BEFORE THE COMMISSIONER APPOINTED BY THE SOUTHLAND REGIONAL COUNCIL

IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	A Resource Consent Application to resource consent to discharge agricultural effluent to land from milking up to 640 cows and housing up to 840 cows in winter barns, to take 85,800L/day of groundwater and to use land for two winter barns, a new agricultural effluent storage facility, and to establish a new dairy farm at 444 Springhills-Tussock Creek Road
REFERENCE NUMBER(S)	**APP-20222055**

COMBINED EVIDENCE OF ALEXANDRA MACDONALD BADENHOP, BRIAN LEONARD MCGLYNN AND SIMON HENRY BLOOMBERG

(WATER QUALITY)

2nd May, 2023

1. Our full names are Alexandra Macdonald Badenhop, Brian Leonard McGlynn and Simon Henry Bloomberg.

2. We work for e3Scientific Limited and have the following roles:

   - Alexandra Badenhop - Technical Director -Water & Environmental Management
   - Dr. Brian McGlynn – Hydrologist and Biogeoscientist
   - Simon Bloomberg – Senior Environmental Scientist

3. We have been asked by Southland Regional Council to prepare this evidence.

QUALIFICATIONS AND EXPERIENCE – Alexandra Macdonald Badenhop

4. I am a professional hydrogeologist and water quality specialist and a Principal Environmental Consultant at e3Scientific. I am a member of the International Association of Hydrogeologists and New Zealand Hydrological Society and a regular presenter at IAH and Hydrological Society conferences in New Zealand and Australia.

5. I hold a Bachelor of Engineering (Environmental) (Hons) (1999) from the University of New South Wales (UNSW) and a Masters of Engineering Science (Groundwater Studies) from UNSW in 2008. The subjects completed for my masters also fulfilled criteria for Master of Engineering Science (Water Quality).

6. I have over 15 years experience working in the water industry in Australia and New Zealand. My experience has encompassed a range of engineering studies including hydrogeochemistry and water quality assessments, groundwater-surface water interactions and investigations to characterise site hydrology, and assessments of environmental effect for take and discharge consents across Otago and Southland.

QUALIFICATIONS AND EXPERIENCE – Brian Leonard McGlynn

7. I am employed as an Environmental Scientist with e3Scientific, Arrowtown, New Zealand. I am also an Adjunct Professor of Hydrology and Biogeosciences in the Nicholas School of the Environment at Duke University, USA.

8. I am a PhD Hydrologist with expertise in watershed and stream hydrological, ecological, and biogeochemical processes. I have extensive experience investigating natural and disturbed watersheds and stream networks. I am currently an Adjunct Professor of Hydrology and Biogeosciences in the Nicholas School of the Environment at Duke University (USA). From 2012 – 2019, I was a Professor of Hydrology and Biogeosciences at Duke University and Chair of the Division of Earth and Ocean Sciences from 2014-2016. From 2002 – 2012 I was an Assistant Professor then Associate Professor of Watershed Hydrology at Montana State University. I am a member of the New Zealand Hydrological Society, the American Geophysical Union (Hydrology and Biogeosciences sections), and have been a member of the Society for Freshwater Science, the European Geophysical Union, and the Geological Society of America. I continue to be actively engaged in research and application at the forefront of environmental science understanding.

9. I hold the following tertiary qualifications; a Bachelor of Arts in Environmental Studies and a Bachelor of Arts in History from Gettysburg College (USA), and a Master of Science in Hydrology and a PhD in Hydrology from the State University of New York College of Environmental Science and Forestry at Syracuse (USA).

10. I have more than 25 years experience working in hydrology, biogeochemistry, ecology, soil and geological science, and water quality beginning in 1994. I have served in project director roles since 2002. I have worked across a wide range of environments from the Arctic to the Amazon including Westland, NZ where my PhD research focused on stream water sources, runoff flowpaths, and resultant water chemistry in cooperation with LandCare and NIWA. I have additionally performed hydrological, biogeochemical, and landscape analysis projects for the US National Science Foundation, US Environmental Protection Agency, US Department of Agriculture, Montana State Department of Environmental Quality, US Forest Service, and a number of Non Governmental Organizations.

