Opononi / Omapere WWTP Upgrade

Opononi WWTP Issues and Options

IZ134400-GN-RPT-001 | F

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Far North District Council

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Executive Summary

Issues Assessment

The Opononi wastewater treatment plant (WWTP) discharges treated wastewater into the Hokianga Harbour. The resource consent for the 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 is in not complying with the current consent E.coli, ammonia, biological oxygen demand (BOD) and total suspended solids (TSS) standards. The rolling 12-month median effluent E.coli concentration regularly exceeds the consent limit of 3,000 cfu/100 mL and has a 32% compliance rate based on samples taken since January 2016. Effluent ammonia nitrogen concentrations have increased since January 2017 and now exceed the rolling 12-month median limit of 30 mg/L. Total suspended solids concentrations show seasonal spikes each summer which are likely caused by increased algae growth. The spikes result in breaches of the rolling 12-month median limit of 35 mg/L.

Hydrodynamic modelling results 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 500m down current and 25,000 at the shoreline.

Improvements to the WWTP are required to support compliance with the current resource consent conditions, and the likely future discharge consent conditions. If the harbour discharge is retained, it is unlikely that a resource consent with more relaxed standards would be granted by NRC. Land disposal has also been investigated as an option for the Opononi WWTP discharge. However, this presents technical and cost challenges due to the steep terrain and poorly draining soils.

Options Assessment

A number of treatment and disposal options have been considered for the Opononi WWTP. Combining the treatment options with suitable disposal options, a number of viable schemes have been identified. From these schemes, four upgrade options have been identified which can address the BOD, TSS, E.coli and ammonia issues:

- Option 4a – Optimised process, chemically assisted solids removal, UV, with an in-pond or in-wetland ammonia removal process (e.g. Bioshells, zeolite fill-and-draw wetland etc) and harbour discharge.
- Option 4b – Optimised process, chemically assisted solids removal, UV, with an external ammonia removal package plant (e.g. SAF) and harbour discharge.
- Option 5 - Optimisation of the current process and discharge of the treated wastewater to land.
- Option 6 – New activated sludge plant plus UV disinfection and harbour discharge.

Cost Estimates

The proposed options were endorsed by FNDC and conceptual level costs for these options have been estimated to ±50% accuracy. These costs are summarised as:

Option	Option 4a	Option 4b	Option 4c	Option 4d
Capital Cost	$2.929M	$4.930M	$18.021M	$4.374M

An MCA has been completed, which demonstrates that Option 4b is preferred under most scenarios, with Option 4a ranked very closely. The options are very similar with the key difference being whether the N removal is in pond or via external process. Option 4a has a lower cost, but is relied on less proven technologies, resulting in 4b being considered safer from an environmental risk perspective. It is recommended that Option 4b or 4a be implemented for the Opononi WWTP. It is worth noting that only Option 5 scored well in terms of cultural context, but that the very high cost of this option meant that it did not score well overall.

1. Introduction

1.1 Project Background

The Opononi wastewater treatment plant (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.

The existing resource consent for the outfall discharge was granted in November 2009, with an expiry date of 31 August 2019. The consent conditions included a requirement to investigate land disposal options and to form a community liaison group (Opononi Omapere Community Liaison Group, OOCLG) to meet at least once per year to discuss matters related to the consent. A copy of the existing resource consent is provided in Appendix A. During the consent period, Far North District Council (FNDC) has commissioned two reports on land disposal of the treated wastewater and has met regularly with the OOCLG to discuss land disposal as well as options for improving the WWTP treatment performance.

In May 2019 FNDC applied to Northland Regional Council (NRC) to renew the existing discharge consent and in July 2019 NRC replied with a request for additional information. FNDC are currently gathering the additional information requested and are continuing to consult with the OOCLG with a view to confirming an upgrade strategy for the WWTP.

FNDC have engaged Jacobs to assist with the latter piece of work by developing a short list of WWTP upgrade options, including land disposal as a disposal option, to present to the OOCLG for discussion and consideration. An agreed strategy will likely be taken forward to include in the consent application and FNDC's long term plan (LTP).

1.2 Purpose of this Report

The purpose of this report is to present the main issues facing the Opononi WWTP and a identify viable improvement options to address the issues. The options will include land disposal as an option which removes the need for harbour discharge.

The report will be used by FNDC to inform assessment of the options to identify a preferred upgrade strategy, as well as informing the OOCLG regarding the options. To aid the assessment of the options, a set of assessment criteria are also presented to enable a multi-criteria analysis (MCA) of the options to be carried out using a consistent approach. This should be completed at a collaborative workshop with the OOCLG where the options will be discussed, with the aim being FNDC and OOCLG agreeing on a preferred upgrade strategy.

2. Design Basis

2.1 Design Horizon

The design horizon for this report is 2055, to align with the 35-year consent duration applied for by FNDC.

2.2 Design Population

2.2.1 Permanent Residents

The permanent resident population of Opononi and Omapere was 546 at the 2018 Census. Long-term population forecasting indicates a decrease in the permanent population of the wider South Hokianga area (FNDC, 2018). For the purposes of this report the permanent resident population of Opononi is assumed to remain static over the design period.

2.2.2 Holiday Makers

The Opononi and Omapere population increases significantly over the Christmas holiday period due to the influx of holiday makers. At the 2018 Census, approximately 40% of the houses in Opononi and Omapere were unoccupied; the majority of these are assumed to be holiday homes. Based on the 2018 Census data, the total number of holiday homes connected to the Opononi/Omapere sewer scheme is estimated to be 160.

Whilst there is no data on holiday home occupancy during the Christmas holiday period, the increase in wastewater flows during this period is known (see Section 2.3). An increase in the number of holiday homes and/or occupancy has been allowed for in the WWTP design. For the purposes of this report, an increase of 2% per year in holiday maker population has been assumed over the 35-year design period, resulting in a total increase of 96% by 2055.

2.3 Wastewater Flows and Loads

2.3.1 Dry Weather Flows

The dry weather flows to the WWTP reflects the influx of holiday makers. Influent flows increase every summer, peaking in January and reducing to base (permanent resident) flows from May to September.

Dry weather influent flows from 2010 to 2019 are shown in Figure 2-1. A dry weather day is defined as any day where the total rainfall for that day and the preceding two days is less than 0.5mm, which on average accounted for 31% of the days in the year. The average dry weather flow (ADWF) statistics are presented in Table 2-1.

Table 2-1: Opononi WWTP Dry Weather Flow Statistics 2010 – 2019

Parameter	Units	Value
Peak 30-day ADWF	m^3/day	309
Annual AWDF	m^3/day	178

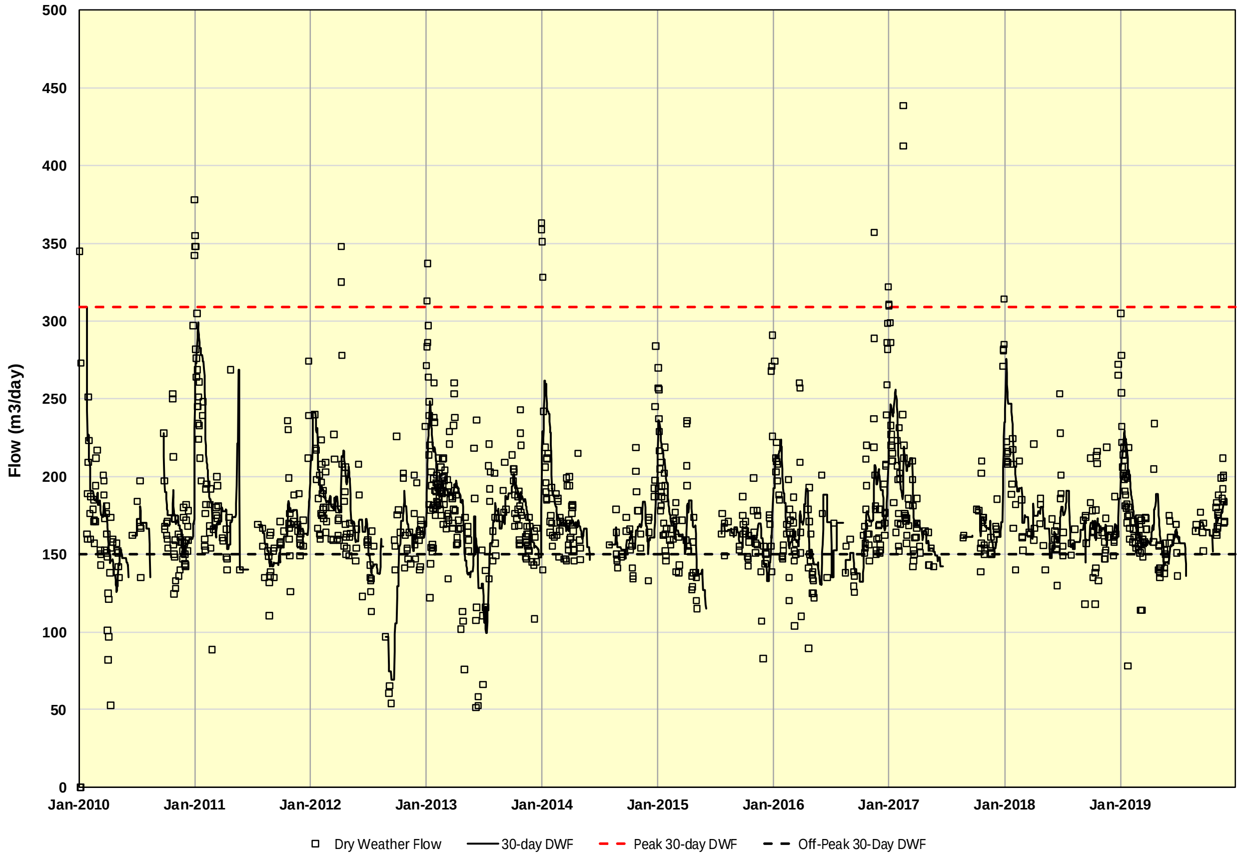

Figure 2-1: Opononi WWTP Dry Weather Flows 2010 – 2019

2.3.2 Wet Weather Flows

A wet weather flow day is defined as any day with more than 5mm rainfall. For the Opononi WWTP this accounted for 16% of the days since January 2010. The average wet weather flow during this period was 287 m^3/day.

The peak recorded wet weather influent flow (PWWF) since January 2010 was 1,290 m^3/day, recorded in January 2011 and was related to a 140 mm rainfall event (FNDC, 2018). This PWWF equates to approximately five times the ADWF for January. A wet weather peaking factor of 5 x ADWF is not unreasonable for sewer systems the age of Opononi/Omapere.

The Opononi WWTP provides wet weather storage capacity within the aerated facultative pond, maturation pond, and effluent storage pond, which allows the influent wet weather flows to be buffered. The peak pond outlet flow is 734 m^3/day and the 99-percentile outlet flow is 490 m^3/day. However, FNDC have applied for a maximum effluent discharge volume of only 450 m^3/day in their 2018 consent application, which is considerably lower than the actual maximum and should be revised.

2.3.3 Pollutant Loads

The sewer catchment of Opononi and Omapere is predominantly domestic, with no significant trade waste inputs. Pollutants of concern in domestic wastewater are BOD, total suspended solids, E.coli, total nitrogen sometimes total ammoniacal nitrogen – TAN) and total phosphorus. There is no routine sampling of the Opononi WWTP influent, however influent samples taken in 2016 and 2018 (and tested for BOD and TSS) were within the ranges expected for domestic wastewater, albeit at the higher end of the typical range. This is similar to other locations around the Far North District, such as the Taipa WWTP which shows higher strength influent. Table 2-2 contains data on the average BOD, TSS, COD and E.coli concentrations of the influent.

Table 2-2 Opononi WWTP Influent Concentrations

Parameter	Units	No. of Samples	Average Concentration
BOD	g/m^3	6	255
TSS	g/m^3	11	229
COD	g/m^3	4	543
E.coli	mpn/100mL	10	2.39×10^7

2.4 Summary

The design basis for the Opononi WWTP is provided in Table 2-3.

Table 2-3: Opononi WWTP Issues and Options Report Design Basis

Parameter	Units	Current	2055	Comment
Permanent resident population		546	546	2018 census; no increase over design period
Number of holiday homes		160	272	Linear growth (2% of current homes)
Holidaymaker population (peak month)		580	980	Estimate based on observed flow increase
Holiday home occupancy (peak month)		3.6	3.6	
Total population (peak month)		1,125	1,530	
Peak 30-day ADWF	m^3/day	309	420	Pro rata off existing flow data
Annual average ADWF	m^3/day	178	200	Pro rata off existing flow data
PWWF	m^3/day	1,290	1,400	Pro rata off existing flow data
Per capita influent BOD load	g/p/d	70		Typical value for domestic wastewater.

2.5 Land Disposal Design Basis

2.5.1 Hydraulic Loading Rate

The methodology for determining the hydraulic loading rate is based on the procedure for "Type 1" slow rate systems provided in the USEPA Process Design Manual for Land Treatment of Municipal Wastewater Effluents (USEPA, 2006). The method set out in the USEPA manual is a standard water balance methodology based on percolation rate to groundwater. Type 1 systems are designed for year-round deep percolation to groundwater as opposed to deficit irrigation systems, which avoid percolation by irrigating only the amount of water either evaporated or used by the plants (evapotranspiration). Often deficit irrigation is used in locations with long dry summer conditions. In wetter climates, deficit irrigation is unlikely to be applicable.

Using the USEPA design methodology, a hydraulic loading rate of 2.0 mm/day is derived as shown in Table 2-4. However, this would need to be confirmed with site specific testing of the ground conditions.

Table 2-4: Opononi WWTP Land Disposal Hydraulic Loading Rate

Parameter	Units	Value	References
Soil type		Clay loam	VK Consulting (2011); Mott MacDonald (2014)
Soil permeability (preliminary design)	mm/day	60	Category 4, Table 5.2 NZS1547 (2012)
Design safety factor		5%	USEPA (2006) type 1 slow rate design methodology
Design annual percolation rate	mm/day	3.0	Soil permeability x safety factor
Annual rainfall	mm /year	1,234	NIWA (2013)
Annual evapotranspiration	mm /year	877	NIWA (2013)
Land disposal hydraulic loading rate	mm/day	2.0	Percolation – rainfall + evapotranspiration

2.5.2 Effluent Quality Requirements

The current effluent quality produced by the WWTP should be sufficient for land disposal. Buffer zones and irrigation stand down periods will provide public and stock health protection from pathogens. Due to the steep terrain, drip line application would likely be required and therefore spray drift is not an issue and UV disinfection should not be needed. It is expected that a disc filter will be required downstream of the irrigation pumps in order to protect the drippers from blockage.

2.5.3 Irrigation Storage Requirement

For preliminary design purposes, 30-days storage (at ADWF) is assumed for the irrigation storage pond. This is a conservative value and provides storage for a period of prolonged wet weather when the land has continuous surface ponding and is unsuitable for irrigation. The storage requirement may be reduced following more detailed site investigations and rainfall analysis. However, given the poorly draining soils in the area, at this stage a conservative value is considered appropriate.

2.5.4 Land Disposal Design Basis Summary

The design basis for land disposal is presented in Table 2-5.

Table 2-5: Opononi WWTP Land Disposal Design Basis

Parameter	Units	Value
ADWF	m^3/day	178
Hydraulic loading rate	mm/day	2.0
Irrigated area	Ha	10
Allowance for buffer zones and storage pond	%	20
Total land area required	Ha	12
Irrigation application method		Dripline
Number of days storage required at ADWF	days	30
Irrigation storage pond volume	m^3	5,300

It should be noted that the land disposal option is currently at the preliminary concept stage and its purpose is to enable stakeholders to compare land disposal with the harbour discharge options. There is a high degree of uncertainty regarding land availability, as well as the technical feasibility and consenting of land disposal, given that site investigations and discussions with land owners have not yet taken place.

3. Existing WWTP

3.1 Existing WWTP Overview

The Opononi WWTP consists of an inlet screen, an aerated facultative pond (termed the “aeration pond”) containing a single brush aerator, and a maturation pond (termed the “detention pond”). Effluent is pumped from the maturation pond to a series of four constructed surface flow wetland cells located above the ponds. The first and largest wetland cell has been sacrificed to enable placement of sludge to avoid the costs of taking the sludge off-site. Treated effluent from the wetland is stored in storage pond and is pumped into the Hokianga Harbour twice per day on the outgoing tide via an outfall pipe.

An aerial photo showing the elements of the Opononi WWTP is provided in Figure 3-1.

Figure 3-1: Aerial Photograph of Opononi WWTP

3.2 Aerated Facultative Pond

The aerated facultative pond is 3 meters deep with a volume of approximately 1,200 m^3. The pond has a concrete wave band and it is assumed to have a clay liner given the clay soils in the area. The pond was de-sludged in the summer of 2018/2019, along with the maturation pond. The pond is smaller than a conventional oxidation pond and relies on a 5.5 kW brush aerator to increase the BOD treatment capacity of the pond. The brush aerator replaced two aspirating-type aerators.

