# KAITAIA AND KAIKOHE WWTP OPTIONS ASSESSMENT

Kaikohe WWTP Options Assessment



Far North District Council



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# 1.0 INTRODUCTION

Far North District Council (FNDC) currently hold a resource consent to discharge treated effluent from the Kaikohe Wastewater Treatment Plant (WWTP) to the Wairoro Stream. This consent expires in November 2021. In preparation for the renewal of the consent, FNDC are undertaking an investigation into the various options available to upgrade the Kaikohe WWTP and meet the new discharge standards of the Proposed Regional Plan (PRP). Although the PRP is yet to become operative, the effluent quality requirements are likely to be more stringent. This options assessment aims to provide documentation required for the renewal of the resource consent and inform the investment planning under the 2021-2031 Long-Term Plan (LTP) process.

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The preferred option to upgrade the Kaikohe WWTP has been derived through an extensive options evaluation process. This process started with the identification of a wide range of potential options, the long list of options. This included historic options considered in previous reports. The options from the long list were then narrowed down to the short list using a qualitative application of the Multi Criteria Analysis (MCA). The shortlisted options were developed to a concept level to allow for a more detailed assessment using a quantitative MCA.

This report presents the basis of design, evaluation methodology and criteria, and evaluation of the long list and short list options. This includes a sensitivity analysis and a risk assessment. Based on this a recommendation of the preferred option has been provided.

# 2.0 EXISTING PLANT

The Kaikohe WWTP is located adjacent to Wairoro Stream and can be accessed from Cumber Road. The treatment system services the local Kaikohe community in addition to Ngawha and the Northland Region Corrections Facility. The WWTP consists of an inlet screen, an anaerobic pond, an oxidation pond and a series of four constructed wetland (CWL) cells. The final wetland cell contains a notched weir from which treated wastewater discharges to a natural wetland (NWL) prior to discharging into the nearby Wairoro Stream (see Figure 1). The plant also has a sludge lagoon (to the north) and a geobag storage area (to the east of the oxidation pond). There are four sampling points; after the CWL, after the NWL, upstream (US) of the discharge to Wairoro Stream and downstream (DS) of the discharge to Wairoro Stream.



## FIGURE 1. BLOCK DIAGRAM FOR THE EXISTING KAIKOHE WWTP

Sludge lagoon Anaerobic Geotech pond bags Inlet SP after screen CWL Oxidation pond Natural Series of wetlands constructed wetlands SP after NWL SP US of discharge SP DS of discharge

Figure 2 below provides an aerial view of the plant with various treatment steps and sampling points labeled.

# FIGURE 2. SCHEMATIC OF WWTP LAYOUT

#### 3.1 **POPULATION AND GROWTH**

The current (2020) and future (2055) residential growth estimates are based on .id population projections<sup>1</sup>. The key assumptions are:

- From 2043 to 2055, there is an average annual population change of 1.52%;
- The industrial growth rate is the same as the residential growth rate.

TABLE 1: KAIKOHE CURRENT AND FUTURE POPULATION						
YEAR	2020	2043	2055			
Population	4,371	5,949	7,129			

TABLE 1. KAIKOHE CURRENT AND EUTURE DODULATION

These assumptions and projections will be used to estimate future flows and loads to the plant (see Section 3.2).

#### 3.2 **INFLUENT FLOWS AND LOADS**

### 3.2.1 INFLUENT FLOWS

The current (2020) and future (2055) influent flow estimates are summarised in Table 2. Current flows are based on plant log data from April 2017 to April 2020 and include both residential and industrial wastewater. The future (2055) influent flows have been estimated using the current influent flows and forecasted population growth in Table 1. It was assumed that industrial waste flows will grow at the same rate as domestic waste flows.

<b>TABLE 2:</b> ESTIMATE OF CURRENT AND FUTURE INFLUENT FLOW					
PARAMETER	2020	2055			
Average Flow (m <sup>3</sup> /day)	1,862	3,036			
Median Flow (m³/day)	1,611	2,628			
90 <sup>th</sup> Percentile Flow (m <sup>3</sup> /day)	2,983	4,865			
Max Flow (m <sup>3</sup> /day)	9,235	15,062			
Average Dry Weather Flow (ADWF)* _(m³/day)	1,707	2,785			

\*Based on consent condition which states that a "dry weather discharge day" is any day which there is less than 1 millimetere of rainfall, and that day occurs after three consecutive days either without rainfall or with rainfall of less than 1 millimeter on each day.

10% of the influent flows are attributed to industrial waste<sup>2</sup>. Therefore, it is assumed 171m<sup>3</sup>/day of the ADWF is from industrial waste and 1,537m<sup>3</sup>/day is domestic waste. The current domestic ADWF wastewater production rate of 352 L/capita/day is higher than typical values observed in New Zealand. Generally, the ADWF is around 220 L/capita/day. The high per capita rates could be due to inflow and infiltration into the wastewater network, or additional connections.

<sup>&</sup>lt;sup>1</sup> <u>https://forecast.idnz.co.nz/far-north/population-households-dwellings?WebID=130</u>

<sup>&</sup>lt;sup>2</sup> WaterNZ, 2018-19 Combined WWTP Data: WWA7f Proportion of Trade Waste 2015-16 in Kaikohe (2020) https://www.waternz.org.nz/WWTPInventory

### 3.2.2 INFLUENT LOADS

An estimate of the current and future influent loads to the WWTP are shown in Table 3. Loads have been calculated based on the observed concentrations at the plant, except were assumptions have been made for parameters that are not sampled.

TABLE 3: CURRENT AND FUTURE INFLUENT LOAD (FEB 17 - FEB 20)						
PARAMETER	AVERAGE CONCENTRATION	CURRENT 2020 LOAD	FUTURE 2055 LOAD			
	(g/m³)	(kg/day)**	(kg/day)***			
cBOD <sub>5</sub>	282	482	786			
TSS	430	734	1,197			
TN*	46	79	128			
NH <sub>3</sub> -N*	41	70	114			
TP*	8	13	21			

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\*Loads based on typical New Zealand production values:

TN - 18g/capita/day

NH<sub>3</sub>-N - 16g/capita/day

TP - 3g/capita/day

\*\**Calculated using the current influent ADWF of 1,707m<sup>3</sup>/day as shown in Table 2.* \*\*\**Calculated using the future influent ADWF of 2,785m<sup>3</sup>/day as shown in Table 2.* 

It is assumed that the current industrial influent water quality remains unchanged as there is no major change in the type of industries serviced by the WWTP. Therefore, the industrial growth is attributed to the existing industrial facilities.

## 3.3 EFFLUENT QUALITY AND DISCHARGE STANDARD

## 3.3.1 CURRENT DISCHARGE CONSENT LIMITS

The existing discharge consent limits the 30-day rolling average of dry weather flow (DWF) discharges from the WWTP to 1,710m<sup>3</sup>/day. Compliance is based on the average daily discharge volume of the 30 most recent "dry weather discharge days". A "dry weather discharge day" is any day on which there is less than 1mm of rainfall, and that day occurs after three consecutive days either without rainfall or with rainfall of less than 1mm on each day. The discharge volume is measured from the outlet of the final constructed wetland. No quality limits apply to the wastewater discharge, instead quality limits apply instream after mixing 80m downstream of the discharge point into Wairoro Stream (as per Condition 7 of the consent)

Figure 3 below compares the 30-day rolling average of DWF discharges against the discharge limit. Exceedances of the discharge limit are likely attributed to rainfall followed by the delay in discharge due to the pond buffering capacity. Between May 2018 and October 2019, only 25% of the discharge flows over the 525-day period were included in the calculation for the 30-day rolling average.



# FIGURE 3. COMPARISON OF DAILY DISCHARGE FLOW, AVG 30-DAY DWF, AND DISCHARGE LIMIT

## 3.3.2 CURRENT EFFLUENT QUALITY

The current influent and effluent loads are shown in Table 4. Kaikohe WWTP is a pondbased treatment system that targets BOD and solids removal with limited nitrogen and phosphorus removal.

<b>TABLE 4:</b> AVERAGE INFLUENT AND EFFLUENT LOADING						
PARAMETER	AVERAGE INFLUENT LOAD (KG/DAY)	AVERAGE EFFLUENT LOAD (KG/DAY)**	PERCENTAGE REMOVED			
cBOD <sub>5</sub>	482	40	92%			
TSS	734	111	85%			
TN*	79	73	7%			
NH <sub>3</sub> -N*	70	69	1%			
TP*	13	11	18%			
DRP	-	8	-			

\*Loads based on typical New Zealand production values:

TN - 18g/capita/day

NH<sub>3</sub>-N - 16g/capita/day

TP - 3g/capita/day

\*\*Calculated based on the wastewater quality data collected between Aug '17 and July '20 from the constructed wetland (CWL) sampling point and the current average effluent flow of 2,028m<sup>3</sup>/day.

Table 5 compares the E.coli count from the four WWTP sampling points. A decrease in E. coli from the constructed wetland (CWL) to the natural wetland (NWL) and an increase from upstream (U/S) to downstream (D/S) of the discharge can be observed.