11. I have taught >13 different university courses focused on water science and management, river and catchment hydrology, water quality, ecohydrology, hydrogeology, and spatial analysis to many hundreds of undergraduate and graduate students while individually mentoring dozens of students through research training and experiential learning. I have served as the primary mentor and advisor for more than 9 M.S. students and 12 Ph.D.

students, and 6 post doctoral professionals who have gone on to successful careers at leading academic institutions, consulting firms, and state and federal agency employment in the water arena.

12. Recognition of my scientific contributions are partially reflected in my impact on the hydrological and biogeochemical sciences as indicated by: 8,867 Google Scholar citations to >100 peer reviewed scientific research papers, H-index of 46, i10 index of 95. http://scholar.google.com/citations?hl=en&user=c2iow7sAAAAJ

13. I have a strong understanding of hydrological processes and how water flowpaths, streamflow source areas, and landscape characteristics impact water chemistry and stream and groundwater quality. I have extensively published in peer reviewed literature on these and related topics that have contributed to scientific understanding and the informed management of natural and human altered stream and watershed systems.

QUALIFICATIONS AND EXPERIENCE – Simon Henry Bloomberg

14. I am a professional Environmental Scientist, Certified Environmental Practitioner, and Senior Environmental Scientist at e3Scientific limited. I am a member of the New Zealand Hydrological Society and Australasian land & Groundwater Association.

15. I hold a Bachelor of Science (Geology and Geography, endorsed in Environmental Science)(2009) and a Masters of Science (Geology)(hons) from the University of Canterbury in 2012. I also completed the Certificate for Sustainable Nutrient Management (Intermediate) from Massey University (2019).

16. I have over 10 years experience applying earth system science for both private and public institutions, and as a consultant in Australia, Vanuatu, and New Zealand. My experience has encompassed a range of environmental studies including site and soil assessments, hydrogeochemistry and water quality assessments, groundwater-surface water interactions, and assessments of environmental effect for discharge consents across Otago and Southland.

CODE OF CONDUCT

17. We confirm we have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014. This evidence is within our areas of expertise, except where we state that we am relying upon material produced by another person. We have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

18. Our evidence pertains to the water quality impacts on water quality of discharging agricultural effluent to land from milking up to 640 cows, taking groundwater and to use land for two winter barns, and to establish a new dairy farm at 444 Springhills-Tussock Creek Road, hereby referred to as Farm 444.

19. We have reviewed all of the available information pertaining to the application as provided on the notified consents webpage [Capil Grove Limited - Environment Southland (es.govt.nz)]

20. We have reviewed the following additional material provided by the Applicant to Environment Southland:

    - LEI (2021). *"Capil Grove Limited – 444 Farm: Water Source Discussion"*. 7 September, 2021.

21. Our evidence includes the following elements:

    - The degraded catchment context
    - The limitations of Overseer modelling to understand water quality impacts
    - Site constraints in terms of climate, soils, subsurface drainage, groundwater and surface water
    - Issues with proposed effluent management
    - Wetlands
    - Summary of water quality effects

BACKGROUND

22. Lowe Environmental Impact (LEI) have stated that the proposed activities will provide environmental improvement on the combined land of Farm 444 due to use of a wintering barn, low application rates of effluent and only applying effluent when soil moisture rates are low.

23. The key evidence provided for this assessment is an Overseer Model, which has also been reviewed by Irricon, and Lumen. Whilst their evidence focusses on the inputs to Overseer, we provide further evidence that Overseer cannot adequately model nutrient losses associated with the activities to provide justification for land use change.

CATCHMENT CONTEXT

24. To meet freshwater obligations under the National Policy Statement for Freshwater Management, the catchment context of the proposed activities needs to be considered:

25. Policy 3 states: "Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments".

26. Policy 5 states "Freshwater is managed (including through a National Objectives Framework) to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved."

