Before the Hearings Panel
At Wellington

Under	the Resource Management Act 1991
In the matter of	an application for resource consent to discharge contaminants to land, air and water associated with the proposed long term upgrade and operation of the Featherston Wastewater Treatment Plan
Applicant	**South Wairarapa District Council**

Statement of evidence in response by Aslan Michael Perwick on behalf of Greater Wellington Regional Council (groundwater)

Date: 10 May 2019

INTRODUCTION

1. My name is Aslan Michael Perwick. I hold the role of Groundwater Services Leader at Pattle Delamore Partners Ltd, a role I have held since 2016.

2. My evidence in response is given on behalf of Greater Wellington Regional Council (GWRC) in relation to the resource consent applications from South Wairarapa District Council (Applicant) for a suite of consents corresponding with the activities and discharges associated with the receipt, treatment, storage, surface water discharge, land application and general management of wastewater received at the Featherston wastewater treatment plant (WWTP) (the "Application"). In particular, my evidence relates to the groundwater aspects of the Application.

Qualifications and Experience

3. I hold Bachelor of Science (Geology) from the University of Auckland, New Zealand., and Master of Science (Hydrogeology) from the University of Birmingham, United Kingdom.

4. I am a member of the International Associated of Hydrogeologists, New Zealand Hydrological Society (NZHS), and Australasian Tunnelling Society (ATS).

5. I am a hydrogeologist with 11 years' experience. I have recent and relevant experience as a groundwater specialist. I have completed numerous detailed groundwater investigations and assessments for large scale civil construction, primary resource related projects, and waste water discharge land application projects in both New Zealand and Australia. This work has included: investigation drilling, groundwater monitoring and testing, geophysical surveying and analysis, analytical and numerical groundwater modelling, groundwater abstraction design and installation, groundwater contaminant testing and assessment, groundwater remediation.

6. Examples of recent projects that I have been involved in include:

    i. Omaha Wastewater Treatment Plant (Watercare) discharge consent (2014-2017) – a 100% land discharge system. I was the technical groundwater lead undertaking the planning and supervision of the hydraulic and groundwater quality investigations, technical analysis and detailed 3D groundwater modelling, groundwater effects assessment and consent conditions.

ii. Waipu Wastewater Treatment Plant (Whangarei District Council) discharge consent (2017-2018) – a 100% land discharge system. I was the technical groundwater lead for the hydraulic groundwater mounding assessment, which utilised a 3D groundwater model.

iii. Base Ohakea (NZDF) PFAS Project (2017 to present) – groundwater assessment and contaminant transport investigation. I was the technical groundwater lead for a detailed groundwater and contaminant transport assessment associated with PFAS contaminants. My work included development of a numerical 3D groundwater and contaminant transport model.

iv. Wellington Water Ltd Regional Plan Review Submission, 2018 - I provided expert witness evidence and expert conferencing on behalf of Wellington Water Ltd (as a submitter) to proposed groundwater and surface water source protection zones as part of the GWRC Regional Plan Change.

v. Auckland City Rail Link (Auckland Transport) Aotea to North Auckland Line (2013 – 2016) – key technical specialist for investigation and assessment of groundwater effects for the Karangahape Underground Station and bored tunnel sections of the alignment from Aotea Station to North Auckland Line interchange, including drilling and pump testing as well as 2D and 3D numerical groundwater modelling.

vi. SH1 (NZTA) Hamilton Expressway SE Bypass (2014) – key technical specialist assessment of groundwater effects for the. Horsham Downs and Gordonton cut sections of the expressway.

My role

7. My role in the Project is as the technical groundwater reviewer of the applicant's assessment of groundwater effects.

8. I co-authored the Section 42A Appendix Report (Featherston WWTP Resource Consent Review) dated 27 February 2019 (FWWTP RC Review Report). This report was attached to the Section 42A Officer's Report. I reaffirm the contents and conclusions of the FWWTP RC Review Report, subject to the matters noted below.