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TABLE 5: EFFLUENT MEDIAN AND 95 <sup>TH</sup> PERCENTILE E. COLI (MPN/100ML)						
E. COLI AFTER CWL AFTER NWL U/S OF DISCHARGE D/S OF DISCHARGE						
Median	7,700	2,100	460	620		
95 <sup>th</sup> Percentile 24,200 19,900 3,600 3,900						

### 3.3.3 PRP WATER QUALITY STANDARDS

A comparison of the Northland Regional Council Proposed Regional Plan (PRP) water quality standards against water quality samples of the Wairoro Stream is shown in Table 6. The water quality values U/S and D/S of the discharge are calculated over a three-year period whereas the PRP standards are assessed on an annual basis.

**TABLE 6:** COMPARISON OF NORTHLAND PROPOSED REGIONAL PLAN WATER QUALITYSTANDARDS AGAINST CURRENT WAIRORO STREAM SAMPLING LOCATIONS

PARAMETER UNIT		COMPLIANCE METRIC	PRP STANDARDS	U/S OF DISCHARGE*	D/S OF DISCHARGE*
	1	Annual Median	≤ 1.0	0.3	0.5
Nitrate**	mg/L	Annual 95th percentile	≤ 1.5	0.4	2.9
A	1	Annual median	≤ 0.24*	0.01	1.8
Ammonia***	mg/L	Annual maximum	$\leq 0.40^{*}$	0.30	21
Temperature***	°C	CRI averaged over 5 hottest days	≤ 24°C	21.1°C	20.7°C
DO	mg/L	7-day minimum	≥ 5.0	7	8
DO		1-day minimum	≥ 4.0	0.5	1.4
рН	-	Annual minimum	6.0 < pH	6.3	5.8
		Annual maximum	pH <9.0	8.1	8.0
		% exceedances over 540	<5%	44%	57%
E. coli	%	% exceedances over 260	<20%	77%	91%
	-f (	Median	≤130	460	620
	cfu/ 100mL	95th percentile	≤540	3,600	3,900

\*The values shown are calculated over the three-year period from August 2017 to July 2020 as opposed to the PRP annual compliance metric.

\*\*Assuming nitrates = the difference between DIN and NH<sub>3</sub>.

\*\*\*The PRP standards for ammonia are based on pH 8 and temperature of 20°C. Upstream and downstream results have not been adjusted.

Temperature results are based on discontinuous temperature monitoring.

Under the current water reform, there is an emphasis on improving discharge quality to freshwater bodies. The current water quality D/S of the discharge is worse than the

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proposed standards. Therefore, it is likely upgrades are required at Kaikohe WWTP if FNDC intend to comply with the proposed quality standards. This would involve upgrades to improve organics removal, nitrogen removal (total nitrogen, nitrate and ammonia), and disinfection to meet E. coli limits.

## 3.3.4 EFFLUENT QUALITY REQUIREMENTS

The effluent quality requirements for Kaikohe WWTP were calculated based on publicly available Wairoro Stream quality data and flow estimations, future plant effluent flow estimations, and the PRP standards (see Table 7 below). It is important to note that the Wairoro Stream flow assumptions are key assumptions to determine the effluent quality requirements for the Kaikohe WWTP. Therefore, these assumptions should be confirmed by the FNDC.

<b>TABLE 7:</b> REQUIRED EFFLUENT QUALITY FORKAIKOHE WWTP.							
	AMMONIA	A (NH3)					
PARAMETER UPSTREAM OF DOWNSTREAM OF DISCHARGE WWTP REQUIREMENT							
Flow (m <sup>3</sup> /day)	120,960	124,000	3,036				
Concentration (g/m <sup>3</sup> )	0.1	0.24	6				
Load (kg/day)	12	30	18				
	NITRA	TES					
PARAMETER UPSTREAM OF DOWNSTREAM OF DISCHARGE USCHARGE WWTP REQUIREMENT							
Flow (m <sup>3</sup> /day)	120,960	124,000	3,036				
Concentration (g/m <sup>3</sup> )	0.6	1	17				
Load (kg/day)	73	124	51				

The complete calculations and assumptions can be found in Appendix 1.

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# 4.0 OPTIONS EVALUATION

## 4.1 MULTI CRITERIA ANALYSIS (MCA)

The options analysis for Kaikohe wastewater scheme was based on a MCA using a number of weighted criteria. The MCA considered each of the options in terms of the following categories:

- 1. Māori cultural values;
- 2. Environmental values;
- 3. Practicability;
- 4. Operability; and
- 5. Financial.

The criteria and weightings under each of these categories are presented in Table 8 below.

The options evaluation process included rating the long list options against these criteria using a 'traffic light' system, where each option was given a rating of low, medium, or high based on a qualitative assessment. Four of the most favourable options from this assessment were taken forward to the short list to be further developed and evaluated. Following discussions with FNDC on the MCA, it was requested to explore an additional option of a full BNR option (100% of the flow). Therefore, in total, five options were evaluated.

The short-listed options were assessed using the same criteria but with a quantitative approach. The options were rated from 1-5 against each criterion. An overall score was then developed for each option based on the scores and weighting of the criteria. The highest scoring option was selected as the preferred option for upgrading Kaikohe WWTP.

TABLE 8: OPTIO	NS EVALUATION CRITERIA			
CATEGORY	CRITERIA	WEIGHTING	DESCRIPTION	SUCCESS FACTORS
Māori cultural values	<ul> <li>Impacts on Māori cultural values and practices.</li> </ul>	20%	<ul><li>Gives effect to Te Mana o te Wai</li><li>Acceptability of process to local iwi</li></ul>	The option safeguards     Māori cultural values     and practices
	• Land Use Effects	2%	Visual, Noise, Traffic impacts	• The option can meet
	• Odour	3%	• The degree to which odour can be expected to be discharged beyond the property boundary	required discharge standards for
Environmental	• Ecological Effects	10%	• The degree to which the effluent quality exceeds the minimum environmental and consent requirements	wastewater (and carbon where
-	Carbon Footprint	3%	• Level of energy consumption, secondary discharges and chemicals required	<ul> <li>applicable)</li> <li>The option can meet amenity standards,</li> </ul>
	• Public Health	4%	<ul><li>Impacts on mahinga kai</li><li>Recreational use of the receiving environment</li><li>Impact of spills and failure</li></ul>	including odour
	Constructability	4%	<ul> <li>Complexity of construction process</li> <li>Distance from networks and services</li> <li>Time taken to commission option</li> </ul>	• The option can be successfully delivered
Practicability	Regulations and     Planning	7%	• Complexity to obtain a consent or other authorisations	-
	• Staging	3%	• Can the option be staged?	
Operability	• The ease of operation and maintenance	6%	<ul> <li>Complexity of operation</li> <li>Required expertise</li> <li>Ease of access</li> <li>H&amp;S risks of plant process</li> <li>Sludge management</li> <li>Reliance on and complexity of plant consumables and replacement componentry</li> </ul>	• The option can be successfully used in the future
	Process reliability and resilience	6%	<ul><li>Known performance of others with similar technologies</li><li>Consistency of quality in the discharge</li></ul>	

			• Ability to maintain compliance with resource consents	
Operability	• Expandability/ future proofing	5%	<ul> <li>The potential for the site to allow for extensions to the treatment process</li> <li>Proofing against changes in compliance requirements</li> </ul>	
	• Hazards	3%	• Proximity to known and potential hazards, e.g., flood plains, climate change hazards	
	Capital Cost	9%	<ul> <li>Cost of implementation</li> <li>Site investigations and procurement of land</li> <li>Ability to reuse existing FNDC assets</li> </ul>	• The costs of the option are understood and able to be paid
Financial	Operating and     Maintenance Costs	9%	<ul> <li>Operations and maintenance requirements (e.g., chemical costs, sludge removal)</li> <li>Power cost</li> </ul>	
	Rating impact	6%	Impact on targeted rate relative to other options	

## 4.2 LONG LIST OPTIONS

The long list was developed considering the following:

- Continued effluent discharge to Wairoro Stream (we understand land disposal options are being considered outside of this project);
- Effluent quality requirements to meet the new discharge standards within the PRP;
- Historical issues experienced at the plant; and
- Review of past plant options assessments of upgrade options.

The proposed long list of options is shown in Table 9 below.

TABLE 9: PRO	POSED LONG LIST OF OPTIONS						
OPTIONS	DETAILS						
Do Nothing (Status Quo)	No changes to the WWTP						
Minor Upgrades	Mechanical mixers + Baffle curtains + Chemical dosing + Rock filter + UV						
	Additional aerators + Baffle curtains + Chemical dosing + Sand filter + UV						
	Mechanical mixers + Baffle curtains + Chemical dosing + Rock filter + UV + Remove constructed wetlands						
Major Upgrades	Floating wetland + Chemical dosing + Clarifier + Surface mixers + UV + Upgrade constructed wetlands						
	Bioreef/Aquamats + Chemical dosing + Actiflo + UV						
	Bioreef/Aquamats + Chemical dosing + DAF + UV						
	Intermittent Decanting Aerated Lagoon (IDAL)						
	Sequencing Batch Reactor (SBR)						
	Biological Nutrient Removal Plant (BNR)						
	Membrane Aerated Biofilm Reactor (MABR)						
Side Stream Treatment Plant	Portion of the flow treated by a mechanical plant (smaller size with higher effluent quality) and the remaining flow treated through the existing pond system. The final effluents are then blended before discharge.						
Industrial Re-use	Portion of the flow treated by a mechanical plant and re-used by industry close by that is willing to take wastewater (none identified at this stage). Remaining wastewater treated through existing pond system.						
Alternative Upgrades	Following oxidation pond, electrocoagulation and clarifier.						
Notes:							

- De-sludging the ponds should be considered for all the minor and major upgrade options based

on pond systems.

