IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications for resource consent (**APP-2005011178.01** and **APP-2018201909.00**) to Horizons Regional Council associated with the construction of a wetland as part of the proposed upgrades to and ongoing operation of the Eketahuna Wastewater Treatment Plant
BY	**TARARUA DISTRICT COUNCIL** **Applicant**

STATEMENT OF EVIDENCE OF ROGER JOHN MACGIBBON (WETLAND DESIGN)
ON BEHALF OF TARARUA DISTRICT COUNCIL

12 November 2018

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INTRODUCTION

Background and role

1. My full name is **Roger John MacGibbon.**

2. I am a Principal Ecologist at Tonkin & Taylor.

3. My evidence is given on behalf of Tararua District Council ("**TDC**") in relation to its application ("the **Wetland Application**") under section 88 of the Resource Management Act 1991 ("**RMA**") for resource consents relating to the construction of a wetland as part of the wider proposed upgrades to and ongoing operation of the Eketahuna Wastewater Treatment Plant ("the **Project**").

4. I became involved in the Eketahuna WWTP ("**EWWTP**") resource consent proceedings in April 2017 following TDC's decision to progress the construction of a wetland as part of the EWWTP proposed upgrades. I was asked to prepare a design concept for the proposed wetland and to consider suitable locations, resulting in the preparation of a report ("the **Wetland Design Report**") which is appended to the Assessment of Environmental Effects ("**AEE**") as Appendix III.

5. My evidence relates to the design concept and suitable locations of the proposed wetland.

Qualifications and experience

6. I have the following qualifications and experience relevant to the evidence I shall give:

   (a) I hold a Bachelor of Science Degree with Honours in Zoology and Ecology from the University of Canterbury (1981).

   (b) I have 35 years' experience working as an ecologist and environmental consultant and have worked in all regions of New Zealand and in Hawaii, Vanuatu and Australia.

   (c) I am currently employed as Principal Ecologist with Tonkin and Taylor. Prior to that I worked for seven and a half years for Opus, also as a Principal Ecologist. Between 1995 and 2010 I owned and managed my own environmental consultancy, Natural Logic Limited, which provided ecological, restoration and sustainable land and water management services to central and local government, and private landowner clients throughout New Zealand.

(d) In the early years of my career I worked for the Department of Conservation ("**DOC**") in Taupo as the manager of the country's largest native plant nursery, and in the Environmental Division of the NZ Forest Service in Wellington, before the creation of DOC.

(e) I specialise in ecological restoration and have provided design, technical support and project management services for a wide range of restoration projects across terrestrial, freshwater and coastal environments. This work has included the rehabilitation of damaged landscapes such as mines and quarries, the restoration of predominantly natural habitat, the enhancement of water quality in natural waterways (rivers, stream, wetlands and estuaries), the control and eradication of weeds and pests, and the management and reintroduction of animals (invertebrates and vertebrates) to restored environments. In particular, I lead the development of one of New Zealand's largest potential biodiversity compensation schemes over 3,650ha associated with the proposed NZ Transport Agency Mt Messenger project.

(f) In the past eight years one area of particular focus has been the design, construction and maintenance of wetlands for the management of nutrients, especially nitrogen, on farms and for local authority wastewater treatment discharges.

(g) I designed and managed the construction of two notable wetland projects in the Waikato (at Putaruru and Cambridge) that were joint venture, applied research initiatives with Dairy NZ, Lincoln University and NIWA, and have provided wetland concept designs and presented evidence for TDC for the Pahiatua Wastewater Treatment Plant.

(h) I have also provided technical advice on wastewater wetland performance and rejuvenation to several local authorities in the North and South Islands and designed a wastewater wetland option specifically to meet Māori cultural needs in the King Country.

Code of conduct

7. I confirm that I have read the 'Code of Conduct' for expert witnesses contained in the Environment Court Practice Note 2014.

8. My evidence has been prepared in compliance with that Code. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I

have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Scope of evidence

9. I have been asked by TDC to provide evidence in relation to the design concept and location of the proposed wetland. In particular, my evidence details or responds to:

   (a) wetland design principles;

   (b) wetland design specifications;

   (c) the Eketahuna wetland design, including size requirements, location and construction details;

   (d) biodiversity planting;

   (e) queries raised by the Panel in its minute dated 29 October 2018 relating to the Wetland Application ("the **Ninth Memorandum**");

   (f) the submission made by Rangitāne o Tamaki Nui-a-Rua ("**Rangitāne**"); and

   (g) matters raised in the Council Officers' Section 42A Reports as they relate to the Wetland Application.