9. I participated in conferencing with Ms Katie Beecroft (LEI), Mr Chris Simpson (GWS), Mr Robert Docherty (PDP), Mr Daryl Irvine (PDP) and Mr Jack Feltham (PDP) on 18 December 2018 and signed a Joint Witness Statement (Land Treatment and Groundwater JWS) dated 20 December 2018.

10. In preparing my evidence I have:

    i. Read the evidence of Mr Chris Simpson (Groundwater), Mr Graham McBride (Public Health Risk) for the Applicant;

    ii. Read the evidence of Mr Daryl Irvine (PDP), Mr Jack Feltham (PDP), and Dr Ausseil for GWRC and both the Technical Expert Conferencing Statements of Water Quality and Groundwater and related wastewater and land treatment experts (Groundwater JWS);

    iii. Read the evidence of Dr. Lee Burbery (Groundwater) on behalf of Wairarapa Regional Public Health.

Code of conduct

11. I have read and agree to comply with Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. My qualifications as an expert are set out above. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that except where I state that I am relying on the evidence of another person, this evidence is within my area of expertise.

Scope of evidence

12. My evidence in response addresses the following matters:

    i. Summary of my Evidence in response;

    ii. An overview of key points from the Groundwater JWS;

    iii. An overview of key points from the Section 42A report that relate to my area of expertise;

    iv. Response to issues raised in the Applicant's evidence (Response to the Applicant's evidence);

    v. Response to submitter evidence (Response to other evidence);

    vi. Draft conditions and proposed mitigation (Conditions/Mitigation); and

    vii. Conclusions.

SUMMARY OF EVIDENCE IN RESPONSE

13. The primary groundwater related risks of this proposed wastewater discharge to land scheme are:

    i. the rise of the groundwater table, often termed *'groundwater mounding'*;

ii. the release of residual contaminants/pathogens to receiving groundwater and connected surface water bodies; and

iii. public health considerations associated with potential exposure to the aforementioned contaminants/pathogens by groundwater or surface water users.

14. In the original consent application, no formal groundwater mounding or groundwater pathogen risk assessment was completed. Through the s92 process and in the lead up to the section 42A officer's report, myself, along with colleagues Mr Feltham, Mr Docherty, and Mr Irvine, have worked with the applicant to communicate our concerns with respect to potential groundwater effects.

15. Some of these key groundwater related concerns have now been addressed and agreed upon through the s92 and conferencing process, however some gaps remain. In my opinion these gaps present fundamental risks to the scheme's ability to function as it has been presented by the applicant.

16. From a functional perspective, the limitations that a shallow groundwater table imposes on the proposed Featherston WWTP discharge scheme are most important. Management of groundwater levels is a critical element that directly influences the ability to irrigate, and hence, it has a direct effect on other key elements of the scheme, namely: land area; land loading rates, storage capacity; and surface water discharge reliance.

17. From a groundwater pathogen risk perspective, a robust understanding of the conceptual hydrogeological processes and properties is required to adequately identify, risk, assess, and address effects on potentially affected receptors.

18. Gaps within the robustness of the groundwater assessment present themselves as potential risks, namely;

iv. underestimation of the scheme's environmental effects and/or potentially affected parties;

v. limitations to the functional ability of the proposed land discharge scheme; and

vi. overall scheme cost e.g. if additional land or storage or other mitigation is ultimately needed.

19. In my opinion, the applicant has not provided a sufficiently detailed site-specific groundwater investigation to inform their groundwater effects assessment. The geology and hydraulic properties of the site within the saturated zone that is being relied upon to dissipate the irrigation drainage,

has been largely assumed from off-site data and/or regional scale study completed for water supply purposes. Whilst this ancillary information is useful, it can only be taken so far before more detailed site-specific data is required to form the backbone of scheme preliminary design.

20. For a site of this size in this complex geological setting where there is a heterogenous alluvial fan with the possibility of shallow deposits of silt/clay/peat, I would expect site-specific investigation boreholes on the ratio of approximately 1 per 10 ha to be undertaken at this stage of the project. This would equate to at least approximately 11 boreholes spaced fairly evenly across the various irrigation sites. The boreholes would be drilled to a depth commensurate with the conceptual setting and needs of the effects assessment, but to a minimum of 5 m below the permanent water table. Geological/geotechnical logging would be completed for all boreholes, and industry standard groundwater monitoring would be completed over at least one-year on all boreholes, and hydraulic testing would be completed on either a selection of boreholes or all boreholes. In most cases, the boreholes would then continue to be used for groundwater monitoring as part of consent conditions. The investigation completed by the Applicant is not at, or even near to, the above described level of detail.

