BEFORE NORTHLAND REGIONAL COUNCIL

UNDER	the Resource Management Act 1991
A N D	
IN THE MATTER	of applications to renew the resource consents associated with the operation of the wastewater treatment plants at Opononi and Kohukohu
BETWEEN	**FAR NORTH DISTRICT COUNCIL**
	Applicant
	NORTHLAND REGIONAL COUNCIL
	Consent Authority

EVIDENCE OF DR REBECCA (BECKY) JOANNE MACDONALD

WASTEWATER TREATMENT

MAY 2023

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INTRODUCTION

Qualifications and experience

1. My full name is Rebecca (Becky) Joanne Macdonald. I am employed by Jacobs New Zealand Ltd (Jacobs), an engineering and environmental consultancy firm, with a role of the Principal Wastewater Engineer in New Zealand. I am the Regional Solutions Director (acting) for Water Infrastructure in Australia and New Zealand. I hold a Bachelor of Engineering with first class honours (BE Hons) in Chemical and Process Engineering (2000) and a Doctorate in Philosophy Degree (PhD) also in Chemical and Process Engineering (2010), both from University of Canterbury in New Zealand. I am a Fellow of the Institute of Chemical Engineers (IChemE), a Chartered Engineer, a Member of the Education Accreditation Panel for IChemE, and an Adjunct Associate Professor in Chemical Engineering at the University of Canterbury. I am a member of the Technical Committee of Water NZ and the Deputy Chair of the Programme of Water.

2. I have 23 years' experience in the field of wastewater and water engineering, commencing a role as Principal Wastewater Engineer with my employer, Jacobs, in 2019. I have worked throughout New Zealand for both public and private sector clients, providing specialist wastewater engineering into the design, construction, and operation of wastewater treatment plants, including providing expert evidence at consent hearings. Clients I have recently worked with include Far North District Council, Christchurch City Council, Selwyn District Council, Hamilton City Council, Wellington Water Limited, Oji Fibre Solutions, and Parliamentary Commissioner for the Environment.

3. I confirm that the evidence I present is within my area of expertise and I am not aware of any material facts which might alter or detract from the opinions I express. I have read and agree to comply with the Code of Conduct for expert witnesses as set out in the Environment Court Practice Note 2022. The opinions expressed in this evidence are based on my qualifications and experience and are within my area of expertise. If I rely on the evidence or opinions of another, my evidence will acknowledge that position.

Involvement with these Applications

Opononi

4. My involvement in the Opononi project started in 2020 when Jacobs were engaged to investigate the issues and options for improving treatment at the Opononi Wastewater Treatment Plant (**WWTP**). I was the technical leader and project director for this project and involved in all aspects of the technical investigations and subsequent recommendations.

5. I prepared a report dated 15 October 2020 titled "*Opononi / Omapere WWTP Upgrade, Opononi WWTP Issues and Options*" which was attached to the Assessment of Effects on the Environment (**Opononi AEE**) for Opononi. My evidence draws on the information provided in this report.

Kohukohu

6. My involvement in the Kohukohu project started in 2020 when Jacobs were engaged to investigate the issues and options for improving treatment at the Kohukohu WWTP as well as the septage management for Kohukohu township. I was the technical leader and project director for this work and involved in all aspects of the technical investigations and subsequent recommendations. In 2022 Jacobs carried out the developed design of a small modifications to the Kohukohu Wastewater Treatment Plant, to maximise the treatment provided by the existing infrastructure. I was the technical leader and project director for this project. This minor upgrade was installed in 2022

7. I led the preparation of two reports which were attached to the Section 92 response for Kohukohu: "*Kohukohu Septage Management Review"* dated July 2020, and *"Kohukohu WWTP Upgrade, Kohukohu WWTP Issues and Options*" dated 15 October 2020. I also led the development of the "*Kohokohu WWTP Land Disposal Site Selection Analysis Report"* dated 17 February 2020, which was appended to the Issues and Options report. My evidence draws on the information provided in these reports as well as the "*Kohukohu WWTP Upgrade – Design Report*", dated 4 May 2022.

8. Prior to my involvement, Assessment of Effects on the Environment (**Kohukohu AEE**) for Kohukohu, prepared by Opus in 2016 included some relevant information.

9. Two reports by other specialists also influence my conclusions: "*Hokianga Harbour Hydrodynamic Study of Wastewater Discharges*", prepared by MetOcean Solutions (March 2020), and "*Semi-quantitative microbial human health risk assessment of Kohukohu WWTP discharge in the Hokianga Harbour*", by Streamlined Environmental Limited (August 2020)

Purpose, scope and structure of evidence

10. In my evidence I will:

    a. Summarise the key findings of my earlier work (as referred to above); and

    b. Address the submissions of relevance to my area of expertise, specifically the treatment and disposal of wastewater;

    c. Address issues arising from the Council's s42A reports; and

    d. Describe conditions changes required

11. Part A of my evidence addresses the above for Opononi WWTP.

12. Part B of my evidence addresses the above for Kohukohu WWTP.

EXECUTIVE SUMMARY

Opononi WWTP

13. The Opononi WWTP discharges treated wastewater into the Hokianga Harbour. The resource consent for this Harbour discharge expired in August 2019 and Far North District Council (FNDC) are investigating options to improve the performance of the WWTP, as well as considering removing the discharge from the harbour altogether by moving to a land disposal system. The Opononi WWTP has not been complying with the current consent E.coli, ammonia, biological oxygen demand (BOD) and total suspended solids (TSS) standards. Improvements to the WWTP are required to support compliance with the current resource consent conditions, and the likely future discharge consent conditions.