With unaerated facultative ponds (often termed oxidation ponds) the aeration needed for the aerobic breakdown of organic matter (BOD) is provided by algae and wind. The “natural” capacity of oxidation ponds is proportional to pond surface area and can be estimated using empirical equations (Mara, 2010).

Calculations indicate that the existing brush aerator should be sufficient to cater for both current and future peak loads. The pond BOD capacity and design loads are provided in Table 3-1.

Table 3-1: Opononi WWTP: Facultative Pond BOD loading capacity versus

Parameter	Units	Value	Comment
Water surface area	m^2	900	
Average temperature (January)	C	19	
"Natural" BOD surface loading capacity in summer	kg/ha/d	235	Mara (2010) formula
"Natural" BOD capacity in summer	kg/day	21	
Aerator BOD capacity	kg/day	105	5.5 kW x 0.8 kgO_2/kWh x 24 h
Aerated pond BOD capacity	kg/day	126	Natural capacity plus aerator capacity
Estimated peak month BOD load to pond (current)	kg/day	79	Population x 70 g/p/d
Estimated peak month BOD load to pond (2055)	kg/day	107	Population x 70 g/p/d

3.3 Disinfection in Facultative and Maturation Ponds

The main purpose of the maturation pond is disinfection through natural die-off of pathogens, as well as some residual BOD removal. The amount of disinfection provided by ponds is a function of hydraulic retention time (HRT) and temperature and can be estimated using a first-order decay model (Mara, 2010). The predicted log removal of *E. coli* during the January peak season, using the standard first-order decay model, is shown in Table 3-2.

Table 3-2: Opononi WWTP: Expected Disinfection Performance of Facultative and Maturation Ponds

Parameter	Units	Facultative	Maturation	Total
Pond volume	m^3	1,200	1,470	
Hydraulic retention time (peak month dry weather flow) - current	days	3.9	4.8	8.7
Hydraulic retention time (peak month dry weather flow) - 2055	days	2.9	3.5	6.4
First order decay coefficient (20 degrees)	day-1	2.60 (Mara, 2010)		
First order decay coefficient (19 degrees)	day-1	2.185 (average January temperature)		
E coli log removal (peak month dry weather flow) - current		0.9	1.1	2.0
E coli log removal (peak month dry weather flow) - 2055		0.9	0.9	1.8

The retention times are short compared to conventional oxidation pond systems which typically have HRTs in the 25–30-day range. Therefore, the log removal of indicator bacteria will be lower than for conventional pond systems. These low retention times suggest that the ponds are undersized for effective removal of BOD, nitrogen and E.coli.

As shown in Table 3-2 an overall 10% reduction in disinfection performance (as measured by *E. Coli* log removal) is predicted over the design period due to increased population. The reduction in performance could be compensated for by installing baffles in both ponds. The installation of baffles in ponds has shown to improve disinfection performance by reducing short-circuiting and "dead zones", thereby improving the HRT distribution of the pond (IWA, 2012).

3.4 Ammonia Removal in Facultative and Maturation Ponds

The ammonia removal efficiency of facultative ponds can be estimated using an empirical first order formula based on surface loading rate and pH (Pano and Middlebrooks, 1982). Using the Pano and Middlebrooks equation, the expected ammonia removal efficiencies are shown in Table 3-3. The short retention time is a key factor in the low ammonia treatment through the ponds.

Table 3-3: Theoretical Ammonia Removal in Facultative and Maturation Ponds (Pano & Middlebrooks, 1982)

Parameter	Units	Facultative	Maturation	Total
Pond volume	m^3	1,200	1,470	
Hydraulic retention time (peak month dry weather flow) - current	days	3.9	4.8	8.7
Hydraulic retention time (peak month dry weather flow) - 2055	days	2.9	3.5	6.4
First order ammonia removal coefficient	day-1	0.00541	0.00950	
Ammonia removal (peak month dry weather flow) - current		2.1%	4.3%	6.4%
Ammonia removal (peak month dry weather flow) - 2055		1.5%	3.2%	4.7%

3.5 Surface Flow Wetlands

The surface flow wetlands consist of five wetland cells in series. The wetland was de-sludged and replanted in 2015. Cell 1, the largest cell, is currently not in use as it is being used to store the sludge from the other wetlands. The wetland cells are overgrown and in need of maintenance (Figure 3-2).

The main function of the wetlands is to provide additional treatment through natural pathogen die-off, algae removal through shading of the water, as well as ammonia removal through nitrification in the wetland root system.

3.5.1 Hydraulic Loading Rate

The wetland is undersized for the peak summer population loading, when compared with typical loading rates. The current total operational wetland surface area (cells 2 – 5) is 1,625 m^2 which equates to a surface loading rate of around 106 mm/day at the peak month dry weather flow. This is in the middle of the typical range for surface flow wetlands in New Zealand; a 2000 survey of constructed wetlands in New Zealand reported hydraulic loading rates of 25 – 178 mm/day, with an average surface loading rate of 78 mm/day (Tanner *et al*, 2000). The USEPA constructed wetland design manual suggests lower surface loading rates of 15-50 mm/day (EPA, 1988).

3.5.2 BOD Surface Loading Rate

Based on inter-stage sampling carried out in 2016 and 2018, the average BOD concentration of the maturation pond effluent (wetland influent) was 40 mg/L. Using this value, the BOD surface loading rate at the current peak month dry weather flow is around 6 g/m^2/day. This loading rate is in the middle of the range of BOD loading rates found in the survey of New Zealand surface flow wetlands (Tanner *et al*, 2000).

3.5.3 Ammonia Removal

Ammonia removal in surface flow wetlands can be estimated using the areal-based P-k-C* model (Kadlec & Wallace, 2009). From observed ammonia removal efficiencies in surface flow wetlands, the following average values (derived from hundreds of existing systems) were used in the calculation:

$C^* = 0$ mg/L

$K_{20} = 14.7$ m/yr (40.3 mm/day)

$\Theta = 1.049$

For the Opononi wetland P = 4 or 5 (number of wetland cells in series)

Using the standard model, a theoretical ammonia removal efficiency of 22% is calculated at the current peak 30 day rolling ADWF. This increases to 29% if wetland cell 1 is included in the treatment process.

Figure 3-2: View of Constructed Wetland looking East

3.5.4 Disinfection

Pathogen reduction in the surface flow wetland can be estimated using the first-order model used for the facultative and maturation ponds. Using this model, a log reduction of around 0.9 is estimated at the current peak 30 day rolling ADWF. This increases to 1.2 if wetland cell 1 is included in the treatment process.

3.5.5 Wetland Treatment Summary

A summary of the theoretical treatment performance of the wetlands is provided in Table 3-4.

3.6 Effluent Storage Pond

The effluent storage pond is used to store effluent between outgoing tides. The effluent storage pond has a total volume of approximately 350 m^3 at top water level based on the WWTP drawings. The pond operates on start and stop level control and discharges twice per day on the outgoing tide. Pond start and stop levels are not known however the retention time in the effluent storage pond is in the order to 1-2 days during dry weather.

The effluent storage pond is not shaded and there is potential for algal growth in the pond which could negate any suspended solids removal occurring in the more shaded wetland cells. During a recent site visit the pond appeared to have a high algae content (Figure 3-3) although it was not clear whether the algae had grown in the storage pond or had passed through from the wetland cells.

Table 3-4: Opononi WWTP Surface Flow Wetlands Theoretical Treatment Performance

		Cells 2 - 5	Cells 1 - 5
Total surface area	m^2	1,625	2,286
Total volume	m^3	300	425
Peak month ADWF - current	m^3/day	178	178
Peak month ADWF - 2055	m^3/day	200	200
Surface loading rate at Peak month ADWF - current	mm/day	190	135
Surface loading rate at Peak month ADWF - 2055	mm/day	259	184
Hydraulic retention time at Peak month ADWF - current	days	0.97	1.4
Hydraulic retention time at Peak month ADWF - 2055	days	0.72	1.0
BOD surface loading rate at Peak month ADWF - current	$gm^{-2}day^{-1}$	7.6	5.4
BOD surface loading rate at Peak month ADWF - 2055	$gm^{-2}day^{-1}$	10.3	7.4
Theoretical ammonia removal (peak month dry weather flow) – current		23%	29%
Theoretical ammonia removal (peak month dry weather flow) – 2055		18%	22%
Theoretical E. Coli log removal (peak month dry weather flow) – current		0.74	1.0
Theoretical E. Coli log removal (peak month dry weather flow) – 2055		0.57	0.79

Figure 3-3: Effluent Storage Pond

4. Effluent Quality

Under the current consent conditions, effluent samples are taken monthly from the effluent storage pond, located downstream of the final wetland cell. Compliance against the resource consent standards is measured using rolling 12-monthly median and 90th percentile values (i.e. rolling medians and 90th percentiles calculated from the most recent 12 samples). This can result in a single event causing multiple breaches of the consent over several months. Alternative approaches exist for consent conditions and these should be considered for future resource consent application, such as calendar year median and 90th percentiles.

4.1 E.coli

Figure 4-1 shows the effluent sampling results for *E. coli* concentrations from 2010 – 2019, along with the resource consent median and 90th percentile limits (shown as dashed lines).

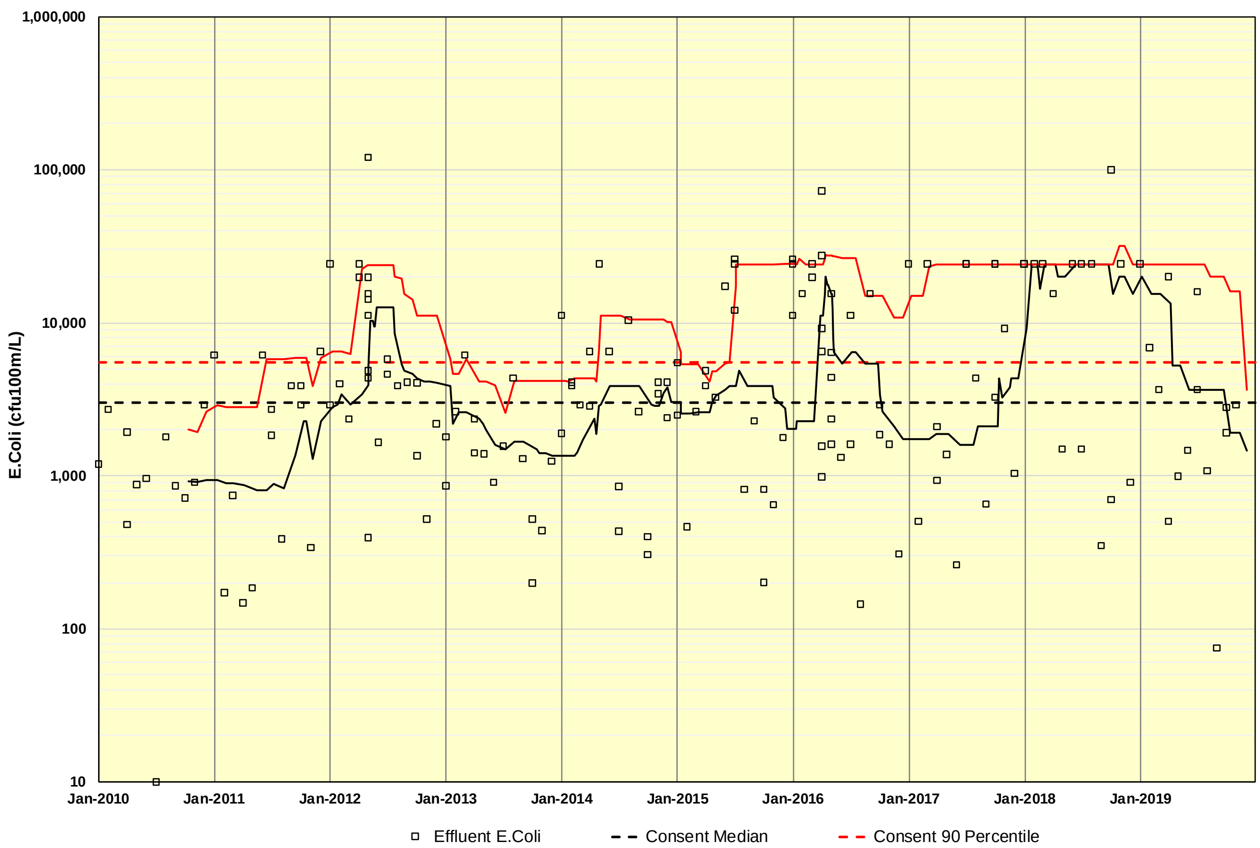

Figure 4-1: Opononi WWTP effluent E. coli concentrations 2010 – 2019

The Opononi WWTP does not comply with the current *E.coli* consent conditions, which is not surprising given the relatively short HRT in the ponds and wetlands. The median raw wastewater E. coli concentration during testing in 2016 and 2018 was in the order of 10^7 cfu/100mL. Therefore, the WWTP is achieving on average around 3.0 - 3.5 log removal of *E. Coli*. This agrees with the first-order decay model results presented in Section 3.

A median 4-log *E. Coli* removal is needed across the entire pond / wetland system in order to assure compliance with the current median consent standard, i.e. an additional 1 log removal is required from the system in order to comply with the current consent standards.

Optimising the existing system for disinfection (reinstating wetland cell 1 and installing baffles in the maturation pond, see Section 6) would improve performance but would probably still not achieve the required 4-log removal over the peak summer season. Additional measures (e.g. UV disinfection) will be required to comply with the current consent conditions. Options for improving *E. Coli* performance are presented in Section 6.1.

Bacterial concentrations in wastewater tend to follow exponential growth and decay curves and hence are normally plotted on a log scale (Figure 4-1). The 90th percentile consent standard of 5,500 cfu/100mL is in the same order of magnitude as the median standard (3,000 cfu/100 mL), less than a half-log difference.

4.2 Ammoniacal Nitrogen

Figure 4-2 shows the effluent sampling results for ammoniacal nitrogen from 2010 – 2019 along with the resource consent median and 90th percentile limits (shown as dashed lines).

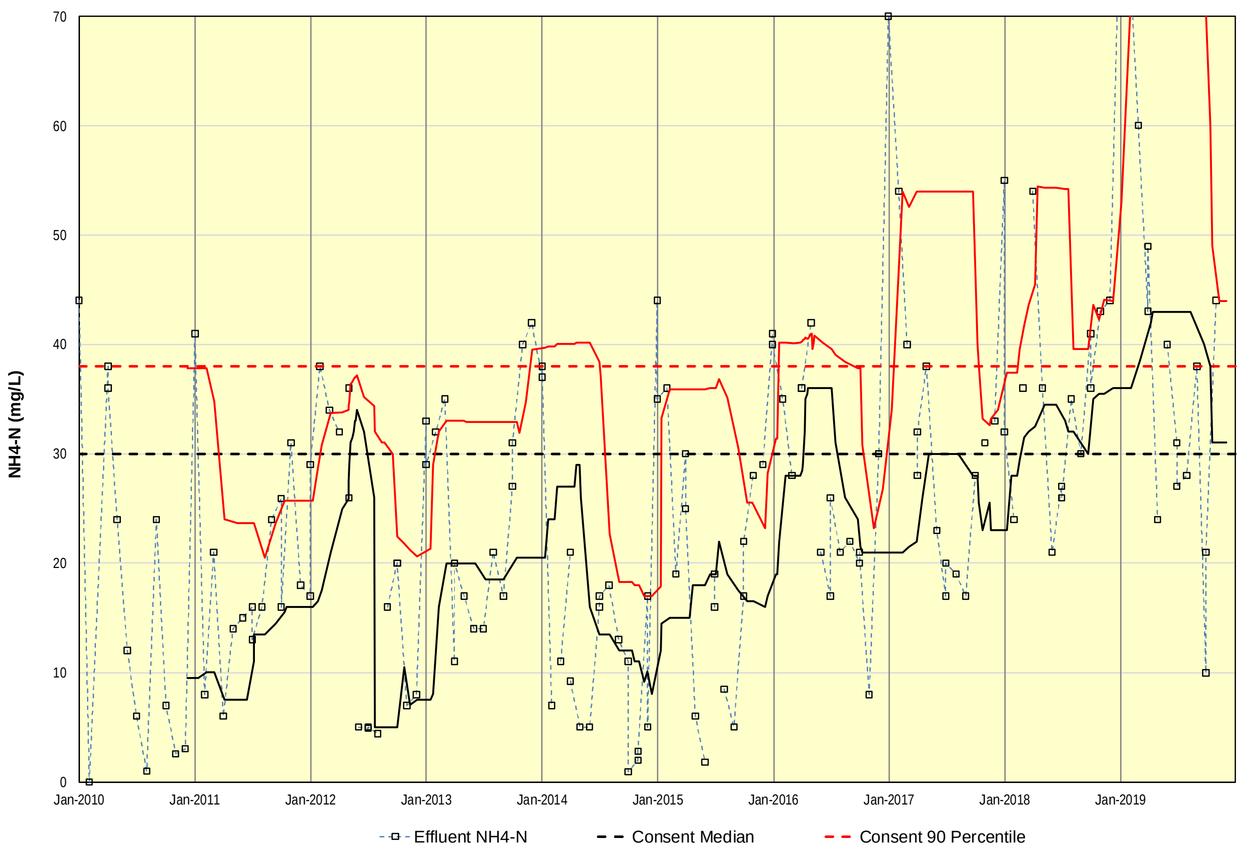

Figure 4-2: Opononi WWTP effluent NH_4-N concentrations 2010 – 2019

The current system does not comply with the consent conditions for ammonia. There is a regular spike in effluent ammonia concentrations every summer (Figure 4-2). This could be due to the seasonal population increase or the warmer temperatures causing an increase in anaerobic activity in the pond. It could also be attributed to the warming of the wetland sludge layers potentially releasing ammonia into the liquid stream (or a combination of these theories). Further investigation is needed to confirm the cause of the seasonal ammonia spikes.