EXECUTIVE SUMMARY

10. The driving purpose behind the wetland proposed for the EWWTP was to address Policy 5-11 in the Horizons One Plan and recognise cultural issues associated with a direct discharge of treated human wastewater to water.

11. Well-designed and well-maintained Surface Flow wetlands have the ability to extract over 90% of the nitrate that enters as discharge or drainage water. Nitrate extraction occurs by a process called denitrification that is driven by naturally occurring denitrifying bacteria.

12. High levels of denitrification occur when water remains in the wetland for prolonged periods (residence time) and the interaction of water and nitrate molecules with organic matter (soil and vegetation) is maximised.

13. Residence time and the rate of denitrification are useful indicators of the effectiveness of land-based treatment of wastewater and therefore useful indicators of the ability of wetland to 'polish' wastewater and to address Policy 5-11 (in providing for land passage before wastewater is discharged to water).

14. Details are provided about the design of the wetland and recommendations are made to about wetland maintenance requirements to sustain wetland plant vigour and wetland performance.

WETLAND DESIGN PRINCIPLES

15. Well-constructed and appropriately-designed wetlands can extract over 90% of nitrate nitrogen contained in drainage water or discharge, especially during summer periods. Data collected from a Cambridge wetland[1] constructed for nitrogen removal has shown that nitrate extraction can be higher than the maximum rates expressed in earlier literature (up to 85% in Lee et al 2009; and 70% in Tanner et al. 2010).

16. Nitrate nitrogen removal occurs predominantly by a process known as denitrification, and requires the presence of denitrifying bacteria that effectively break down the nitrate and nitrite molecules into nitrogen gas and water molecules.

17. The effectiveness of this process, that is, the complete removal of nitrate from the system (as opposed to it being stored somewhere) makes constructed wetlands a very useful tool on farmland challenged with high nitrate leaching levels, and industrial and domestic waste processing plants where elevated nitrate concentrations need to be managed.

18. Wetlands designed to extract nitrate by denitrification are often referred to as “Surface Flow wetlands” ("**SF wetlands**") and need to be built to specific design parameters if they are to perform effectively (see the design requirements referred to below).

19. Wetlands can also be effective at reducing living faecal bacteria levels by enhancing mortality due to prolonged exposure to sunlight. Some studies have recorded faecal bacteria mortality of greater than 90% as they pass through wetlands (Tanner et al 1995a).

20. Wetlands are generally less effective at extracting phosphorus ("**P**"). There is no biochemical process like denitrification to breakdown phosphorus in a wetland; the main mechanisms for “removal” of P in wetlands are deposition attached to sediments onto the wetland floor and by plant uptake.

21. Research has shown that wetlands vary in their capacity to remove P. Newly established and maturing wetlands generally exhibit quite high P removal (up to 74%, Tanner et al 1995b), mostly due to plant uptake. Some studies,

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[1] Data provided by Louise Cook, Demonstration Manager, Owl Farm, Cambridge

however, have shown wetlands can revert to being net P generators when plants have reached full size because once wetland plants reach maturity they then tend to release more P (in shed leaves) than they take up.

22. If sediment and P loads are high in drainage or discharge water it is recommended that sediment retention ponds are created upstream of the wetland to trap the sediment and chemically-bound P. This accumulated sediment can then be dredged periodically for disposal off-site.

WETLAND DESIGN SPECIFICATIONS

23. The design of the wetland is very important if optimal nutrient extraction and faecal bacteria mortality is to be achieved. Tree and shrub covered wetlands (often established for wetland biodiversity) and ponds with large areas of open water are of little value.

24. To maximise nitrate extraction within the wetland it is necessary to have the water disperse evenly over the whole wetland (ie a relatively shallow, flat bottomed design) and to prolong the retention of water within the wetland as long as possible (at least 24 hours) by creating a gentle gradient and high plant material interception.

