in all reaches of the Waikato River catchment area, irrespective of whether this is required to reach the 80-year water quality goals for the Waikato River.

28. The importance of adopting a subcatchment forensic approach is apparent in an analysis I undertook on behalf of the Primary Stakeholders Catchment Trust for the Lake Waikare & Whangamarino subcatchment (The full report is attached, Annex 3)

29. The long-term water quality data collected by the Waikato Regional Council from 5 sites within this subcatchment were summarised and compared to the PC1 80 yr. water quality targets set for the Waikato River at the Mercer Bridge monitoring site. This site is immediately downstream of the outfall of this subcatchment into the Waikato River.

30. In brief, this analysis showed that:

    a. Nitrogen (N) was not a factor affecting the water quality in this subcatchment, relative to the PC1 80 yr. goals.

    b. Sediments and P are the major contributors from this subcatchment that affect the water quality in the Waikato River at the Mercer Bridge, relative to the PC1 80 yr. goals.

    c. The water quality, with respect to P and sediments declined as the water passed through Lake Waikare and Wetland from the pastoral area in this subcatchment.

    d. Approximately 55% of the P (and by implication sediment) came from farmland and the balance (45%) was from within Lake Waikare and the Whangamarino Wetland.

    e. It is likely that the koi carp, by disturbing the banks and lake bed, are a major factor affecting the

amount of P and sediment entering the Waikato River from this subcatchment.

f. Removing the koi carp could achieve the water quality goals set for this subcatchment, and for the Waikato River at the Mercer Bridge, at small expense relative to the cost of land-based mitigation options (e.g. fencing the upper reaches of the streams in the subcatchment).

g. This analysis has major implications in terms of management of the water quality in this subcatchment, with respect to the relevant water quality goals set in PC1 to be achieved within 80 yrs.

31. It is possible that other subcatchments in the lower reaches of the Waikato River, and along the Waipa River, will have a similar water quality profiles (i.e. sediments and P and not N are the major factors limiting water quality).

32. If this is so, the need for NRP, Grandparenting and hence the use of Overseer may be unnecessary in many of the 74 subcatchments along the Waikato River, to achieve the water quality targets, as set out in PC1 year 80.

33. It is recommended that PC1 be re-written to unambiguously reflect this sub-catchment forensic approach to water quality management and make explicit the recommendations of the 3rd report of the Land & Water Forum, which requires that the 4 contaminants be prioritized in terms of their likely effects on water quality in a given subcatchment and in the Waikato River.

34. This forensic approach could greatly reduce the cost of 'cleaning up' the Waikato River by ensuring that mitigation options are introduced only as and when required to achieve the 80 year water quality goals.

35. It is recommended that PC1 when revised, reflects the fact that some sub-catchments may not require N mitigation and hence the need for Grandparenting, NRPs and the use of the Overseer N model, may not be required.

OVER EMPHASIS ON NITROGEN

36. Currently PC 1 places emphasis on managing N, almost to the exclusion of P and the other two contaminants - sediment and pathogens. This is reflected in PC 1 (Rule Section 3.11.5.3

(2) and Schedule B) the need for farm-level "Nitrogen Reference Points" (NRP), "Grandparenting" and the use of the "Overseer" nutrient management model (or any other approved model).

37. However the Section 32 Report (C.2.2.6) states "…phosphorus is more important than N in controlling annual median phytoplankton biomass…"

38. The Technical Leaders Group (TLG) dismissed Olsen P and the P runoff model in Overseer as a potential means of managing P runoff (Section 32 page 146-147) because there is 'insufficient confidence' to apply them to a quantitative property-level regulation."

39. This is a surprising conclusion. Overseer does incorporate a P loss model. A major factor determining P runoff is the soil P concentration (Olsen P test), which is routinely measured on farms. The CV for Olsen P is about 20%, assuming the correct soil sampling protocol is followed.

40. Thus the errors in predicting P runoff using Overseer are likely to be as reliable as the Overseer-predicted N leaching loss.

41. Notwithstanding the above a tool (Mitigator) has now been developed to estimate P losses at the farm levels. It is more precise than the Overseer P loss model because it takes into account the spatial nature of P losses (e.g. P hotspots). In revising PC 1 it is recommended that Mitigator should be considered as an on farm management tool.