27. The site is in the Makarewa Groundwater Management Zone. Water quality in the Makarewa GMZ is variable. The poorly drained soils lead to mixed to reducing redox conditions and the main contaminant pathways are known to be through artificial and deep drainage. [1] A review of the state of groundwater in the Makarewa GMZ suggests that there has been deterioration in mean state of nitrate toxicity from 2010-2019 (note that the five year mean was shown to be the worst in 2016 (Band C) when 7 sites were measured, in 2019 only one site was measured). (Norton, et al., 2019).

28. The site is within the Oreti Freshwater Management Unit. Surface water from the site flows into the Makarewa River, which flows into the Oreti River and subsequently to the New River Estuary. Review of the state of freshwater attribute states within the Oreti catchment

[1] https://www.es.govt.nz/environment/water/groundwater/groundwater-management-zones/makarewa, accessed 1/05/2023

showed that 56% were in D state for DIN and 17% were in D state for DRP, and 61% in E state for *E. coli*, 28% in E state for sediment (turbidity).63% of sites were failing to meet objectives for long filamentous periphyton cover. The Oreti flows into the New River Estuary, which along with the Jacobs River Estuary and Toetoes (Fortrose) Estuary "are all currently receiving nutrient and sediment inputs beyond their assimilative capacity. They are showing signs of eutrophication and expansive degraded areas, as indicated by areas currently in D band state for macroalgae (EQR), Gross Eutrophic Zone (GEZ), mud content and extent, and sediment oxygen levels (aRPD). A reduction in nutrient and sediment inputs would be needed to improve all these attributes above D band at all sites in these estuaries". (Norton, et al., 2019).

29. Review of the catchment context demonstrates that the site is within groundwater and surface water catchments that are suffering significant deterioration due to nutrient loading. Nutrient loadings to these catchments therefore need to be decreased.

USE OF OVERSEER MODELLING TO UNDERSTAND WATER QUALITY IMPACTS

30. The assertion that the change in land use to intensive dairy farming would improve groundwater and stream water quality and ultimately improve conditions in the catchment is entirely predicated on the results of the OVERSEER model which is 1) not fit for purpose, and 2) potentially based on selective use of available parametrizations, 3) based on questionable modeling assumptions, and 4) includes no quantitative or qualitative treatment of the uncertainty inherent in the whole approach and its results.

31. The OVERSEER model has been developed in New Zealand to assist in long term on-farm and agricultural productivity planning nutrient management. It has been increasingly used outside of its design scope as acknowledged by 1) the model developers, 2) a recent Ministry for Primary Industries (MPI) and Ministry for the Environment (MfE) commissioned Independent Review Panel (MPI Technical Paper no: 2021/12, July 2021), and 3) MPI and MfE itself in its response to the independent review.

32. Below is the summary statement from the detailed analysis performed by the expert scientific advisory panel commissioned by MPI and MfE. In short, they detail fundamental issues with the application of OVERSEER to estimate nutrient loss when it is applied to the on-farm agricultural settings for which it was developed. Using OVERSEER for rain event driven nutrient fluxes was not evaluated since they are too far beyond the design scope or efficacy of the modeling approach. In the Farm 444 scenario, most nutrient fluxes to groundwater, tile drains, and local streams would be during rain events that are dominant features the Southland climate.

> *"Although Overseer's user interface and the use of actual production metrics make it a user-friendly model, it was not originally designed for its current use of accurately estimating nutrient losses. Therefore, its structure does not adequately represent the complex system dynamics underpinning nutrient loss and this limits the confidence we can have in its outputs. Our core concerns are that Overseer:*
>
> - *Is a steady state model attempting to simulate a dynamic, continually varying system;*
> - *Uses monthly time-steps;*
> - *Uses average climate data and, therefore, cannot model episodic events, or capture responses to climate variation;*
> - *Does not balance mass;*
> - *Does not account for variation in water and nutrient distribution in the soil profile;*
> - *Does not adequately accommodate deep-rooting plants;*
> - *Focuses on nitrate and omits ammoniacal nitrogen and organic matter dynamics; and*
> - *Lacks consideration of surface water and nutrient transport, as well as critical landscape factors. "*
>
> *"As a result of these concerns, we do not have confidence that Overseer's modelled outputs tell us whether changes in farm management reduce or increase the losses of nutrients, or what the magnitude or error of these losses might be."*
> *https://www.mpi.govt.nz/dmsdocument/46360-Overseer-whole-model-review-Assessment-of-the-model-approach*