25. The design requirements to optimise nitrate removal in SF wetlands are:

    (a) The wetland should be fully covered in sedges, reeds and rushes. Denitrifying bacteria require high levels of organic material to flourish.

    (b) Water levels within the wetland should not exceed 500mm (optimum level is 300mm). This is because most of our native sedges and rushes prefer depths less than 500mm. Where the fall from one end of a wetland to the other is greater than 500mm additional bays should be created with reinforced weirs between each bay to ensure the water level does not exceed 500mm in any bay.

    (c) Water must be retained in the wetland for no less than 24 hours and preferably longer. The longer the retention time the greater the reduction of nitrate. Thick planting with sedges, reeds and rushes helps to prolong retention. Longer water retention also leads to reduced oxygen levels which in turn enhances denitrifying bacteria performance.

    (d) The wetland should be flat bottomed to allow even dispersal of water which improves the interaction of nitrate molecules and denitrifying bacteria. The wetland should ideally have a length to width ratio of between 3:1 and 5:1 to ensure water does not pool or channelize (up to 10:1 is acceptable).

(e) Only plant species tolerant of permanent immersion in water should be used, and local site conditions, especially the presence and severity of frost, will dictate the species used and the natural source of the plant stock. Poor plant species and provenance[2] selection have been one of the most common reasons for treatment wetland failure in New Zealand over the last 15 years.

26. Newly constructed wetlands reach optimal denitrification performance more quickly if the organic content of the wetland soil is high. This is because denitrifying bacteria proliferate in soils with high organic content as well as on plant material. Consequently, it is recommended that all top soil is retained for deposition over the wetland base following excavation and extra organic matter is imported if soils are stony or organic content is low.

27. Constructed nutrient treatment wetlands do not need to be lined or impervious to function well. Provided the downward movement of water is slow and the organic content of the wetland soil is high denitrification will also be high as water percolates down through the wetland base.

28. In situations where existing groundwater quality is high and needs to be protected it may be necessary to line a wetland either with clay or a synthetic base layer. In these circumstances it is important that the base layer is positioned at a depth well beneath the organic soil layer so that it doesn't interfere with plant root and rhizome growth.

EKETAHUNA WETLAND DESIGN

Purpose

29. The wetland to be built at Eketahuna was conceived as a way of addressing Policy 5-11 of the Horizons One Plan. This policy requires in part that: "*before entering a surface water body all new discharges of treated human sewage must: (i) be applied onto or into land, or (ii) flow overland*".

30. The wetland, as proposed, will result in the discharge being applied to land as it enters the wetland, and it will flow over and through the land as it moves from one end of the wetland to the other. The wetland has been designed to achieve prolonged retention of the discharge in the shallow, vegetation-filled

[2] Provenance refers to a local natural population of an indigenous plant species that may be genetically distinct from a population of the same species in a different geographical area.

wetland to ensure that all of the discharge flow intercepts and is filtered by the organic substrate or the wetland vegetation as it passes through the wetland.

31. Although not necessary to meet Makakahi River water quality standards (refer to the evidence of Dr Ausseil), a secondary function of the wetland will be to 'polish' the quality of the discharge by removing a proportion of the nitrate remaining in the discharge before it reaches the Makakahi River. SF wetland systems naturally convert nitrate to nitrogen gas and water by denitrification.

Dimensions

32. The mean WWTP discharge from the Eketahuna WWTP has been reported as 651 cubic metres per day (Opus 2018 a) with the maximum discharge flow reported as 1868m^3 per day (30L/s). It is understood that a significant proportion of the high flow peaks is a result of storm water intrusion into the sewerage piping in the town. Consequently, it is likely that the maximum wastewater component of the daily discharge is considerably less than 1868m^3/day and that the maximum levels occur during prolonged wet periods (when river flows will be high).

33. The Eketahuna SF wetland has been designed to hold 100% of the volume of the maximum recorded daily discharge for a minimum period of 24 hours. Allowing for the wetland vegetation to occupy up to 25 to 30% of the wetland volume once the plants reach maturity, a wetland with a capacity to hold 2668m^3 is necessary to retain peak flows for 24 hours. At a maximum operational wetland depth of 500mm this means the wetland must have a minimum surface area of 5336m^2 (0.53 ha). Consequently, the wetland has been designed to be 5500m^2 in surface area. Approximate surface dimensions are 170m long and an average width of about 33m.