Using the hydraulic retention times in the facultative and maturation ponds, the surface hydraulic loading rate on the wetlands, and standard empirical equations, a theoretical overall ammonia removal efficiency of 28% is calculated across the ponds and wetlands during peak month dry weather flows (Section 3). There is no data on the influent ammonia concentrations.

As mentioned previously, the effluent ammonia concentration have been increasing steadily since January 2015 (Figure 4-2). Dry weather flows have not increased over this period (Figure 2-1). The increase could be related to sludge build-up in the ponds releasing ammonia in the warmer temperatures. As both ponds were de-sludged in early 2019, ammonia concentrations may return to the pre-2015 levels. Elsewhere in the Far North District high concentration influent characteristics have been observed which would impact on the ammonia concentration of the treated wastewater. Further monitoring in 2020 will confirm this.

Regardless of the cause for elevated ammonia, based on current and historic performance, additional ammonia removal measures are likely required to comply with the current consent standards. Options for improving ammonia performance are presented in Section 6.2.

4.3 BOD and Total Suspended Solids

Figure 4-3 and Figure 4-4 show the effluent sampling results for BOD and total suspended solids from 2010 – 2019 along with the resource consent median and 90th percentile limits (shown as dashed lines).

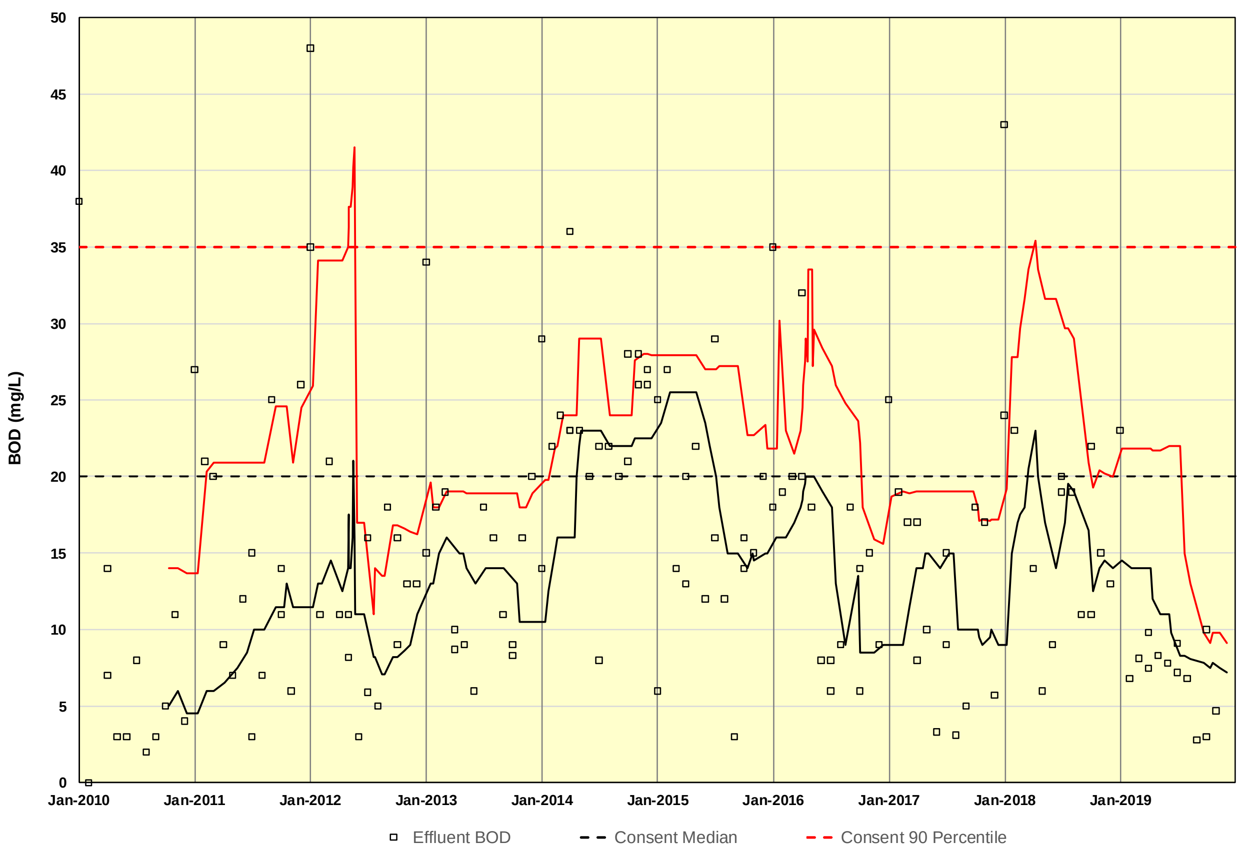

Figure 4-3: Opononi WWTP effluent BOD concentrations 2010 – 2019

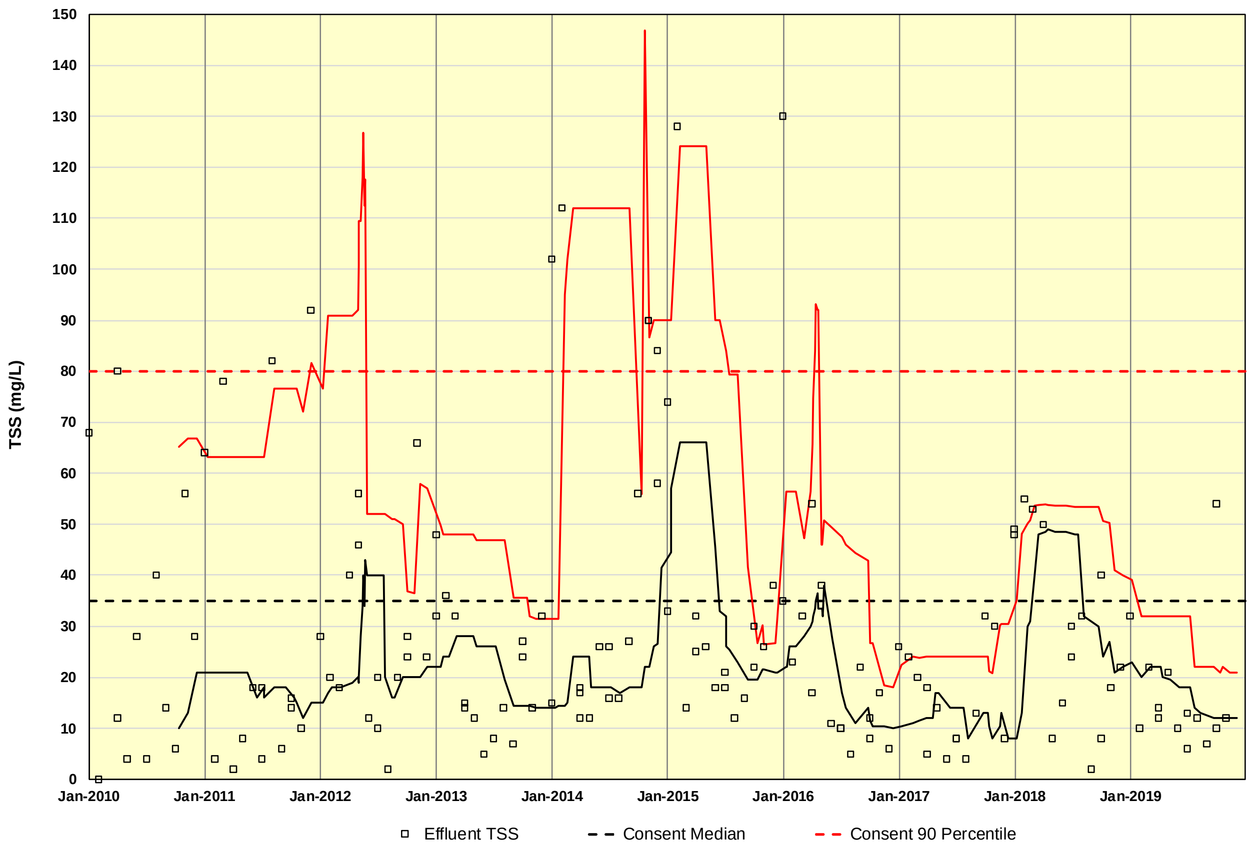

Figure 4-4: Opononi WWTP effluent TSS concentrations 2010 - 2019

The current system does not comply with the consent total suspended solids (TSS) conditions. This is likely due to the low HRT not providing sufficient time for the solids to settle. Suspended solids concentrations have a seasonal pattern typical for pond treatment systems, reflecting the natural increase in algae growth over summer (Figure 4-4). Options for improving TSS performance are presented in Section 6.3.

BOD largely follows the TSS trend. A reduction in BOD concentration is apparent over the last year, reflecting the reduction in TSS, possibly due to the pond de-sludging which would reduce the potential for solids carryover as well as increasing the HRT in the ponds and allowing more settling time.

4.4 Overall Effluent Compliance Statistics

The overall effluent quality statistics from 2016 to 2019 are presented in Table 4-1. This data reflects the performance with the current wetland configuration (i.e. since replanting and taking Cell 1 off line). Compliance rate is calculated as the number of rolling 12 monthly-sample median or 90th percentile values that comply with the consent standard divided by the total number of samples.

Table 4-1: Opononi WWTP Effluent Quality Summary 2016 - 2019

Parameter	Units	No. of Samples	Median			90th percentile		
			Consent	Overall	Compliance Rate	Consent	Overall	Compliance Rate
E. coli	cfu/100mL	72	3.0x103	4.4x103	32%	5.5x103	2.4x104	1%
NH_4-N	mg/L	60	30	30	53%	38	43	44%
BOD	mg/L	60	20	11	86%	35	23	99%
TSS	mg/L	60	35	16	85%	80	49	95%

From this data it is clear that the WWTP is not able to meet the current consent conditions across all four parameters.

4.5 Statistical Issues with Current Consent Compliance Criteria

Some statistical inconsistencies within the current consent compliance criteria should be addressed in the new resource consent, in order to comply with best practice as set out in the New Zealand Municipal Wastewater Monitoring Guidelines (2002). This will also aid in avoiding unnecessary technical non-compliances.

4.5.1 Percentiles versus Look-up Tables

The current compliance criteria are listed as median and 90th percentile values calculated from the most recent 12 samples (taken monthly). The 90th percentile values are calculated by excel which is not a transparent method and places an undue risk of false non-compliance on the discharger. The method recommended by the New Zealand Municipal Wastewater Monitoring Guidelines is to use a maximum number of exceedances rather than percentiles. Look-up tables can be used to determine the number of allowable exceedances based on the number of samples and discharger's risk. For example, for 12 samples, the number of allowable exceedances for median and 90th percentile standards are 8 and 3 respectively (to keep the discharger's risk less than 10%) (NZWERF 2002).

4.5.2 Rolling versus Calendar Compliance Period

The current consent uses a rolling period (i.e. the most recent 12 samples) rather than a 12-month calendar period. Calendar compliance periods are recommended in the New Zealand Municipal Wastewater Monitoring Guidelines as they avoid multiple non-compliances due to the same sample (NZWERF 2002).

5. Receiving Environment

5.1 Harbour Values and Water Quality Standards

Important values of the Hokianga Harbour that can be impacted by wastewater discharges include:

- Recreation and aesthetics: Water quality should be suitable for swimming at all times and the visual and aesthetic values of the environment should be maintained.
- Shellfish consumption: The harbour should continue to support the healthy growth and survival of shellfish, and it should be safe to gather shellfish for human consumption at all times.
- Aquatic ecosystem health: The harbour should continue to maintain the healthy functioning of aquatic ecosystems.

The Proposed Regional Plan for Northland (NRC 2019) Policy H.3.3 (Coastal water quality standards) contains coastal water quality standards that are designed to protect the recreational, aesthetic, shellfish gathering and ecosystem values of coastal waters in the region. The standards are therefore useful to assess whether the discharge could be affecting any of the important harbour values listed above. Standards in Policy H.3.3 of relevance to wastewater discharges are shown in Table 5-1.

Table 5-1: PRP for Northland (July 2019) Policy H.3.3 - Coastal Water Quality Standards for Estuaries*

Parameter	Units	Median	90th percentile	95th percentile
Faecal coliforms (shellfish gathering)	cfu/100mL	14	43	
Enterococci (contact recreation)	cfu/100mL			200
Ammoniacal nitrogen	mg/L	0.023		

* This policy is currently under appeal and is not operative

The following points are noted in relation to the Opononi discharge:

- Phosphorus is not normally a concern in coastal waters as nitrogen is almost always the limiting nutrient (NIWA, 2018). None of the current consents for WWTP's discharging directly into the Hokianga Harbour (Opononi, Rawene, Kohukohu) contain phosphorus limits.
- Based on the Estuary Trophic Index toolbox (NIWA 2018) the Hokianga Harbour has a low physical susceptibly to nitrogen impacts and experiences minor stress from catchment nitrogen loads (FNDC 2018). None of the WWTP's discharging directly into the Hokianga Harbour contain total nitrogen limits and total nitrogen is not considered to be an issue for the Opononi WWTP discharge.
- Ammoniacal nitrogen limits are included in the current Opononi WWTP resource consent conditions. Chronic exposure to concentrations above those set out in Table 5-1 can be harmful to marine fauna.
- The indicator bacteria used for marine water quality monitoring are faecal coliforms (shellfish consumption) and enterococci (contact recreation). *E. coli* is regarded as a more accurate pathogen indicator compared to faecal coliforms. The impacts on shellfish gathering have been assessed by way of a quantitative microbial risk analysis (QMRA).

5.2 Dilution in Harbour

5.2.1 Hydrodynamic Modelling Study

Treated wastewater from the Opononi WWTP is discharged on the outgoing tide into the Hokianga Harbour. The outfall discharge point is around 12 meters below mean sea level, approximately 400 meters from the Opononi shoreline, opposite the mouth of the Waiahoria Stream. An aerial photo showing the outfall discharge point location is provided in Figure 5-1.

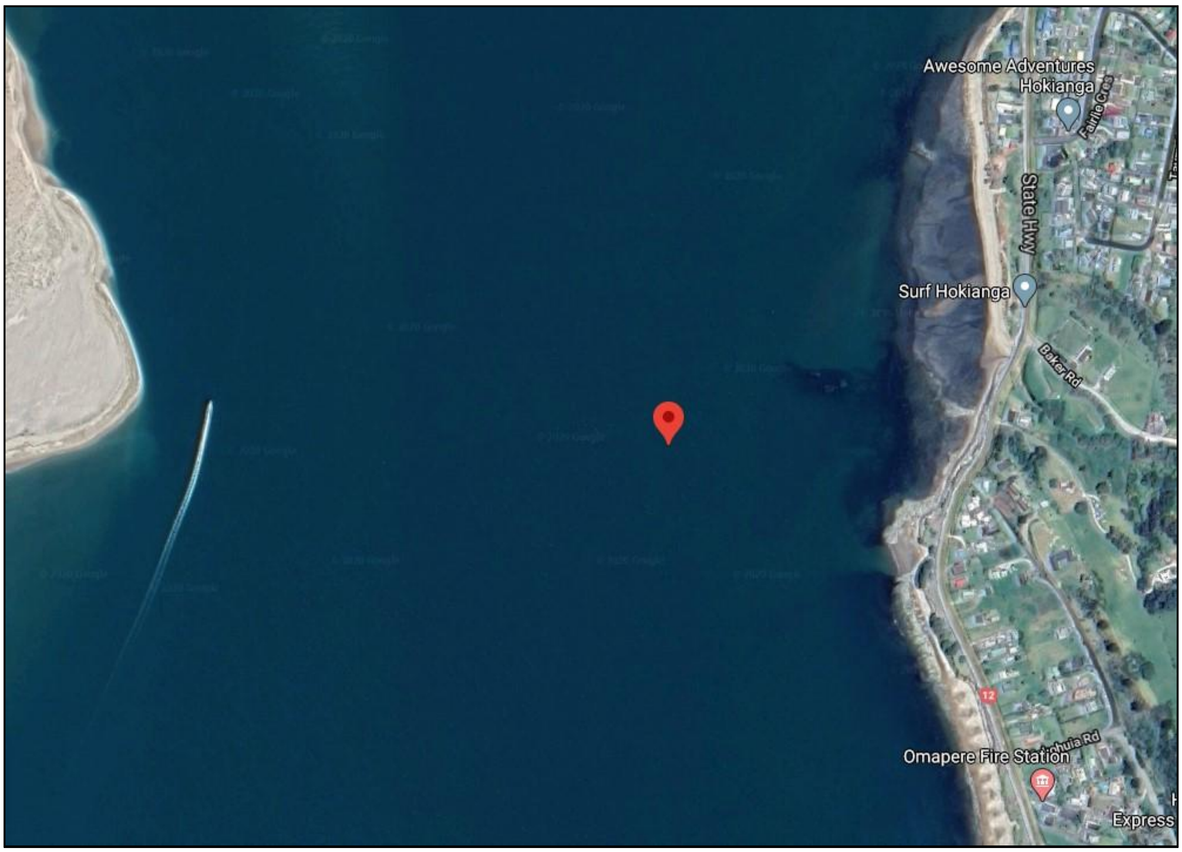

Figure 5-1: Opononi WWTP Outfall Discharge Point Location

In 2019 FNDC commissioned MetOcean Solutions to undertake a hydrodynamic study of the Hokianga Harbour and the dilution and dispersion of the four treated wastewater discharges into the Harbour (Kaikohe, Kohukohu, Rawene and Opononi).