- It is assumed that mechanical plants would require disinfection and a sludge processing *facility.* 

A high-level qualitative MCA matrix for the long list options was presented to FNDC in a teleconference on the 21/09/20. After discussing the options and receiving feedback from the Council, a final MCA matrix was prepared (see Appendix 2).

A preliminary long list of options can be found in Appendix 3. This contains a comprehensive list of all the historic options which were considered in previous assessments.

## 4.3 SHORT LIST OPTIONS

Based on the MCA evaluation and short-listing discussions with FNDC, the following options have been taken forward to the short list:

- **Option 1:** In Pond Upgrades (Additional Aerators + Baffle Curtains) + Chemical Dosing + Tertiary Treatment (Sand Filter + UV);
- **Option 2:** Bioreef/Aquamats + Chemical Dosing + Actiflo + UV + Remove Wetlands;
- **Option 3**: IDAL;
- **Option 4A:** Side Stream Treatment Plant (BNR); and
- **Option 4B:** BNR.

These options have been developed to a concept level to allow a more detailed and informed assessment to select the preferred option. This included developing infrastructure upgrade requirements; risks and capital and operating costs for each of the options.

# 4.3.2 OPTION 1 – ADDITIONAL AERATORS + BAFFLE CURTAINS + CHEMICAL DOSING + SAND FILTER + UV

This option will utilise the inlet screen, anaerobic pond, oxidation pond, wetlands, and sludge lagoons of the existing Kaikohe WWTP. The treatment process at the plant will be upgraded to include aeration and baffle curtains in the oxidation pond, chemical dosing, and tertiary treatment which will consist of sand filtration, and UV disinfection.

A block diagram of the upgraded treatment process is shown in Figure 4.

- De-sludging of the anaerobic and oxidation ponds to improve performance and enable the installation of the aerators and baffle curtains.
- Installing pond surface aerators and baffle curtains in the oxidation pond to maximise ammonia removal.
- Installing a new tertiary treatment system. This will involve:
  - installing a sand filter for solids removal; and
  - constructing one or more buildings for a chemical dosing system (phosphorus removal) and UV units.
- Pipeline modifications to connect the new treatment processes.

• Potential modifications to the plant access road to provide the required turning circle for a chemical delivery truck, and a chemical delivery pad alongside the building.



## FIGURE 4. BLOCK DIAGRAM FOR OPTION 1

# 4.3.3 OPTION 2 - BIOREEF/AQUAMATS + CHEMICAL DOSING + ACTIFLO + UV + REMOVE

## WETLANDS

This option will utilise the inlet screen, anaerobic pond, oxidation pond, and sludge lagoons of the existing Kaikohe WWTP. The treatment process at the plant will be upgraded to include diffused aeration combined with an attached growth system in the oxidation pond (Bioreef or Aquamats), chemical dosing, and tertiary treatment which will consist of Actiflo, and UV disinfection.

An in pond attached growth system consists of fabric curtains that provide surface area for bacterial growth. Aeration is provided between the curtains via diffused aeration pipes. This system achieves longer sludge residence times hence improving nitrogen removal.

A block diagram of this treatment process is shown in Figure 5.

- De-sludging of the anaerobic and oxidation ponds to improve performance and enable the installation of the baffle curtains, aeration, and attached growth system.
- Decommissioning the wetlands.
- Installing baffle curtains for separation, diffused aeration, and the attached growth system (Bioreef/Aquamat) in the oxidation pond to create nitrification and de-nitrification zones.
- Installing a solids separation process unit (Actiflo).
- Constructing one or more buildings for blowers, chemical dosing system (phosphorus removal) and UV units.
- Pipeline modifications to connect the new treatment processes and bypass the wetlands.
- Installing a new discharge pipeline and discharge structure.
- Potential modifications to the plant access road to provide the required turning circle for a chemical delivery truck, and a chemical delivery pad alongside the building.



# FIGURE 5. BLOCK DIAGRAM FOR OPTION 2

### 4.3.4 OPTION 3 - IDAL

This option will utilise the anaerobic pond and oxidation pond of the existing Kaikohe WWTP. The treatment process at the plant will be upgraded to include a new screening and grit removal package plant, IDAL, filtration, UV disinfection, and a sludge dewatering system.

An IDAL is a pond based activated sludge process where secondary settled wastewater is decanted in batches instead of continuously. Aeration and settling are time-phased in the IDAL and occur in the same pond. The IDAL system will be constructed in the oxidation pond.

A block diagram of this treatment process is shown in Figure 6.

- Decommissioning the inlet screen and installing a screening and grit removal package plant.
- De-sludging of the anaerobic pond to improve performance.
- Decommissioning the wetlands.
- Re-purposing part of the oxidation pond as the buffer pond and part as the new IDAL with ancillary systems.
- Constructing one or more buildings for the blowers, UV units, and the sludge de-watering system.
- Pipeline modifications to connect the new treatment processes and bypass the wetlands.
- Installing a new discharge pipeline and discharge structure.
- Potential modifications to the plant access road to provide the required turning circle for a chemical delivery truck, and a chemical delivery pad alongside the building.



FIGURE 6. BLOCK DIAGRAM FOR OPTION 3

### 4.3.5 OPTION 4A - SIDE STREAM TREATMENT PLANT (BNR)

This option will utilise the anaerobic pond, oxidation pond, wetlands, and sludge lagoons of the existing Kaikohe WWTP. The treatment process at the plant will be upgraded to include a new screening and grit removal package plant, flow splitter, a side stream treatment plant (BNR), filtration, UV disinfection, and a sludge de-watering system.

BNR is a process used for nitrogen and phosphorus removal. It consists of an anaerobic zone, an anoxic zone, and an aeration zone. The nitrates produced in the aerobic zone are recycled to the anoxic zone for denitrification, resulting in nitrogen removal. In the anaerobic zone, Phosphorus Accumulating Organisms (PAOs) release phosphorus which is subsequently taken up in large quantities in the aerobic zone. Intracellular phosphorus is removed from the wastewater as the sludge is removed.

The BNR plant will be sized to treat 88% of the influent flow. This percentage was calculated based on the effluent quality requirements estimated in Section 3.3.4. Table 10 below summarises these mass balance calculations.

TABLE 10: COMBINED EFFLUENT QUALITY.										
PARAMETER		BNR PLANT	EXISTING POND- BASED WWTP							
	$NH_3(g/m^3)$	2	34	6						
Effluent	BOD (g/m <sup>3</sup> )	5	20	7						
Quality	$NO_{3} (g/m^{3})$	7.5	5	7						
Flores	Effluent Flow (m³/day)	2,672	364	3,036						
Flows	% Total Effluent Flow	88%	12%	100%						

Notes:

Effluent concentrations for the BNR plant are target values. Effluent concentrations for the current WWTP are based on effluent data.

 $NH_3$  concentration for the combined effluent should be < 6 g/m<sup>3</sup>. See Section 3.3.4.  $NO_3$  concentration for the combined effluent should be < 17 g/m<sup>3</sup>. See Section 3.3.4.

Recommended BOD concentration for the comvined effluent:  $< 25 \text{ g/m}^3$ .

The effluent of the BNR plant and the pond system will be combined before going through UV disinfection and being discharged to the Wairoro Stream. A block diagram of this treatment process is shown in Figure 7.

The treatment process upgrades will include:

De-sludging of the anaerobic and oxidation ponds to improve performance.

- Decommissioning the inlet screen and installing a screening and grit removal package plant.
- Installing a flow splitter.
- Installing the side stream plant (BNR).
- Constructing one or more buildings for the blowers, UV units, and the sludge de-watering system.
- Pipeline modifications to connect the new treatment processes.
- Potential modifications to the plant access road to provide the required turning circle for a chemical delivery truck, and a chemical delivery pad alongside the building.



# FIGURE 7. BLOCK DIAGRAM FOR OPTION 4A

### 4.3.6 **OPTION 4B - BNR**

This option will not utilise any of the infrastructure and equipment of the existing Kaikohe WWTP. A new plant will be built in the WWTP site including a new screening and grit removal package plant, BNR, filtration, UV disinfection, and a sludge dewatering system.

A block diagram of this treatment process is shown in Figure 8.

- De-sludging and decommissioning of the anaerobic and oxidation ponds. The ponds have to be de-sludged before being decommissioned to avoid algae growth and odour issues.
- Decommissioning the inlet screen and installing a screening and grit removal package plant.
- Constructing concrete reactors for the BNR system.
- Constructing one or more buildings for the blowers, UV units, and the sludge de-watering system.
- Pipeline modifications to connect the new treatment processes.
- Potential modifications to the plant access road to provide the required turning circle for a chemical delivery truck, and a chemical delivery pad alongside the building.



### FIGURE 8. BLOCK DIAGRAM FOR OPTION 4B

## 4.3.7 CAPEX AND OPEX ESTIMATIONS

Table 11 shows a comparison among the estimated capital and operation cost ranges for Options 1 to 4B. The assumptions and exclusions related to these cost estimations are detailed below.