34. The maximum flow rates are likely to reduce as the problem with stormwater intrusion is reduced over time so the residence time of peak discharges is likely to increase.

35. Median flows will be retained in the wetland for over 4 days which should result in nitrate extraction of well over 50% if the wetland is well maintained.

Wetland location

36. The proposed location of the WWTP wetland is on the lower terrace of the Eketahuna Golf Course beside the Makakahi River (Figure 1). There is

sufficient room at the proposed site to construct a 5500m^2 wetland. The wastewater discharge will be piped from the WWTP (southeast of the proposed wetland site) to the head of the wetland (see Figure 1 inset).

Managing flood risk and sediment erosion

37. The proposed wetland site lies on a floodplain of the Makakahi River and is known to flood periodically. Earth bunds will be built around the river-facing wetland margins to deflect flood flows and will be between 1.3 and 2.5 metres high and designed to repel flood waters generated by at least 1 in 50 year rain events (2% AEP [Annual Exceedance Probability]). Details of the flood modelling, bund height calculations and bund design can be found in the WSP-Opus 2018 *Eketahuna WWTP Hydraulic modelling* report.

38. During larger flood events it is expected that flood waters will spill over into the wetland and pass through it. Provided flood flow rates are not extreme the wetland plants can be expected to tolerate periods of complete immersion in flood water and the deposition of sizeable loads of sediment. To reduce the risk of erosion as water flows over the bunds, it is recommended that reinforced flood sills are created at the upstream and downstream ends of the wetland to better manage flood waters that do pass through the wetland.

39. The earth excavated to create the wetland will be used to make the bunds. The bunds will be thickly planted with flood and erosion resistant sedges and rushes to minimise the risk of sediment erosion.

40. Details of the measures to be taken to prevent sediment erosion during construction can be found in the Opus (2018) *Eketahuna Wastewater Treatment Plant Wetland Erosion and Sediment Control Plan (ESCP*) appended to the Wetland Application and AEE as Appendix VI.

Inflow and outlet structures

41. Wastewater will be piped from the WWTP to the wetland and will be released through a dispersal gallery to spread the inflow across the width of the wetland.

42. The outlet structure to carry discharge from the wetland to the Makakahi River has been designed to cope with predicted peak flow volumes (including water captured by heavy rain events) and to withstand erosion when the river is in flood. Details of the recommended outlet structure design can be found

in the *Opus (2018) Eketahuna WWTP Wetland Outlet Sizing* report appended to the Wetland Application and AEE as Appendix V.

43. This report suggests that the wetland will be able to cope with peak discharge flows and a 10- year ARI (i.e. average recurrence interval) rainfall event with only short periods of less than 24 hour water retention or depths greater than 50cm. The plants used in nutrient treatment wetlands are able to withstand several days of complete water immersion so no damage is expected with 10 year rain events.

Wetland permeability

44. It has been agreed that the wetland will be lined with a layer of substrate with a high clay or silt content to reduce the rate of downward percolation of discharge through into the groundwater. The intention of the clay/silt base layer will be to slow down percolation through the wetland base to the recommended rate[3] of no more than 10% of the average daily inflow (this equates to a hydraulic conductivity of less than $1.4x10^{-7}$m/s). I would accept a condition that stipulated that this level of permeability was required and I understand such a condition is proposed by TDC, as included in the evidence of Ms Manderson.

45. Complete impermeability is not desirable because much of the denitrifying activity occurs in the organic soil layer in the wetland; consequently, discharge passing through a partially permeable lining is likely to have a lower nitrogen content than water leaving the wetland where the liner is completely impermeable.

Faecal bacteria

46. Constructed SF wetlands can generate faecal bacteria if waterfowl, especially ducks and to a lesser extent pukekos, utilise the wetland as habitat.

47. Duck occupancy, and therefore faecal contamination, can be minimised by ensuring plant cover is achieved across the entire wetland surface during the wetland establishment phase. Ducks will generally only land on open water areas.