LUC AS AN ALLOCATIVE TOOL FOR N.

42. This issue has arisen in the Section 42 A report (B 1.3.3 para 144). It appears that there is still some support for this approach.

43. I believe it is appropriate for me to comment on this matter given the evidence I presented to the Commissioners in the case of the Horizon One Plan in 2012, and given the problems that have arisen in implementing Horizon's One Plan which uses LUC as the basis for allocating N losses.

44. LUC classes were introduced in the 1950's as an adjunct to soil maps. Soil maps were useful in terms of defining NZ soil resources but soil-mapping units did not necessarily infer anything in respect to the potential land use and productive capacity of the soils. Importantly, LUC classes were

specifically based on the potential to grow clover-based pastures.

45. These estimates were based on the 'best available information and technology' available at that time. In other words the definitions and descriptions of LUCs are time-bound and in particular represent the 'best guess' scientists were able to make some 40-50 years ago.

46. Our current understanding is that the amount of nitrate leached, or to be more correct, the amount of nitrate leached into the drainage water of the soil can be written as:

    Nitrate leached is a function of the management of: *Landscape, Farm type, Farm system, Animal, Pasture, Soil, Fertiliser and Effluent.*

47. The components of each category are set out in the table below:

Category	**Components**
Landscape	Riparian buffers & Wetlands (natural & man-made)
Farm Type	Dairy, Sheep & beef, Cropping
Farm System	In situ gazing, partial grazing (standoff pads), nil grazing (herd homes),
Animals	Stocking rate, types of supplements with various N contents, wintering on or off.
Pastures	Clover content, pasture types (rooting depth) pasture production & utilization
Cropping	Cultivation technique, timing, fertiliser N practice.
Soil	Irrigation, drainage, soil fertility, pugging management, erosion management.

Effluent	System type and management, pasture or cropping.
Fertiliser	Amount & timing of N fertiliser.

48. For emphasis, LUC per se is not a factor listed in the above for obvious reason that nitrate leaching is determined by a group of factors much broader than those that determine LUC

49. It was my opinion then, as it is now, that the LUC approach for allocating N losses is fatally flawed.

APPLYING A SUBCATCHMENT APPROACH

50. As noted (para 23) PCI proposes a subcatchment approach and that the "Waikato Regional Council will work with others (one assumes the land owners in the subcatchment) to develop sub-catchment scale plans…."

51. Applying the recommendations from the 3rd Land and Water Forum report to this approach would mean that Subcatchment Plans would be developed for each of the 74 subcatchments.

52. The WRC has long-term water quality monitoring sites in most of these subcatchments and a 10 sites along the length of the Waikato River.

53. PC1 sets out the 80 yr. water quality goals required for each subcatchment and along the Waikato River.

54. It should be possible to compare this long-term water quality data to the 80 yr. water quality goals and hence determine which contaminant (s) is (are) limiting the water quality in each subcatchment.

55. Based on this analysis, a water quality management plan could be developed for each subcatchment.

56. This subcatchment plan would then inform the landowners and the Regional Council as to what

specific mitigation options are required to achieve the 80 yr. water quality goals.

57. Armed with this information, the land-owner, with the assistance of his farm consultant, could prepare a Farm Management Plan (FMP) outlining the farm specific mitigation options consistent with the subcatchment plan.

58. If for example, N is identified as the major contaminant Overseer could then be used in a qualitative sense to determine which on farm N mitigation options to apply.

59. Alternatively, if P and/or sediments were identified as the cause for poor water quality the landowners may then decide to developed a large wetland at the base of the subcatchment rather than fencing off large tracts of land in the subcatchment headwaters.

60. There are many benefits which extend from this approach:

    a. It would avoid unnecessary application of grandparenting, NRP and the use of Overseer in a regulatory role.

    b. It would give the landowners in any given subcatchment flexibility over what mitigation options are best for their land and their subcatchment.

61. The Regional Council would remain in control of the process via:

    a. Their ongoing measurements and trend analysis of the water quality in the main rivers and in the subcatchments.

    b. Subcatchment Management Plans (SMP) and specific Farm Management Plans (FMP) would be statutory requirements.

    c. Depending on the trends in water quality over, time, relative to the 80 yr. goals, the RCs could

require stricter land management mitigation via the SMP and FMPs.

Dr D C Edmeades

9 May 2019