TABL	<b>TABLE 11:</b> CAPEX AND OPEX FOR OPTIONS 1 TO 4B.										
ΟΡΤΙΟ	NS	CAPEX (-5 TO +30%)	OPEX (-5 TO +30%)								
NO	DESCRIPTION										
1	Additional Aerators + Baffle Curtains + Chemical Dosing + Sand Filter + UV	\$3.1M - \$4.3M	\$400K - \$550K								
2	Bioreef/Aquamats + Chemical Dosing + Actiflo + UV + Remove Wetlands	\$12.6M - \$17.2M	\$730K - \$1M								
3	IDAL	\$6.5M - \$8.9M	\$580K - \$800K								
4A	Side Stream Treatment Plant (BNR)	\$15.0M - \$20.6M	\$670K - \$920K								
<b>4B</b>	BNR	\$17.5M - \$24.0M	\$700K - \$950K								

## Assumptions and Exclusions

- The following items have been excluded from the capital cost estimations to upgrade the Kaikohe WWTP:
  - Decommissioning and disposal of current infrastructure and equipment that are not included in the upgraded system;
  - Major earthworks and piling;
  - New consents or renewing existing consents;
  - Geotechnical and survey studies;
  - Ground remediation;
  - Alarms, camera systems and fire protection systems;
  - Transformers, generators and power upgrades; and
  - Access roads.
- Any equipment to be used as part of the upgrade, is considered to be in good operational condition;

- Operational cost estimates do not include interest on capital and depreciation.
- A unit energy charge of \$0.10/kWhr has been used to estimate the power costs. The cost estimate does not include any fixed charges paid by the site.
- Cost estimates exclude GST.

## 4.3.8 SHORT LIST OPTIONS MCA

The MCA scoring of each short-listed option is shown in Table 12 below. These options were evaluated according to the criteria and weightings presented in Table 8 (see Section 4.1).

The complete short list options MCA can be found in Appendix 4.

TABI	TABLE 12: SHORT LIST OPTIONS EVALUATION.								
ΟΡΤΙΟ	OPTIONS								
NO	DESCRIPTION								
1	Additional Aerators + Baffle Curtains + Chemical Dosing + Sand Filter + UV	56.0							
2	Bioreef/Aquamats + Chemical Dosing + Actiflo + UV + Remove Wetlands	45.5							
3	IDAL	60.2							
4A	Side Stream Treatment Plant (BNR)	51.2							
<b>4B</b>	BNR	55.0							

# 4.4 SENSITIVITY ANALYSIS

The weighting given to each of the criteria influences the overall score given to each of the short-listed options. It is therefore important to test the sensitivity of the MCA to the weightings to ensure that it remains as unbiased as possible. For this analysis, the various criteria were grouped according to the categories shown in Table 13.

TABLE 13: SENSITIVITY ANALYSIS CATEGORIES							
CATEGORY	CRITERIA						
Non-Technical	Māori cultural values Environmental values						
Technical	Practicability Operability						
Management	Financial						

The weighting of each of these categories were inflated at the expense of the others in different scenarios to determine the effect of the weighting on the overall rating of the options. A total of nine weighting scenarios were applied to the MCA. These followed the methodology outlined below in the table below.

TABLE 14: SENSITIVITY ANALYSIS OUTCOMES.										
	SCENARIOS WEIGHTING									
CATEGORY	1	1A	1B	2	2A	2B	3	3A	3B	
Non- Technical	+20%	+20%	+20%	-10%	-20%	-	-10%	-20%	-	
Technical	-10%	-20%	-	+20%	+20%	+20%	-10%	-	-20%	
Management (Financial)	-10%	-	-20%	-10%	-	-20%	+20%	+20%	+20%	

A visual representation of the allocated weightings for all nine scenarios is presented in Figure 9.



## FIGURE 9. WEIGHTINGS OF SENSITIVITY SCENARIOS

The outcome of the sensitivity analysis is summarised in Table 15 below. For each of the scenarios, the highlighted value indicates the highest scoring option. The full sensitivity analysis can be found in Appendix 4.

TABL	FABLE 15: SENSITIVITY ANALYSIS OUTCOMES.											
OPTION	IS		SCENARIOS									
NO	DESCRIPTION	ORIGINAL WEIGHTING	1	1A	1B	2	2A	2B	3	3A	3В	
1	Additional Aerators + Baffle Curtains + Chemical Dosing + Sand Filter + UV	56.00	50.50	54.90	46.10	52.50	58.20	47.50	65.30	66.70	64.80	
2	Bioreef/Aquamats + Chemical Dosing + Actiflo + UV + Remove Wetlands	45.50	45.10	45.40	44.40	45.20	45.90	44.60	46.80	46.90	46.60	
3	IDAL	60.20	57.20	58.60	54.80	59.00	60.80	56.20	65.00	64.60	63.80	
4A	Side Stream Treatment Plant (BNR)	51.20	49.50	47.60	50.50	54.70	54.60	54.40	50.60	51.40	48.30	
4B	BNR	56.00	50.50	54.90	46.10	52.50	58.20	47.50	65.30	66.70	64.80	

The sensitivity analysis outcomes indicate that the main factor influencing the choice of Option 1 or Option 3 as the preferred option is costs. Option 3 was the preferred option for all the scenarios where the weighting of the management (or financial) category was kept under 24%. On the other side, Option 1 was the preferred option for the three scenarios (3, 3a, and 3b) where the management category weighting was inflated to 44%. This is because the capital and operational costs of Option 3 are significantly above the costs of Option 1.

Options 2 and 4 were not the preferred options for any of the tested scenarios. This indicates that Options 1 and 3 are the most favourable options from cultural, environmental, technical, and financial perspectives.

The sensitivity analysis has demonstrated that the weightings used for the short list evaluation did not show a strong bias to any particular criteria. This analysis indicates that Option 3 is the preferred option according to the MCA.

### 4.5 **RISK ANALYSIS**

The risks associated with each short list option were assessed using a quantitative risk matrix (as per AS/NZ 4360:2004). The risk framework shown in Table 16 was used to derive a risk score for each of the options. The higher the total score, the riskier the option is. The risk scores of the short-listed options must be taken into consideration when selecting the preferred option.

Risk scores are derived by evaluating the likelihood of a risk occurring and the consequence if it does occur. A risk score is given by multiplying the value associated with the likelihood by the value associated with the consequence.

TABLE 16: RISK FRAMEWORK.									
LIKELIHOOD			CONSEQUENCES						
Parameter	Severe	Major	Moderate	Minor	Negligible				
		5	4	3	2	1			
Almost certain	5	Extreme	Extreme	Extreme	High	High			
Likely	4	Extreme	Extreme	High	High	Medium			
Possible	3	Extreme	Extreme	High	Medium	Low			
Unlikely	2	Extreme	High	Medium	Low	Low			
Rare	1	High	High	Medium	Low	Low			

TABLE 16: RISK FRAMEWORK.

The full list of risks is presented in the risk matrix included in Appendix 5. The overall risk scores for the four shortlisted options have been summarised in Table 17 below.

**TABLE 17:** SHORT LIST OPTIONS RISK ASSESSMENT.

OPTIC	OPTION								
NO	DESCRIPTION	SCORE							
1	Additional Aerators + Baffle Curtains + Chemical Dosing + Sand Filter + UV	116							
2	Bioreef/Aquamats + Chemical Dosing + Actiflo + UV + Remove Wetlands	123							
3	IDAL	107							
4A	Side Stream Treatment Plant (BNR)	106							
<b>4B</b>	BNR	106							

As presented in Table 17, the risk assessment indicates that Options 3, 4A and 4B currently present the same level of risk, which is significantly lower than the level of risk of Options 1 and 2.

# 5.0 RECOMMENDATION

The options evaluation process indicates that Option 3 (IDAL) is the preferred option for upgrading the Kaikohe WWTP. This option has scored highest in the MCA and presented a low risk score. Measures can be put into place to reduce the likelihood (and consequently further reduce the risk scores) of the risks associated with this option.

# 5.1 NEXT STEPS

The following next steps are recommended:

- 1. FNDC to confirm the Wairoro Stream flow assumptions, as these are key assumptions to determine the required effluent quality of the Kaikohe WWTP. This includes:
  - Mean river flow;
  - MALF and Q5 values; and
  - Typical low flow values (flows below the mean value) and duration of low flow periods.
- 2. FNDC to confirm their preferred option; and
- 3. Refine costs to provide higher level of certainty for budgeting purposes, and during this process consider staging options to establish the costs to ratepayers over time.

# 6.0 LIMITATIONS

## 6.1 GENERAL

This report is for the use by Far North District Council only, and should not be used or relied upon by any other person or entity or for any other project.

This report has been prepared for the particular project described to us and its extent is limited to the scope of work agreed between the client and Harrison Grierson Consultants Limited. No responsibility is accepted by Harrison Grierson Consultants Limited or its directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this report in any other context or for any other purposes.

## 6.2 ESTIMATES

Should this report contain estimates for future works or services, physical or consulting, those estimates can only be considered current and will only reflect the extent to which the detail of the project is known to the consultant (feasibility, concept, preliminary, detailed, tender etc) at the time given.

The client is solely responsible for obtaining updated estimates from the consultant as the detail of the project evolves and/or as time elapses.