21. Data collected from the type of investigation described in Paragraph 20 would be incorporated into the conceptual understanding of the subsurface to provide proof of feasibility and/or inform scheme design around areas of the site which did not contain favourable ground conditions. From there, an analytical or numerical groundwater assessment is typically employed, more often these days through the use of a 3D numerical model (as the Applicant has in this instance). The field data is used within the model development and calibration process to provide reasonable surety that the modelling tool is able to produce predictions with defensible validity.

22. At present, I understand that only 3 site-specific boreholes have been installed by the Applicant, all located within approx. 300 m of the existing WWTP oxidation pond. The area of investigation represents approximately 7 ha of the area of proposed irrigation. A selection of third-party boreholes, which are primarily located off-site, have been included as model calibration targets, although groundwater level data from these is considered only of moderate reliability by the applicant (*Appendix B to 14 December Letter from GWD Ltd titled 'Further Evaluation of Groundwater Effects Associated with the Land Application of Wastewater at Featherston'*). Largely the actual areas proposed for irrigation have not been investigated and the groundwater model has not been informed and calibrated to reflect reliable on-site groundwater data. This is insufficient in my opinion for the scale and area of the required groundwater predictions.

23. The paucity of groundwater monitoring and geological data to *'ground truth'* the applicant's conceptual assessment and numerical groundwater model casts some doubt over the validity of the predicted groundwater effects.

24. Overall, due to the lack of site-specific data supplied by the Applicant, I am not in a position to provide a technical review to a level where I can state that all reasonably expected aspects of a groundwater assessment for this type and scale of discharge consent have been completed. Furthermore, whilst the predictions presented by the applicant may appear to display fair and reasonable effects from the scheme's operation (in average climatic conditions only), there is too much doubt within the model assumptions for these to be accepted/approved by a reviewer. Should ground conditions differ even moderately from what has been assumed, the scheme may not be able to operate as it has been proposed. In my opinion this presents an unacceptable level of risk and it may not be able to be adequately or practicably mitigated by the Applicant's proposal to use adaptive management techniques.

25. I do note that some significant changes in the groundwater model set-up and the assumed/adopted hydraulic parameters have occurred since the original groundwater assessment was presented within the s92 works compared with Mr Simpson's submitted evidence. Examples are:

    vii. The area and magnitude of the predicted groundwater level being shallower than 0.6 m depth has increased significantly. This is not desirable.

    viii. Existing and predicted groundwater flow directions have altered notably in some areas.

    ix. The area and shape of the predicted 5-year travel time envelope (pathogen risk) has changed considerably.

26. Whilst the changes to the applicant's predictions appear to be associated with incorporation of some additional data, the scale of the changes validate my overall concern that the applicant's effects assessment is too uncertain due to insufficient site-specific data.

27. I recommend the below options for progressing the situation:

    x. Complete the additional field investigation work and provide the outstanding groundwater assessment information as set out in the JWS (and if needed update the groundwater effects assessment accordingly) to provide surety of the predicted groundwater effects – AND –

xi. Adoption of the specific additions to the proposed consent conditions, as outlined in Paragraphs 58 to 60 of my evidence.