For the Opononi outfall, the modelling results showed a high level of dilution 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 500m down current and 25,000 at the shoreline (MetOcean, 2020).

5.2.2 Contaminant Concentrations in Harbour

Using the known effluent pollutant concentrations, and the dilution factors from the hydrodynamic model, the harbour faecal coliform and ammoniacal nitrogen concentrations near the outfall discharge location can be calculated. These are presented in Table 5-2.

Table 5-2: Contaminant Concentrations in Harbour based on 2016 -2019 Effluent Results & Hydrodynamic Model

Parameter	Units	Effluent Results 2016 – 2019	Dilution Factor	Harbour Near Discharge Point	Harbour Near Shoreline	Harbour Water Quality Standards
Median dilution factor				25,000 x	Not provided	
95th percentile dilution factor				1,000 x	25,000 x	
Median Effluent Quality						
E. Coli concentration	cfu/100mL	$4.4x10^3$	Median 95%ile	0.018 4.4	- 0.018	14* 43*
NH_4-N concentration	mg/L	32	Median 95%ile	0.001 .032	- 0.001	0.023
TSS concentration	mg/L	16	Median 95%ile	<0.001 .016	- <0.001	n/a
95th %ile Effluent Quality						
E. Coli concentration	cfu/100mL	$2.4x10^4$	Median 95%ile	0.96 24	- 0.96	43*
NH_4-N concentration	mg/L	60	Median 95%ile	0.002 .06	- 0.002	n/a
TSS concentration	mg/L	54	Median 95%ile	0.002 .05	- 0.002	n/a

* Harbour shellfish consumption standards are in faecal coliforms.

As shown in Table 5-2, dilution reduces contaminant concentrations to below the receiving water standards near the discharge point. 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.

Upgrading the WWTP to meet the current and future consent standards would provide an additional safeguard against any adverse effects on the environment.

5.2.3 QMRA Outcomes

A QMRA was completed by Streamlined Environmental with the results reported in a report (A Quantitative Microbial Risk Assessment of the Opononi WWTP discharge and receiving environment) in March 2020. The report found that Wastewater treatment that reduces virus concentrations in the WWTP discharge by 2-log (i.e. 100-fold) reduction will reduce health risks associated with the discharge (in relation to inhalation, ingestion during swimming and consumption of shellfish harvested) at all exposure sites, to levels below the NOAEL.

In published literature, a 2log virus removal is the most predominantly reported level of reduction in virus concentrations in constructed wetland treatment systems. In line with the QMRA results, if the wetland treatment system is achieving a 2log virus removal, as commonly indicated by available literature, the level of treatment currently applied at the Opononi WWTP is sufficient to reduce illness risks associated with recreation or consumption of harvested raw shellfish below the “no observable adverse effect level” (NOAEL).

If the wetland performance is in question, UV disinfection can be specified to meet the log reduction requirements indicated by the QMRA. It should be noted that Option 5 does not need this due to the effluent being disposed to land.

6. WWTP Improvement Options

Currently the Opononi WWTP is not meeting the existing consent conditions. Based on the assessment of WWTP performance, the sensitivity of the receiving environment, the consent limits, and the hydrodynamic study outputs, the issues requiring improvement are:

§ Reducing effluent indicator bacteria concentrations (i.e. increasing the disinfection performance of the WWTP

§ Reducing total suspended solids concentrations

§ Reducing ammonia concentrations.

Options for addressing these issues are discussed in the following sections.

6.1 Disinfection Improvements

6.1.1 Wetland Cell 1 Reinstatement

Reinstating wetland cell 1 will increase the residence time in the wetland system by approximately 40%, thereby increasing natural die-off of pathogens and reducing the effluent *E.coli* concentration. The additional retention time may also improve TSS, BOD and ammonia removal.

Reinstating wetland cell 1 would involve clearing out the wetland contents and transporting the contents to a landfill or to the sludge drying beds in Kaitaia. The wetland will then require replanting and plant establishment prior to commissioning.

6.1.2 Baffles in Maturation Pond

The amount of disinfection provided by ponds is a function of HRT, sunlight and temperature, and can be estimated using a first-order decay model (Mara, 2010). Hence, measures that improve the average residence time in a pond will improve disinfection performance.

Plastic curtain baffles installed in the maturation pond would reduce short-circuiting and improve the disinfection performance of the pond (IWA, 2012). Baffle curtains are commonly used in New Zealand ponds as a means of improving disinfection performance (Ratsey, 2016). Plastic curtain stub baffles can be easily retro-fitted next to the pond inlet and outlet to improve performance.

6.1.3 UV Disinfection

A UV disinfection system could be installed on the final effluent prior to discharge to the harbour. UV disinfection of pond or wetland effluent is reasonably common in New Zealand due to increasing effluent bacterial standards; examples include Thames WWTP, and Woodend and Kaiapoi WWTP's (Waimakariri District).

The variable algae content of wetland effluent will result in correspondingly variable UV disinfection performance. Algae reduces UV transmission, shields microorganisms from UV radiation and can also foul the lamp sleeves. To mitigate this, UV systems come with automatic lamp sleeve wipers and some units have a double skinned wiper with acid in the gap to provide a chemical clean of the surface as it wipes.

A 1–2 log removal of faecal coliforms could be achieved with a UV system treating the wetland effluent. The unit could be either installed in a channel or inline in the outfall pipe. During periods of no effluent flow, the unit would be switched off. A small shed containing the control cabinet would be required.

Performance would be significantly improved if a suspended solids removal plant was provided prior to the UV system. Examples of such systems include Waipawa and Waipukurau WWTP's (Central Hawkes Bay District).

6.1.4 Membrane Filtration

Membrane filtration involves filtering the effluent through ultrafiltration membranes with a pore size of around 0.04 microns, which is sufficient to remove most bacteria and viruses as well as all suspended solids.

Membrane filtration provides the highest level of disinfection and suspended solids removal and are typically used for highly sensitive receiving environments. Examples of membrane filtration on pond effluent in New Zealand include Hikurangi WWTP (Whangarei District), Wellsford WWTP (Auckland District) and Motueka WWTP (Tasman District). However, performance at these sites has been variable. Membranes are complex to operate and would involve a step change in operator training, skill level and monitoring. Membranes require the use of potentially hazardous chemicals which must be stored and handled correctly.

6.2 Suspended Solids Improvements

6.2.1 Effluent Storage Pond Cover

Installing a floating plastic cover on the surface of the effluent storage pond would prevent the growth of algae occurring, however any algae passing into the pond from the wetland would remain in suspension. Therefore, the reduction, if any, in TSS concentration is difficult to predict. In addition, the cover would reduce disinfection performance by blocking out UV radiation.

6.2.2 Chemically Assisted Solids Removal (either filtration, settling, or flotation)

Algae is very fine and requires a chemical conditioning process (coagulation and / or flocculation) to remove effectively. Coagulants include aluminium sulphate (alum) and ferric chloride. Polymer flocculants may also be used, either by themselves or in conjunction with a coagulant. The selection of chemical will come down to cost and effectiveness (which can be determined using jar tests).

Following chemical conditioning, the coagulated and flocculated solids are removed in either a clarifier, dissolved air flotation (DAF) unit, or a sand filter. The footprint of lamella settlers or DAF units is generally smaller. It is understood that at least one WWTP in the Far North District, as well as several drinking water treatment plants, use sand filtration (or vermifiltration) and therefore this process is familiar to the Far North Waters Alliance operators. Examples of chemically assisted solids removal on pond effluent include:

§ Coromandel WWTP (sand filtration)

§ Waipawa & Waipukurau WWTP's (lamella clarifier / sand filtration)

§ Waihi WWTP (induced air flotation).

6.2.3 Electrocoagulation

Electrocoagulation is a variant of chemically assisted solids removal. Instead of dosing a metal solution into the wastewater, metals are released from a submerged anode (either iron or aluminium) by passing an electrical current through the water. The coagulated solids are then removed via filtration or clarification in the same manner as chemically assisted solids removal.

A NIWA benchtop study found that the operating cost for electrocoagulation was higher than for conventional chemically assisted solids removal, due to the high electricity consumption and anode replacement. However, electrocoagulation provided disinfection in addition to solids removal (Park and Craggs, 2019). It should be noted that this was a single study based on the batch processing of a sample of wastewater using operating conditions that are vastly different to normal WWTP operation. Hence the result cannot be translated. There are no full-scale applications of electrocoagulation on municipal wastewater in New Zealand. The electrocoagulation process has a large footprint and the anode must be replaced regularly.

6.3 Ammonia Improvements

6.3.1 In-Pond Nitrification Systems

In-pond nitrification systems promote nitrification within ponds by placing a high surface area media in the pond for nitrifying bacteria to grow on. Some systems also include aeration of the media. A variety of systems have been retrofitted on New Zealand ponds, including:

- Rock filter / sprinkler systems (Rangiora, Motueka)
- Hanging curtains (Waipawa, Waipukurau)
- AquaMats (Raglan, Te Kauwhata, Matamata)
- Bioshells (Kaitangata, Heriot, Paihia).

In-pond nitrification systems have had varying degrees of success to date in New Zealand. The systems use different mechanisms to enhance the same nitrogen removal process and the performance results are highly variable. A challenge with these systems has been to achieve reliable winter performance (when nitrifier growth rates reduce). Most in-pond systems require additional modifications such as aerators and baffles. Lack of robust and consistent monitoring data before and after upgrading (post the handover period) makes the performance improvements difficult to reliably quantify.

Due to the site-specific pond dimensions and loading rates, pilot trials are recommended to confirm which, if any, system would be suitable for Opononi.

6.3.2 External Nitrification Systems

External nitrification systems typically comprise aerated tanks containing a high surface area media. A clarifier downstream of the aeration tank provides separation of the solids generated. In some cases, sludge is returned to the aeration tank creating an activated sludge element to the treatment process. These external systems provide a more controlled environment than the in-pond systems and can be sized to achieve reliable year-round performance. However, they are more complex to operate.

A commonly used nitrification technology is the submerged aerated filter (SAF), which consists of an aeration tank filled with fixed plastic media, followed by a clarifier and return sludge system. SAF's are commonly used in the UK for tertiary ammonia removal on municipal wastewater treatment plants and are reported to achieve less than 1 mg/L ammonia nitrogen year-round (Heath *et al* 2001). In New Zealand, SAF's have been used in on-site wastewater treatment package plants however, we are unaware of any SAFs retrofitted to an oxidation pond.

6.3.3 Fill and Drain Zeolite Wetland

The “fill and drain” wetland process (also known as the Advanced Wetland System or AWS) consists of zeolite beds which adsorb ammonium ions (NH_4^+) and promote the growth of nitrifying bacteria. The wetlands are fed intermittently and ammonium is adsorbed into the zeolite beds during the flooding stage. The adsorbed ammonium is then nitrified in the drain stage as air is drawn into the beds.

A pilot scale fill and drain zeolite wetland has recently been trialled at the Wellsford WWTP and achieved an ammonia removal efficiency of around 50% (Jacobs, 2019). Based on the pilot trial loading rates, the Opononi wetland is large enough to accommodate a fill and draw zeolite wetland in one cell. The fill empty cycle could be timed with the tidal discharge.

Currently this system has only been implemented in New Zealand at pilot scale at one WWTP and the applicability of this system for the Opononi WWTP should also be pilot tested before FNDC commit to this process.

6.3.4 Pond Aeration

Adding additional aerators to the facultative pond could promote nitrification through increased mixing and converting the facultative pond towards a complete mix aerated lagoon process. The increased mixing would create a suspended bacterial floc on which nitrifying bacteria could grow. The sludge layer in the facultative pond would be disturbed by the additional mixing energy and the maturation pond would become a settling pond to store the solids carried over from the facultative pond. Aerating the pond would normally be used to improve BOD treatment.

The energy required to mix ponds using mechanical aerators is in the range 20 – 40 W/m^3 (Metcalf and Eddy, 2014). Based on the facultative pond volume of 1,200 m^3, between 24-48 kW of aeration power would be required to mix the pond. This would incur a high annual power cost and would probably require an upgrade to the site power supply. In addition, the pond would require a plastic liner to protect against scouring from the increased mixing. Alternatively, a concrete pad could be placed beneath the aerators to protect the clay liner.

The pond aeration option also comes with risks due to the relatively short retention time in the pond (3 – 5 days at peak month dry weather flows) which is at the lower end for nitrification. In addition, the nitrifying bacteria could be washed out during high wet weather flows which would disrupt ammonia removal for a period of time while a sufficient nitrifying bacteria population is re-established.

6.4 Activated Sludge Plant

The ponds and wetlands could be replaced by a mechanical activated sludge plant which would produce a high-quality effluent with low BOD, TSS and ammonia concentrations. The activated sludge process provides operational process control and therefore more consistent effluent quality (less variability) than the current pond / wetland process which is essentially uncontrolled and reliant on climatic conditions.

The activated sludge process can take various configurations, including extended aeration or sequencing batch reactor (SBR). The activated sludge process is a high rate process with a hydraulic retention time of less than 24 hours. A UV disinfection unit would also be required to meet the effluent bacterial standards.

7. Land Disposal

7.1 Previous Investigations

Two studies into land disposal for the Opononi WWTP have been completed. These studies and the key findings are summarised in the following sections.

7.1.1 Alternative Disposal Options Study (VK Consulting Ltd, March 2011)

This report investigated the feasibility of five potential land disposal sites suggested by the OOCLG. A map showing the five sites investigated is provided in Figure 7-1.

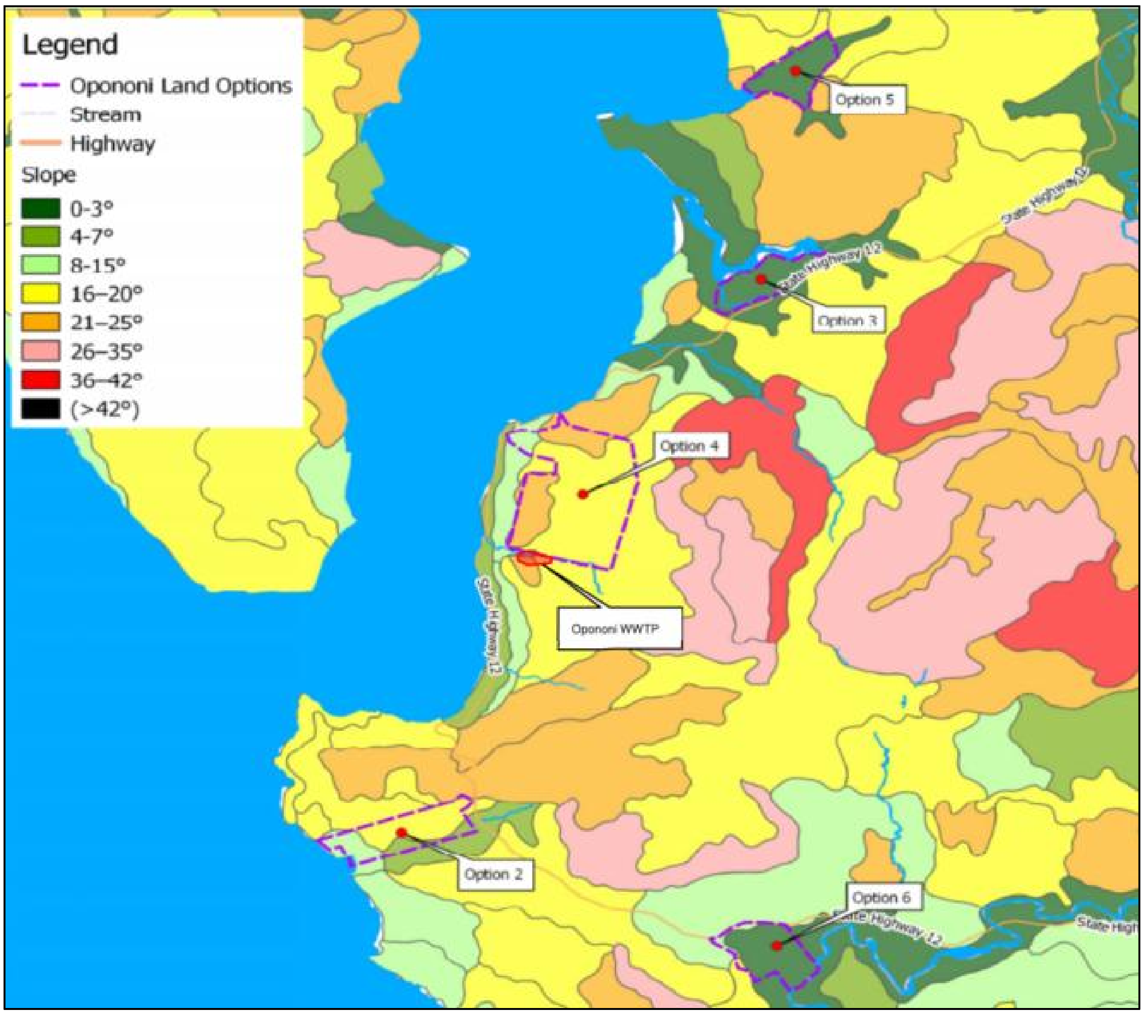

Figure 7-1: Land Disposal Site Locations (Mott MacDonald, 2014)

Of the five sites considered, three were considered feasible (Options 2, 3 and 6 above). Options 2 and 3 had imperfectly to poorly drained clay loam soils and a hydraulic loading rate of 1.7 mm/day was used for these sites. Option 6 (Waimamaku Beach Rd) had moderately well-draining soil and a hydraulic loading rate of 3mm/day was used. Option 6 was furthest from the WWTP (8.3 km) and located on the other side of the Omapere Hill. Capital cost estimates for the land disposal systems ranged from $3.7M to $4.3M (2011 dollars).