# **APPENDICES**

# APPENDIX 1 EFFLUENT QUALITY REQUIREMENTS CALCULATIONS

# **KAIKOHE WWTP OPTIONS**

#### **Required Effluent Quality Calculations**

N:\1014\147856\_01-Kaikohe and Kaitaia WWTP\400 Tech\420 Calculations\Kaitaia\[Copy of KatS - Logbook-gcb.xlsx]Main
DATE: 30/09/20
10/06/2020

#### HG PROJECT NUMBER: 1014-147856-01

#### Assumptions

#### Wairoro Stream

 Mean flow
 1.4 m3/s

 Catchment Area
 47 km2
 Note: Based on Table 9 from Vol2: Water Resources Analysis, Northland Water Storage and Use Project (March 2020)

 Normalised 7day MALF
 0.004 m3/s/km2

 7day MALF
 0.19 m3/s

 Daily flow
 120,960 m3/day

Future WWTP effluent 3,036 m3/day Average flow from influent (data received from FNRC)

#### **Median Concentrations**

Notes: Effluent concentrations are based on WWTP logbook data Median effluent, US and DS values have been used to align with the PRP evaluation standards Assuming Nitrates = DIN - NH3 See graphs for assumed US values for NH3 and DIN

Parameter	Effluent US	DS	PRI	P Limit
cBOD5	19			
TSS	49			
TN*	36			
NH3-N*	34	0.1	1.8	0.24 annual median
TP*	5			
DRP	4			
DIN	40	0.7		
Nitrates	6	0.6	0.53955	1 annual median

NH3	US	DS	Target WWT
Flow (m3/day)	120,960.0	123,996.2	3,036
Concentration (g/m3)	0.1	0.24	<b>5.8</b> §
Load (kg/day)	12.1	29.8	17.7
Nitrates	US	DS	Target WWT
Flow (m3/day)	120,960.0	123,996.2	3,036
Concentration (g/m3)	0.6	1	16.9 ş
Load (kg/day)	72.6	124.0	51.4

Note: Loads are median conc \* average flows









# APPENDIX 2 MCA (LONG LIST OF OPTIONS)

# ti Criteria Analysis

					Status Quo		Minor Upgrades	Minor Upgrades		Minor Upgrades		Major Upgrades		
					Do Nothing	Chei	anical mixers + Baffle curtains + mical dosing + Rock filter + UV	Che	tional aerators + Baffle curtains + emical dosing + Sand filter + UV	Mechanical mixers + Baffle curtains + Chemical dosing + Rock filter + UV + Remove constructed wetlands	+ Surface	vetland + Chemical dosing + Clarifie mixers + UV + Upgrade constructe wetlands		
	Category		Description	Score	Comment	Score	Comment	Score	Comment	Score Comment	Score	Comment		
CI	fāori ultural alues	Impacts on Māori cultural values and practices.	<ul> <li>-Gives effect to Te Mana o te Wai.</li> <li>-Acceptability of process to local iwi</li> </ul>	R	Maintaining existing wetland aligns with cultural values. No inprovements in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing werland, introducing rock filter to treatment process and making minor improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing welland and some improvement in the quality of the effluent being discharged to the waterbody. Location of WVTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	Introducing rock filter to treatment process and making minor improvement in the quality of the efficient being duckarged to the waterbook, matter and the state of the state of the state of the matter and vertainds still remain. Location of WWTP was potentially contentious. Reflects some cultural values. Discharge to waterbook does not reflect cultural values.	R	Additional floating wetlands, upgrade of constructed wetlands with some improvemen in the quality of the effluent being discharge the waterbody. Location of WWTP was potentially contentiou Discharge to waterbody does not reflect cultu values.		
	nvironment al values	Land Use Effects	· Visual, Noise, Traffic impacts	G	No visual, noise and traffic impact.	G	Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	G	Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	G Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	0	Small visual, noise and traffic impact. Construction of new clarifier and UV may res in some disruption to the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.		
		Odour	•The degree to which odour can be expected to be discharged beyond the property boundary.	0	Historical odour complaints from adjacent farm.	0	Historical odour complaints from adjacent farm.	0	Historical odour complaints from adjacent farm.	0 Historical odour complaints from adjacent farm.	0	Historical odour complaints from adjacent fa		
		Ecological Effects	<ul> <li>The degree to which the effluent quality exceeds the minimum environmental and consent requirements.</li> </ul>	R	High risk of exceeding the nitrate, ammonia, DO and E. coli limits of the PRP. Additional may also exceed guidelines in NPS-FM for phosphorus limits.	R	Potential for insufficient nitrification. High risk of exceeding the nitrate, ammonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.	0	Risk of exceeding the nitrate, ammonia and DO limits of the PRP.	Potential for insufficient nitrification. High risk of exceeding the nitrate, anmonia and DO limits of the RPR. Risk of exceeding NPS-FM guidelines for phosphorus.	R	Potential for insufficient nitrification. High ri of exceeding the nitrate, ammonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.		
		Carbon Footprint	<ul> <li>Level of energy consumption, secondary discharges and chemicals required.</li> </ul>	G	No change from current system. Power requirements of pond based treatment system are relatively low.	0	Additional power requirements for mechanical mixers, UV unit and other equipment.	0	Additional power requirements for aerators, sand filter, UV units, and other equipment.	O Additional power requirements for mechanical mixers, UV unit and other equipment.	0	Some power requirements for mechanical mixers, UV units, and other equipment.		
		Public Health	<ul> <li>Impacts on mahinga kai</li> <li>Recreational use of the receiving environment</li> <li>Impact of spills and failure</li> </ul>	R	Risk to public health due to pathogens and viruses in the treated effluent. High concentrations of nutrients in the effluent can impact on food gathering activities.	R	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in the effluent can impact on food gathering activities.	0	Risk to public health will be significantly reduced with UV disinfection treatment. Improved effluent quality with minor control is unlikely to have major impacts on food gathering activities.	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in the effluent can impact on food gathering activities.	R	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in effluent can impact on food gathering activiti		
n	Practicabilit	Constructability	·Complexity of construction	G	No construction/commissioning required.	0	Will require small scale construction works.	0	Will require small scale construction works.	0 Will require small scale construction works.	0	Will require medium scale construction work		
P	y	Constructability	process · Distance from networks and services · Time taken to commission option	u	NO COILSU UCTOOL/COMMISSIONING FEQUITED.	0	Easy to commission.	0	Easy to commission.	Easy to commission.	0	Moderate to high difficulty to commission.		
		Regulations and Planning	Complexity to obtain a consent or other authorisations	£	No additional consents required. Challenging consent process as does not achieve freshwater target standards.	R	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not achieve freshwater target standards.	0	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate.	E Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not achieve freshwater target standards.	R	Building consent required (chemical plant ar tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not ach freshwater target standards.		
		Staging	Can the option be staged?	G	No construction required.	0	Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	0	Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	O Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	R	Major upgrades are required. It is cost-effecti to build them in one stage.		
(	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	G	No change from current system. De-shudging ponds is a laborious task. Poor- quality sludge.	G	Simple operation. Additional equipment would have to be maintained. Des-ludging ponds is a laborious task. Poor- quality sludge.	G	Simple operation. Additional equipment would have to be maintained. De-sludging ponds is a laborious task. Poor- quality sludge.	G Single goerstice, Additional equipment would have to be maintained. De-bludging prodict is a laboritous task. Poer- quality studge. Removing the weland would eliminate the current heavy maintenance requirements.	G	Simple operation. Desludging ponds is a laborious task. Poor- quality sludge. Excess of sludge would also b removed from clarifier.		
		Process reliability and resilience	Known performance of others with similar technologies Consistency of quality in the discharge Ability to maintain compliance	R	No change from current system. Compliance issues related to nutrients and E.coli removal.	R	Very limited process control with pond-based treatment system. Consistency in effluent quality may have some improvements as a result of the treatment upgrade.	0	Limited process control with pond-based treatment system with aeration. Consistency in effluent quality will improve as a result of the treatment upgrade.	<ul> <li>Very limited process control with pond-based treatment system.</li> <li>Consistency in effluent quality may have some improvements as a result of the treatment upgrade.</li> </ul>	0	Limited process control with pond-based treatment system. Consistency in effluent quality will improve result of the treatment upgrade.		
		Expandability/ future proofing	with resource consents -The potential for the site to allow for extensions to the treatment process -Proofing against changes in compliance requirements	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Aerators and chemical dosing add limited flexibility to deal with changes in compliance requirements.	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the pl		
		Hazards	<ul> <li>Proximity to known and potential hazards, e.g., flood plains, climate change hazards</li> </ul>	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	o	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	o	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	o	Plant is in a valley. Access hazard for construction works due to narrow, windy an steep access. Risk of avian botulism. Site security issues with fencing and gates.		
					<i>y</i>									
	Financial	Capital Cost	Cost of implementation     Site investigations and procurement of land     Ability to reuse existing FNDC assets	G	No additional costs associated with this option.	0	Medium comparative capital costs.	0	Medium comparative capital costs.	O Medium comparative capital costs.	0	Medium comparative capital costs.		
		Operating and Maintenance Costs	Operations and maintenance requirements (e.g., chemical costs, sludge removal) Power cost	G	No additional costs associated with this option.	0	Medium comparative O&M costs.	R	Medium to high comparative O&M costs.	O Medium comparative O&M costs.	G	Low comparative O&M costs.		
		Rating impact	<ul> <li>Impact on targeted rate relative to other options</li> </ul>	G	No additional costs associated with this option.	0	Medium comparative rate impact.	0	Medium comparative rate impact.	0 Medium comparative rate impact.	0	Medium comparative rate impact.		