GROUNDWATER JWS

28. There are a number of items which were agreed within the JWS that have either not been fulfilled or not fulfilled adequately. These are:

xii. JWS Item 6 – the supply of available applicant collected shallow field investigation data and third-party borehole log information. This was to be provided by the Applicant to support the hydrogeological assumptions that have been adopted for the groundwater assessment and modelling work. This information has not been provided for my review and assessment. No bore hole logs or site-specific geological cross-sections have been provided within any of the Applicant's supplied material. This is not standard practice and does not allow for the review to be completed.

xiii. JWS Item 6 – supply of a groundwater modelling technical report by the Applicant. Whilst a report was provided post-JWS, the report does not contain some key industry standard modelling information to enable my full review. Key items outstanding/residual issues include:

i. The recharge/drainage settings for the model. These have not been supplied and consequently I am unable to check if the predicted drainage from Ms Beecroft's soil-water model for the proposed irrigation blocks have been applied correctly within Mr Simpson's groundwater model.

ii. Mass Balance / Flow Budget information. There has been no supply information to enable basic checking on groundwater inflows, outflows, and storage within the model.

iii. Assessment of a 'Wet Year' scenario. This has not been provided, and hence I am not able to review the groundwater effects of the proposed scheme under a wetter than average climatic situation, which would likely exacerbate groundwater mounding effects.

iv. Uncertainty testing. There has been no supply of predictions for potential alternative calibrations e.g. no groundwater mounding predictions supplied for a scenario(s) which contains more conservative, but

realistically possible, hydraulic parameters. Due to the paucity of site data, this approach could have been employed to provide some more information of the potential range of groundwater mounding effects.

xiv. JWS Item 9 - Details on the properties/land owners which have been contacted via a mail drop to ensure identification of all potential water abstraction receptors e.g. groundwater bores, surface water users. Given that the predicted 5-year groundwater travel time envelop has changed (grown) during the consent process, I am uncertain which properties have been contacted and whether this is satisfactory or not. I make further relevant points on this aspect in my response to applicant evidence in paragraphs 32 to 53 below.

SECTION 42A REPORT

29. I consider the points made in the FWWTP RC Review Report and summarised in the s42A Officers Report to still be valid as the majority of concerns ? addressed in the Land Treatment and Ground JWS as discussed above are still outstanding, particularly around groundwater mounding assessments and the impact on this on the proposed irrigation regime. I have re-affirmed the relevant concerns raised in the Section 42A report in this evidence.

30. In particular, I note that concerns I raised with the proposed conditions have been largely uncovered in Mr Sven Exeter's evidence ().

31. The exception is the assessment of groundwater related pathogen/human health risk, which has been progressed since the issue of the s42A Officers Report. I have provided review of updated pathogen risk assessment in paragraph 60 below.

RESPONSE TO THE APPLICANT'S EVIDENCE

Groundwater mounding

32. In relation to Mr Simpson and Ms. Beecroft's evidence on groundwater mounding related effects I provide the following comments.

33. In my opinion, insufficient site investigation has been provided by the applicant to confirm the key hydrogeological inputs/assumptions used within their groundwater mounding assessment. The mounding assessment underpins many parts of the overall proposed scheme and therefore the scheme may not be able to operate as it has been proposed if there are even moderate differences in the physical world vs modelled world.

34. One of my primary concerns is the assumed hydraulic properties of the subsurface, e.g. the assumed thickness and continuity of high permeability gravel dominated geology beneath the proposed irrigation areas, and the depth to which the gravel geology is encountered e.g. insufficient *'ground-truthing'*.

35. The presence of a lesser/thinner than expected permeable gravel substrate and/or presence of thicker surface soils and/or shallow mud/silt/clay/peat layers, presents a risk to the proposed scheme via reduced hydraulic capacity.

36. Within the applicant's S92 response, information from 3 shallow soil profiles collected in November 2015 by are provided. Groundwater occurrences are noted as being shallow and within the soil zone (B-Horizon). Summary of encountered groundwater:

    xv. 0.7 m depth to water (Profile 1: Site B near Murphy's Line), in gravelly silty CLAY;

    xvi. 0.48 m depth to *'wet and mottled soil'* (Profile 4: Site B near southern end of Burts Rd), in silty CLAY;

    xvii. 0.8 m depth to water (Profile 5: Site B near Featherstone Golf course), in gravelly sandy CLAY.

    Occurrences of groundwater within the clay dominated soil zone, which could be perched groundwater or the phreatic watertable, do not appear to have been incorporated into the groundwater mounding assessment, as the model assumes only high permeability gravel dominated geology (all the way to ground surface). I have a concern that this has not been considered by the Applicant's groundwater expert.