7.1.2 Treatment Upgrade and Land Disposal Options (Mott MacDonald, 2014)

This report investigated the feasibility of partial land disposal (summer only) as the land was found to be unsuitable for irrigation for seven months of the year. During the seven months that land disposal was not possible, the treated wastewater would be discharged into the harbour. Two of the sites previously considered in the 2011 VK Consulting report were selected for costing purposes (Options 2 and 4 in Figure 7-1). A design hydraulic loading rate of 1.7 mm/day was used and dripline irrigation was assumed due to the highly sloping land. Capital cost estimates for the land disposal systems were $3.4M and $5.3M (2014 dollars).

7.2 Winter Irrigation and Storage Requirement

A key parameter for land disposal, especially with low permeability soils such as those in the Opononi area, is the allowable irrigation rate over winter or prolonged wet periods and hence the required irrigation storage volume. The 2014 Mott MacDonald investigation found that irrigation was not possible over winter (seven months of the year), which resulted in a winter storage volume of 39,000 m^3. Due to the cost of providing this large storage volume, discharge to harbour over winter was proposed instead.

In contrast, the 2011 VK Consulting report proposed irrigation storage volumes of between 2,000 and 13,000 m^3 depending on the site and irrigation rainfall scenario. A range of potential irrigation rainfall limit scenarios was presented for each site (< 4mm, <10mm, unlimited). The higher the allowable rainfall during irrigation, the lower the storage required.

If land disposal was selected as the preferred discharge option, then winter storage will need to be provided, or harbour disposal during wet weather events would be required which would impact the level of treatment required. Further site-specific investigations and a detailed water balance are required to assess the irrigation storage requirements.

8. Combined Solution Options

An implementable wastewater treatment scheme comprises the collection and transfer system, the treatment process, and the disposal of the treated effluent. For consent renewals, upgrade is not always required if the WWTP is meeting the consent conditions. However, for the Opononi WWTP the system is experiencing compliance issues and therefore treatment process upgrade is required to meet the current consent conditions. Consideration of land-based disposal is also required as part of the previous consent conditions. It should be noted that the effluent quality required for land-based disposal is typically less stringent than for harbour disposal.

Based on our assessment of the current Opononi WWTP performance issues we have identified six options for the Opononi WWTP. Five of the options maintain the current harbour discharge, each option with increasing levels of treatment to address the current non-compliances. Option 5 proposes discharge to land. The options presented are in order of increasing effluent quality and likely cost. The exception is the discharge to land option which will likely be the highest cost option, but has different treatment requirements than for the harbour disposal options.

8.1 Option 1: Optimise Existing WWTP and Maintain Harbour Discharge

Scope of Upgrade Works

This option involves the following upgrade works:

§ Install stub curtain baffles on maturation pond to reduce pond short-circuiting

§ Reinstate Wetland Cell

§ Clear wetlands cells of vegetation overgrowth.

Benefits

The main benefit of Option 1 is that it is a low-cost option that maximises the performance of the existing WWTP infrastructure. This option is considered reasonable as the hydrodynamic modelling report showed that effects from the existing discharge on harbour water quality are within the acceptable limits.

Consequences / Issues

Revised effluent quality standards would be needed to align the consent standards with the optimised plant performance. It is considered unlikely that a resource consent with more relaxed standards would to be granted by NRC.

8.2 Option 2: UV Disinfection and Maintain Harbour Discharge

Scope of Works

This option includes all the items listed in Option 1, plus the installation of a new UV disinfection system on the wetland effluent prior to discharge into the harbour.

Benefits

The UV plant would be sized to provide sufficient disinfection to achieve compliance with the consent *E. coli* standards and as a result public health risks in the harbour would be reduced.

Consequences / Issues

There would only be an improvement in disinfection treatment but the effluent quality would not change in terms of ammonia, BOD and TSS. Revised effluent BOD, TSS and ammonia standards would be needed to align the new consent with the optimised plant performance.

8.3 Option 3: UV Disinfection plus Ammonia Removal and Maintain Harbour Discharge

Scope of Works

This option includes all the items in Option 2, plus the installation of an ammonia removal process. Site specific testing and pilot trials would be recommended prior to selecting the preferred ammonia removal technology.

Benefits

This option would likely be able to achieve sufficient *E. coli* and ammonia treatment.

Consequences / Issues

Depending on the technology selected, increased operational complexity is possible. This option would not improve BOD and TSS treatment. Therefore, this option is unlikely to address the current non-compliance issues, or future proposed conditions.

8.4 Option 4: UV Disinfection, Ammonia Removal, Chemically Assisted Solids Removal and Maintain Harbour Discharge

Scope of Works

This option includes all the items in Option 3, plus a chemical solids removal plant to remove residual algae from the wetland effluent. A chemical storage / dosing shed would be required. Algae removed from the effluent would be returned to the inlet of the WWTP.

Benefits

This option would likely provide sufficient treatment. Furthermore, removing the TSS effluent would likely improve UV disinfection performance. The removal of algae would reduce the green colour of the treated wastewater making a visible improvement in effluent quality (visually clear).

Consequences / Issues

Maintaining good chemical coagulation / flocculation performance can be difficult, and can require ongoing adjustments and optimisation of dose rate and/or chemical. The process will require an increase in operation and maintenance complexity compared with the current system.

8.5 Option 5: Optimise Existing WWTP and a New Discharge to Land

Scope of Works

This option includes the treatment performance items as per Option 1, with disposal via a new land disposal system comprising the following elements:

- Transfer pump station and rising main
- Irrigation storage pond
- Irrigation pump station and disk filter
- Dripline irrigation network.

Benefits

This option removes the discharge from the harbour thereby removing the public health risk associated with a harbour discharge. Because of the steep terrain around Opononi, it is likely that a dripline irrigation system will be required and therefore it is unlikely that UV disinfection will be needed for this option as aerosols are not produced. Ammonia removal is not a priority for land disposal as ammonia is retained in the soil, taken up by grass and, if managed correctly, will not pose a risk to aquatic animals. Therefore, it is expected that only improvements to optimise the performance of the existing infrastructure (Option 1) would be needed.

Consequences / Issues

Currently there is a high degree of uncertainty regarding this option. No site investigations have taken place and no land owners have been approached to ascertain the possibility of land purchase or lease. Resource consents, easements and designations would be needed for the transfer pipeline and disposal area. Assuming a suitable parcel of land can be identified, a five-year timeline is estimated from commencement of site-specific investigations to commissioning of the land disposal system.

The disc filter and dripline irrigation network would require ongoing maintenance and the pasture cut and carry operation (e.g. baleage) will need ongoing management. In addition, the land disposal system is likely to be non-viable during heavy rainfall and vulnerable to extreme weather events, unlike the harbour outfall.

This option is expected to have a high capital and operating cost.

8.6 Option 6: Activated Sludge Plant plus UV Disinfection and Harbour Discharge

Scope of Works

This option includes replacing the existing pond and wetland system with a new activated sludge plant comprising the following elements:

- Inlet screen
- Activated sludge plant (either an SBR or extended aeration plant)
- UV disinfection system

§ Sludge thickening, storage and loadout facilities.

Benefits

This option provides the highest effluent quality and the most consistent effluent quality as the process is controlled and does not rely on natural processes, as the current system does.

Consequences / Issues

The activated sludge process is highly mechanised and would require a step change in operation and maintenance effort, staff training and operating costs compared with the current low maintenance, “low tech” system. The process would consume more energy as all of the aeration is provided mechanically. Sludge would need to be processed on a daily basis and a disposal route would need to be found for the waste sludge.

This option makes no use of the existing assets which would be decommissioned. This option is would have a high capital and operating cost.

8.7 Summary

As the Opononi WWTP is not able to meet the current consent limits, only options which address all non-compliant parameters are worth further consideration and investment. Options than cannot address these parameters are considered fatally flawed in terms of the ability to meet the current resource consent conditions.

Of the long-list of options identified above, only options 4, 5 and 6 are expected to meet the required effluent quality standards. Four options will be taken forward for further consideration, and Option 4 has been expanded to options 4a, and 4b – considering different ammonia and solids removal options. As all options will be designed to meet the consent requirements, coupled with the hydrodynamic study findings, the key aspects to consider become reliability of treatment performance and ease of operation, as well as the affordability of the option. Options which are robust, technically proven, and familiar to operators in the district have been shortlisted ahead of options which are currently in trial phase or are complex to operate.

The list of four shortlisted options is outlined below. Note that all options include optimisation of the existing system 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:

- Option 4a – Optimised process, chemically assisted solids removal, UV, with an in-pond or in-wetland ammonia removal process (e.g. bioshells, zeolite fill-and-draw wetland) and harbour discharge.
- Option 4b – Optimised process, chemically assisted solids removal, UV, with an external ammonia removal package plant (e.g. SAF) and harbour discharge.
- Option 5 - Optimisation of the current process and discharge of the treated wastewater to land.
- Option 6 – New activated sludge plant plus UV disinfection and harbour discharge.

9. Cost Estimates of Recommended Options

Four options for the Opononi WWTP upgrades have been shortlisted and endorsed by FNDC to be taken forward to complete cost estimates and undergo the MCA process. These include;

1. Option 4a – Optimised process, chemically assisted solids removal, UV, with an in-pond or in-wetland ammonia removal process (e.g. bioshell, zeolite fill and draw wetland) and harbour discharge.
2. Option 4b – Optimised process, chemically assisted solids removal, UV, with an external ammonia removal package plant (e.g. SAF) and harbour discharge.
3. Option 5 – Optimisation of the current process and discharge of the treated wastewater to land.
4. Option 6 - New activated sludge plant plus UV disinfection and harbour discharge

Indicative cost estimates have been completed for each of the options listed in sections 9.1 to 0. These have been compiled from quotes received from contractors and suppliers, previous work on the Opononi WWTP and similar FNDC projects such as the Taipa WWTP upgrades.

The total costs also include contingency amounts and risk allowances as recommended in Table 4.4 of the IChemE Guide to Capital Cost Estimation for a Fluid Processing Plant (IChemE, 2000). It should be noted that the following cost estimates are high-level and have an accuracy of ±50%, more detailed analysis would need to be carried to obtain a more accurate cost estimation. Additionally, differing levels of risk contingency have been applied to the items listed in the cost estimates in the following sections. Items of greater cost and scope certainty have had a lower risk contingencies applied to them and vice versa. The overall risk contingency for each option may be solely contain a low/high or a combination of both lower and higher contingency factors, in this case standard and reduced labels have been used for indication.

9.1 Option 4a Indicative Cost Estimate

Option 4a comprises optimising the current process, providing chemically assisted solids removal and UV disinfection, with an in-pond or in-wetland ammonia removal process (e.g. bioshells or a zeolite fill-and-draw wetland). Discharge remains to harbour. Indicative pricing for Option 4a can be found in Table 9-1, refer to Appendix C for detailed cost estimates and supplier product catalogues.

Table 9-1 Indicative Cost Estimate for Option 4a

Item	Unit	Quantity	Rate	Total	Comment
Opononi WWTP Process Optimisation					
Supply and install baffle curtains	Item	1	$28,000	$28,000	SiteCare quotation. This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of the collected waste to the Kaikoura landfill.
Wetland vegetation clearance and disposal	Item	1	$66,000	$66,000	SiteCare quote for wetland maintenance 8/07/20. This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of the collected waste to the Kaitaia landfill. FNDC could execute this work as part of the Far North Waters Alliance rather than an external contractor.

Wetland reinstatement	Item	1	$98,000	$98,000	SiteCare to: - To attend restore " Sacrificed Wetland Cell" as per scope. - Redirect inlet pipeline from WWTP to "Sacrificed Wetland Cell", and install outflow to Wetland Cell
Treatment Upgrades					
Wedeco UV LBX120E UV Disinfection Unit	Item	1	$114,000	$114,000	Based on Xylem price quote includes contingencies for the install, Instrumentation, piping and electrical costs
Instrumentation costs: 1. Flowmeter 2. Turbidity meter 3. UV Transmissivity	Items	1	$53,000	$53,000	Based on quotes received in 2019 from instrumentation suppliers. The total prices includes installation, instrumentation and controls, piping and electrical costs based on factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation.
Solids Removal : DAF Plant	Item	1	$790,000	$790,000	Based on Filtec indicative costs received July 2020. The total price also includes electrical costs as per the factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation for a Fluid Processing Plant.
In-pond Ammonia Removal - Bioshells	Item	1	$780,000	$780,000	Based on Marshall projects indicative costs from July 2020 for supply and install of ~60 bioshells and hexacovers. Note this technology has been costed to provide indicative costs, but other in pond options can be considered. An additional 20% has been added to the final cost on recommendation from the supplier.
Risk Allowance (reduced)	%	54	$1,000,000	$1,000,000	The Risk allowance is based on factor recommend in Table 4.4 of the IChemE Guide to capital cost estimation for engineering and supervision fees for a Fluid Processing Plant for a Fluid Processing Plant. The overall option risk allowance is a combination of a lower contingency factor (34%) applied to the Baffle curtain installation task and the higher contingency factor (54%) applied to the remaining tasks (excluding wetland vegetation clearance).
Total Capital Costs				$2,929,000	

9.2 Option 4b Indicative Cost Estimate

Option 4b is the same as 4a, but instead of an in-pond or wetland ammonia removal system, an external ammonia removal package plant (e.g. SAF) is included. Indicative pricing for Option 4b can be found in Table 9-2, refer to Appendix C for detailed cost estimates and supplier product catalogues.

Table 9-2 Indicative Cost Estimate for Option 4b

Item	Unit	Quantity	Rate	Total	Comment
Opononi WWTP Process Optimisation					
Supply and install baffle curtains	Item	1	$28,000	$28,000	SiteCare quotation. This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of the collected waste to the Kaitaia landfill.
Wetland vegetation clearance and disposal	Item	1	$66,000	$ 66,000	SiteCare quote for wetland maintenance 8/07/20. This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of th collected waste to the Kaitaia landfill. FNDC could execute this work as part of the Far North Waters Alliance rather than an external contractor.
Wetland reinstatement	Item	1	$98,000	$98,000	SiteCare to: - To attend restore " Sacrificed Wetland Cell" as per scope. - Redirect inlet pipeline from WWTP to "Sacrificed Wetland Cell", and install outflow to Wetland Cell 1.
Treatment Upgrades					
Wedeco UV LBX120E UV Disinfection Unit	Item	1	$114,000	$114,000	Based on Xylem price quote includes contingencies for the install, Instrumentation, piping and electrical costs.
Instrumentation costs: 1. Flowmeter 2. Turbidity meter 3. UV Transmissivity	Items	1	$53,000	$53,000	Based on quotes received in 2019 from instrumentation suppliers. The total price includes installation, instrumentation and controls, piping and electrical costs based on factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation for a Fluid Processing Plant.