14. The hydrodynamic study of the wastewater discharges into the Hokianga Harbour (by MetOcean, 2020) showed a high level of dilution in the harbour with a median dilution factor of approximately 25,000 near the discharge point. The 95th percentile (exceeded 95 percent of the time) dilution was 1,000 near the discharge, 5,000 at about 500 meters down current and 25,000 at the shoreline.

15. A number of options have been considered for the Opononi WWTP. Combining the treatment options with suitable disposal options, four feasible upgrade options were identified which can address the BOD, TSS, E.coli and ammonia issues. A multicriteria assessment scored these options resulting in two similar options scoring highly (upgrading the existing treatment to provide enhanced ammonia, total suspended solids and pathogen disinfection). Both of these options were based on continuing discharge into the Hokianga Harbour. The only option that included land disposal scored highly for Māori cultural values, however it had a very high cost and as a result did not score well overall.

16. I largely agree with the conclusions reached in the s42A Report. I do not agree with the recommended conditions of the consent as these do not align with the findings of the technical studies undertaken.

Kohukohu WWTP

17. The current WWTP generally performs well the median effluent faecal coliform concentration for the past 10 years is 800 cfu/100 mL which is comfortably within the consent rolling median limit of 5,000 cfu/100mL. The maximum faecal coliform limit of 15,000 cfu/100mL was exceeded on six occasions in the past 10 years. A percentile limit which allows a number of exceedances is more practical for consent compliance, to allow for the natural variability of effluent quality. Similarly, for ammonia, a median or other percentile-based consent limit is more practical than a maximum value and would reduce the risk of a non-compliance. I concluded that a significant upgrade of the Kohukohu WWTP upgrade was not required, although there are some relatively inexpensive measures that would improve the treatment performance and these were implemented in 2022.

18. The hydrodynamic study of the wastewater discharges into the Hokianga Harbour (by MetOcean, 2020) found that based on the hydrodynamic modelling results, there is no discernible effect of the Kohukohu discharge within the main body of the Hokianga Harbour. A desktop assessment of land disposal sites found that most of the land around Kohukohu unsuitable for land disposal with

two potentially suitable sites identified, but these did not provide sufficient irrigation area.

19. A multicriteria assessment scored the improvements carried out in 2022 scored highly for relocation of the inlet and baffle installation in the oxidation pond as well as vegetation maintenance in the wetlands (Jacobs, May 2022). Installing UV disinfection scored low, due to the significant cost penalty of this pathway. Sensitivity analysis of the scoring did not change this overall ranking. I concluded that installing UV disinfection, whilst possible, would have minimal benefit. The commonly used percentile approach should be applied to monitoring of pathogens, specifically monitoring for faecal coliforms, as well as any other parameters.

20. It is important to note that due to all options scored zero percent Māori cultural values and practices. This was due to all the feasible options continuing with a discharge into the harbour.

21. I largely agree with the conclusions reached in the s42A Report. I do not agree with the recommended conditions of the consent as these do not align with the findings of the technical studies undertaken.

PART A: OPONONI WWTP

KEY FINDINGS OF EARLIER WORK

22. This section summarises the work submitted in support of the application.

Opononi - Process overview

23. The Opononi WWTP services the communities of Opononi and Omapere. The WWTP was constructed in 1985 and consists of an inlet screen, a partially mixed aerated lagoon, a maturation pond, a surface flow wetland, and an effluent storage pond. Treated wastewater is pumped from the storage pond into the Hokianga Harbour on the outgoing tide, via an outfall pipe.

Population

24. In the 2018 Census, the permanent resident population of Opononi and Omapere was 546 and long-term population forecasts indicate a decrease in the permanent population of the wider South Hokianga area. For the purposes of this resource consent application, a conservative assumption was made, that the permanent resident population of Opononi and Omapere remain static over the design life.

25. Approximately 160 houses in Opononi and Omapere are thought to be holiday homes. Whilst there is no data on holiday home occupancy during the Christmas holiday period, the flows and loads are monitored so the contribution of holiday homes has been considered. An increase in the number of holiday homes and/or occupancy of 2 percent per year has been assumed over the 35-year design period, resulting in 272 holiday homes by 2055.

Flows and loads

26. Influent flow data from Opononi WWTP information for the period 2010 to 2019 has been used as the basis for developing future flows for the year 2055 as follows:

    a. average dry weather flow (ADWF), 200 cubic meters per day,

    b. peak 30-day rolling ADWF, 420 cubic meters per day.

    c. peak wet weather flow (PWWF) 1,400 cubic meters per day

27. A wet weather day was defined as any day with greater than five millimetres of rain and accounts for 16 percent of the days in the year based on the 2010 to 2019 data set. A dry weather day was defined as any day where the total rainfall for that day and the preceding two days is less than 0.5 millimetres. Dry days were found to account for 31 percent of the days in the year based on the 2010 to 2019 data set. The peak 30-day rolling ADWF increased during the Christmas holiday period.