37. In Figure 5 of Mr. Simpson's evidence, two individual *'Wet Areas'*, approximately 1 ha each, are noted within the eastern portion of Site B, located between Otauira Stream and the Featherston Golf Course. There is overall little explanation or specifics on these Wet Areas provided by the applicant; but I interpret that these are likely to be areas of commonly boggy ground and shallow groundwater. I note that at least one of Wet Areas has not been incorporated into Mr Simpsons prediction of areas with groundwater levels <0.6 m depth (Figure 9 of Mr Simpson evidence). There is also no mention from Mr. Simpson or Mrs. Beecroft that the proposed irrigation scheme modelling has specifically excluded these Wet Areas and/or planned for appropriate exclusion zones around these Wet Areas, within the scheme design. This issue requires further explanation by the Applicant, as well as the confirmation of presence/absence of other Wet Areas within the site bounds which are planned for irrigation.

38. The impact of points raised within paragraphs 34, 35, 36, and 37 above would present primarily in the form of underestimation of groundwater mounding magnitude and/or aerial extent of mounding, and/or duration of groundwater levels elevated to within the <0.6 m below ground level threshold. This in turn could have follow-on effects to the overall scheme e.g. need for additional land and/or higher loading rates to other areas, additional storage capacity requirements, and/or additional reliance on the surface water discharge route. I refer to Dr. Ausseil's evidence regarding the potential impacts that more reliance on surface water discharge could have.

39. There is also some potential for creation or exacerbation of off-site groundwater mounding effects, primarily to the property boundaries which do not border a surface water drainage feature. The Applicant has not provided an assessment of the predicted rise in groundwater level on adjacent land parcels, and I am therefore not able to provide specific review of the predicted effects to surrounding land. The actual effects to third party land would likely present as potential reduced land performance / resilience to the impacts of extended wet weather periods e.g. exacerbation of saturated soil conditions and/or groundwater flooding/ponding. In my opinion, the Applicant should provide a quantitative prediction of expected groundwater level rise, the area and location of any rise, and the expected duration – for each adjoining land parcel. Consent conditions which refer back to these predictions should also be incorporated. I have some further explanation on this matter in Paragraph 58 and 59 of my evidence.

40. I do agree with Mr. Simpson's evidence that where surface water features and/or drains bound a site boundary, risk of off-site groundwater mounding effects are essentially mitigated by the surface water drainage features.

41. Similarly, there has not been an assessment of climate forces and seasonal influences e.g. how the proposed scheme will perform operationally under wetter than average years/extended periods, and what the effects would be on potentially affected parties and/or the receiving environment. Ms Beecroft explains in her paragraph 121 that seasonal forces *"…have been incorporated into the scheme design*.", however there has been no explanation/information provided from the Applicant how regionally elevated groundwater levels (e.g. during wet years) would impact (or not) on the available irrigation area and for how long, and how frequently this could occur. Without this information, I am not able to form an opinion on how resilient the proposed scheme is to wet climate forces or potential effects to adjacent land parcels.

42. In paragraph 119 of Ms Beecroft's evidence, she states that some further subsurface investigations were completed in 2018. However, the results of these investigations have not been reported or provided for review. This could provide some most useful information to inform my review, but without supply of these data, I am not able to take the comment that *"The investigations confirm the underlying geology described in Appendix 7 of the consent application."* into consideration.

43. In Paragraph 120, Ms Beecroft refers to areas of shallow groundwater and that *"The exclusion of these high groundwater level areas does not impact on the irrigation regime proposed"*. I am unable to agree with this comment in its current context, as no information has been provided by the applicant as to how alterations to available irrigation area would impact the overall scheme. Furthermore, there has been no supply of specifics in terms of the physical area, duration, and frequency of groundwater that is predicted to be <0.6 m depth within the site bounds.

44. In Paragraph 122 Ms Beecroft outlines her opinion that *"it is essential to include climatic extremes, and their impact on the discharge regime in the assessed data set to ensure variations influence the long-term average."* I agree with this statement, however, I do not agree this has been done for the proposed activity, as the impact of climatic extremes on groundwater mounding has not been considered, and this element is pertinent to the overall operation of the proposed scheme and its predicted effects.