These findings and the full report have been accepted by MPI and MfE and the Government has committed to addressing the issues raised by the Review Report (Government response to the findings of the Overseer peer review report, August 2021 https://www.mpi.govt.nz/dmsdocument/46357/direct)

33. All of the bullet points outlining the concerns of the expert review panel summary above pertain directly to the application of OVERSEER in this case. For example:

- The model operates at a monthly time step with long term average climate data while nutrient export dynamics at Farm 444 are driven by short term rainfall events not captured in long term climate averages. Storm driven nutrient export to groundwater, tile drains, and local creeks is not a steady state process, rather it is dynamic in time with maximum fluxes associated with short duration, intense rainfall/runoff events. These fluxes cannot be adequately approximated with steady state assumptions in OVERSEER.
- Mass balances of nutrient inputs (e.g. atmospheric deposition, fertilisation, pavement washoff), standing stocks (e.g. vegetation and soil stores) and outputs (e.g. land atmosphere fluxes, soil water drainage, and runoff) are fundamental to estimating landuse change impacts on water quality. It is not possible to reliably project changes in exports due to land use change without estimates of these key balances. OVERSEER does not balance water and nutrient mass.
- There is no treatment of lateral nutrient transport or consideration of the landscape setting in the application of the OVERSEER model. This is particularly problematic in the Farm 444 application since the location of the proposed intensive dairy operation in on drained wetlands with gleyed and peat hydric wetland soils and likely high water tables still.

34. The summary above of MPI/MfE concerns regarding the OVERSEER model and its inappropriate application clearly indicates that it is not appropriate for use in this water quality improvement case by Farm 444 and its consultants. The conclusion that the proposed Farm 444 intensive dairy operation project would reduce catchment loading and improve water quality is not adequately supported by a weight of evidence approach. Instead, it is based on a model not fit for purpose as widely acknowledge by an expert review panel, MPI and the Ministry of the Environment.

SITE ENVIRONMENTAL CONSTRAINTS

35. Climate – the climate of the Farm 444 area is characterised by frequent prolonged and often intense precipitation that can occur in any season of the year. Strong seasonality in the energy available to evaporate (and transpire) water to the atmosphere leads generally wetter conditions in winter and drier in summer. However, some of the region's largest

floods have occurred in summer demonstrating that surface nutrients can be flushed into the subsurface and that shallow subsurface and surface runoff can occur throughout the year. NIWA reports that on average, Winton experiences 175 rain days/events per year and Gore experiences 202 (Macara, 2013). This means that more than approximately 1 in 2 days will see rain that could mobilise nitrate and other nutrients to groundwater and local streams and that this rain event frequency is similar in all months of the year.

36. Because the area inclusive of Farm 444 is mostly energy limited across the year, there is not excess energy available to evaporate additional water applied to the ground surface. Liquid applied in excess of natural precipitation will largely percolate through the soil to shallow groundwater. Liquid applied in dry times might partially evaporate and partially recharge soil moisture but this would enhance the infiltration and percolation of any subsequent rainfall that would mobilise soluble nutrients such as nitrate (NO_3^-) leading to enhanced nutrient export and declines in area water quality.

37. The soils – LEI state that "The majority of the farm overlies the Gleyed Physiographic Zone (light blue), with the remaining area located in the Peat Wetlands (dark blue) and Bedrock/Hill Country Physiographic Zones (green) as shown in Figure 3.4 below. These soils indicate the historic and potentially current presence of wetlands across the site, and the potential for rapid mobilisation of nitrate and dissolved reactive phosphorous to shallow groundwater and subsurface and surface lateral transport to nearby streams.