48. On farmland, constructed wetlands will generally reduce faecal bacteria levels (due to exposure to sunlight) even with some input from waterfowl because influent bacteria loads are high. However, faecal bacteria loads

[3] Refer to the recommendations of Jack McConchie and Ella Boam in the 17 September "Eketahuna Further Information Response".

entering the Eketahuna wetland from the WWTP are likely to be low because of bacterial inactivation as the discharge passes through the new UV disinfection system so there is a possibility that even low site occupancy by pukekos and other waterfowl may increase faecal bacteria levels in the wetland to some extent.

Planting and wetland maintenance

49. SF wetlands must be fully planted (ie no open water areas) to perform optimally. Plants should be planted at a density of two plants per square metre (this equates to 0.7m spacings between plants) across the entire base of the wetland.

50. Only a small number of species are suitable for planting in a treatment wetland. Species planted must be tolerant of constant immersion in water, capable of withstanding frosts, able to tolerate low oxygen soil conditions, and grass- or sedge-like to serve as a filter to water flow. A list of recommended native plant species known to be suitable for treatment wetlands are recommended in my report: *"Eketahuna WWTP Wetland Proposal – Location and Design Concept*" May 2018, Appendix III to the Wetland Application and AEE.

51. Blanking (ie replacement of plants that die) will be necessary to fill all gaps. Weeds, especially willow seedlings, will also need to be controlled on an annual basis until full canopy cover is achieved (up to five years following planting).

52. On-going plant maintenance is necessary to ensure the plants retain their vigour and the wetland continues to extract nitrate at optimal levels. All of the sedges, rushes and reeds planted in the treatment wetland will need to be heavily topped approximately every five years to restore vigour, and any gaps filled with replacement plants. All cut vegetation will need to be removed from the wetland to prevent the decomposing vegetation increasing organic N and P in the outflow to the river.

QUERIES RAISED BY THE PANEL RELATING TO THE WETLAND

53. My responses to the Panel's queries as they relate to the design of the wetland are set out below.

[2.6]: The proposed constructed wetland is to "polish" the wastewater prior to discharging to the Makakahi River. Given that the wetland is to be part of the treatment process what standards would be appropriate to apply to the discharge

prior to discharging to the Makakahi to ensure the wetland remains efficient? For such standards, what lead in time would be appropriate for the wetland to become operational?

54. As discussed above in my evidence, the proposed wetland is aimed at addressing Policy 5-11 (and providing some cultural mitigation), and the 'polishing' function is secondary. From the perspective of wetland function and reasonable performance, generally speaking the only treatment function that a SF wetland can perform is nitrate reduction (by denitrification).

55. In this case, though, the discharge that will enter the wetland from the EWWTP is already at acceptable nitrate water quality levels (refer to Dr Ausseil's evidence). Therefore, the wetland is not an essential part of the treatment process in this regard; rather it is an additional benefit which is why its function is referred to as 'polishing'.

56. If any aspect of water quality was to be measured to assess the treatment performance of the wetland it should only be for nitrate but I would question the need for any monitoring of the wetland outflow given that the wetland is unlikely to generate nitrate and the EWWTP nitrate discharge currently has a very minor contribution to in-stream nitrate-nitrogen concentrations and loads (as stated in Dr Ausseil's evidence).

57. In terms of a lead-in time, constructed wetland vegetation usually takes two years to grow sufficiently before optimal levels of denitrification begin to occur and that is how long I would anticipate the growth to take in this case.

[2.7]: Information provided with the application shows that wetlands can be an efficient method to remove nitrate from water. Given that much of the Soluble Inorganic Nitrogen (SIN) in the discharge is ammoniacal nitrogen, is it possible for the applicant to increase the nitrate concentration (decreasing ammoniacal-nitrogen concentration) in the discharge prior to discharging to wetland, therefore reducing the SIN load discharged to the Makakahi River?

58. My understanding, based on the evidence of Mr Crawford and Dr Ausseil, is that while the proportion of ammoniacal-N in the SIN content of the discharge is high the actual concentrations of both ammoniacal-N and nitrate are low and not likely to cause environmental effects when the discharge enters the river. This is addressed in the evidence of Dr Ausseil.