45. Overall there is uncertainty associated with groundwater level management and the impact this may have on scheme operability, potential adverse environment and/or third-party effects, and indirectly, the potential cost of the scheme.

46. It is my opinion that these uncertainties have not been reduced sufficiently via site-specific investigation to provide reasonable surety of predicted effects, and furthermore, it is not clear adaptive management techniques would address the situation without potential alteration of effects.

Public health effects

47. In relation to public health aspects of Mr McBride and Mr Simpson's evidence I provide the below comments.

48. The evidence is silent on if there is a risk (or not) to water users downstream, along Donald's Creek and Otauria Stream (and their connected water ways). This includes the potential for surface water users/takes directly taking from the waterways, and/or groundwater users within the riparian zone of the water ways.

49. This pathway is particularly relevant due to the scheme's proposed direct discharge to Donald's Creek (which can be either UV treated, or non-UV treated), and the presently unquantified seepage rates from the WWTP Oxidation Ponds (pre-UV treatment process) of which the majority of this seepage is likely to flow towards and into Otauira Stream. In my capacity as reviewer, I have not investigated whether there are current water users which could be considered adversely affected; but given the frequent number of shallow boreholes in the region, it is possible that there are. I also note the possibility of future users within these zones. This aspect requires comment/assessment from the Applicant.

50. In paragraph 9 of Mr McBride's evidence, Mr McBride confirms his support for the applicant's adoption of a 5-year groundwater residence/travel time to be an appropriate time period. I agree this time period is appropriate for the primary groundwater pathogen risk management zone.

51. Figure 9 of Mr. Simpson's evidence presents the applicant's proposed 5-year groundwater travel time envelop. I will refer to this henceforth as the Primary Groundwater Pathogen Risk Management Zone. Whilst I am in general agreement with the aerial extent proposed in Figure 9, I recommend incorporating some alterations and the addition of the secondary groundwater risk management zone, to provide coverage for uncertainties associated with preferential flow paths, seasonally altered flow directions, and nearby up-or-cross gradient groundwater abstraction. If adopted, this may incorporate some additional affected parties. Further details are outlined in Paragraph 60 of my evidence.

52. Mr. Simpson and Mr. McBride evidences states that risk to shallow potable groundwater supplies within the Primary Groundwater Risk Management Zone is more than minor. I agree with this result.

53. In their evidence, they appear to confirm that the applicant will commit to providing an alternative potable water supply/system to existing water supply bores that are considered affected (listed in Table 1 of Mr Simpson's evidence). It is not completely clear from the evidence, but it indicates that this would apply to all shallow groundwater bores within the 5-year groundwater travel time envelop (Primary Groundwater Pathogen Risk Management Zone). Shallow has been defined as 30 m depth. I agree in principal with this approach but would seek alteration / addition / clarification on some aspects. These are discussed within Paragraph 60 of my evidence.

RESPONSE TO OTHER EVIDENCE

54. I provide specific mention to the evidence of Dr. Lee Burbery, who has prepared groundwater effects related evidence on behalf of Wairarapa Regional Public Health.

55. Dr. Burbery raises key points on the Applicant's assessment of groundwater pathogen risks and groundwater mounding risks. The outcomes and reasoning behind these key points I believe to be in general agreement with my own findings, and there are numerous examples of our technical agreement, namely;

    i. Dr. Burbery Paragraph 37 - "*Whether the site is suitable for the proposed activity remains dubious to me, given the shallow water table condition and potential risk of surface flooding that could hinder irrigation operations."* This agrees with my own concerns relating to the presence of a shallow water table.

    ii. Dr. Burbery Paragraph 42 - "*I harbour some reservations over the accuracy of the mounding assessment that stems from uncertainty in assumptions regarding the hydraulic gradient, but more importantly the hydraulic conductivities for the shallow aquifer."* This agrees with my own concerns relating to uncertainties of the applicant's assessment.

    iii. Dr. Burberry Paragraph 56 - "*To me it seems prudent that the activity status of the 7 bores the AEE identifies as being sited within 2 km down-gradient of the disposal field (which includes well S27/0080 I refer to above) be formally identified. The vulnerability of and risk of contamination of these well waters can then be assessed objectively. In particular, it should be identified whether the wells are used for potable domestic supply or not and if so, whether groundwater is treated before use, for this impacts on the level of risk*." This recommendation largely agrees with my own recommendations for consent conditions to provide further levels of pathogen risk management (see paragraph 60 below), although amongst other things, I have recommended 2.5 km down-gradient rather than 2 km.