Solids Removal - DAF Plant	Item	1	$555,000	$555,000	Based on Filtec indicative costs received July 2020. The total price also includes electrical costs as per the factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation for a Fluid Processing Plant.
Out of pond Ammonia Removal - SAF Plant	$/m^3/day	178	$13,000	$2,314,000	Consultation with Hynds NZ for a SAFF plant. High level, indicative pricing is $13k/m3/day. The total cost is for delivery of the current ADWF of 178 m3/day, this price includes installation and contractor costs.
Risk Allowance (reduced)	%	54	$ 1,702,000	$ 1,702,000	The Risk allowance is based on factor recommend in Table 4.4 of the IChemE Guide to capital cost estimation for engineering and supervision fees for a Fluid Processing Plant. The overall option risk allowance is a combination of a lower contingency factor (34%) applied to the Baffle curtain installation task and the higher contingency factor (54%) applied to the remaining tasks (excluding wetland vegetation clearance).
Total Capital Costs				$ 4,930,000	

9.3 Option 5 Indicative Cost Estimate

Option 5 comprises optimising the current process and discharging of the treated wastewater to land. Indicative pricing for Option 5 can be found in Table 9-3, refer to Appendix C for detailed cost estimates and supplier product catalogues.

Table 9-3 Indicative Cost Estimate for Option 5

Item	Unit	Quantity	Rate	Total	Comment
Opononi WWTP Process Optimisation					
Supply and install baffle curtains	Item	1	$28,000	$28,000	SiteCare quotation. This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of the collected waste to the Kaitaia landfill. T
Wetland vegetation clearance and disposal	Item	1	$66,000	$66,000	SiteCare quote for wetland maintenance 8/07/20. This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of the collected waste to the Kaitaia landfill. FNDC could execute this work as part of the Far North Waters Alliance rather than an external contractor.
Wetland reinstatement	Item	1	$98,000	$98,000	SiteCare to: - To attend restore " Sacrificed Wetland Cell" as per scope. - Redirect inlet pipeline from WWTP to "Sacrificed Wetland Cell", and install outflow to Wetland Cell 1
Treatment Upgrades					
Wedeco UV LBX120E UV Disinfection Unit	Item	1	$114,000	$114,000	Based on Xylem price quote includes contingencies for the install, Instrumentation, piping and electrical costs
Instrumentation costs: 1. Flowmeter 2. Turbidity meter 3. UV Transmissivity	Items	1	$53,000	$53,000	Based on quotes received in 2019 from instrumentation suppliers. The total price includes installation, instrumentation and controls, piping and electrical costs based on factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation.

Solids Removal : DAF Plant	Item	1	$790,000	$790,000	Based on Filtec indicative costs received July 2020. The total price also includes installation and electrical costs as per the factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation.
In-pond Ammonia Removal - Bioshells	Item	1	$780,000	$780,000	Marshall projects indicative costs from July 2020 for supply and install of ~60 bioshells and hexacovers. Note this technology has been costed to provide indicative costs, but other in pond options can be considered. A margin of 20% has been added as recommended by Marshall Projects
Land-based Discharge					
Option 4 - Baker Farm	Item	1	$3,670,000	$3,670,000	The total cost for this option is an inflation adjusted price for Option 4 recommended in Section 3.3 of the 2014 study completed by Mott MacDonald. The study was a high-level cost analysis for Option 4.
Infrastructure Costs	%	76	$2,790,000	$2,790,000	An additional allowance estimate has been added based on factors for purchased equipment installation, instrumentation, and electrical works for a land-based disposal option. These factors have been based on recommendations from Table 4.4 of the IChemE Guide for Capital Cost Estimation
Risk Allowance for Land-based Discharge	%	137	$8,851,000	$8,851,000	A risk allowance for land-based discharge includes factors for the engineering and supervision, construction expenses, contractors fee and contingencies as recommended by Table 4.4 of the IChemE Guide for Capital Cost Estimation
Risk Allowance (reduced)	%	42	$781,000	$781,000	The Risk allowance is based on the contingency factor recommend in Table 4.4 of the IChemE Guide to capital cost estimation for contingencies for a Fluid Processing Plant. The overall option risk allowance is a combination of a lower contingency factor (34%) applied

					to the baffle curtain installation task and the higher contingency factor (54%) applied to the remaining tasks (excluding wetland vegetation clearance).
Total Costs				$18,021,000	

9.4 Option 6 Indicative Cost Estimate

Option 6 is to replace the current WWTP process with a new activated sludge plant process, with UV disinfection and harbour discharge. Indicative pricing for Option 6 can be found in Table 9-4, refer to Appendix C for detailed cost estimates and supplier product catalogues.

Table 9-4 Indicative Cost Estimate for Option 6

Item	Unit	Quantity	Rate	Total	Comment
Decommissioning of current system					
Allowance	Item	1	$300,000	$300,000	This is an estimated allowance for decommissioning the current system and repurposing it
Treatment Upgrades					
Wedeco UV LBX120E UV Disinfection Unit	Item	1	$114,000	$114,000	Based on Xylem price quote includes contingencies for the install, Instrumentation, piping and electrical costs
Instrumentation costs: 1. Flowmeter 2. Turbidity meter 3. UV Transmissivity	Items	1	$114,000	$53,000	Based on quotes received in 2019 from instrumentation suppliers. The total price includes installation, instrumentation and controls, piping and electrical costs based on factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation.
Activated Sludge Treatment Plant					
Indicative Cost of plant	Item	1	$2,478,000	$2,478,000	This price includes: Inlet works, construction costs associated with the SBR system, contractor design, commissioning, power supply and contingencies. It is an adjusted estimate from the Taipa Upgrade Issues and Options Report (May, 2018)
Risk Allowance (standard)	%	54	$1,429,000	$1,429,000	The Risk allowance is based on the contingency factors for engineering and supervision recommend in Table 4.4 of the IChemE Guide to capital cost estimation for contingencies for a Fluid Processing Plant.
Total Capital Costs				$4,374,000	

9.5 Summary of Costs, Benefits and Risks

9.5.1 QMRA Outcomes

As discussed in Section 5.2.3 a QMRA was completed by Streamlined Environmental which found that, if the wetland treatment system is achieving a 2log virus removal as commonly indicated by available literature, the level of treatment currently applied at the Opononi WWTP is sufficient to reduce illness risks associated with recreation or consumption of harvested raw shellfish below the “no observable adverse effect level” (NOAEL).

If the wetland performance is in question, UV disinfection can be specified to meet the log reduction requirements indicated by the QMRA. It should be noted that Option 5 does not need this due to the effluent being disposed to land.

Table 9-5 summarises the benefits, risks and costs for each of the four options.

Table 9-5 Summary of Options Benefits, Risks and Costs

Option	Option 4a	Option 4b	Option 5	Option 6
Benefits and Risks	Relatively low Opex In-pond ammonia removal systems have inconsistent results Will meet consent conditions Ease of operation Fill and Drain wetlands are proven at pilot scale only Highly compatible with existing infrastructure Maintain harbour discharge	Relatively low Opex High quality effluent produced Will meet consent conditions More technical to operate Reliable technology Additional monitoring and maintenance required Limited SAF suppliers in New Zealand Compatible with existing infrastructure Maintain harbour discharge	Expensive option – both Capex and Opex Large footprint required High quality effluent produced Will meet consent conditions More technical to operate Land purchase required Extensive consultation process More acceptable to Maori Compatible with existing infrastructure Establish land-based discharge	Higher Opex High quality effluent produced Will meet consent conditions Small footprint More technical to operate Highly future proofed solution Reliable technology Not compatible with existing infrastructure Maintain harbour discharge

Option	Option 4a	Option 4b	Option 5	Option 6
Capital Cost	$2.929M	$4.930M	$18.021M	$4.374M

10. Multi-Criteria Assessment

10.1 Criteria

The proposed criteria for the Multi Criteria Analysis (MCA) have been provided by FNDC and are outlined in Table 10-1.

The risks and benefits of each option have been identified and were considered using an MCA process in a collaborative workshop held with FNDC on the 26th August 2020. The MCA criteria used can be summarised at a high level as follows:

1. Cultural acceptability: iwi/stakeholder concerns from consultation including effects on the mauri of the water, amenity and perception of a discharge to water.
2. Environmental criteria: ensuring the harbour is safe for recreational activities including the gathering of kai moana, particularly close to the disposal site, and a reduction of nutrient load (N and P) going into the harbour from the WWTP, and that amenity impacts such as noise, visual aesthetics and odours are not significantly impacted
3. Practicability criteria: that the option can be consented in a timely manner, and considers the complexity of the construction process, distance from networks and services and the overall time taken to construct and commission the option
4. Operational Criteria: technical factors including reliability, technical feasibility, robust & proven technology, operational resilience, staging/flexibility for future upgrading, Health and Safety in design and operational complexity.
5. Economic Criteria: Order of magnitude capital and operating cost estimates will inform the affordability of each option as well as the likely impact on rates.

Table 10-1: Opononi WWTP Assessment Criteria

Number	Category	Criteria	Description	Success Factors
1	Māori cultural values	Impacts on Māori cultural values and practices.	Gives effect to Te Mana o te Wai. Acceptability of process to local iwi	The option safeguards Māori cultural values and practices
2	Environmental values	Land Use Effects	Visual, Noise, Traffic impacts	The option can meet required discharge standards for wastewater (and carbon where applicable) The option can meet amenity standards, including odour
		Odour	The degree to which odour can be expected to be discharged beyond the property boundary.	
		Ecological Effects	The degree to which the effluent quality exceeds the minimum environmental and consent requirements.	
		Carbon Footprint	Level of energy consumption, secondary discharges and chemicals required.	

		Public Health	Impacts on mahinga kai Recreational use of the receiving environment Impact of spills and failure	
3	Practicability	Constructability	Complexity of construction process Distance from networks and services Time taken to commission option	The option can be successfully delivered
		Regulations and Planning	Complexity to obtain a consent or other authorisations	
4	Operability	The ease of operation and maintenance	Complexity of operation Required expertise Ease of access H&S risks of plant process. Sludge management Reliance on and complexity of plant consumables and replacement componentry	The option can be successfully used into the future
		Process reliability and resilience	Known performance of others with similar technologies Consistency of quality in the discharge Ability to maintain compliance with resource consents	
		Expandability/ future proofing	The potential for the site to allow for extensions to the treatment process Proofing against changes in compliance requirements	
		Hazards	Proximity to known and potential hazards, e.g., flood plains, climate change hazards	
5	Financial considerations	Capital Cost	Cost of implementation Site investigations and procurement of land Ability to reuse existing FNDC assets	The costs of the option are understood and able to be paid
		Operating and Maintenance Costs	Operations and maintenance requirements (e.g., chemical costs, sludge removal) Power cost	
		Rating impact	Impact on targeted rate relative to other options	

The weightings for the primary and sub-criteria are shown in Table 10-2. The results of the assessment are presented in Table 10-3 and Figure 10-1.

Table 10-2: MCA Primary and sub-criteria weightings

Primary Criteria	Weighting	Secondary Criteria	Weighting
Economic Criteria	40.0%	Capital Cost	33%
		Operating and Maintenance Costs	33%
		Rating Impacts	33%
Environmental Criteria	20.0%	Land Use Effects (visual, noise and traffic impacts)	15%
		Odour (degree to which odour will be eperienced beyond WWTP boundary)	15%
		Ecological Effects (does effluent quality exceed consent limits)	30%
		Carbon Footprint (level of energy and consumables required)	10%
		Public Health (protection of mahinga kai, impact on recreation, impact of spills or failure)	30%
Maori Cultural Values	20.0%	safeguards Māori cultural values and practices	100%
Practicability Criteria	10.0%	Constructability (complexity, distance from services, time to commission)	20%
		Land Purchase (if required)	50%
		Regulations and Planning (complexity in obtaining consent)	30%
Operational Criteria	10.0%	Complexity of operation / required experience	25%
		Sludge management	25%
		Reliance on and complexity of plant consumables and replacement componentry	25%
		Health and Safety risks or plant process / access to site	25%

Table 10-3: MCA Assessment Results

	Option 4a	Option 4b	Option 5	Option 6
Key-Criteria Summary	Optimised process, solids removal, UV, in-pond/wetland N removal, harbour discharge	Optimised process, solids removal, UV, external N removal, harbour discharge	Optimise current process - discharge to land	New activated sludge plant plus UV disinfection and harbour discharge
Economic Criteria	0.35	0.32	0.00	0.19
Environmental Criteria	0.07	0.14	0.13	0.12
Maori Cultural Values	0.00	0.00	0.20	0.00
Practicability Criteria	0.06	0.03	0.03	0.04
Operational Criteria	0.07	0.08	0.05	0.06
Results	0.54	0.58	0.41	0.41
Rank	2	1	3	4

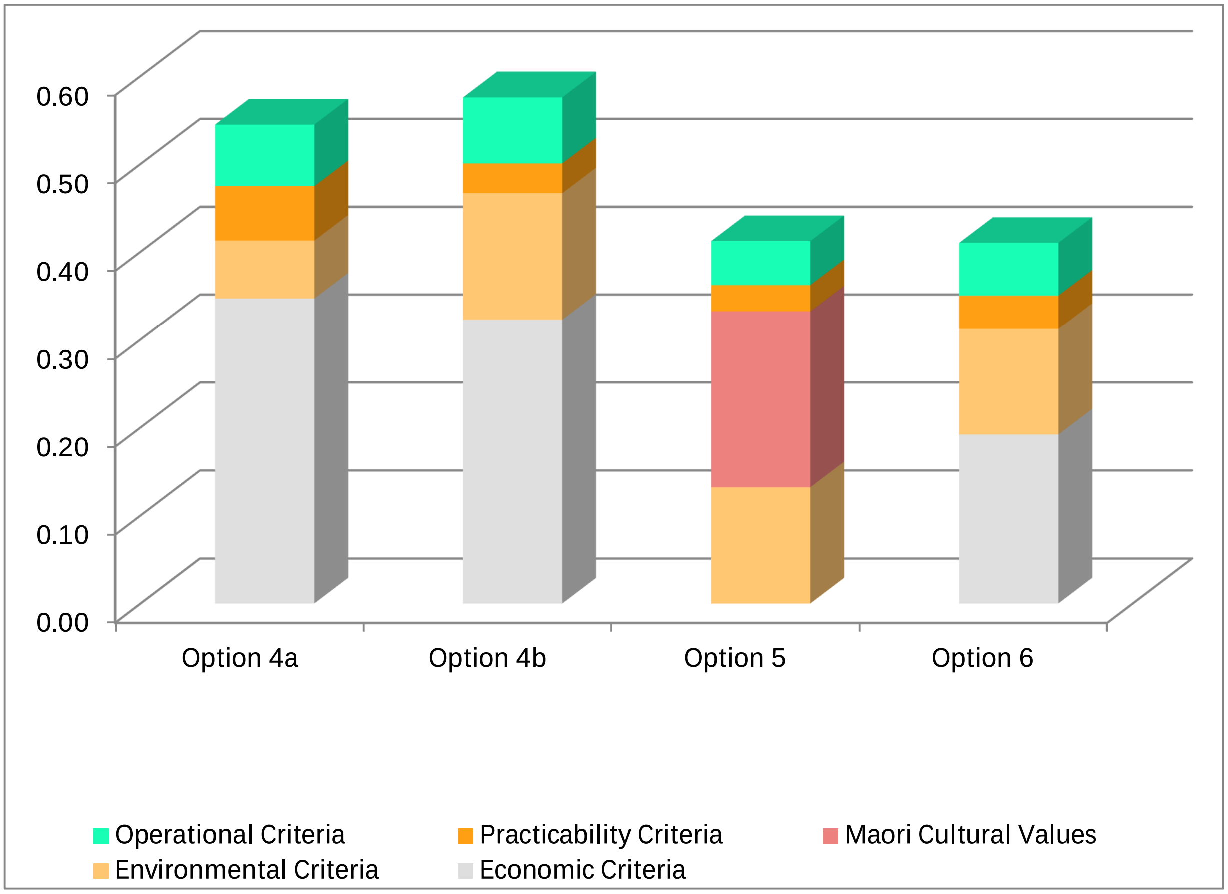

Figure 10-1: MCA Assessment Results – Graphical Representation.

The MCA results show that Options 4a and 4b score very similarly, with Option 4b scoring highest overall – the key benefits being a relatively low cost, a more proven and robust treatment option, and a better environmental outcome. Option 4a and 4b are very similar with the key difference being the N removal process, with 4a being an in-pond system which has a lower cost overall. Option 5 is the only option which scores for cultural at all, but the high cost of this option brings its overall score down.

There was concern that if the weightings were changed, the preferred options may also change, so a number of scenarios were run on the MCA outcomes through changing the weightings (sensitivity analysis) to determine if the preferred options changed. The outcomes of the sensitivity analysis and the changes to the weighting which were adopted are summarised in Table 10-4 and Figure 10-2.