28. The Opononi resource consent application requests a maximum discharge volume of 450 cubic meters per day. This is not expected to be sufficient as estimates based on recent data calculate the peak 30-day rolling ADWF to be 420 cubic meters per day by 2055. I recommend that the consented discharge volume be amended to a peak 30-day rolling ADWF of 420 cubic meters per day.

29. The sewer catchment of Opononi and Omapere is predominantly domestic with no significant trade waste discharges and this is not expected to change. Sampling of the influent wastewater is not routinely undertaken, but some limited sampling was carried out in 2016 and 2018 and is summarised in Table 1.

Table 1: Influent Wastewater Characteristics from the Opononi WWTP 2016 to 2019

Parameter	Number of samples	Median	Mean
E. coli, cfu/100ml	10	23,900,000	-
Biological oxygen demand (BOD), mg/L	6	-	255
Chemical oxygen demand (COD), mg/L	4	-	543
Total Suspended Solids (TSS), mg/L	11	-	229

Treated wastewater

30. Sampling data from 2010 to 2019 for the treated wastewater from the Opononi WWTP was analysed and a summary is shown in Table 2.

Table 2: Treated Wastewater from Opononi WWTP 2016 to 2019

Parameter	Number of samples	Median		90 percentile	
		Consented	Measured	Consented	Measured
E. coli, cfu/100ml	72	3,000	4,400	5,500	24,000
Total ammoniacal nitrogen (TAN), mg/L	60	30	30	38	43
Biological oxygen demand (BOD), mg/L	60	20	11	35	23
Total suspended solids (TSS), mg/L	60	35	16	80	49

31. The data shows that the consent limit for *E. coli* is being exceeded by the current treatment process for both the median and 90 percentile and that this occurs throughout the year. Approximately a three-log reduction is occurring during treatment, whilst at least a four log reduction is required to meet the consent conditions.

32. The ninetieth percentile for total ammoniacal nitrogen is regularly being exceeded, and analysis for the data shows that this has been steadily increasing over the period 2010 to 2019. The data also shows that there is a regular peak in summer, which is likely due to the combination of higher population and higher temperatures impacting the nitrogen reactions in the ponds.

33. The testing for biological oxygen demand and total suspended solids shows that it is generally within resource consent conditions. During winter months of 2019 the median total suspended solids was exceeded. Following desludging of the ponds in 2018, both the median and ninetieth percentile data reduced to be comfortably within the consent conditions.

Wastewater treatment

34. The Opononi WWTP is not meeting the existing consent conditions with both increased disinfection and total ammoniacal nitrogen treatment required.

35. A long list of nine treatment options were identified, some of which provide a full solution and others require coupling with other technology:

a. reinstate wetland cell 1 to increase the retention time for disinfection and nitrogen treatment to occur

b. installing baffles in the maturation pond to reduce short circuiting and improve treatment of nitrogen

c. install UV disinfection to improve pathogen inactivation and therefore provide disinfection treatment

d. install membrane filtration to provide removal of pathogens and therefore provide disinfection treatment

e. install in-pond nitrification using a proven and reliable technology; this would require pilot scale testing at the WWTP prior to a final decision

f. install an external nitrification process, using a proven and reliable technology; again this would require pilot scale testing at the WWTP prior to a final decision

g. install pond aeration, to reduce the biological oxidation demand ahead of the ponds which would allow the natural pond nitrification process to occur.

h. construct an advanced wetland system to provides improved nitrogen treatment; this would require pilot scale testing at the WWTP prior to a final decision

i. replace with existing WWTP with a new, mechanical, activated sludge plant and UV disinfection plant to provide both nitrogen and disinfection treatment

Wastewater disposal

36. Currently treated wastewater from the Opononi WWTP is discharged on the outgoing tide into the Hokianga Harbour. The outfall discharge point is about twelve meters below mean sea level, approximately four hundred meters from the Opononi shoreline, opposite the mouth of the Waiahoria Stream.

37. A desktop investigation of potential land disposal sites was carried out by VK Consulting Ltd in 2011. This study concluded that land disposal was possible during the summer months, but that application rates were limited due to the type of soils and limitations due to rainfall. VK Consulting Ltd (2011) estimated that between 2,000 and 13,000 cubic meters of buffer storage would be required.

38. A further investigation into land disposal was carried out by Mott MacDonald in 2014 which found that due to the soil conditions, irrigation was only possible during five months of the year, over summer. During the remaining seven months alternative disposal or storage of the treatment wastewater would be required. Mott MacDonald (2014) calculated that 39,000 cubic meters of storage would be required and recommended winter discharge to the Hokianga Harbour.