56. Dr. Burberry Paragraph 57 - "*The potential for groundwater mounding effects to impose on the operation of the proposed deferred deficit irrigation practice could be assessed better. Assuming the criterion of no-irrigation to be exercised if the water table is within 1 m of the ground level is accepted in the consent conditions then regulation of this rule will require some thoughtful consideration. Notably, water table depths should be monitored at locations where they are naturally shallowest (e.g. in dips)*

and ideally at more than one location across the disposal field." This recommendation largely agrees with my own recommendations for consent conditions to provide specific conditions relating to the management and performance standards of groundwater mounding effects (see paragraph 58 and 59 below).

CONDITIONS MITIGATION

57. I provide the following comments on the applicant's proposed conditions of consent relating to groundwater risks.

58. The Applicant has proposed to prepare an environment management plan which will determine what the environmental related groundwater monitoring conditions and performance standards are. As this has not yet been prepared I am not able to provide review comments as to the appropriateness and robustness of this plan. I believe a framework of this plan, with relevant items e.g. monitoring locations, monitoring frequencies, and proposed limit(s) of effects, should have been provided within the application. This would allow for review by all interested parties, including myself and submitters. Without significantly more certainty on these conditions, the proposed scheme may end up being able to be operated in a manner that creates effects different and potentially more adverse from that proposed by the Applicant.

59. In my opinion, specific conditions relating to the amount of permissible offsite groundwater level rise should be included, along with appropriate monitoring. Such conditions should be aimed to limit groundwater level rise at the boundary to each adjoining land parcel to quantifiable and measurable groundwater levels. In practice this could be done through assigning groundwater 'Alert' levels and monitoring boreholes, which allow sufficient time to restrict irrigation to certain areas should the groundwater Alert level be triggered.

60. Condition No. 17 of Schedule 4 titled *'Alternative Potable Water Supply'* in my opinion should be updated to include the below aspects:

    i. The applicant should assess the risk of additional areas further downgradient within a specified riparian zone of the surface water bodies pertinent to the site discharges and incorporate additional zones into the Primary Groundwater Pathogen Risk Management Zone.

    ii. Alteration of how the alternative potable water supply is determined within the Primary Groundwater Pathogen Risk Management Zone. I suggest that this be altered to identify potentially affected third-parties based on property boundaries

rather than the recorded bore location e.g. all land parcels which are either wholly or partially captured within the zone should be incorporated initially and then once the bore location(s) is accurately confirmed a decision can be made as to whether a replacement water supply is required or not. This is because the recorded location of boreholes is often significantly inaccurate, particularly for older boreholes.

iii. Creation of a Secondary Groundwater Pathogen Risk Management Zone to provide, at a minimum, a site-specific risk assessment and management measures within the consent conditions for existing and future users.

iv. Areas upgradient and across gradient from the discharge locations should be incorporated into a suggested Secondary Groundwater Pathogen Risk Management Zone. There is risk in these directions due to; seasonal changes in groundwater flow direction, flow dispersion and preferential flow paths (which is not covered by the particle tracking employed within Mr Simpson's model), spray drift (which potentially could enter borehead works or be preferentially recharged through macropores), and the potential draw of groundwater from abstraction. This suggested secondary zone may not strictly require provision of alternative water supply, but should at a minimum incorporate a site-specific risk assessment and management measures within the consent conditions for existing and future users within a specified buffer distance.