[2.8]: The applicant has provided information on the reduction in loads discharged to the Makakahi River as a result of the treatment provided by the wetland. These reductions will have been based on an efficiency of the wetland in removing

contaminants. Could information please be provided as to the efficiency rate used, whether this varies between seasons and if such an efficiency rate would be appropriate as a potential condition of consent?

59. Well-designed and well-maintained SF wetlands typically extract between 50% and 90% of nitrate during the summer time, and between 30% (in the colder lower South Island) and 50% (in the warmer upper North Island) in winter. An average annual nitrate extraction rate of 50% has been assumed as a realistic performance level for the Eketahuna wetland.

60. In terms of the appropriateness of an efficiency rate as a condition, as set out in the evidence of Dr Ausseil nitrate-nitrogen removal though the wetland will make very little difference to in-stream SIN concentrations, which Dr Ausseil notes accords with the fact that the EWWTP discharge is only a very minor contributor to the nitrate-nitrogen measured in the Makakahi River. Based on Dr Ausseil's evidence, I do not propose including any nitrate reduction or efficiency rate condition.

COMMENTS ON SUBMISSION BY RANGITĀNE O TAMAKI NUI-A-RUA

61. The submission made by Rangitāne raises queries as the design and effectiveness of the proposed wetland. My responses are set out below.

At Page 2: The application does not assess the effects of the discharge as modified by passing through the proposed wetland. There is insufficient detail about the design of the proposed wetland, including the ratio of contaminants that will pass through the base of the wetland versus flowing across the wetland, to allow for a reasonable assessment of the effectiveness of the wetland in treating contaminants.

62. As discussed in my evidence above, the wetland will be constructed in a way that will allow up to 10% of the flow to pass down through the wetland base, with the remainder flowing through the wetland length to the river. The contaminant polishing capabilities of surface flow wetlands have been discussed in my evidence and my earlier report. All natural wetland systems release organic nutrients as vegetative material is shed and decomposes but provided the wetland is well-maintained the volume of nutrient released by the wetland should not, on average, exceed what is taken up.

At Page 3: The wetland design report focusses on maximizing the nutrient removal effectiveness of the proposed wetland, but does not describe what the design requirements to address cultural effects are. That indicates that the wetland has *not be design for the purpose of addressing cultural effects, but as a further nutrient removal processing step.*

63. As above the wetland was conceived as a way to address Policy 5-11 and respond to cultural concerns related to direct discharges. Optimising the denitrification process is a good measure of the extent of interaction between the water discharge and organic matter (soil and vegetation) as the discharge flows through the wetland. It therefore provides good surrogate measure of the effectiveness of a wetland as a form of treatment to land. Denitrifying bacteria live in the organic layer at the base of the wetland and on the vegetation. The greater the reduction of nitrate the greater the contact that has occurred between water molecules and organic matter. While I cannot provide judgement as to whether cultural effects have been suitably mitigated by this process my opinion is that residence time and nitrate removal rates are appropriate measures of the cleansing benefits of wetlands.

MATTERS RAISED IN COUNCIL OFFICERS' SECTION 42A REPORTS RELATING TO THE WETLAND

Mr Logan Brown

64. Mr Brown states at paragraph 10 that *"To date we have none of the wetlands proposed in this application that is a wetland specifically constructed for the treatment of wastewater within the Region."* As a point of clarification (and as reiterated throughout my evidence) the Eketahuna wetland was conceived of and designed as a way of addressing Policy 5-11 and recognising cultural concerns. Its 'polishing' function is secondary.

65. Mr Brown has proposed (paragraph 15 a to d) some additional parameters that he believes should be included in a wetland management plan. I respond to those within my area of expertise.

“a. That the plan shows how the formation of preferential flow paths will be prevented within the wetland and if preferential flow paths do develop the process that will be followed to overcome the problem”.

(a) Preferential flow paths should not occur if the wetland has been well designed and constructed. The key requirements are: that the wetland base is perfectly level in cross section so that water spreads evenly across the entire surface; vegetation is established across the full wetland surface – this takes the energy out of the flow and prevents channel formation; inflow is dispersed as it enters the head of the wetland via a dispersal gallery – this reduces the erosive energy that would occur if the discharge entered the wetland through a single pipe.

(b) If preferential channels do begin to form then these can be infilled with an excavator and the density of wetland plants increased to reduce the likelihood of it occurring again.

