IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER A hearing of application APP-1994001032.01 for resource consent in relation to the discharge of treated meat works effluent to the Oroua River, Discharge of treated wastewater onto and into land that may enter groundwater, Discharge of odour and aerosols into air, Land Use Consent for a discharge structure in the bank of the Oroua River and a bed level control structure in the Otoku Stream from the AFFCO Plant, Feilding.

Section 42A Report of DAVID HORNE, Effects of Wastewater on Soil Properties and Risk of Surface Nutrient Leaching

5 October 2016

A. QUALIFICATIONS / EXPERIENCE

1. My full name is David John Horne. I am an Associate Professor in the Soil and Earth Science Group in the 'Institute of Agriculture and Environment' at Massey University. I am contracted to provide expertise on the consent application by Manawatu AFFCO relating to the discharge of contaminants associated with the upgrading of their Meat Processing Plant.

2. I hold a PhD in Soil Science from Massey University. I have 25 years' of experience in the research and teaching of Soil Science.

3. I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014. I agree to comply with this Code of Conduct. This report is given within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

B. PROPOSED ACTIVITIES

4. AFFCO New Zealand Limited (the "Applicant") has applied for a number of resource consents to allow for the operation and discharge of wastewater from their Feilding plant. The details of these are contained within the application and accompanying Assessment of Environmental Effects (AEE) and are considered in more detail in other technical evidence and will not be repeated here.

5. Of particular reference to my assessment is the proposal to apply wastewater to the four land discharge areas (totalling 142 ha). These areas have been divided into Land Management Units (LMU1, LMU2, LMU3 and LMU4) based on soil type and the parameter that is most limiting to wastewater irrigation. Each LMU will be subject to different irrigation management practices.

C. SCOPE OF REPORT

6. My report focuses on an assessment of the management and impacts of land application of AFFCO's wastewater on soil properties and the risk of surface nutrient leaching from the root zone at the proposed site.

7. I have visited the site where the land based irrigation system is proposed to take place. The features that I observed on site are consistent with the description in the application.

8. I have used a soil water balance to model the proposed land application system. In this model, I have used; approximately 30 years of climate data, input variables that reflect the properties of the soils at the site and the scheduling criteria proposed by the applicant. I have also conducted an Overseer analysis for illustrative purposes.

D. RECEIVING ENVIRONMENT

9. The receiving environment is described in section 4 of the AEE and associated appendices. I concur with the characterisation of the soils given in Appendix C.

E. EFFECTS OF THE PROPOSAL

10. I am of the view that the proposed system to irrigate AFFCO's wastewater to land is sound.

11. In particular, there are a number of features of the proposed system that will help minimise the environmental impacts of the irrigation of wastewater on the soil and the quality of drainage water.

<u>Area available for wastewater irrigation and effect on hydraulic and nutrient loads</u>

12. I note the relatively large area available for irrigation (142.4 ha). This has important implications for the hydraulic and nutrient loads to soils at the site.

13. In a year when average wastewater volumes are applied, wastewater irrigation is unlikely to meet the soil water deficit that develops during summer when the majority of wastewater is applied to land. In other words, the average application depths (59 to 152 mm) are very modest and they are considerably smaller than the average depths applied by farmers who irrigate (only) water in this region.

14. Even the maximum application depths (75 to 300 mm) are not large and are likely to just match the soil water deficit in an average summer.

15. To place the proposed hydraulic load in context, the amount of wastewater applied to land here (expressed as equivalent depth) is smaller than one typically observes at sites where wastewater is irrigated to land.

16. This excess hydraulic capacity is noted by the applicant in their claim that "there is capacity to discharge up to 331,775 m^3/y of effluent onto land, in reality on average 179,300 m^3/y will be discharged to land".

17. Of course, if more wastewater was irrigated to the current area, nutrient loads would increase in a corresponding manner.