39. Reviewing this previous work, three options for wastewater discharge are:

    a. land disposal with winter storage provided, noting that the nutrients contained in wastewater can be beneficial to plant growth, so different levels of treatment are appropriate for a land discharge environment;

    b. land disposal with disposal to the Hokianga Harbour disposal during winter and/or wet weather events, noting that the treatment process would need to align with the harbour discharge environment; and

    c. disposal to the Hokianga Harbour.

40. Investigations carried out by MetOcean Solutions (MetOcean 2020) considered the dilution in the Hokianga Harbour. MetOcean concluded that “based on this assessment the current effluent discharge is not breaching the receiving water quality standards at the shoreline or even near the outfall discharge”.

Multicriteria assessment

41. A treatment process upgrade is required. This includes optimising the existing treatment by installing curtain baffles on the maturation pond, reinstating wetland cell 1, and de-vegetating the overgrowth in the existing wetland cells, as well as installation of UV disinfection.

42. Consideration of land-based disposal was required as part of the previous consent conditions and this identified that land disposal is possible, albeit with limitations.

43. A long list of six combined treatment and disposal options were identified:

    a. optimise existing WWTP and maintain Hokianga Harbour discharge

    b. UV disinfection and maintain Hokianga Harbour discharge

    c. UV disinfection plus ammonia removal and maintain Hokianga Harbour discharge

    d. UV disinfection, ammonia removal, chemically assisted solids removal and maintain Hokianga Harbour discharge

    e. optimise existing WWTP and a new discharge to land

    f. activated sludge plant plus UV disinfection and Hokianga Harbour discharge

44. From this long list a short list of four options was identified, that would provide both the required level of treatment and adequate disposal:

    a. Optimising and improving the existing WWTP process, by incorporating chemically assisted solids removal, UV, with an in-pond or in-wetland ammonia removal process and Hokianga Harbour discharge

    b. Optimising and improving WWTP process, by incorporating chemically assisted solids removal, UV, with an external ammonia removal package plant and Hokianga Harbour discharge

    c. Optimising the existing WWTP process and discharge of the treated wastewater to land.

    d. Construction of a new activated sludge WWTP plus UV disinfection and Hokianga Harbour discharge.

45. A multicriteria assessment was carried out in a collaborative workshop on 26th August 2020, which considered five weighted primary criteria as shown in Table 3, with secondary criteria providing a structure for assessment.

Table 3 Multicriteria assessment for Opononi WWTP

Criteria	Weighting
Economic/affordability	40%
Environmental/climate	20%
Māori cultural values	20%
Practicability/feasibility	10%
Operational	10%

46. This assessment scored the two options optimising and improving the WWTP process as preferred based on the above criteria and weightings. Sensitivity analysis showed the relative rankings were retained, except for one scenario where the weighting for Māori cultural values and environmental and climate considerations were both increased to 30 percent. This reversed the ranking with the option Optimising the existing WWTP process and discharge of the treated wastewater to land scoring highest. This option has the highest estimated capital cost at over $18 million, compared with less than $5 million for all of the other options.

47. It was concluded that the Best Practicable Option (BPO) comprised the following:

    a. Implementing chemically assisted solids removal,

    b. Installing UV Disinfection treatment, and

    c. Installing specific ammonia removal technology (either in-pond or external package plant).

48. This is similar to that outlined in the Section 42A report and proposed consent conditions with one key difference; it recommended that the selection of the most appropriate ammonia reduction technology be carried out as part of the design, thereby allowing any recent technology developments to be incorporated.

MATTERS RAISED BY SUBMITTERS

49. The issues raised by submitters relevant to my area of expertise are:

    a. Alternative treatment options

    b. Alternative disposal options, specifically land application

    c. Population growth

50. These are addressed below.

Alternative treatment options

51. A number of submitters including Peter Reid, Ngatikorokoro Trust for Nga Hapu o te Wahapu o, Janine Elizabeth McVeagh, David Mark Hankins, Judith Reinken, Manuel Dr Robyn, Anna Josephine Bercich, Suzanne Lesley Duff, Awatea Te Rei Toi-Potae, Flynn Martin Land, Rhiannon Abbot-McGregor, Wai 2003 and Wai 250 Claimants as part of Nga Hapu o, Te Hikutu, Ngati Kaharau, Ngati Hau, & Te Mahurehure, Darleen Sheree Tana, Elizabeth Pearson, Bernadette Papa, Tim Webb, Sam Lees, Paula Hohua, Juliet Tihema, Mervyn Dove, Patrick Land, Carbon Neutral Trust NZ, requested that alternative and sustainable treatment options should be considered.

52. The Issues and Options Report (Jacobs, October 2020) considered twelve different broad treatment technologies addressing various treatment requirements. Within each technology are numerous sub-technologies all suited to different situations.