38. Groundwater levels - The site is in the Makarewa Groundwater Management Zone. The proposed water take is from a spring into which a shallow bore (2 m below ground level) has been installed. Photos provided of the spring area demonstrate waterlogging and surface ponding of the soil after a rainfall event in summer (24 February 2023), at which time the dish drains were responding to rainfall. The description of the conditions in the bore states, "Water levels in the bore, albeit with some fluctuation, remains constant, and even in dry conditions with current pumping does not lower significantly." "For a large duration of the year the water level in the bore is below the ground surface. It rises to the surface often during wet periods (typically winter) and flows from the top of the bore casing." "flow from the bore into the adjacent drain is intermittent, and does not flow year round. Depending on the year surface flow could range from 4 to 10 months". These comments all provide evidence that groundwater levels are very close to the ground

surface and fluctuate significantly through the year, and that in some years, near surface saturation (as evidenced by flow into the drain) may occur for most of the year.

39. Surface Water - Science research worldwide – and fundamental hydrological and nutrient transport processes given the climate and rainfall patterns of the area – show wetland soils, shallow water tables, and active drains systems support rapid transport of nutrients to groundwater and surface water during rainfall events. Systems like this are highly responsive to rainfall meaning infiltrating rainfall and effluent leads to shallow groundwater levels rising and falling and lateral throughflow to streams and rivers. This is clearly evident in local stream and shallow groundwater dynamics as described in the water take consent application and shown below in the hydrograph of nearby Hedgehope stream (Figure 1). Much of this observed runoff is driven by water infiltration and movement on land similar to Farm 444 that would readily transport available nutrients, especially nitrate.

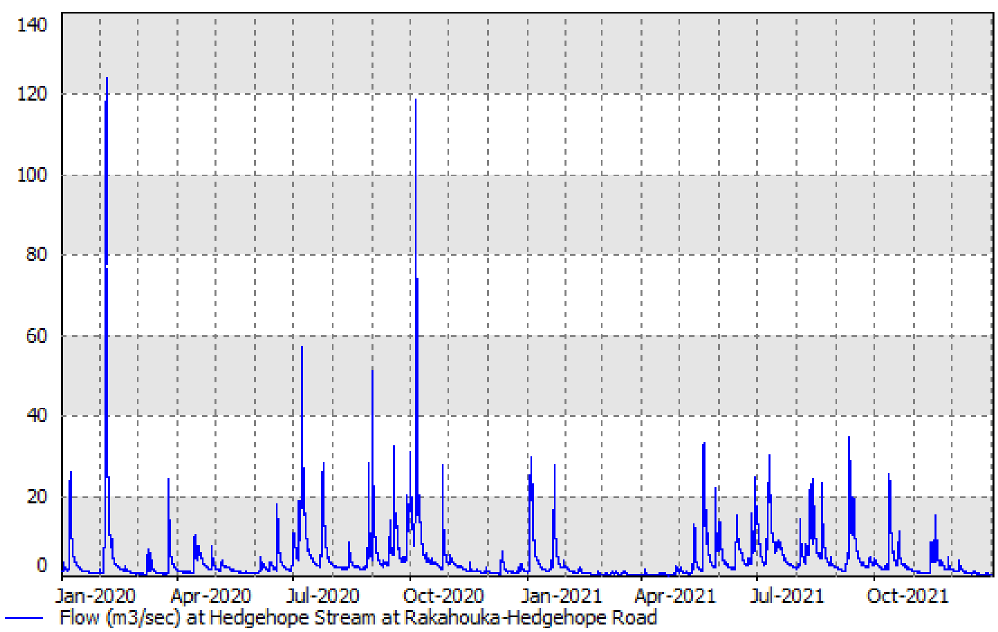


Figure 1: Local streamflow reflects rain event driven runoff across two recent years. Note, increases in streamflow reflect rain event driven water and nutrient transport to streams in every month of the year.