Minimising nutrient accumulation in the soil profile

18. As the irrigated land area is large, the nutrient loads, expressed as kg/ha/yr, are also modest. The average N and P application rates under wastewater irrigation range from 76 to 203 Kg N/ha/yr and from 13 to 34 kg P/ha/yr. These rates would be typical of pastoral farming in this region.

19. Maximum proposed rates of N and P addition to some LMUs are high (360 to 400 kg N/ha/yr and 60 to 66 kg P/ha/yr). However, the applicant proposes to manage any potential problems associated with nutrient accumulation (mostly through 'cut and carry' and maize cropping).

20. The P status of soils will be kept in check by limiting applications of P to LMU1 and LMU2 to 60 kg P/ha. They also plan to grow maize on some areas to minimise P accumulation in these soils.

21. If N application to areas is large (in excess of 250 kg N/ha), the applicant proposes to remove N by practising 'cut and carry'.

Irrigation management

22. I note the nuanced consideration given to the soil parameter limiting the likely success of wastewater application to each LMU and the refined strategies for irrigation management. Wastewater application to LMU1 and LMU2 is constrained by the risk of P accumulation while the instantaneous application rate and N loading are the central issue for LMU3 and LMU4, respectively.

23. Particularly noteworthy is the very conservative irrigation regime proposed by the applicant. A superior form of deficit irrigation will be employed. While deficit irrigation ordinarily sees the soil wet to field capacity, the applicant proposes to irrigate to a point 5 mm below field capacity on LMUs 1 to 3 i.e. there will still be a 5 mm deficit at the conclusion of irrigation. On the more permeable LMU4, the deficit will be 1 mm at the conclusion of irrigation.

24. Deficit irrigation practised in the manner proposed here - the soil moisture content following irrigation will not be higher than within 5 mm (LMU 1 to 3) or 1 mm (LMU 4) below field capacity - will minimise the risk of drainage of irrigated wastewater even from the Kairanga silt loam, a soil with poor natural drainage.

25. The use of low rate sprinklers for irrigation to LMU2, LMU3 and LMU4 is best practice. Only (up to) 12 mm is applied per application depth to LMUs 2, 3 and 4.

Suitability of soils for wastewater irrigation

26. There is a range of soils at the site, from the free draining Rangitikei and Manawatu soils to the imperfectly drained Parewanui – which occupies a relatively small area - and poorly drained Kairanga soils.

27. All of these soils are suitable for summer irrigation of wastewater. Only the Kairanga and Parewanui soils might be deemed unsuitable for year round irrigation of wastewater, however, this is not an issue at this site as irrigation will mostly occur in summer and a deficit irrigation regime specifically accounts for any shortcomings in a soil's drainage ability.

28. Values for k_{sat} and k_{-40} have been used to fine tune irrigation management to the LMUs. Under the proposed irrigation management i.e. smaller application depths and low rate application, wastewater should be able to infiltrate and move through the soil with minimum risk of either preferential flow or impeded water movement.

Nitrogen leaching

29. I suggest that the likely N leaching from Byreburn farm has been underestimated. As I understand matters, the applicant claims that N leaching under wastewater irrigation is likely to be approximately 21 kg N/ha/yr. An irrigated dairy farm with intermediate to coarse textured soils, growing in excess of 17,000 kg DM/ha/yr, is likely to leach significantly more than 21 kg N/ha/yr.

30. For illustrative purposes, I have conducted an Overseer analysis. I acknowledge that I am not armed with all the farm information required to construct a truly representative Overseer file for Byreburn farm. My Overseer file suggests that leaching losses under wastewater irrigation (with the characteristics of the proposed system) on a typical dairy farm would be 50 kg N/ha/yr. I would argue that typical or expected values for this type of landuse on these soils, including irrigation, would be in the range of 40 to 60 kg N/ha/yr.