# KAIKOHE WWTP OPTIONS - Long List

			Major Upgrades	Major Upgrades	М	lechanical Plant		Mechanical Plant		Mechanical Plant
			Bioreef/Aquamats + Chemical dosing + Actifle + UV + Remove all wetlands	Bioreef/Aquamats + Chemical dosing + DAF UV + Remove all wetlands	+	SBR		MABR		IDAL
Category	<ul> <li>Criteria</li> </ul>	Description	Score Comment	Score Comment	Score	Comment	Score	Comment	Score	Comment
Māori cultural values	Impacts on Māori cultural values and practices.	- Gives effect to Te Mana o te Wai. - Acceptability of process to local ivi	Some improvement in the quality of the effluer being discharged to the waterbody. Removal of all wetlands. Minimal upgrade with cultural impact. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultura values.	all wetlands. Minimal upgrade with cultural impact. Location of WWTP was potentially contentiou	f Significant being disci effluent we s. gathering a ral Location o therefore n	<ol> <li>vetland) are decommissioned. improvement in the quality of the effluent harged to the waterbody. High quality ould be unlikely to effect potential food activities and flora and fauna. (WWTP was potentially contentious major land changes could be opposed. to waterbody does not reflect cultural values.</li> </ol>	R	Ponds funcl, wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WTV was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Ponds finel. wetland) are decommissioned. Significant improvement in the quality of the fifth being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WVTP was potentially contentious. Discharge to waterbody does not reflect cultural w
Environme al values		·Visual, Noise, Traffic impacts	O Small visual, noise and traffic impact. Installation and construction of biored/agumats, Actiflo and UV may result in some disruption to the community. The Kaikobe WWTP is in a remote rural area with few neutry farms.	some disruption to the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	construction some disru The Kaikol nearby farm		0	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	0	Small visual, noise and traffic impact. Installation construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with nearby farms.
_	Odour Ecological Effects	<ul> <li>The degree to which odour can be expected to be discharged beyond the property boundary.</li> <li>The degree to which the effluent quality exceeds the</li> </ul>	O Risk of exceeding the nitrate, ammonia and DO limits of the PRP. Ability to denitrify through	O Risk of exceeding the nitrate, ammonia and I limits of the PRP. Ability to denitrify through	O G Low risk o	odour complaints from adjacent farm. of exceeding the nitrate, ammonia and E. coli he PRP and NPS-FM guidelines for	G	Historical odour complaints from adjacent farm. Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for	G	Historical odour complaints from adjacent farm. Low risk of exceeding the nitrate, ammonia and E. limits of the PRP and NPS-FM guidelines for
_	Carbon Footprint	minimum environmental and consent requirements. •Level of energy consumption,	denitrification zone.	denitrification zone.		<ol> <li>Ability to denitrify.</li> <li>t additional power requirements for</li> </ol>	R	phosphorus. Ability to denitrify.	R	phosphorus. Ability to denitrify. Significant additional power requirements for
	Public Health	secondary discharges and chemicals required.	bioreef/aquamats aerations, Actiflo, UV units, and other equipment.	bioreef/aquamats aerations, DAF, UV units, a other equipment. Power upgrade likely to be required. O Risk to public health will be significantly	be require	al plant. Significant power upgrade likely to d. lth risks will be significantly reduced with	6	mechanical plant. Significant power upgrade likely to be required. Public health risks will be significantly reduced with	6	mechanical plant. Significant power upgrade likely be required. Public health risks will be significantly reduced w
	rubic rieann	Impacts of maninga kai     Recreational use of the     receiving environment     Impact of spills and failure	<ul> <li>reduced with UV disinfection treatment, reduced with UV disinfection treatment. Improved effluent quality with minor control is unlikely to have major impacts on food gathering activities.</li> </ul>	s Improved effluent quality with minor control unlikely to have major impacts on food gathering activities.	tertiary tre	eatment.	0	tertiary treatment.	u	tertiary treatment.
Practicabi y	lit Constructability	Complexity of construction process Distance from networks and services Time taken to commission option	8 Will require medium scale construction works. Moderate to high difficulty to commission.	Will require medium scale construction work Moderate to high difficulty to commission. Plant is in a valley. Challenging for construct works due to narrow, windy and steep access	High diffic Plant is in	re large scale construction works. ulty to commission. a valley. Challenging for construction works row, windy and steep access.	R	Will require large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	o	Will require medium scale construction works. Medium difficulty to commission. Plant is in a valley. Challenging for construction v due to narrow, windy and steep access.
	Regulations and Planning	<ul> <li>Complexity to obtain a consent or other authorisations</li> </ul>	D Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate.	O Building consent required (chemical plant an teriary treatment). Chemicals might require a compliance certificate.	d O Building or and tertiar	onsent required (sludge de-watering system ry treatment).	0	Building consent required (sludge de-watering system and tertiary treatment).	0	Building consent required (sludge de-watering sys and tertiary treatment).
	Staging	Can the option be staged?	R Major upgrades are required. It is cost-effective to build them in one stage.	Major upgrades are required. It is cost-effecti to build them in one stage.	e <mark>o Additional</mark>	SBR units can be staged as required.	R	MABR modules likely to be installed in one stage.	R	IDAL installation cannot be staged.
Operabilit	y 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	D Additional equipment (e.g. Actifio) would have to be maintained. in the maintained is a laborinous task. Poor- quality sludge: Excess of sludge would also be removed from Actifio.	O Additional equipment (e.g. DAF) would have be maintained. The maintained of is a laborious task. Poor- quality shape. Excess of sludge would also b removed from DAF.	complexity require mo cause reso Removing difficulties	and maintaining the mechanical plant adds to the process. Mechanical plant is likely to ore intensive operator involvement. May urcing issues. The wetland would eliminate the current to maintain it. vel complexity sludge management.	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the welland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	o	Operating and maintaining the mechanical plant complexity to the process. Mechanical plant is like require more intensive operator involvement. May resourcing issues. Removing the welland would eliminate the curren difficulties to maintain it. Medium level complexity sludge management.
	Process reliability and resilience	<ul> <li>Known performance of others with similar technologies</li> <li>Consistency of quality in the discharge</li> <li>Ability to maintain compliance with resource consents</li> </ul>	D Limited process control with pond-based treatment system. Consistency in effuent quality will improve as result of the treatment upgrade.	result of the treatment upgrade.	of the treat is a Known tec	cy in effluent quality will improve as a result tment upgrade. -hnology with reliable performance.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Limited references of this technology.	G	Consistency in effluent quality will improve as a of the treatment upgrade. Known technology with reliable performance.
	Expandability/ future proofing	<ul> <li>The potential for the site to allow for extensions to the treatment process</li> <li>Proofing against changes in compliance requirements</li> </ul>	Pond-based technology is land intensive.     Potential to add growth media as required.     Low flexibility to deal with changes in     compliance requirements or to expand the plan		ant. Limited la Geotechnic	otprint of mechanical plant will increase future expansion of the treatment system to a pond-based system. and availability required removal of trees. cal risks associated with plant site.	0	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	0	Pond-based technology is land intensive. Limited flexibility to expand system. Some flexibility to adjust treatment according to a compliance requirements.
	Hazards	<ul> <li>Proximity to known and potential hazards, e.g., flood plains, climate change hazards</li> </ul>	O Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fercing and gates.	O Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	works due Risk of avi	a valley. Access hazard for construction to narrow, windy and steep access. ian botulism. ty issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.
Financia	Capital Cost	Cost of implementation     Site investigations and     procurement of land     Ability to reuse existing FNDC	O Medium comparative capital costs.	O Medium comparative capital costs.	R Medium to	) high comparative capital costs.	R	High comparative capital costs.	R	Medium to high comparative capital costs.
	Operating and Maintenance Costs	assets ·Operations and maintenance requirements (e.g., chemical costs, sludge removal) ·Power cost	R Medium to high comparative O&M costs.	R Medium to high comparative O&M costs.	R High comp	parative O&M costs.	R	High comparative O&M costs.	R	High comparative O&M costs.
	Rating impact	Impact on targeted rate relative	0 Medium comparative rate impact.	0 Medium comparative rate impact.	D Madama a	omparative rate impact.		High comparative rate impact.	-	Medium comparative rate impact.