53. Four technologies considered pathogen treatment:

    a. wetland reinstatement to increase the retention time for disinfection to occur

    b. installing baffles in the maturation pond to reduce short circuiting and improve disinfection

    c. install UV disinfection to improve pathogen inactivation and therefore provide disinfection treatment

    d. Install membrane filtration to provide removal of pathogens and therefore provide disinfection treatment

54. Three technologies targeted the removal of total suspended solids

    a. Installing a floating plastic cover to prevent the growth of algae (solids), however this also reduces disinfection

    b. Adding chemicals to assist with flocculation/coagulation of the algae

    c. Installing electrocoagulation technology to precipitate the algae, however this has only been tested at laboratory scale and data from proven full scale testing would be required to properly evaluate

55. Four technologies considered nitrogen treatment

    a. in-pond natural nitrification using a proven and reliable technology; with a plethora of possible options available, this would require pilot scale testing at the WWTP prior to a final decision

    b. external, mechanical nitrification process, using a proven and reliable technology; there are a variety of options available that could be tuned for the local conditions

    c. install pond aeration, to reduce the biological oxidation demand ahead of the ponds which would allow the natural pond nitrification process to occur.

    d. construct an advanced wetland system to provides improved nitrogen treatment; this would require pilot scale testing at the WWTP prior to a final decision

56. One advanced treatment technology was considered:

    a. replace the existing WWTP with a new, mechanical, activated sludge plant and UV disinfection to provide both nitrogen and disinfection treatment

57. From this list of technologies, a long list of nine treatment options were identified for Opononi WWTP, some of which provide a full solution and others require combining to provide the required level of treatment.

58. As explained above, the BPO included:

a. implementing chemically assisted solids removal,

b. installing UV Disinfection treatment, and

c. installing specific ammonia removal technology (either in-pond or external package plant).

Land disposal options

59. A number of submitters, including Peter Reid, Emily Ashby, Seabourne Rust and Diane Yanakopuloa, Janine Elizabeth McVeagh, Manuel Dr Robyn, Craig and Kirsty Joiner, Hokianga Health Enterprise Trust, Michael Barickman, Roger Brand, Elizabeth Warr, Robin Ian Anderson, Patricia Lynne Stewart, Rebecca Thorne, Hokianga Harbour Care Inc, Imogen Brough Kristina Robertson, Marissa Dowling, Theresa & Culley Palmer, Kate Murray, Elijah Robert Reginald Land, Cecil Joseph Robert Land, Carbon Neutral Trust NZ expressed concerns regarding treated wastewater disposal, most specifically noting a preference for disposal to land of the treated wastewater.

60. Two studies into land disposal for the Opononi WWTP have been completed by others and were reviewed as part of the Issues and Options Study (Jacobs October 2020).

61. VK Consulting Ltd carried out a desk top study in 2011 which concluded that land disposal was possible during the summer months and that treated wastewater storage would be required in winter. Similarly, a study by Mott MacDonald in 2014 found that due to the soil conditions, irrigation was only possible during five months of the year, and that 39,000 cubic meters of storage would be required over the winter months.

62. The Mott MacDonald (2014) study recommended a hybrid solution with discharge to the Hokianga Harbour during winter, and land discharge in summer. This study also noted that the nutrients contained in wastewater can be beneficial to plant growth and as a result the treatment required for land disposal is different to that required for a discharge into the Hokianga Harbour.

63. A combined solution that incorporated land disposal was identified and explored during the options assessment. This was not carried forward due to three key factors:

a. the ongoing need to continue discharge into the Hokianga Harbour for much of the year, due to wet weather,

b. modelling showing that the receiving water quality will not be breached, and

c. the high capital cost associated with developing a land disposal scheme that would only be used during dry summer periods.

Population Growth

64. A number of submitters, including David Mark Hankins, Craig and Kirsty Joiner, Anna Josephine Bercich, and Pheobe Watkins expressed concerns that population growth had not been considered.

65. The Issues and Options Report (Jacobs, October 2020) notes that the permanent resident population of Opononi and Omapere was 546 at the 2018 Census and that long-term population forecasting indicates a decrease is likely in the permanent population of the wider South Hokianga area.

66. A key challenge for the Opononi WWTP is that the Opononi and Omapere population increases significantly over the Christmas holiday period due to the influx of holiday makers. In 2018 an estimated 160 holiday homes were connected to the Opononi/Omapere sewer scheme. Whilst there is no data on holiday home occupancy during the Christmas holiday period, the increase the increase in wastewater flows during this period is known and included in the design information.

67. It was concluded that population growth will be due to an increase in holiday makers, at a rate of two percent per year over 35-year period, resulting in a total increase of 96 percent by 2055 to a total of 272 holiday homes.

COUNCIL'S PRE-HEARING REPORT AND CONDITIONS

68. I largely agree with the conclusions reached in the s42A Report, with only three comments I wish to make in response. However, I do not agree with the recommended conditions of the consent and request amendments to align with the findings of the technical studies undertaken.

Section 42A Report

69. *Paragraph 18*: The Opononi resource consent application requested a maximum discharge volume of 450 cubic meters per day. Based on recent data the peak 30-day rolling ADWF is estimated to be 420 cubic meters per day by 2055. My recommendation is that the consented discharge volume be amended to a peak 30-day rolling ADWF of 420 cubic meters per day.

70. *Paragraph 104*: The Best Practicable Option (BPO) is similar to that outlined in the Section 42A report and proposed consent conditions, but with the important difference that the selection of the most appropriate ammonia reduction technology will be carried out as part of the design, thereby allowing any recent technology developments to be incorporated. The recommendation is:

    a. Implementing chemically assisted solids removal,

    b. Installing UV Disinfection treatment, and

    c. Installing specific ammonia removal technology (*either* in-pond or external package plant).

