BEFORE ENVIRONMENT SOUTHLAND

In the matter of a hearing of resource consent applications

And

In the matter Woldwide Farming Group Resource Consent applications

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SUMMARY STATEMENT OF BELINDA MEARES

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1. Taking my evidence as read, I would like to highlight a few key points that have been discussed in the past few days, regarding the use of soil moisture monitoring, the cumulative nitrogen loading rate on the Horner Block, and effluent applications relative to field capacity on different soils. I will also comment on the relevance of Farm Environment Plan (FEP) Auditing, and briefly address the use other mitigations not recognised in Overseer, such as Plantain as a nitrogen loss mitigation.

2. My evidence broadly relates to both applications WW1&2 and WW4&5. It includes specific comments on WW1&2 responding to the applicant's evidence, further comment may be required on WW4&5 once the applicant's evidence has been presented.

Soil Moisture Monitoring

3. In my evidence I discuss the use of Soil Moisture Monitoring in paragraphs 36 – 42. The FEP for Woldwide One and Two (WW1&2) states that the Environment Southland (ES) Heddon Bush soil moisture monitoring site will be used to assist with scheduling Farm Dairy Effluent (FDE) applications, I have assumed that the Horner Block and Woldwide Four and Five (WW4&5) also use this site.

4. There has some discussion throughout the hearing about the suitability of using a singular soil moisture sensor to schedule FDE irrigation across multiple soil types, with variable Profile Available Water (PAW) characteristics. The guidance set by Irrigation NZ for the Good and Best Management Practice (GMP and BMP) for installation of Soil Moisture Monitoring is as follows:

    a. "IrrigationNZ's inaugural Soil Moisture Monitoring Master Class in 2015 brought together a cross section of experts from research and industry to discuss the issues and increase the understanding of soil moisture monitoring technologies and their applications. One of the outcomes from the master class was agreement on two standards for soil moisture monitoring – Good Management Practice and Best Management Practice.

    Good Management Practice

    b. "This refers to the minimum standard required to achieve good decision making from soil moisture monitoring:
        i. One site per irrigation system and/or crop.
        ii. The site is located in the soil type with the lowest Water Holding Capacity, but that soil type is representative of at least a quarter of the irrigated area.
        iii. Each site has one sensor located within the active root zone.
        iv. A precise (repeatable) sensor is used.
        v. The irrigator receives some basis training in interpreting soil water measurements.
        vi. The data from the sensor is transferred to a computer or the cloud so that soil moisture trends can be graphed and analysed."

Best Management Practice

c. "This refers to the standard that would allow the maximum benefit to decision making from soil moisture monitoring:
    i. Two sites per irrigation system and/or crop.
    ii. One site is located within the soil type with the lowest Water Holding Capacity, but that soil type is representative of at least quarter of the irrigated area. The second site located within the soil type with the highest Water Holding Capacity but again representative of at least a quarter of the irrigated area.
    iii. A precise (repeatable) sensor is used that is also field calibrated.
    iv. The data from the sensor is telemetered in real-time to a computer or the cloud to allow for real time decision making.
    v. Professional advice is used to help with the initial interpretation of the data."

5. Using the nutrient budget summaries provided for WW1&2, Horner and WW4&5 from what I understand - the soils input into the nutrient budgets, have been informed from a combination of the soil maps derived from the Scandrett/Killick reports and Topoclimate.

6. Based on the blocks receiving barn slurry and liquid effluent identified in each of the nutrient budgets provided, I have characterized the soils of each of these blocks by Profile Available Water, into commonly used PAW bands. I have used the PAW characteristics from each of the soils identified from the Factsheets from Landcare Research's S-Map database, for the top 0-60cm of soil.

7. The PAW categories range from Well Drained through to Poorly Drained. The values for each of these bands are 30 – 60 mm being well drained, 60 – 90mm being moderately well drained, 90 – 120 mm being imperfectly drained, 120 – 150mm Poorly drained and then >150 mm being very poorly drained.

8. By identifying the blocks receiving liquid effluent or barn slurry in the nutrient budgets, I found that the blocks fell into the following PAW categories:

Effluent/Slurry Application Area as applied in Overseer Nutrient Budgets		
Drainage Category	**PAW 0-60cm**	**Approximate % of Area**
Well drained	30 - 60	0%
Moderately well drained	60 - 90	30%
Imperfectly well drained	90 - 120	30%
Poorly drained	120 - 150	40%
Very poorly drained	>150	0%

Table 1 Profile Available Water Characteristics of Blocks Receiving FDE or Slurry

9. The Heddon Bush site soil moisture monitoring site, as identified in Mr. Killick's report is the Gleneg soil, this soil has a PAW in the top 0-60cm of 53mm, therefore falling into the very well drained 30 – 60mm category. This suggests that the Heddon Bush site has a lower PAW than the effluent application areas across the farms.