# KAIKOHE WWTP OPTIONS - Long List

Description           aori cultural         -Gives effect to Te Mana o te Wai.           - Acceptability of process to local ivi         -Acceptability of process to local ivi           - The degree to which odour of be expected to be discharged rects         -Visual, Noise, Traffic impact           - The degree to which odour of be expected to be discharged rects         -Visual, Noise, Traffic impact           - The degree to which odour of be expected to be discharged rects         -Visual, Noise, Traffic impact           - Visual, Visual, Noise, Traffic impact         -Visual, Noise, Traffic impact           - Visual, Visual, Noise, Traffic impact         -Visual, Noise, Traffic impact           - Visual, Noise, Traffic impact         -Visual, Noise, Traffic impact           - Visual, Noise, Traffic impact         -Visual, Noise, Traffic impact           - The degree to which odour of be expected of energy consumption secondary discharges and chemicals required.         -Impacts on mahinga kai - Impact of son mahinga kai - Time taken to commission option           - Option be staged?         - Can the option be staged?         - Can the option be staged?	an 0 	Mechanical Plant           BNR           Comment           Ponds (nct. wetland) are decommissioned. Significant improvement in the quality of the efficient being discharged to the waterbody. High interfere majc and changes could be opposed. Discharge to waterbody does not reflect cultural values.           Small visual, noise and traffic impact. Installation and construction of the mechanical planma result the kakade Wirth Fit in a remose merid area with few nearby farms.           Historical colour compliants from adjacent farm.           Loss of exceeding the nitrate, annonia and t. Philic health risks will be significantly reduced with the result of exceeding the significant prover upgrade likely to be required.           Vill required large scale construction works.           High difficulty to commission.           Vill required large scale construction works.           High difficulty to commission.           Nill quality treatment.           Nill required large scale construction works.           High difficulty to commission.           Nill required large scale construction works.           High difficulty to commission.           Nill required and heating additions for phone scale addition addition of the system as required.	Portion plant. Re	Side Stream Treatment Plant         Of effluent Treated through mechanical maining effluents treated through existing system. Final effluents are blended for discharge.           Ourment         Comment           Mantating editing welland and some improvement in the quality of the effluents are discharged to the valendo.         Sintating editing welland and some improvement in the quality of the effluents high discharged to the valendo.           Sintating editing welland and some improvement in the quality of the effluents high discharged to the valendo.         Sintating editing welland and some improvement in the quality of the filter that the discharge to the valendo.           Sintating editing welland and some improvement in the quality of the filter that the discharge to waterbody does not reflect cultural values.         Sintating editing welland and some improvement in the mechanical plant may result in the mechanical plant may result in the result of the mechanical plant.           The Kalkole WVP is in a remote rural area with few marky farms.         Historical odour complaints from adjacent farm.           Low risk of exceeding the intrate, ammonia and E cult limits of the PFB and NYS-Mg quidlens for phosphorus. Part of restment underlaken froughly to estimate and NYS-Mg quidlens for mechanical plant.           Significant additional power requirements for mechanical plant.         Significant power upgrade likely to be required.           Will require medium to large scale construction works.         High difficulty to commission.           Platic health risks will be reduced with partial tertary treatment.         Midding consent required foliage de-watering syste	and re-use take wast t Score	Industrial Reuse Industrial Reuse Industrial Reuse Industrial Close by that is willing to I offluent treated by mechanical plant d by industry close by that is willing to Revater. Remaining wasteware treated Frough existing pond system. Comment Pands fuct, wethand are decommissioned. Effluent void on the discharged to the ware body. No effect on food gathering activities and fors and Leadon 0 WTP was potentially contrained. Discharge to waterbody does not reflect cultural values. Medium visual, noise and traffic impact, mostly related to building a pipeline from the WTP to the industry. Part of evaluational power requirements for mechanical plant and pumps staton. A portion of discharge with stuff go to her inver. Therefore, may lead to some ecological effects. Supficient additional power requirements for mechanical plant will be goatificantly reduced with VI disaffection reasment. Papertion facts the discussion of such arguing the oral strivities, will regate large take construction with due to narrow, windy and steep access. Finaling consent required (sludge de-watering Consens), will be orgatification Final time and pump station. Final will be orgatification Final state of the charge of the final. Final state is the order of the order of provide discussion of mores to provide and the orgatification exerting Consense. Finaling consent required (sludge de-watering Consense. 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aor cultural - Gives effect to Te Mana o te wai. - Acceptability of process to local ivi - Visual, Noise, Traffic impact - The degree to which odour - be sepret the to be direcharged be synch the aropeate to which the effluent quality exceeds the minimum environmental and consert requirements. - Izevel of energy consumption secting environment - Recreational use of the receiving environment - Impacts on mahinga kai - Recreational use of the receiving environment - Impact of spills and failure ity - Complexity of construction process - Distance from networks and services - Timtaken to commission or other authorisations - Can the option be staged?	5 0 an 0 4 4 4 4 4 4 4 4 4 4 4 4 4	Punds fund: werland) are decommissioned. Significant improvement in the quark by the effluent being discharged to the waterbody. High the figure being discharged to the waterbody. High therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values. 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Ruilding consent required folladge de watering system and tertiary treatment.	Score R	Comment Production: eta-allo are decommissioned. Effluent would not be discharged to the water body. Or effect on for displaying a stress and flors and caration of WWTP was potentially contentions. Interferor major land changes could be opposed. Discharge to waterbody does not reflect cultural vulues. Medium visual, noise and traffic impact, mostly related to building a pipeline from the WWTP to the industry. The stress of the stress of the stress related to building a pipeline from the WWTP to the industry. Part of substress of the stress of the stress related to building a pipeline from the twitter to industry. Part of substress will still go to the free. Therefore, may lead to some ecological effects. Significant additional power requirements for mechanical plant and pump station. Significant power upgrade likely to be required. 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The degree to which odour is be expected to be discharged bevond the nonerry boundary of the degree to which the eminimum environmental and consent requirements.     The degree to which the eminimum environments and secondary discharges and chemicals required.     The degree to which degree to the degree of the degree	an 0 y. 6 6 6 7 7 7	and construction of the mechanical plant may result some discription for the community. The Kalobe WWTP is in a remote raral area with few northy fames. New northy fames. Historical odoar complaints from adjacent farm. Low risk of ecceeding the nitrate, ammonia and E. coli limits of the PR and NPS-N4 gaidelines for flowspherus. Aultity to denirith's hospherus. Aultity to denirith's hospherus. Aultity to denirith's hospherus. Aultity to denirith's hospherus. Aultity to denirith's provide the requirements for mechanical plant. Significant power upgrade likely to be required. Public health risks will be significantly reduced with tertiary treatment. Will require large scale construction works. High difficulty to commission.	0 0 0 0 0 0 0 0 0	construction of the mechanical plant may result in some discuption for the community. The Kallohe WWIP is in a remote rural area with feer loady farms. Historical odour complaints from adjacent farm. Historical odour complaints from adjacent farm. In our side of exceeding the strate, ammonia and E coli mins of the PFW and MNFM guidelines for phosphorus. Part of restment undertaken through phond system which may impact final effluent quality. Addity to desirtify in part. Dealer of the effect of the effect of the effect of the mechanical plant Significant power ugrade likely to be required. Significant power ugrade likely to restment. Flant is na valley. Challenging for construction works, they in a valley. Challenging for construction works, due to narrow, windy and steep access. Ruilding consent required (sludge de-watering system and teriary treatment). Modular mechanical plants can be added to the system	й О О К С О О О С С С С С С С С С С С С С	related to building a pipeline from the WWTP to the industry. Part of wastewest still treated through existing part of wastewest still treated through existing adjacent fram. A portion of sticharge will still go to the river. Therefore, may lead to some ecological effects. Significant additional power requirements for mechanical plant and pump station. Significant power upgrade likely to be required. Risk to public health will be significantly reduced with IV disinfects, some effect on food gathering activities. Risk to public health will be significant of the efficient of the efficient will still be discharged to A portion of the efficient will still be discharged to activities. Risk to public health will be equired for construction works de to narrow, which y and steep access. Insiding consent required (sludge de-watering system). Consents will be required (sludge de-watering system). PADC would need to oftain permission of owners to roos private land (required).	0 0 8 8 8 8 8 9 9 9 9 9 9 9 9 9 9 9 9 9	The Kakohe WWTP is in a remote rural area wit few nearby farms. Part of wastewater still treated through open treatment system. Options doesn't ready endour issue. Infigh risk of exceeding the nitrate, ammonia and Chain limits of the PD. Infigh risk of exceeding the nitrate, ammonia and Chain limits of the PD. Infigh risk of exceeding the nitrate, ammonia and chain limits of the PD. Infigh risk of exceeding the nitrate, ammonia and Agae blooms in Summer. Significant additional power requirements for mechanical plant. Infigh concentrations of nutrients in the effluent flight concentrations of nutrients in the effluent the treated effluent. High concentrations of nutrients in the effluent set will require medium scale construction works. High difficulty to commission due to limited experience or exposure of technology in NZ Potentially challenging consent process due to freshwater target standards and limited example technologia adopted in XZ for municipal wasters treatment.