v. Areas extending downgradient from the discharge sites up to 2500 m should be incorporated into a suggested Secondary Pathogen Risk Management Zone. Boreholes outside the Primary Pathogen Risk Zone but within this suggested secondary zone should require at a minimum a site-specific risk assessment and management measures, but may not strictly require an alternative supply (depending on the assessment). The addition of the zone is due to the nature of the site hydrogeological setting, which is prone to preferential flow paths which can migrate contaminants significantly faster than the bulk average. Based on work within Blaschke *et al*, (2016)[1], the 2500 m distance has been recognised as reasonable to adopt to provide risk reduction for viruses in

[1] Blaschke, A. P., Derx, J., Zessner, M., Kirnbauer, R., Kavka, G., Strelec, H., Pang, L. (2016). Setback distances between small biological wastewater treatment systems and drinking water wells against virus contamination in alluvial aquifers. Science of the Total Environment, 573, 278-289.

gravel geology without further site-specific information to confirm otherwise.

vi. Clarification on the reasonings for the 30 m bore depth cut-off for the Primary Groundwater Pathogen Risk Zone, and comment on whether deeper boreholes within the aerial extent of the primary zone should be incorporated into the suggested Secondary Groundwater Pathogen Risk Management Zone.

vii. Clarification on the approach to mitigation for any future shallow groundwater boreholes or takes within the Primary Groundwater Pathogen Risk Management Zone and any Secondary Groundwater Pathogen Risk Managements Zones that are adopted.

viii. Groundwater quality monitoring conditions relating to tracking of potential persistent chemicals/toxicants, including the commonly termed '*Emerging Contaminants'* family of chemicals, should be included with this consent. These will naturally need to include clauses for periodic review and update, due to the changing nature of this family of chemicals e.g. invention/awareness of new contaminants, changing contaminant exposure level guidelines. However, I do suggest that the finer details of these particular conditions could be determined post consent decision. These contaminants typically pose a chronic rather than acute public health risk.

RESPONSE TO SUBMITTERS

61. There are several submissions relating to potential groundwater contamination and associated public health risks. I have provided explicit commentary on this matter, as well as my recommendations for consent conditions within my evidence.

62. There are some submissions relating to groundwater level management, and I have provided explicit commentary on this matter, as well as my recommendations for consent conditions within my evidence.

CONCLUSIONS

63. In my opinion there are gaps within the robustness of the groundwater assessment present themselves as potential risks, namely;

    i. underestimation of the scheme's environmental effects and/or potentially affected parties;

ii. limitations to the functional ability of the proposed land discharge scheme; and

iii. overall scheme cost (e.g. if additional land or storage.

64. In my opinion, the applicant has not provided a sufficiently detailed site-specific groundwater investigation to inform and confirm their groundwater effects assessment. The geology and hydraulic properties of the site within the saturated zone, that is being relied upon to dissipate the irrigation drainage, has been largely assumed from off-site data and/or regional scale studies for water supply purposes.

65. In addition to Paragraph 63, in my opinion the applicant should provide the specific details of the groundwater related monitoring conditions and performance standards e.g. monitoring bore locations, monitoring frequencies, and proposed limit(s) of effects, that they intend to achieve at this stage of proceedings, so it can be assessed by all interested parties (including myself), rather than to be determined post-consent decision.

66. The Applicant has proposed to provide alternative potable water supplies to shallow groundwater users within a specified zone of risk. I support this condition in principle, but I have also made some further recommendations pertinent to the groundwater pathogen risk assessment. If these recommendations are adopted, these would fulfil my remaining concerns on groundwater pathogen risk management.

67. Overall, due to the lack of supplied information, I am overall not in a position to provide a technical review to a level where I can state that all reasonably expected aspects of a groundwater assessment for this type and scale of discharge consent have been completed.

68. I recommend the below options for progressing the situation:

    i. Complete the additional field investigation work and provide the outstanding groundwater assessment information as set out in the JWS (and if needed update the groundwater effects assessment accordingly) to provide surety of the predicted groundwater effects plus adoption of the alterations to consent conditions I have outlined – AND –

    a. Adoption of the specific additions to the proposed consent conditions, as outlined in Paragraphs 58 to 60 of my evidence.

Aslan Michael Perwick
10 May 2019