10. This means that the soil moisture information derived from the Heddon Bush site is not necessarily representing the soil moisture content of the other soils. I will note that in terms of scheduling FDE applications given that the soil moisture sensor is in the lowest PAW soil, which is the Gleneg soil. This means if the relativities of the information are understood well, they can still be correlated into management decisions between the different soils. However, from the FEPs it is not clear on how this information is correlated from the Heddon Bush site to the different soils in a quantifiable way.

11. If BMP for soil moisture monitoring was followed this would mean the installation of a soil moisture sensor on the Braxton soil, which at 149mm (0-60cm) is the heaviest PAW soil present in the nutrient budgets. This would allow quantification that the FDE applications were being scheduled and applied according to soil moisture requirements.

12. Installation of soil moisture monitoring on the Braxton soils could also enable trigger points to be identified that indicate the soil may dry enough to exhibit cracking, which could provide an indication of when effluent applications on the soils should be avoided.

Possible Consent Condition

13. The timing and rate of application of effluent and solid animal waste to land is justified through the implementation and use of Best Management Practice soil moisture monitoring. *As defined by Irrigation New Zealand's Soil Moisture Monitoring Good and Best Management Practise.*

Effluent Applications and Soil Water Movement

14. There has been some discussion around the management of effluent applications and the depth relative to the soil moisture and field capacity. There were two key terms which I thought would be beneficial to provide a definition for, these are matrix and preferential flow.

Matrix Flow

15. Matrix flow is when water moves through micropores within and around, rather than just rapidly around soil aggregates. Matrix flow allows effluent in the soil to have enough residence time to allow attenuation of contaminant or nutrients from the effluent.

16. Well drained soils such as the Gleneg and the Drummond tend to exhibit matrix flow, these soils have a low <u>direct</u> contaminant risk for applied effluent. These soils also tend to have high infiltration rates at the soil surface. Well drained soils are typically leaky in nature with regards to the leaching loss of nitrogen. This is because well drained soils often deliver greater amount of drainage water annually than poorly drained soils, providing more opportunity to leach.

Preferential Flow

17. Preferential flow means that, water favours movement down preferred pathways within the soil structure when soils are draining. Preferential flow is also commonly called by-pass flow, as the process results in a large proportion of the soil matrix being bypassed during the drainage process. Preferential flow typically takes place down large continuous cracks or a series of intermittent and somewhat connected soil cracks or channels with large pore space.

18. Soils with a tendency to exhibit preferential flow, such as the Braxton soil, tend to pose a greater direct contaminant risk for applied effluent. While these soils tend not to be as leaky as well drained soils, they also do tend to promote gaseous losses of nitrogen.

19. It is noted that management techniques applied such as, pasture, grazing management and cultivation etc will impact on the movement of water through soils. I support that the management practise of maintaining a high pasture cover through summer to assist with slowing or avoiding the drying of the Braxton soil resulting in cracking.

20. The matrix and preferential flow patterns discussed demonstrate that different soils have different infiltration rates and abilities to absorb, drain and shift water through the soil profile. Therefore, where there is a risk of surface or ground water contamination, effluent application rates should be matched to a soils individual ability to absorb or infiltrate effluent.

Good Management Practice for Effluent

21. It is generally accepted that two key effluent best management practices are, deferred or deficit irrigation, where the soil moisture deficit matches the applied application depth. And low rate irrigation tools.

Deferred Irrigation

22. Deficit or deferred irrigation involves storing effluent then irrigating it strategically when there is a suitable soil water deficit, therefore avoiding the risk of generating surface runoff or direct drainage of effluent.

23. Dr. Roberts discussed the practice of deficit irrigation; I would adopt Dr. Robert's approach that it would be prudent to ensure that the application of FDE matches the soil's deficit relative to field capacity, to avoid inducing drainage of effluent to groundwater or inducing the drainage of existing soil water beneath the applied effluent.

24. It is my understanding that in Southland, there are regular soil water deficits greater than 10 mm mainly occur between the months of October and May. However, the generation of liquid effluent starts at the during calving in late winter (late July/August). This means that having sufficient storage for effluent, is essential to ensure that any following irrigation only occur during times when an adequate soil water deficit exists. Additionally, to this is the consideration of the storage of the wintering barn slurry collected while animals are housed over winter.

25. Whilst storage is the most important infrastructural requirement, the accurate scheduling of FDE to coincide with soil moisture deficits is also critical, this is relevance to my discussion around the importance of having quality on farm records for effluent applications, and quantifiable soil moisture monitoring.

Low Rate Effluent Irrigation

26. Also discussed Mr. Scandrett's evidence was the use of low application rate irrigators. Irrigators which apply at a rate of less than 10mm/hr are considered low rate irrigators. I support the use of low rate effluent irrigation, as a good practice for effluent management.

27. Low rate effluent irrigation is particularly relevant on soils that have preferential flow pathways, for example small cracks. As mentioned, preferential flow provides little soil contact time, and decreased opportunity to attenuate the effluent.