71. *Paragraph 156*: A three-year timeframe is reasonable for implementing chemically assisted solids removal and installing UV disinfection treatment. However it will take longer to assess, design, procure and install ammonia removal technology. It is recommended that a six-year timeframe be provided for the implementation of ammonia removal technology.

Proposed Conditions of Consent

72. *Condition 3*: Analysis of recent data (2016 to 2019) shows that the wastewater treatment plant is not achieving the limits for the determinants listed and the proposed treatment upgrades target these. I consider the following consent limits are reasonable for the current treatment plant, prior to upgrading and should replace the table contained in Condition 3.

Determinant	Median Concentration	90th Percentile Concentration
5 day Biochemical Oxygen Demand (grams per cubic metre)	20	**35**
Escherichia Coli (per 100 millilitres)	4,400	**24,000**

Total ammoniacal nitrogen (grams per cubic metres)	30	**43**
Total suspended solids (grams per cubic metre)	**35**	**80**

73. *Condition 11:* Based on recent data the peak 30-day rolling ADWF is estimated to be 420 cubic meters per day by 2055. I recommend the text in Condition 11 is deleted and replaced with the following "The peak 30-day rolling average dry weather flow (ADWF) of treated wastewater discharged the Hokianga Harbour shall not exceed 420 cubic meters per day."

74. *Condition 17 c*: I recommend that the selection of the most appropriate ammonia reduction technology be carried out as part of the design, thereby allowing any recent technology developments to be incorporated. This requires Condition 17 c to be modified as follows:

Installing an ammonia removal technology (either in pond or external).

75. *Condition 19*: I recommend that a percentile determinant concentration is included, in place of the maximum. Using 90th percentile will provide consistency with the previous consent conditions and within this consent. For Condition 19 this means replacing "Maximum Concentration" with "90th percentile concentration".

PART B: KOHUKOHU WWTP

KEY FINDINGS OF EARLIER WORK

76. This section summarises the work submitted in support of the application.

Kohukohu – Process overview

77. The Kohukohu WWTP was constructed in 1984. The WWTP treats liquid septic tank effluent from the settlement of Kohukohu and consists of a single facultative (oxidation) pond followed by a surface flow wetland which is divided into five cells. Treated wastewater is discharged by gravity into a channel in the tidal mud flats next to the WWTP, from where it flows into the main body of the Hokianga Harbour about 240 meters south of the WWTP.

Population

78. In the 2018 Census, the permanent resident population of Kohukohu was 168 and long-term population forecasts indicate a decrease in the permanent population of the wider South Hokianga area. For the purposes of this resource consent application, a conservative assumption was made, that the permanent resident population of Kohukohu remain static over the design life.

Flows and loads

79. As the Kohukohu WWTP is a pond based treatment system with a long retention time, flows out of the WWTP are buffered by the retention time in the pond. As no population increase is predicted, inflows are expected to remain the same. In the period 2015 to 2019,

    a. average daily flow (ADF) was 30 cubic meters per day,

    b. 30-day rolling ADWF was 20 cubic meters per day,

    c. peak 30-day rolling ADWF was 41 cubic meters per day.

80. A dry weather day was defined as any day where the total rainfall for that day and the preceding two days is less than 0.5 millimetres. The 30-day rolling ADWF increased during winter months. Dry days were found to account for 27 percent of the days in the year.

81. A wet weather day was defined as any day with greater than five millimetres of rain and accounts for 23 percent of the days in the year. The highest recorded daily peak wet weather flow (PWWF) to the Kohukohu WWTP over the 2015 to 2019 period was 176 cubic meters per day which equates to a peaking factor of approximately ten. This combined with the peak average flows occurring in indicates there are noticeable infiltration and/or stormwater connections.

82. There was no influent sampling data for the Kohukohu WWTP. The sewer catchment of Kohukohu is predominantly from individual, on-site, domestic, septic tanks. A well-performing septic tank should typically remove around 80 percent of suspended solids and 50 percent of the biological oxygen demand from the raw wastewater. Investigations found that the septic tanks were being desludged every five years, and this is considered sufficient (Jacobs, July 2020). Therefore, the biological oxygen demand and suspended solids loading into the WWTP are expected to be significantly lower than for typical raw wastewater.

83. Sampling data from 2010 to 2019 for the treated wastewater from the Kohukohu WWTP was analysed and a summary is shown in Table 1.

Table 1: Treated Wastewater Characteristics from Kohukohu WWTP 2010 to 2019

Parameter	Number of samples	Consent criteria	Median	Mean	Maximum
Faecal coliforms, cfu/100ml	75	5,000 (average) 15,000 (maximum)	800	-	114,000
Total ammoniacal nitrogen (TAN), mg/L	72	40	18	20	49
Biological oxygen demand (BOD), mg/L	72	-	8.4	9.5	30
Total Suspended Solids (TSS), mg/L	72	-	10	16	70

84. The consent limit for faecal coliforms has a median of 5,000 coliform forming units per 100 millilitres (cfu/100ml) and a maximum of 15,000 cfu/100ml. Deeper analysis of the faecal coliform data shows that the consent maximum has been exceeded six occasions since 2010. These exceedances have occurred in summer and at a similar time to peaks in total suspended solids.