40. Wetlands – Across the region, climatic conditions and the generally low topographic slope angles resulted in extensive historic wetlands as indicated by widespread hydric soils (e.g. gley soils and peat/organic soils) like those that cover the Farm 444. Similar to the Farm 444, many of these wetlands have been ditched and at least partially drained but largely maintain elevated water tables and close connectivity between surface soils, shallow

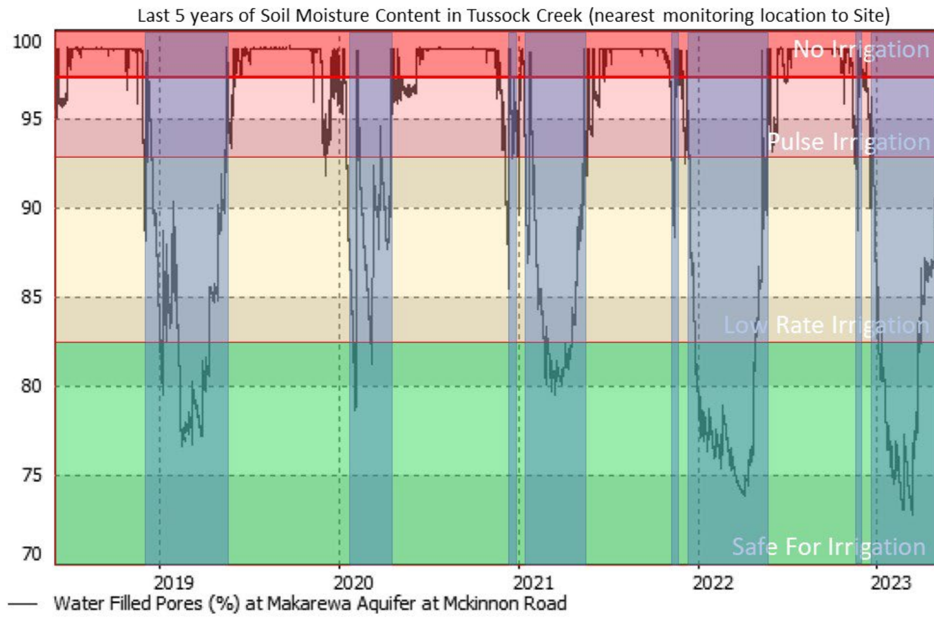
groundwater, and lateral throughflow to streams. This is further discussed in paragraphs 42 - 47.

41. Subsurface drainage - the LEI AEE stated that "The soils on the farm are predominantly poorly drained, so the farm is drained by a network of subsurface drains. The location of the sub-surface drains is unknown but are assumed to be in all paddocks except on the hills of the Tuffin Block and Sharks Tooth Hill." The presence of subsurface drainage allows for the rapid movement of infiltrating water to surface water bodies, reducing residence and treatment times of nutrients and pathogens within the soil.

EFFLUENT MANAGEMENT

42. The applicant proposes to discharge farm dairy effluent (FDE) to all parts of the farm as set out in Appendix C of the Farm 444 Effluent Management Plan (LEI, 2022). Some of these areas may be wetlands and may need to be excluded. See paragraph 46 for more details.

43. The Effluent Management Plan indicates that as a guide to whether irrigation can occur, the Farm 444 staff member should review the soil moisture monitoring site at Tussock Creek (https://maps.es.govt.nz/index.aspx?app=soil-moisture), and if the soil moisture is in the red then conditions may not be suitable for irrigation. The advice from DairyNZ is that the application depth should be less than the soil water deficit. A review of the last five years of soil moisture data (Figure 2) shows the periods where irrigation under this management practice irrigation may be possible (blue shaded areas). In addition to the statements in paragraph 33 regarding the many days per year where rainfall occurs which would limit application ("never use pods in the rain"), there is also a limited window for irrigation based on the irrigable soil moisture ranges.