28. Therefore, low application rates of effluent of less than 10mm/hr, will assist in allowing the applied effluent to remain within the root zone where it is available for plant uptake. Low rate effluent applications also aid to avoid ponding of effluent at the soil surface; ponding at the soil surface can increase the risk of overland flow of contaminants.

29. Again, this relates to the ability of soil moisture sensors as a tool to be able to match and verify in that the soil moisture deficit relative to the application depth of effluent, has been made with the utilization of the nutrient and minimization of the leaching in mind.

Nitrogen Loading Rate and Horner Block

30. In my evidence I have discussed the loading rate of nitrogen, combined from the slurry and nitrogen fertilizer applications on the Horner block. While I agree with Dr. Robert's opinion that the cut and carry nature of the Horner block means that additional nutrients need to be supplied to balance the nutrient mining occurring. I do maintain my opinion that the high loading rate of nitrogen to the block increases the inherent risk of nutrient loss.

31. The management of taking silage cuts from the Horner block means that as Dr. Robert's suggested a good proportion of the nitrogen and other nutrients are likely to be exported from the block in the form of silage.

32. To speak to the risk and probability, which has been discussed in the past few days, in my opinion, cutting silage does decrease the probability of elevated nitrogen losses from the block as a result of the high loading. However, the inherent risk of having a high nitrogen loading in the soil is increased. A careful degree of management needs to be applied year-round to mitigate this risk. I support Ms. Phillips opinion that annual advice should be sought from a qualified consultant specializing in nutrient management, as it relates to cut and carry operations.

Overseer Limitations in Modelling Soils with Shrink-Swell Tendencies

33. Dr Robert's during his evidence touched on the inability of Overseer to model the impact of the cracking of the Braxton soils. I agree with Dr. Robert's position on this, Overseer is unable to model the impact of the cracking. I also agree that provided Overseer is used in an apples with apples comparison – and the relativities are compared, it is a good tool to compare the impact of on farm management changes.

34. I would like to clarify paragraph 74 of my evidence. The intention of paragraph 74 was to highlight Overseer's inability to model the relativity of the impact on the nutrient losses, associated with soils with shrink-swell tendencies.

35. As discussed previously, to compare apples and apples, I acknowledge that both the current and proposed nutrient budgets do not include this ability. However, this means that the impact on nutrient losses and the application of mitigations regarding the soil cracks, are generally only able to be qualitatively compared.

FEP Auditing

36. In my experience the implementation of an FEP auditing program is a crucial part of the process of continuous improvement in terms of ongoing environmental performance. In my experience an FEP audit will assess the on-farm implementation of an FEP, and the fitness of purpose. An FEP auditor will assess the management areas as they relate to the individual farm these are;
    a) Irrigation Management
    b) Nutrient Management
    c) Collected Animal Effluent
    d) Soil Management
    e) Waterbodies
    f) Point Sources
    g) Non-Irrigation Water use for example dairy shed water usage

37. Crucial to the success of an FEP audit is that it is carried out by a suitably qualified individual. My experience with FEP auditing and the implementation of FEP auditing programs has largely been focused in the Canterbury region.
38. Below is an excerpt from the Environment Canterbury Certified FEP Auditor Manual which details the certification requirements:

    "Certified Farm Environment Plan (FEP) Auditor – means a person that, either

I. is approved by the Chief Executive of Environment Canterbury as meeting the following criteria and is registered on the Environment Canterbury website as a Certified Farm Environment Plan Auditor or
II. is a member of an International Standards Organisation accredited audit programme, that has been approved by the Chief Executive of Environment Canterbury, as including audit criteria equivalent to that set out in Part C or Schedule 7:
III. has at least 5 years' professional experience in the management of pastoral, horticulture or arable farm systems; and
    a. holds a Certificate of Completion in Advanced Sustainable Nutrient Management in New Zealand from Massey University; or
    b. holds a tertiary qualification in agricultural science or demonstrates an equivalent level of knowledge and experience; and

c. is a current member of a Professional Institute that requires members to subscribe to a Code of Ethics and has a procedure in place for dealing with complaints made against members; and
d. demonstrates to Environment Canterbury, proficiency in the auditing of Farm Environment Plans against the matters set out in Part C of Schedule 7."

Nitrogen Loss Mitigation

39. Mr. Youngman discussed the sowing of an area of Plantain as a nitrogen loss mitigation. Plantain is an example of an alternative pasture species. Plantain works by;
    1. **Dilution:** it increases the volume of urine that animals produce, this result of this is that the concentration of urine is diluted, therefore diluting the nitrogen loading rate of the urine patch.
    2. **Reducing:** These diverse pastures have shown the potential to lower the urinary nitrogen excreted by dairy cows in short-term, late-lactation studies.
40. The percentage reduction in nitrogen leaching as a result of Plantain is relative to the percentage of the of the sward sown, and amount consumed by the dairy cows. Mr. Youngman is correct that alternative pasture species such as Plantain is a nitrogen loss mitigation, that is not currently recognized by the Overseer model. I discuss this matter in paragraph 63 of my evidence.

Belinda Meares

04 October 2019