85. The consent limit for ammoniacal nitrogen has a maximum of 40 milligrams per litre which was exceeded a number of times in early 2018. Following desludging of the pond in 2018, to provide increased treatment volume, this parameter reduced and is now comfortably within the consent limit.

86. Ammoniacal nitrogen, biological oxygen demand, and total suspended solids, all are comfortably within the typical treatment performance characteristics for oxidation ponds (Hickey et al, 1989)

Wastewater treatment

87. The facultative pond at the Kohukohu WWTP is square in shape and has a surface area of approximately 750 square meters and is 1.5 meters deep. Calculations show that the pond has sufficient capacity to cater for the current and future population, given the influent has been pre-treated in septic tanks.

88. Improvements to the pond in 2022 included relocating the inlet away from the centre of the pond to within 1 meter of the pond edge and installing a baffle wall from the middle of the northern bank and spanning approximately two thirds of the distance across the pond. These modifications were installed to minimise short circuiting (Jacobs, May 2022).

89. The main function of the wetlands is to provide additional disinfection (through natural pathogen die-off), and algae removal (through shading of the water). Some ammonia removal can also be achieved through nitrification occurring in the plant root zones. Maintenance of the vegetation (removal) was carried out in 2018 and again in 2022 (Jacobs, May 2022).

90. Options for wastewater treatment improvements focused on disinfection. Two recommendations; to relocate the inlet and install a baffle on the oxidation pond to reduce short circuiting, as well as carry out maintenance on the vegetation in the wetland were implemented in 2022 (Jacobs, May 2022).

91. An additional option of installing UV disinfection was considered. Given that the faecal coliform median is comfortably within the consent limit, with occasional exceedances of the maximum limit, UV disinfection would not be required most of the time. Applying a percentile limit (such as 90 percentile) allows a number of exceedances over a specific period of time. This approach is commonly for the natural treatment systems, such as ponds and wetlands that have natural variability.

Wastewater disposal

92. A desktop investigation of potential land disposal sites was carried out. Eight criteria were applied: proximity to the WWTP, proximity to residential dwellings, locations of cultural significance, proximity to waterways, slope of the land, groundwater, flooding risk, and tsunami risk. The Ngai Taupoto, Tauteihiihi and Pikiparia maraes are located within 5km of the WWTP and these along with other, known culturally significant sites for the Kohukohu mana whenua and the local community had a the 500m buffer applied.

93. Five blocks of land were identified for further consideration. Investigations found that three of these land parcels were suspectable to flooding and were excluded from further evaluation. The remaining two land parcels did not provide sufficient area for irrigation so were also excluded. Based on the information available and the criteria applied, no feasible land disposal options were identified and land disposal was not considered further at this time.

94. Investigations carried out by MetOcean Solutions (Met Ocean 2020) considered the benefits of installing a longer outfall compared with the current discharge location. Based on the conclusions that "no discernible effect is expected as a result of the Kohukohu discharge within the main body of the Hokianga Harbour" compared to the current discharge location, the option of a longer outfall was excluded from further consideration. I concluded that, based on the information available, continuing with the existing discharge was the only feasible option.

Multicriteria assessment

95. A multicriteria assessment was carried out in a collaborative workshop on 26th August 2020, which considered five weighted primary criteria as shown in Table 2, with secondary criteria providing a structure for assessment.

Table 2 Multicriteria assessment for Kohukohu WWTP

Criteria	Weighting
Economic/affordability	40%
Environmental/climate	20%
Māori cultural values	20%
Practicability/feasibility	10%
Operational	10%

96. This assessment scored the improvements carried out in 2022; the relocation of the inlet and baffle installation in the oxidation pond as the preferred option and the vegetation maintenance in the wetlands as the next highest scoring option (Jacobs, May 2022). Installing UV disinfection was the lowest ranked option due to the significant cost penalty of this pathway. Sensitivity analysis of the scoring did not change this overall ranking. I concluded that installing UV disinfection, whilst possible, would have minimal benefit. The commonly used percentile approach should be applied to monitoring of pathogens, specifically monitoring for faecal coliforms, as well as any other parameters.

97. It is important to note that all options received a zero for Māori cultural values and practices. This was due to all the feasible options continuing a discharge into the Hokianga Harbour.

MATTERS RAISED BY SUBMITTERS

98. The issues raised by submitters relevant to my area of expertise are:

a. Level of treatment

b. Impacts of climate change

c. Alternative disposal options

d. Consent conditions breached

99. These are addressed below.

Level of wastewater treatment

100. A number of submitters, including Tauteihiihi Marae Trustees (Rebekah Fuller), Tapuwae Incorporation, Northland Branch of the Green Party Aotearoa, and Gail and John Aiken expressed concern regarding the proposed level of wastewater treatment, the quality of the discharge and breaches of consent conditions.