Year	Irrigation Possible (yellow and green)
1 Jun 2018 to 31 May 2019	Early December 2018 to mid May 2019
1 Jun 2019 to 31 May 2020	Late January 2020 to Mid April 2020
1 Jun 2020 to 31 May 2021	Brief Periods from early December 2020, consistent from Mid January 2021 to mid May 2021
1 Jun 2021 to 31 May 2022	Brief period in November 2021, then consistent Mid December 2021 to mid May 2022
1 Jun 2022 to Present Day	Brief period in November 2022, then consistent from mid December 2022 to mid/late May 2023 (expected)

Figure 2. Soil Moisture at Tussock Creek. Data sourced from Environment Southland's Beacon and Environmental Data hub

44. The Applicant's new pond is very large (17,800 m^3) as it is designed to meet the needs of storage from mid-May to mid-September. However as noted in Figure 2, soil moisture conditions are generally not consistently favourable for irrigation to commence until November at the earliest, but more commonly December, and in the worst-case scenario, January. At the other end of the season, irrigation would have to cease as early as mid-April, but more often mid-May is suitable. The applicant should provide more evidence to show the design of their effluent management system is suitable for the worst-case conditions likely to occur (e.g., period 1 Jun 2019 to 31 May 2020), and if there are alternative management approaches required to be included in the Effluent Management Plan.

45. The Applicant has not provided a description of the required number of days and/or area required (ha) to receive FDE application (at the stated rates for each soil type) in order for the volume of FDE discharged to land to be balanced with the FDE stored pond capacity. As noted in Paragraph 44 above, the provision of this information is necessary to assess why the Applicant's design capacity of the FDE management infrastructure and proposed application rates and areas are appropriate for not only maintaining the storage capacity but also for meeting the nutrient budget of 150 kg N/ha/yr.

WETLANDS

46. The current intent of the freshwater reforms in the NPS-FM and the NES-F is to protect wetland and encourage their restoration while allowing for current pasture landuse on wetlands and former wetlands to continue. This "Pasture Exclusion" clause is to support the continuing use of pasture for grazing purposes. This exclusion is not targeted at pasture being converted for other land uses. It does not apply to wetlands in other areas of grassland that are not grazed, (such as areas of farmland not used for grazing purposes). In the Farm 444 landuse change to dairy case, the "Pasture Exclusion" may not apply since an application for landuse change consent is necessary and the area is proposed to largely be used for effluent disposal (FDE Application) rather than grazing (Ministry for the Environment. , 2022).

47. The applicant has not provided any documentation regarding assessment, delineation, and mapping of wetlands on the Farm 444 property. Given that the site was likely all wetlands prior to farm conversion based on the wetland soils across the farm (hydric gleyed soils and peat/organic soil), there are very likely extensive wetlands remaining that, although they have been historically drained, might not meet the pasture exclusion due to the land use change. In addition, wetlands along riparian margins may also still exist. Assessment, delineation, mapping, and AEEs specific to these wetlands would be necessary to comply with the Freshwater reforms in the NPS-FM and NES-F 2020.

ASSESSMENT OF EFFECTS – SUMMARY OF APPLICATION AND DEFICIENCIES

48. The AEE states that "The 20 m separation required by the Regional Effluent Plan is expected to ensure that there will be no movement of FDE into any surface water bodies. It is not expected that the low application depths, application when soil conditions are appropriate, combined with the total nitrogen application rate not exceeding 150 kg N/ha/y, at a distance not less than 20 m from any watercourse, will lead to any significant transport of contaminants via overland flow or through shallow groundwater to any surface water…. Based on the considerations identified above, it is expected that the effects of the FDE application to land on surface water will be less than minor."

49. The AEE further states "While there will be shallow groundwater movement through the soil from rainfall and towards surface streams, the groundwater is unlikely to be affected

from application of FDE for the following reasons: the application timing is matched to periods when there is a soil moisture deficit and there is a low proposed nutrient loading of up to 150 kg N/ha/y. At this low N loading contamination of groundwater is not expected to occur. There is sufficient area for effluent application to ensure this low N load from FDE applications is maintained…. An artificial drainage network is present across the farm and increases the risk of preferential drainage. Application of FDE will only occur when there is a soil moisture deficit, therefore drainage through to the artificial network to groundwater will be avoided, or at worst, minimised."