"b. The design and mapping of the fence to prevent stock access to the wetland."

(c) A stock proof fence will be provided along the top of the terrace above the wetland site.

"c. The monitoring to be undertaken to inform the monitoring of the effectiveness of the wetland and also the actions to the undertaken if the wetland isn't performing as designed."

(d) The only water treatment function that the wetland will perform is to reduce nitrate levels. As nitrate levels in the discharge are already low I do not think there is any risk of the wetland generating nitrate concentrations that might cause water quality effects in the river. Therefore, I do not consider such monitoring is required.

66. In paragraph 16 Mr Brown states that "*The monitoring of the wetland will be vital to monitor the reduction in nitrate that occurs as a result of the installation of the wetland and to also ensure that the wetland over time does not start to underperform",* and later in the same paragraph states*: "The constructed wetland is to become part of the treatment process for the wastewater discharge as the final "polish" prior to entering the Makakahi River."*

67. As stated previously in my evidence, while the wetland will serve to polish some of the nitrate from the discharge the wetland is not needed as a treatment device for nitrate and its driver is Policy 5-11 of the One Plan and the need to provide land passage. Nitrate discharge concentrations leaving the EWWTP are already sufficiently low not to cause water quality issues in the Makakahi River. For the reasons already set out, I do not agree that such monitoring is 'vital' and do not consider it to be necessary.

68. In paragraph 17 (and repeated at paragraph 45c) Mr Brown writes: *"In addition I would recommend that conditions are included on the consent that ensure that the wetland reduces the nitrate concentration by 50 percent, and that the other contaminants in the discharge (e.g. DRP, E.coli) do not become worse as a result of the operation of the wetland."*

69. As stated above, based on the evidence of Mr Crawford and Dr Ausseil, I do not consider monitoring of the wetland outflow is essential to safeguard river water quality. However, if a reduction was to be imposed then a requirement for monitoring of nitrate at the wetland outflow, provided the 50% target is set as an annual average, would be acceptable. The wetland is being designed with the principal purpose of addressing Policy 5-11 and in creating a sedge-rush wetland that mimics natural riparian wetland habitat, as proposed, natural nutrient cycling will occur. This will result in natural seasonal generation of decomposing organic material that will produce elevated levels of phosphorus and nitrogen from time to time.

70. Consequently, I do not believe it is appropriate that any aspect other than nitrate is measured at the wetland outlet if it is a repeat of what is measured at the WWTP outlet.

Mr Baker

71. Mr Baker raises several of the same issues raised by Mr Brown which I have responded to above. In paragraph 6 Mr Baker states: "*Nevertheless, should the wetland allow vertical migration of treated wastewater (i.e. leakage) there is the potential for the groundwater contained in the lower terrace to become contaminated, and it is likely that this will enter the river*."

72. As stated in my evidence above, it is likely that the discharge that percolates down through the wetland base into the groundwater will have a lower nitrate concentration than the discharge entering the wetland (resulting from denitrification as it passes through the organic wetland base) and conceivably lower than the existing groundwater. The clays or silts that will be used to line the wetland base to achieve the reduced permeability standard will also serve as an effective filter to all contaminants other than soluble nutrients (DRP, nitrate and ammonium). Groundwater effects are discussed in further detail in the evidence of Ms Ella Boam.

73. In relation to Mr Baker's comments on the water from seepage of the wetland entering the adjacent river; that is intended by the system and all the water from the wetland that does not seep or get evaporated will be discharged to the river. Again the key point is to achieve land passage and that occurs in either case.

Fiona Morton

74. At paragraphs 30 – 34 Ms Morton summarises Mr Brown's Section 42A Report as it pertains to surface water quality. I consider my responses to Mr Brown's report, as set out above, address Ms Morton's comments.

75. Ms Morton discusses the interface between groundwater and the wetland at paragraphs 35 – 39 of her report. Again, I have dealt with these matters above in my response to Mr Baker's report and these matters are also addressed in the evidence of Ms Boam.

Roger John MacGibbon

12 November 2018

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WSP-Opus. 2018b. *Eketahuna Wastewater Treatment Plant Wetland Erosion and Sediment Control Plan (ESCP*)

WSP-Opus. 2018c. Eketahuna WWTP Hydraulic modelling.