Table 10-4: Sensitivity analysis and impact of weighting changes

Primary Criteria	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Base Case
Economic Criteria	40%	80%	20%	20%	40%
Environmental Criteria	10%	5%	30%	20%	20%
Maori Cultural Values	10%	5%	30%	20%	20%
Practicability Criteria	20%	5%	10%	20%	10%
Operational Criteria	20%	5%	10%	20%	10%
	100%	100%	100%	100%	100%

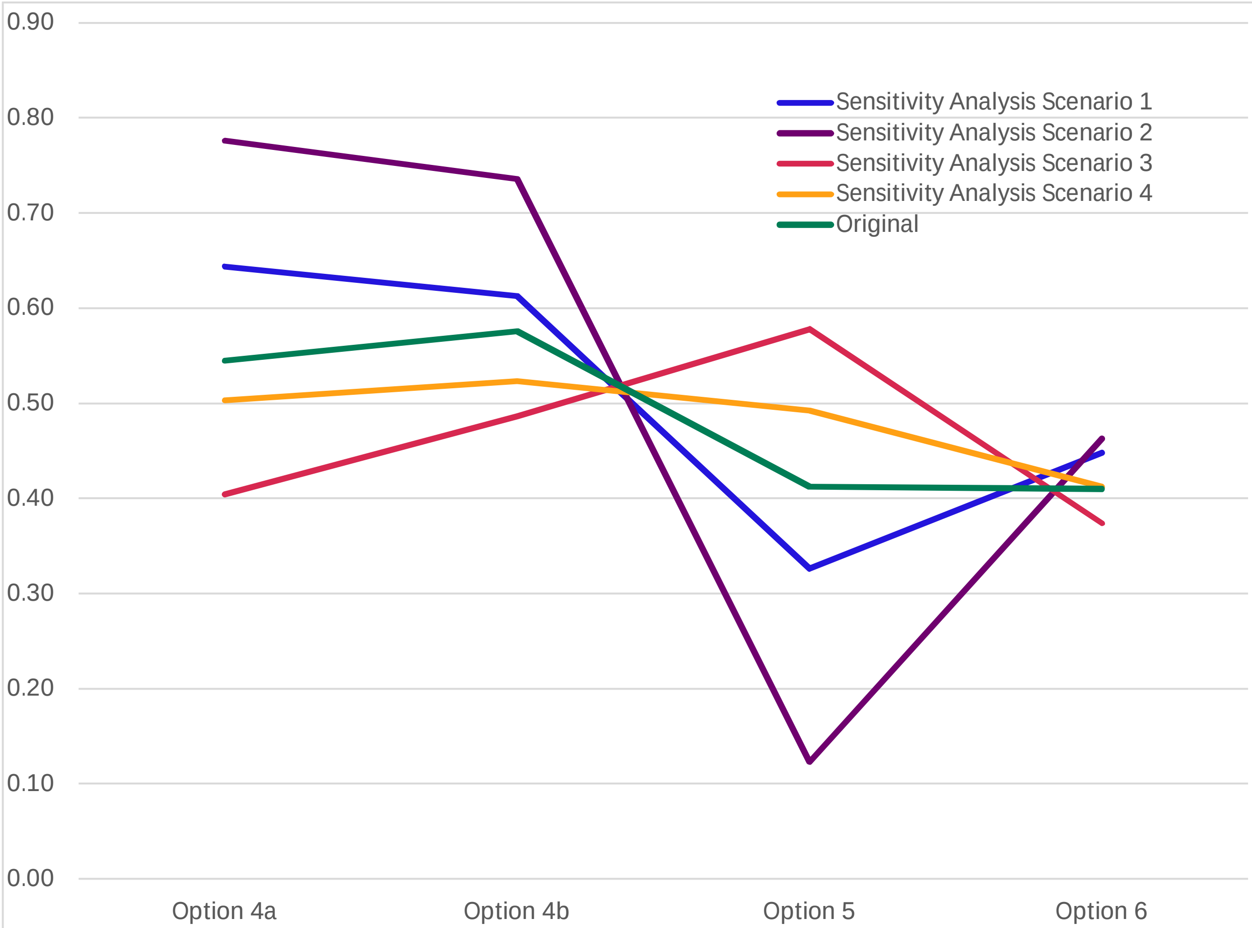

Figure 10-2: Comparison of MCA criteria scores for each scenario

The sensitivity analysis shows that the preferred options do not change under most of the scenarios with 4a and 4b scoring highest overall in nearly all scenarios, but that under Scenario 3, Option 5 becomes preferred. In this scenario more emphases is put on environmental and cultural values.

11. Conclusions and Next Steps

11.1 Summary

The Opononi WWTP is in not complying with the current consent E.coli, ammonia, BOD and total suspended solids standards. The rolling 12-month median effluent E.coli concentration regularly exceeds the consent limit of 3,000 cfu/100 mL and has a 32% compliance rate based on samples taken since January 2016. Effluent ammonia nitrogen concentrations have increased since January 2017 and now exceed the rolling 12-month median limit of 30 mg/L. Total suspended solids concentrations show seasonal spikes each summer which are likely caused by increased algae growth. The spikes result in breaches of the rolling 12-month median limit of 35 mg/L.

Hydrodynamic modelling results 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 500m down current and 25,000 at the shoreline.

11.2 Conclusion

Improvements to the WWTP are required to comply with the current resource consent conditions. If the harbour discharge is retained it is considered unlikely that a resource consent with more relaxed standards for BOD and TSS would to be granted by NRC. Land disposal of the Opononi WWTP will be difficult and costly due to the steep terrain and poorly draining soils, however previously identified sites are included for comparison with the harbour discharge options.

Four upgrade options have been recommended for the WWTP which can address the BOD, TSS, E.coli and ammonia issues:

- Option 4a – Optimised process, chemically assisted solids removal, UV, with an in-pond or in-wetland ammonia removal process (e.g. Bioshell, zeolite fill and draw wetland etc) and harbour discharge.
- Option 4b – Optimised process, chemically assisted solids removal, UV, with an external ammonia removal package plant (e.g. SAF) and harbour discharge.
- Option 5 - Optimisation of the current process and discharge of the treated wastewater to land.
- Option 6 – New activated sludge plant plus UV disinfection and harbour discharge.

Indicative capital cost summaries have been prepared and are summarised as follows:

Option 4a	Option 4b	Option 5	Option 6
$2.929M	$4.930M	$18.021M	$4.374M

An MCA has been completed, which demonstrates that Option 4b is preferred under most scenarios, with Option 4a ranked very closely. The options are very similar with the key difference being whether the N removal is in pond or via external process. Option 4a has a lower cost, but is relied on less proven technologies, resulting in 4b being considered safer from an environmental risk perspective. It is recommended that Option 4b or 4a be implemented for the Opononi WWTP. It is worth noting that only Option 5 scored well in terms of cultural context, but that the very high cost of this option meant that it did not score well overall.

12. References

AS/NZS 1547:2012 On-site domestic wastewater management

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Appendix A. Existing Resource Consent

COPY OF CONDITIONS IMPOSED BY THE ENVIRONMENT COURT IN ITS DECISION (A121/2009) DATED 18 NOVEMBER 2009

NOTE: *Pursuant to Section 116 of the Resource Management Act 1991, the date of commencement of this consent is 18 November 2009.*

CON20070266701 **Notified New and Replacement**

FAR NORTH DISTRICT COUNCIL, PRIVATE BAG 752, KAIKOHE 0440

To undertake the following activities associated with the operation of a wastewater treatment system on Lot 1 DP 110735 and Lot 1 DP 167208 Blk VII Hokianga servicing the townships of Omapere and Opononi, as defined by the operative Far North District Council Plan, and all existing connections to this system that are outside these townships, as at the date of commencement of these consents:

(01) To discharge treated wastewater into the Hokianga Harbour at or about location co-ordinates 1634768E 6069462N.

(02) To discharge treated wastewater to land from the base of a wastewater treatment system at or about location co-ordinates 1635620E 6069420N and 1635800E 6069350N.

(03) To discharge contaminants, primarily odour, to air from a wastewater treatment system at or about location co-ordinates 1635620E 6069420N and 1635800E 6069350N.

(04) To occupy and use the bed of the Hokianga Harbour for an existing wastewater discharge pipeline structure.

Note: All location co-ordinates in this document refer to Geodetic Datum 2000, New Zealand Transverse Mercator Projection.

Subject to the following conditions:

(01) & (02) Coastal and Land Discharge

1 The quantity of treated wastewater discharged to the Hokianga Harbour shall not exceed 685 cubic metres per day.

2 Notwithstanding Condition 1, the Consent Holder shall minimise, as far as practicable, any increase in the quantity of wastewater discharged to the Hokianga Harbour as a result of stormwater inflow and infiltration into the

sewage reticulation network and treatment system. This shall include the prevention, as far as is practicable, of stormwater run-off from the surrounding land entering the treatment system. For compliance purposes, the Consent Holder shall record the daily wastewater inflow volume to the treatment system.

3 The Consent Holder shall notify the Northland Regional Council's Monitoring Senior Programme Manager in writing of any proposed changes to the wastewater treatment and coastal discharge system, as installed at the date of commencement of these consents, at least one month prior to the proposed change(s) being undertaken.

4 The Consent Holder shall maintain a meter on both the inlet to, and the outlet from, the treatment system that has a measurement error of ±5% or less. These meters shall then be used to determine compliance with Conditions 1 and 2.

5 The Consent Holder shall re-calibrate the meters required by Condition 4 at least annually to ensure that the specified accuracy is maintained. Written verification from a suitably qualified person that the meter has been calibrated during the previous 12 month period shall be forwarded to the Northland Regional Council's Monitoring Senior Programme Manager by 1 May each year.

6 Treated wastewater shall only be discharged to the Hokianga Harbour for a maximum of three hours each tidal cycle between one hour and four hours after high tide via the discharge pipeline from the treatment system, as installed at the date of commencement of these consents.

7 The Consent Holder shall calibrate the tidal clock used to control the time of discharge to the Hokianga Harbour at least annually to ensure that the programmed high tide discharge time is, as far as is practicable, the same as when high tide actually occurs at the site. Written verification from a suitably qualified person that this calibration has been undertaken during the previous 12 month period shall be forwarded to the Northland Regional Council's Monitoring Senior Programme Manager by 1 May each year.

8 The Consent Holder shall ensure safe and easy access to Northland Regional Council sampling site 101580, Marsh Discharge, so that treated wastewater samples can be safely collected.

9 There shall be no discharge of contaminants onto or into land, or into water, from any part of the treatment system except via seepage from the base of the treatment system and the designated outlet pipe from the treatment system into the Hokianga Harbour.

10 The discharge of contaminants to land via seepage from the base of the treatment system shall not result in any adverse effects on the water quality of the Waiarohia Stream, as measured immediately downstream of either the treatment ponds or the constructed wetland system. For compliance purposes the downstream water quality shall be compared with the water quality immediately upstream of the constructed wetland system. The error of the analytical method and measuring instrument at the 95%ile confidence level shall be included in determining all parameters.

11 Notwithstanding any other conditions, the discharge of any contaminant (either by itself or in combination with the same, similar or other contaminants or water) shall not result in any of the following effects in the water quality of the Hokianga Harbour, as measured at any point at, or down-current of, where the treated wastewater first contacts the surface of the Hokianga Harbour:

(a) The production of conspicuous oil or grease films, scums or foams, floatable or suspended materials;

(b) Any conspicuous change in the colour or visual clarity;

(c) Any emissions of objectionable odour;

(d) Any significant adverse effects on aquatic life; and

(e) No more than minor adverse change in either the Escherichia coliform or Enterococci concentration.

For compliance purposes, the down-current water quality shall be compared to the background water quality of the Hokianga Harbour at an up-current site that is not affected by this discharge for each of the above parameters. The error of the analytical method and measuring instrument at the 95%ile confidence level shall be included in determining all parameters.

(03) Discharge to Air

12 The Consent Holder's operations shall not give rise to any discharge of contaminants at or beyond the legal boundary of Lot 1 DP 110735 and Lot 1 DP 167208 Blk VII Hokianga which is deemed by a suitably trained and experienced Enforcement Officer of the Regional Council to be noxious, dangerous, offensive or objectionable.

(04) Discharge Pipeline Structure

13 This consent only authorises the existing structure as installed at the date of commencement of this consent.

14 The Consent Holder shall, within three months of the date of commencement of this consent, forward to the Regional Council's Monitoring Senior Programme Manager and the representatives of the community liaison group required by Condition 21, a plan drawn by a registered surveyor that shows the location of the existing pipeline structure from State Highway 12 to the outlet of the pipeline.

15 The pipeline shall be buried at all times and the structural integrity of the pipeline shall be maintained at all times. The Consent Holder shall undertake inspections of the bed of the Hokianga Harbour where the pipeline is installed and also the outlet of the pipeline at least once every two years, with the first inspection occurring within three months of the date of commencement of this consent. The Consent Holder shall give the representatives of the community liaison group required by Condition 21 at least seven days notice of the proposed inspection of the pipeline. A written report on the results of this inspection shall be forwarded to the Northland Regional Council's Monitoring Senior Programme Manager and the representatives of the Community Liaison Group by 1 May every two years from the date of commencement of this consent. The written report for the first inspection shall be forwarded with the plan required by Condition 14 to the Northland Regional Council's Monitoring Senior Programme Manager

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and the representatives of the community liaison group required by Condition 21.

Advice Note: Any maintenance or repair work on the discharge pipeline will need to meet the permitted activity criteria of Rule 31.4.4(f) of the Regional Coastal Plan for Northland or otherwise be the subject of an application for resource consent.

General Conditions (01) – (04)

16 The Consent Holder shall maintain the treatment system so that it operates effectively at all times, and a written record of all maintenance undertaken shall be kept. In addition, the Consent Holder shall forward to the Northland Regional Council's Monitoring Senior Programme Manager within six months of the date of commencement of these consents, a maintenance programme for the constructed wetland that includes, but is not limited to, details of how the extent of the areas within the wetland that require plant coverage will be maximised and how the plants within the wetland will be maintained.

17 To prevent damage to the wastewater treatment system, stock shall not be allowed to enter any area that is utilised for the treatment of wastewater.

18 The Consent Holder shall, within six months of the date of commencement of these consents, forward to the Northland Regional Council's Monitoring Senior Programme Manager a list of all existing connections to the Omapere and Opononi Wastewater Treatment System that are outside the townships of Omapere and Opononi, as defined by the operative Far North District Council Plan.

19 The Consent Holder shall monitor these consents in accordance with Schedule 1 (attached). If the monitoring results show that any of the following determinants in the treated wastewater are exceeded, as measured at NRC sampling site 101580:

Determinand	**Median Concentration**	**90 percentile Concentration**

Determinand	Median Concentration	90 percentile Concentration
5 day Biochemical Oxygen Demand (grams per cubic metre)	20	35
Escherichia Coli (per 100 millilitres)	3,000	5,500
Total ammoniacal nitrogen (grams per cubic metre)	30	38
Total suspended solids (grams per cubic metre)	35	80

The Consent Holder shall, within one month of becoming aware of any exceedance, forward to the Northland Regional Council's Monitoring Senior Programme Manager a written report that provides the following:

(a) Reasons for the exceedance;

(b) What actions are required to correct the exceedance and prevent it from re-occurring again; and

(c) What actions are intended to be actually undertaken by the Consent Holder to correct the exceedance.

Advice Note: The Northland Regional Council may undertake receiving water sampling of the Hokianga Harbour in the event that there is a non-compliance with any of the trigger level concentrations.

20 The Consent Holder shall undertake an investigation into alternative land areas that are considered by local Iwi to be suitable for the discharge of treated wastewater to land from Opononi and Omapere townships. The Consent Holder shall, within one month of the date of commencement of these consents, meet with the community liaison group required by Condition 21 to discuss the scope, process and timetable of the investigation and final written report. This investigation shall then be completed within 18 months of the date of commencement of these consents and the results forwarded to the representatives of the Community Liaison Group. A written

report shall be forwarded to the Northland Regional Council's Monitoring Senior Programme Manager and the representatives of the Community Liaison Group within two years of the date of commencement of these consents which includes, but is not limited to, the following:

(a) A detailed map showing the land areas that are considered by local Iwi as being suitable for a discharge to land of treated wastewater.

(b) Details of the Consent Holder's investigation into these identified land areas being utilised as wastewater disposal areas.

(c) Conclusions on whether the identified land areas can technically be utilised as treated wastewater disposal areas.

21 The Consent Holder shall, for the purpose of discussing matters relating to this consent, form a community liaison group consisting of representatives from the Pakanae, Kokohuia, Waiwhatawhata and Waimamaku Marae (Nga Marae O Te Wahapu), Te Runanga O Te Rarawa and also a duly appointed representative from each of the Omapere and Opononi communities. The Consent Holder shall hold a meeting with the liaison group not less than once every year to discuss matters related to these consents. The meeting shall only be held if a representative(s) of the community liaison group request a meeting with the Consent Holder. If such a request is made, then the Consent Holder shall organise a meeting at a local venue for members of the community liaison group to attend, and invite all other representatives of the community liaison group. The meeting shall be held at a time convenient for the majority of the community liaison group. Until such time as the investigation into alternative land disposal areas has been completed, the Consent Holder shall meet with the community liaison group quarterly to discuss progress with the investigation. The Consent Holder shall organise these meetings at a local venue and invite all members of the community liaison group to each meeting. The meeting shall be held at a time that is convenient for the majority of the community liaison group members.