50. The summary of assessment of environmental effects does not appear to be supported by reliable evidence and is predominantly based on a model not fit for purpose and an incomplete understanding or portrayal of water and nutrient movement across landscapes in accordance with the site environmental constraints. If there was no marked infiltration or throughflow they would not need drains. Additional FDE application would only increase percolation to groundwater and transport to streams regardless of the season of application. This is exemplified in the rainfall record and provided hydrograph that indicate significant rain and runoff are possible any day of the year.

51. These fundamental hydrological and nutrient transport processes have been well known for more than 50 years yet are not considered in OVERSEER modelling nor in the AEEs included in the consent application. The hydrology and nutrient transport processes of the site and the near singular reliance on an OVERSEER model not fit for this purpose seriously challenge the conclusions contained in the consent application and its consultancy reports including the AEE. Specifically, the statements "*When compared to the existing collective of farms being incorporated as part of this project, there is an improvement from the reduction of intensive sheep and beef grazing and dairy support.* " and *"Nitrogen losses = 28 kg N/ha/yr vs 34 kg N/ha/yr for the previous farms operations combined"* and *"The effects of the proposed activity are deemed to be less than minor based on the modelled reduction in the nitrogen lost from the farm. Further, the proposal may on the whole be beneficial to the environment when compared to the existing operations."* from Lowe AEE are highly problematic as the expert scientific advisory panel commissioned by MPI and MfE detailed fundamental issues with the application of OVERSEER to estimate nutrient loss when it is applied to the on-farm agricultural settings

for which it was developed. Using OVERSEER for rain event driven nutrient fluxes was not further evaluated by the panel since they are too far beyond the design scope or efficacy of the modelling approach. In the FARM 444 scenario, most nutrient fluxes to groundwater, tile drains, and local streams would be during rain events that are dominant features the Southland climate. The review panel went on to state "As a result of these concerns, we do not have confidence that Overseer's modelled outputs tell us whether changes in farm management reduce or increase the losses of nutrients, or what the magnitude or error of these losses might be." (*https://www.mpi.govt.nz/dmsdocument/46360-Overseer-whole-model-review-Assessment-of-the-model-approach)*. These findings and the full report have been accepted by MPI and MfE and the Government has committed to addressing the issues raised by the Review Report (Government response to the findings of the Overseer peer review report, August 2021 https://www.mpi.govt.nz/dmsdocument/46357/direct)

52. There are strong limits to how much nitrogen can be utilised by plants and denitrified by bacteria. The term "nitrogen saturation" has been used to described catchment and soil systems that have experienced a history of N deposition and that become increasing "leaky" with continued loading. In this case, each additional unit of N results in increasing rates of N transport. Since nitrate (NO_3-) is soluble it is readily transported with any water movement. In the case of FARM 444, effluent spreading (FDE application) would deliver N to the soil likely far in excess of what could be utilised in the soils (microbes) and plants. During water limited dry times, this N would accumulate in the soil if there was no vertical water lateral water movement. However, if no excess energy was available on the time scales of liquid application rates, water would move vertically to the water table (groundwater) or into artificial drains and laterally to streams. Any significant precipitation anytime or even light precipitation in wet times, would mobilise/pickup available nitrate and transport it to groundwater and local streams. Because Southland is characterised by frequent prolonged and often intense precipitation that can occur in any season of the year, nitrate would be readily mobilised and transported to local groundwater and streams.

53. Wetlands across the property have not been adequately assessed or addressed in the AEE.

54. The applicant has not proposed any groundwater or surface water quality monitoring, as "The low application of nutrient in comparison to the catchment land use and fertiliser applications means it is unlikely that useful conclusions will be able to be drawn from any water quality monitoring program which specifically relate to the proposed activities". However, it is likely that there will be significant transport of nutrients from the property, particularly during wet weather events.

References

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