APPENDIX 1: AERIAL SCHEMATIC OF THE PROPOSED EKETAHUNA WWTP WETLAND

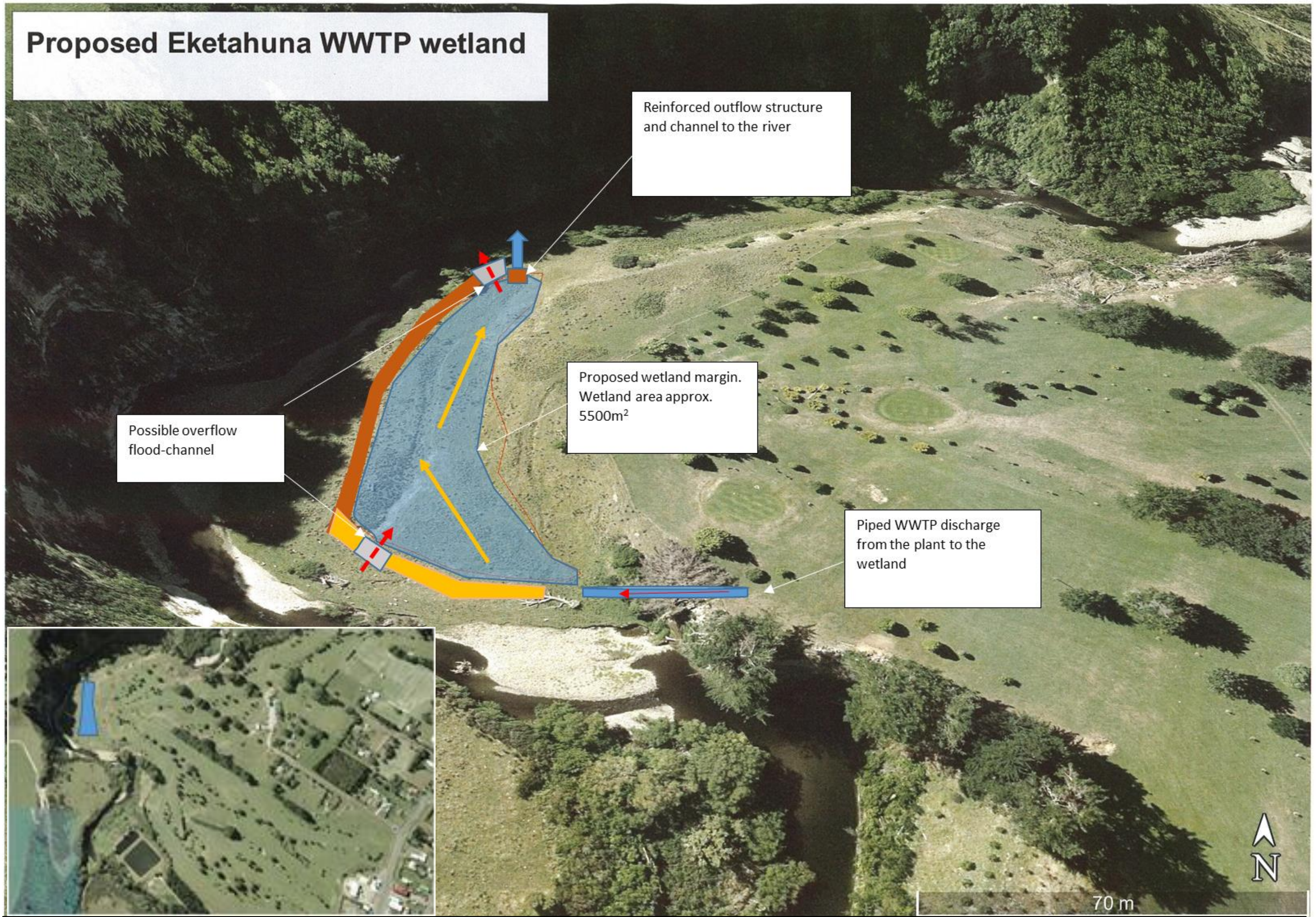

Figure 1: Aerial photograph of the lower terrace showing the position and configuration of the proposed WWTP wetland, and the location of the wetland relative to the WWTP (inset)