101. The wastewater entering the treatment plant has been pre-treated by domestic septic tanks in the network, resulting in a lower concentration of the various components. As shown in Table 1, the Kohukohu WWTP is comfortably achieving the condition of total ammoniacal nitrogen. Total ammoniacal nitrogen, biological oxygen demand, and total suspended solids, all are comfortably within the typical treatment performance characteristics for oxidation ponds (Hickey et al, 1989).

102. The exception is pathogen treatment, measured by the indicator organism faecal coliforms. Whilst comfortably within the median condition, this parameter has exceeded the maximum condition on six occasions in the period 2010 to 2019. As a result, options for wastewater treatment improvements focused on disinfection of pathogens. Two recommendations; to relocate the inlet and install a baffle on the oxidation pond to reduce short circuiting, as well as carry out maintenance on the vegetation in the wetland, were implemented in 2022 (Jacobs, May 2022).

103. The six occasions when the faecal coliforms have exceeded the maximum have been generally in summer and correlate with periods of higher total suspended solids. It is likely that the improvements carried out in 2022 have mitigated this, but it will take at least two years of operation to confirm this. The current consent condition is a maximum, not to be exceeded. Applying a percentile limit (such as 90 percentile) allows a number of exceedances over a specific period of time is a more commonly used condition, especially in more recent consents. This permits some variability, such as extreme weather events, that can negatively impact treatment for short periods, but provides reassurance that poor treatment performance will be captured by the median and ninety percentile.

104. I recommend adopting the median and ninety percentile consent condition for pathogens.

Impacts of climate change

105. A number of submitters, including Roger Brand, Linda Kaye, Northland Branch of the Green Party Aotearoa, Jessie McVeagh, Joanne Lillian Shanks, Tauteihiihi Marae Trustees (Rebekah Fuller) expressed concerns regarding the implications of climate change.

106. The impacts of climate change, specifically the impact of sea level rise, specifically storm surge, inundation and flooding of the Kohukohu WWTP were not considered in detail in the issues and options assessment. Climate change impacts have been more generally considered in a desktop assessment as part of the flood risk assessment. Analysis of GIS, flood and tsunami zones were superimposed at the location of the WWTP which has concluded that the WWTP is not located in an area susceptible to flooding.

Alternative disposal options

107. A number of submitters, including Linda Kaye, Northland Branch of the Green Party Aotearoa, Janine McVeagh, Jessie McVeagh, Ngai Tūpoto Marae, Tapuwae Incorporation, Louis Toorenburg, Hokianga Health Enterprise Trust (Magareth Broodkoorn), Tauteihiihi Marae Trustees (Rebekah Fuller), and Ngati Korokoro Hapu/Trustees (Sheena Ross) expressed concerns regarding the assessment of discharge option, most specifically noting a preference for disposal to land of the treated wastewater.

108. The Land Disposal Site Selection report (Jacobs, February 2020) describes the systematic assessment of the options that was undertaken for land disposal of treated wastewater from Kohukohu WWTP. This assessment considered ten criteria including:

a. Proximity to the Kohukohu WWTP, to avoid the high costs and septicity issues associated with the construction and operation of long pipelines and pump stations

b. Slope of the land, addressing the risks of surface run off and potential land stability issues

c. Proximity to water ways

d. Proximity to residential dwellings

e. Proximity to locations of cultural significance, noting that if any land disposal sites were identified mana whenua would be asked for further guidance

f. Groundwater, to avoid potential contamination

g. Elevation above sea level to address storm surge and future proof for climate change

h. Tsunami zone

i. Flood risk, including from extreme weather events which are becoming more frequent under climate change

j. Irrigation rate, to avoid very large irrigation areas should the allowable irrigation rate be really low

109. This assessment identified two possible land parcels. However these land parcels are less than the estimated of three hectares required for disposal. Based on this available information and the criteria applied, feasible land disposal options were not identified and land disposal was not considered further. Should the criteria change or more information become available, then this conclusion can be revisited.

Consent conditions breached

110. Three submitters Northland Branch of the Green Party Aotearoa, Ngai Tūpoto Marae, Tapuwae Incorporation express concerns regarding consent condition breaches. The purpose of the recommended treatment upgrade is to improve treatment so that consent breaches are avoided. Two recommendations; to relocate the inlet and install a baffle on the oxidation pond to reduce short circuiting, as well as carrying out maintenance on the vegetation in the wetland, were implemented in 2022 (Jacobs, May 2022).

COUNCIL'S PRE-HEARING REPORT

111. I largely agree with the conclusions reached in the s42A Report. However, I do not agree with two of the proposed conditions of the consent as these do not align with the findings of the technical studies undertaken.

112. *Condition 4 b*: There are many causes of low dissolved oxygen in facultative ponds and technologies for addressing this, including chemical and mechanical. I recommend deleting the following text from Condition 4 b "e.g. temporary mechanical surface aeration".

113. *Condition 21*: I recommend that a 90th percentile will provide consistency with the previous consent conditions and within this consent. For Condition 21 this means replacing “95th Percentile” with “90th percentile concentration”.

Dr Rebecca (Becky) Joanne Macdonald

3 May 2023