22 The Consent Holder shall, for the purposes of adequately monitoring the consent as required under Section 35 of the Resource Management Act 1991, on becoming aware of any contaminant associated with the Consent Holder's operations escaping otherwise than in conformity with this consent:

(a) Immediately take such action, or execute such work as may be necessary, to stop and/or contain such escape;

(b) Immediately notify the Northland Regional Council's Monitoring Senior Programme Manager, Northland District Health Board's On-call Health Protection Officer and the community liaison group for this consent, by telephone of an escape of contaminant;

(c) Take all reasonable steps to remedy or mitigate any adverse effects on the environment resulting from the escape; and

(d) Report to the Northland Regional Council's Monitoring Senior Programme Manager and the community liaison group for this consent in writing within one week on the cause of the escape of the contaminant and the steps taken or being taken to effectively control or prevent such escape

23 The Northland Regional Council may, in accordance with Section 128 of the Resource Management Act 1991, serve notice on the Consent Holder within two months of the date that it formally receives a report required in accordance with Conditions 19, 20, 22, and Schedule 1, of its intention to review the conditions of these consents.

24 The Regional Council may, in accordance with Section 128 of the Act, serve notice on the Consent Holder of its intention to review the conditions of these consents annually during the month of June. The review may be initiated for any one or more of the following purposes:

(a) To deal with any adverse effects on the environment that may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or to deal with any such effects following assessment of the results of the monitoring of the consent and/or as a result of the Northland Regional Council's monitoring of the state of the environment in the area;

(b) To require the adoption of the best practicable option to remove or reduce any adverse effect on the environment;

(c) To provide for compliance with rules in any regional plan that has been made operative since the commencement of the consent;

(d) To deal with any inadequacies or inconsistencies the Northland Regional Council considers there to be in the conditions of the consent, following the establishment of the activity the subject of the consent;

(e) To change existing, or impose new limits on, conditions relating to the quality of the discharge and the receiving waters;

(f) To change the monitoring programme contained in Schedule 1; and

(g) To deal with any material inaccuracies that may in future be found in the information made available with the application (notice may be served at any time for this reason).

The Consent Holder shall meet all reasonable costs of any such review.

EXPIRY DATE: 31 AUGUST 2019

SCHEDULE 1

MONITORING PROGRAMME

The Consent Holder shall undertake the following monitoring:

1 Wastewater volumes

The Consent Holder shall keep a written record of both the daily, midday to midday, inflow volumes to the treatment system and the wastewater discharge volume using the meters required by Condition 4 of this Consent.

2 Treated wastewater

The following sampling and analyses shall be undertaken on at least one occasion each calendar month. During the winter months, the sampling shall be undertaken during, or immediately after, a rain event on at least three occasions.

A composite* wastewater sample shall be collected from the outlet of the treatment system at NRC Sampling Site 101580: Marsh discharge.

The composite wastewater sample shall be analysed for the following:

Escherichia coli
5 day Biochemical Oxygen Demand
Total Suspended Solids
Total Ammoniacal Nitrogen

**A sample made up of equal volumes from three samples taken at least one minute apart during the same sampling event.*

Temperature, pH and dissolved oxygen concentration shall be recorded in the wastewater sample using an appropriate meter, and in accordance with standard procedures.

3 Waiarohia Stream

On a quarterly basis, a sample of water shall be collected from the Waiarohia Stream at NRC Sampling Sites:

- 101579: Waiarohia Stream @ Above marsh, approximate location coordinates 1635907E 6069331N; and
- 100756: Waiarohia Stream @ Below marsh, approximate location coordinates 1635728E 6069372N.

These water samples shall then be analysed for Escherichia coli concentration.

The upstream and downstream Escherichia coli concentration shall be compared after each sampling occasion to determine whether there is any adverse effect on the water quality of the Waiarohia Stream as a result of the discharge of contaminants to land via seepage from the base of the constructed wetland system (as regards Condition 10).

This monitoring shall cease after a two year period if the results show that the discharge of contaminants to land via seepage from the base of the constructed

THE SEAL OF THE ENVIRONMENT COURT NEW ZEALAND wetland system is not having an adverse effect on the water quality of the Waiarohia Stream.

4 Compliance with Condition 19

Median Value

The median value for the determinands listed shall be a "rolling" median calculated on the 12 most recent treated wastewater samples collected. Until such time as 12 individual monthly samples have been collected, the results of sampling to date shall be utilised for compliance purposes.

3.2 90th Percentile Value

The 90th percentile value shall be calculated annually for the period 1 May to 30 April using, as a minimum, the results from the monthly sampling required by Section 2. Until such time as 12 individual monthly samples have been collected, the results of sampling to date shall be utilised for compliance purposes.

5 Collection of Samples

All samples shall be collected using standard procedures and in appropriate laboratory supplied containers.

All samples collected as part of this monitoring programme shall be transported in accordance with standard procedures and under chain of custody to the laboratory.

All samples taken shall be analysed at a laboratory with registered quality assurance procedures#, and all analyses are to be undertaken using standard methods, where applicable.

 # Registered Quality Assurance Procedures are procedures which ensure that the laboratory meets recognised management practices as would include registrations such as ISO 9000, ISO Guide 25, Ministry of Health Accreditation.

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6 Non-compliance with Consent Conditions

The Consent Holder shall notify the Regional Council of any non-compliance of the "rolling median" trigger level concentrations stated in Condition 19 or any adverse effects on the water quality of the Waiarohia Stream, immediately after the results of the monitoring required by Sections 2 and 3 are known.

If the Consent Holder detects any noxious, dangerous, offensive or objectionable odours at the legal boundary of the treatment system, then the Regional Council should be notified immediately.

7 Reporting

The Consent Holder shall forward an annual report to the Regional Council's Monitoring Senior Programme Manager and the community liaison group for this consent by 1 May each year, for the preceding year 1 April and 31 March, detailing the following:

- The daily wastewater inflow and discharge volumes, and
- An assessment of any increase in the inflow volumes as a result stormwater infiltration and inflow, and what is proposed to be undertaken to rectify any identified problems. The daily rainfall record for this area shall be included in this assessment to identify rainfall events; and
- The monitoring results for Section 2 and 3; and
- All the calculated "rolling" medians for the period and the 90 percentile value for the determinands listed in Condition 19.

All required numerical monitoring results shall be provided in a Microsoft Excel spreadsheet, or otherwise an alternative format agreed to beforehand with the Regional Council.

Advice Note: The daily rainfall can be taken from the Regional Council rainfall recorder site 534403: Hokianga Harbour - Omapere. This data will be supplied by the Regional Council on written request by the Consent Holder.

Appendix B. Cost Estimates & Supplier Quotations

Jacobs	CALCULATION SHEET			Ref no.	IZ134400-GN-SCH-001
	Project	Opononi WWTP Options Assessment		Date	15-10-20
	Client	Far North District Council		Project no.	IZ134400
	Page	1 of 1		Designer	JD
	Subject	Opononi WWTP Upgrade Options Assessment		Checked	BM

Item	Unit	Quantity	Rate	Total	Comment
Option 4A – Optimised process, chemically assisted solids removal, UV, with an in-pond or in-wetland ammonia removal process (e.g. bioshell, zeolite fill and draw wetland) and harbour discharge					
Opononi Process Optimisation					
Supply and install baffle curtains	Item	1	$ 27,234	$ 28,000	SiteCare quotation.This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of the collected waste to the Kaitaia landfill. There is a greater certainty on the scope of this work therefore a lower risk factor has been applied to this task.
Wetland vegetation clearance and disposal	Item	1	$ 65,675	$ 66,000	SiteCare quote for wetland maintenance 8/07/20. This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of th collected waste to the Kaitaia landfill. No contingency is to be applied to this task as it is not required. Additionally FNDC could execute this work in house without needing an external contractor.
Wetland reinstatement	Item	1	$ 97,765	$ 98,000	SiteCare to: - To attend restore " Sacrificed Wetland Cell" as per scope. - Redirect inlet pipeline from WWTP to "Sacrificed Wetland Cell", and install outflow to Wetland Cell.
Treatment Upgrades					
Wedeco UV LBX120E UV Disinfection Unit	Item	1	$ 46,870	$ 114,000	Xylem price quote includes contingencies for the install, Instrumentation, piping and electrical costs
Instrumentation costs: 1. Flowmeter 2. Turbidity meter 3. UV Transmissivity	Items	1	$ 21,590	$ 53,000	Based on quotes received in 2019 from instrumentation suppliers. The total prices includes installation, instrumentation and controls, piping and electrical costs based on factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation.
Solids Removal : DAF Plant	Item	1	$ 500,000	$ 790,000	Filtec indicative costs received July 2020. The total price also includes electrical costs as per the factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation for a Fluid Processing Plant.
In-pond Ammonia Removal - Bioshells	Item	1	$ 650,000	$ 780,000	Marshall projects indicative costs from July 2020 for supply and install of ~60 bioshells and hexacovers. An addition 20% has been added to the toal cost on recommendation from the supplier.

Jacobs	CALCULATION SHEET		Ref no.	IZ134400-GN-SCH-001
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	Client	Far North District Council	Project no.	IZ134400
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	Subject	Opononi WWTP Upgrade Options Assessment	Checked	BM

Item	Unit	Quantity	Rate	Total	Comment
Risk Allowance (reduced)	%	54	$ 1,000,420.00	$ 1,001,000	The Risk allowance is based on factor recommend in Table 4.4 of the IChemE Guide to capital cost estimation for engineering and supervision fees for a Fluid Processing Plant for a Fluid Processing Plant.
Total Costs				$ 2,930,000	
Option 4b – Optimised process, chemically assisted solids removal, UV, with an external ammonia removal package plant (e.g. SAF) and harbour discharge.					
Opononi Process Optimisation					
Supply and install baffle curtains	Item	1	$ 27,234	$ 28,000	SiteCare quotation.This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of the collected waste to the Kaitaia landfill. There is a greater certainty on the scope of this work therefore a lower risk factor has been applied to this task.
Wetland vegeation clearance and disposal	Item	1	$ 65,675	$ 66,000	SiteCare quote for wetland maintenance 8/07/20. This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of th collected waste to the Kaitaia landfill. No contingency is to be applied to this task as it is not required. Additionally FNDC could execute this work in house without needing an external contractor.
Wetland reinstatement	Item	1	$ 97,765	$ 98,000	SiteCare to: - To attend restore " Sacrificed Wetland Cell" as per scope. - Redirect inlet pipeline from WWTP to "Sacrificed Wetland Cell", and install outflow to Wetland Cell 1.
Treatment Upgrades					
Wedeco UV LBX120E UV Disinfection Unit	Item	1	$ 46,870	$ 114,000	Xylem price quote includes contingencies for the install, Instruemntation, piping and electrical costs.
Instrumentation costs: 1. Flowmeter 2. Turbidity meter 3. UV Transmissivity	Items	1	$ 21,590	$ 53,000	Based on quotes received in 2019 from instrumentation suppliers. The total prices includes installation, instrumentation and controls, piping and electrical costs based on factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation for a Fluid Processing Plant.
Solids Removal - DAF Plant	Item	1	$ 500,000	$ 555,000	Filtec indicative costs received July 2020. The total price also includes electrical costs as per the factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation for a Fluid Processing Plant.

Jacobs	CALCULATION SHEET		Ref no.	IZ134400-GN-SCH-001
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Item	Unit	Quantity	Rate	Total	Comment
Out of pond Ammonia Removal - SAF Plant	$/m3/day	178	$ 13,000	$ 2,314,000	Consultation with Hydns NZ for a SAFF plant. High level, indicative pricing is $13k/m3/day. The total cost is for delivery of the current ADWF of 178 m3/day, this price includes installation and contractor costs.

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	Subject	Opononi WWTP Upgrade Options Assessment	Checked	BM

Item	Unit	Quantity	Rate	Total	Comment
Risk Allowance (reduced)	%	54	$ 1,701,880.00	$ 1,702,000	The Risk allowance is based on factor recommend in Table 4.4 of the IChemE Guide to capital cost estimation for engineering and supervision fees for a Fluid Processing Plant.
Total Costs				$ 4,930,000	
Option 5 - Optimisation of the current process and discharge of the treated wastewater to land.					
Opononi Process Optimisation					
Supply and install baffle curtains	Item	1	$ 27,234.00	$ 28,000	SiteCare quotation.This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of the collected waste to the Kaitaia landfill. There is a greater certainty on the scope of this work therefore a lower risk factor has been applied to this task.
Wetland vegetation clearance and disposal	Item	1	$ 65,675	$ 66,000	SiteCare quote for wetland maintenance 8/07/20. This price includes team mobilisation, price of the Permathene baffle curtains, the tasks and the transport of th collected waste to the Kaitaia landfill. No contingency is to be applied to this task as it is not required. Additionally FNDC could execute this work in house without needing an external contractor.
Wetland reinstatement	Item	1	$ 97,765	$ 98,000	SiteCare to: - To attend restore " Sacrificed Wetland Cell" as per scope. - Redirect inlet pipeline from WWTP to "Sacrificed Wetland Cell", and install outflow to Wetland Cell 1
Treatment Upgrades					
Wedeco UV LBX120E UV Disinfection Unit	Item	1	$ 46,870	$ 114,000	Xylem price quote includes contingencies for the install, Instruemntation, piping and electrical costs
Instrumentation costs: 1. Flowmeter 2. Turbidity meter 3. UV Transmissivity	Items	1	$ 21,590	$ 53,000	Based on quotes received in 2019 from instrumentation suppliers. The total prices includes installation, instrumentation and controls, piping and electrical costs based on factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation.
Solids Removal : DAF Plant	Item	1	$ 500,000	$ 790,000	Filtec indicative costs received July 2020. The total price also includes installation and electrical costs as per the factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation.
In-pond Ammonia Removal - Bioshells	Item	1	$ 650,000	$ 780,000	Marshall projects indicative costs from July 2020 for supply and install of ~60 bioshells and hexacovers. A margin of 20% has been added as recommended by Marshall Projects

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CALCULATION SHEET		Ref no.	IZ134400-GN-SCH-001
Project	Opononi WWTP Options Assessment	Date	15-10-20
Client	Far North District Council	Project no.	IZ134400
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Item	Unit	Quantity	Rate	Total	Comment
Land-based Discharge					
Option 4 - Baker Farm	Item	1	$ 3,400,000	$ 3,670,000	The total cost for this option is a inlfation adjusted price for Option 4 recommended in the 2014 high level cost analysis completed by Mott MacDonald.

Jacobs

CALCULATION SHEET				Ref no.	IZ134400-GN-SCH-001
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Item	Unit	Quantity	Rate	Total	Comment
Equipment Allowance	%	76	$ 2,789,200.00	$ 2,790,000	An aditional allowance estimate has been added based on factors for purchased equipment installation, instrumentation, and electrical works for a land based disposal option. These factors have been based on recommendations from Table 4.4 of the IChemE Guide for Capital Cost Estimation
Risk Allowance for Land-based Discharge	%	137	$ 8,850,200.00	$ 8,851,000	A risk allowance for land based discharge includes factors for the engineering and supervision, construction expenses, ontractors fee and contigencies as recommended by Table 4.4 of the IChemE Guide for Capital Cost Estimation
Risk Allowance (reduced)	%	42	780,220	781,000	The Risk allowance is based on the contingency factor recommend in Table 4.4 of the IChemE Guide to capital cost estimation for contingencies for a Fluid Processing Plant.
Total Costs				$ 18,021,000	
Option 6 – New activated sludge plant plus UV disinfection and harbour discharge.					
Decommissioning of current system					
Allowance	Item	1	$ 300,000	$ 300,000	This is an estimated allowance for decomssioning the current system and repurposing it
Treatment Upgrades					
Wedeco UV LBX120E UV Disinfection Unit	Item	1	$ 46,870	$ 114,000	Xylem price quote includes contingencies for the install, Instruemntation, piping and electrical costs
Instrumentation costs: 1. Flowmeter 2. Turbidity meter 3. UV Transmissivity	Items	1	$ 21,590	$ 53,000	Based on quotes received in 2019 from instrumentation suppliers. The total prices includes installation, instrumentation and controls, piping and electrical costs based on factors recommended in Table 4.4 of the IChemE Guide to capital cost estimation.
Activated Sludge Treatment Plant					
Indicative Cost of plant	Item	1	$ 2,477,740	$ 2,478,000	This price includes: Inlet works, construction costs associated with the SBR system, contractor design, comissioning, power supply and contigencies. It is an adjusted estimate from the Taipa Upgrade Issues and Options Report (May, 2018)

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Item	Unit	Quantity	Rate	Total	Comment
Risk Allowance (standard)	%	54	$ 1,428,300.00	$ 1,429,000	The Risk allowance is based on the contingency factor recommend in Table 4.4 of the IChemE Guide to capital cost estimation for contingencies for a Fluid Processing Plant.
Total Costs				$ 4,374,000	