31. I hasten to add that, in terms of this application, I do not see a leaching value of 50 kg N/ha/yr as particularly problematic, particularly when it is weighed against the befits of land application for river water quality. As the applicant notes, the site is not located in a sensitive management zone. My point here is simply that the claim that "Assuming that the entire 21 kg N/ha/yr is leached, this corresponds to a low N leaching loss which would meet the 20 year limit for class II land" is debatable to say the least.

32. It is important to maintain soil structure integrity as this determines the infiltration and drainage rates. As noted, soil structure damage may result from animal, vehicle and equipment traffic on wet soils, the presence of large amounts of sodium (Na) and the adverse effects of organic material.

33. It is unlikely that treading damage caused by wastewater irrigation will have an adverse impact on soil structure due to the deficit irrigation regime, a resting period of 5 days between irrigation and grazing, and the cessation of irrigation during periods of heavy rainfall.

34. A monitoring program is proposed to identify any potential problems associated with Na accumulation in the soil. Gypsum dressings are an effective way to address deterioration in soil structure caused by Na.

35. The applicant outlines problems that can develop at some wastewater irrigation sites due to anaerobic soil conditions and/or excessive BOD loads. However, anaerobic soil conditions and excessive BOD loads are unlikely to be a problem at the site.

<u>Storage volume</u>

36. I have considered the storage volume that would be required if all wastewater was to be applied to the current land area according to the proposed irrigation protocols. The model that I developed, which used climate data for the past 20 years, estimates that a pond with a storage volume of approximately 178,000 m^3 would be required to prevent surface water discharge.

37. However, as noted above, increasing the volume of wastewater irrigated to the current land area would result in an increase in the nutrient load i.e. the rate of N and P addition to the soils at the site.

F. CONDITIONS

38. I agree with most of the conditions proposed by the applicant.

39. I suggest that Condition 8 stipulate that on completion of irrigation to LMUs 1 to 3, the soil water deficit shall be at least 5 mm and that at the conclusion of irrigation to LMU 4, the soil water deficit will be at least 1 mm.

40. In terms of day to day management of irrigation, I note the significance of condition 9.

41. I suggest that two or three 'monitor paddocks' be identified on each LMUs 1 to 3 and that the soil sampling described in Condition 16 be carried out systematically in these areas. Fewer monitor paddocks would be required on LMU4.

42. While I acknowledge that many features of the proposed system resemble general or ordinary farm business, I would make the following two suggestions.

43. Firstly, that an annual Overseer budget (or something similar) is prepared to keep track of nutrient flows into and from the site, particularly N leaching. The challenges associated with interpreting annual Overseer budgets aside, I think that the trends that these budgets might identify could be useful to the applicant as they seek to manage water and nutrients at the site.

44. Secondly, that on a five year basis, soil at a depth of 20 to 30 cm in the monitor paddocks is sampled for chemical analysis as described in Condition 16. While I acknowledge that the average P load is in keeping with good agronomic practise, the maximum rates (50 to 60 kg P/ha) are excessive. Sampling further down the profile in the manner suggested here would be inexpensive, of minimal inconvenience, and would give the applicant confidence that P is not accumulating further down the profile.

G. CONCLUSION

45. Given the volumes of wastewater produced in an average year at the AFFCO plant, the area of irrigated land is relatively large. Even in years of maximum wastewater irrigation, the hydraulic load will not exceed the average soil water deficit that develops over summer.

46. Given the proposed irrigation regime, the soils at the site are well suited to wastewater irrigation,

47. A nuanced irrigation regime is proposed whereby the parameter most likely to limit sustainable wastewater irrigation to the soil on each LMU is identified and addressed.

48. A very conservative from of deficit irrigation will be practised. Deficit irrigation is the ‘gold standard’ for wastewater irrigation.

49. The nutrient load to the irrigated area in an average year is also modest and reflects standard farming practise in the region.

50. The maximum nutrient application rates are significantly larger. However, a number of tactics such as ‘cut and carry’ and maize cropping will be put in place to reduce N and P levels in the soils.

David Horne

5 October 2016