be expected to be discharged bevond the property boundar effunct quality exceeds the effluent quality exceeds the inimum environmental and consent requirements. rint -Level of energy consumption secondary discharges and chemicals required. -Impacts on mahinga kai -Recreational use of the receiving environment -Impact of spills and failure (complexity of construction process -Distance from networks and services -Time taken to commission of other authorisations Can the option be staged?	Y. G n. R G R	Low risk of ecceeding the nitrate, annonia and E. Low risk of ecceeding the nitrate, annonia and F. phosphorus. Addity to denirify. Significant additional gover requirements for mechanical plant significant power upgrade likely to be required. Public health risks will be significantly reduced with tertiary treatment. Will require large scale construction works. High difficulty to commission. nullifing consent required (shadge de-watering system and tertiary treatment).	0 0 8 0 0 0 0	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS PM guidelines for pond system which may impact final effluent quality. Ability to denirring in part. Significant additional power requirements for mechanical plant significant power upgrade likely to be required. Public health risks will be reduced with partial tortary treatment. Will require medium to large scale construction works. High difficulty to commission. Plant is a valley. Challenging for construction works, also to narrow windy and steep access. Publiching consent required folladge dewatering system and tertiary treatment). Modular mechanical plants can be added to the system	0 <b>k</b> 0 k 2 2 2 2 2 2 2 2 2 2 2 2 2	pond system. Historical odour complaints from adjacent fam. A portion of discharge will still go to the river. Therefore, may lead to some ecological effects. Significant additional power requirements for mechanical plant and pump stations. Significant power upgrade likely to be required. Mark to public bachen will be significantly reduced with UV distification rearment. A portion of the efficient will still be discharged to the river. Therefore, some effect on food gathering artivities. Will require large cach construction works. High afficiently to commission. Frant is in a valley. Challenging for construction works due to narrow, windy and steep access. Building consent required (sludge de watering system). Consents will be required for the construction of pippline and pump station.	0 R R R 0	treatment system. Options doesn't resolve dou issue. High risk of exceeding the nitrate, annonia an Coll limits of the PP. Frant is likely to do not have enough BOD remo Significant advector of the system enchanical disting required. Significant advectory upgrade likely to be required. Significant advectory upgrade likely to be required in the treated effluent. No chemical dosing required. Significant advectory and the system in the treated effluent. High concentrations of nutrients in the effloant algae blooms can impact on food gathering activities. Will require medium cable construction works. High difficulty to commission due to limited experience or exposure of technology in NZ No additional consents required. Protentially challenging consent process due to restlywater target standards and limited exampl technology adopted in NZ for municipal wastew treatment.
erts         -The degree to which the effluent quality exceeds the minimum environmental and consent requirements.           -Level of energy consumption secondary discharges and chemicals required.           -Impacts on mahinga kai -Recreational use of the receiving environment -Impact of spills and failure           ity         -Complexity of construction process -Distance from networks and services -Time taken to commission or other authorisations           deficient         -Complexity to obtain a conso or other authorisations           Can the option be staged?         -	G A, R G R	coli limits of the FRP and NFS-PA guidelines for phosphora. Subty to desirrify. Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required. Public health risks will be significantly reduced with tertiary treatment. Will require large scale construction works. High difficulty to commission. Building consent required (bludge de-watering system and tertiary treatment).	0 k 0 0	limits of the PRP and NFS-PR guidelines for pool system which may impact final effluent quality. pool system which may impact final effluent quality. Significant additional yower requirements for mechanical plant. Significant power upgrade likely to be required. Public health risks will be reduced with partial tertiary treatment. Will require medium to large scale construction works. High drift up combations, for construction works due to narrow, windy and steep access. Instituting consent required (sludge de-watering system and tertiary treatment). Modular mechanical plants can be added to the system	0 K 0 0	Therefore, may lead to some ecological effects. Significant additional power requirements for mechanical plant and pump station. Significant power upgrade hikty to be required. Risk to public health will be significantly reduced with UV disinfection treatment. A portion of the effluent will still be discharged to the river. Therefore, some effect on food gathering activities. Will require large scale construction works. High difficulty to commission. Plant is in a value. Challenging for construction works due to narrow, windly and steep access. Fuilding consent required (sludge de-watering system). Consents will be required of the construction of pipeline and pump station.	R R R U U U	Coll limits of the PRP. Coll limits of the PRP. Plant is likely to do not have enough BIOD remore light and the PRP. Alger bhorns in Summer. Significant additional power required. No chemical dosing required. It is the result of Huant. High concentrations of nutrients in the effluent. High concentrations of nutrients in the effluent in the result of Huant. High concentrations of nutrients in the effluent will require medium scale construction works. High difficulty to commission due to limited experience or exposure of technology in NZ No additional consents required. No additional consents requ
secondary discharges and chemicals required. 	G	methanical plant. Significant power upgrade likely to be required. Public boath risks will be significantly reduced with tertiary treatment. Will require large scale construction works. High difficulty to commission. Building consent required bludge dewatering system and tertiary treatments.	к 0 к 0 0	mechanical plant. Significant power upgrade likely to be required. Rublic health risks will be reduced with partial tertiary treatment. Will require medium to large scale construction works. High afficult to commission. Final is in a valle, Challenging for construction works due to narrow, windy and steep access. Building consent required (sludge de-watering system and tertiary treatment). Modular mechanical plants can be added to the system	K O K	mechanical plant and pump station. Significant power upgrade likely to be required. Bisk to public health will be significantly reduced with UV disinfector treatment. A portion of the effluent will still be discharged to the river. Therefore, some effect on food gathering activities. Uill require large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access. Paulding consent required (sludge de-watering system). Consents will be required for the construction of pipplien and pump station. PMC would need to obtain permission of owners to cross private land (required).	R R R R O	mechanical plant. No chemical doing required. Significant power upgrade likely to be required. In the rested effluent. High concentrations of nutrients in the effluent High concentrations of nutrients in the effluent will require medium scale construction works. High difficulty to commission due to limited experience or exposure of technology in NZ No additional consents required. No additional consents required. Potentially challenging consent process due to reshvoate target standards and limited example technology adopted in NZ for municipal wastess treatment.
Recreational use of the receiving environment -Impact of spills and failure ity -Complexity of construction process -Distance from networks and services -Time taken to commission or other authorisations Can the option be staged?		tertiary treatment. Will require large scale construction works. High difficulty to commission. Inuliding consent required (sludge de-watering system and tertiary treatment).	0 k 0 0	treatment. Will require medium to large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access. Puilding consent required (sludge dewatering system and vertiary treatment). Modular mechanical plants can be added to the system	Q R R	with IV distinfection treatment. A portion of the diffuence will still the discharged to the river. Therefore, some effect on food gathering activities. Will require large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access. Building consent required forthe construction of pipeline and puper station. PROC would need to obtain permission of owners to cross private land (required.)	R	in the treated effluent. High concentrations of nutrients in the effluen algae bioms can impact on food gathering extivities. Will require medium scale construction werks High difficulty to commission due to limited experience or exposure of technology in NZ No additional consents required. Protentially challenging consent process due to freshwater target standards and limited examp technology adopted in NZ for municipal waster treatment.
process -Distance from networks and services -Time taken to commission option nd Planning -Complexity to obtain a cons or other authorisations Can the option be staged?		High difficulty to commission. Inuffiding consent required tabudge de-watering system and tertilary treatments.	R 0 0	High difficulty to commission. Plant is in a value, Challenging for construction works due to narrow, windy and steep access. Building consent required (sludge de-watering system and tertiary treatment). Modular mechanical plants can be added to the system	R R	High difficulty to commission. Plant is in a value. Challenging for construction works due to narrow, windy and steep access. Indiding consent required (sludge de-watering system). Consents will be required for the construction of pipplen and pupp station. PMC would need to obtain permission of owners to cross private land (required).	R	High difficulty to commission due to limited experience or exposure of technology in NZ No additional consents required resetually challenging consent process due to freshwate target standards and limited exampl technology adopted in NZ for municipal wastes treatment.
process -Distance from networks and services -Time taken to commission option nd Planning -Complexity to obtain a cons or other authorisations Can the option be staged?		High difficulty to commission. Inuffiding consent required tabudge de-watering system and tertilary treatments.	к 0 0	High difficulty to commission. Plant is in a value, Challenging for construction works due to narrow, windy and steep access. Building consent required (sludge de-watering system and tertiary treatment). Modular mechanical plants can be added to the system	R	High difficulty to commission. Plant is in a value. Challenging for construction works due to narrow, windy and steep access. Indiding consent required (sludge de-watering system). Consents will be required for the construction of pipplen and pupp station. PMC would need to obtain permission of owners to cross private land (required).	0 R	High difficulty to commission due to limited experience or exposure of technology in NZ No additional consents required. Potentially challenging consent process due to freshwater target standards and limited examp technology adopted in NZ for municipal waste treatment.
d Planning - Complexity to obtain a cons or other authorisations Can the option be staged?	ent O O R	system and tertiary treatment).	0	and tertiary treatment). Modular mechanical plants can be added to the system	R	system). Consents will be required for the construction of pipeline and pump station. FNDC would need to obtain permission of owners to cross private land (if required).	0	Potentially challenging consent process due to freshwater target standards and limited examp technology adopted in NZ for municipal waster treatment.
	0 R	BNR streams can be added to the system as required	0	Modular mechanical plants can be added to the system as required.	R	Modular mechanical plants can be added to the	R	
neration and Complexity of operation	R					system as required. Due to pipeline construction likely to be completed in one stage.		Electrocoagulation cannot be staged.
Complexity of operation     Complexity of operation     Complexity of operation     Complexity     Complex	of	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the weitand would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause OSM of two WWTPs. Removing the welland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R 2	Operating and maintaining the mechanical plant and long pipeline adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the weiland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the electrocoagulat system adds complexity to the process. This sy is likely to require more intensive operator involvement. May cause resourcing issues. Medium to high level complexity sludge management especially with chemical sludge.
<ul> <li>Known performance of othe with similar technologies</li> <li>Consistency of quality in the discharge</li> <li>Ability to maintain complian</li> </ul>		Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.	G	Resource consent to discharge treated effluent to the Wairoro River could be surrendered. Known technology with reliable performance.	R	Limited knowledge on technology and perform for large scale municipal wastewater treatmen NZ.
with resource consents           / future         -The potential for the site to allow for extensions to the treatment process           -Proofing against changes in compliance requirements	O	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Georgening tisks associated with plant site	0	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	0	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Generchnical risks associated with plant site	R	Smaller footprint of electroccoagulation plant. Uncertain on sizing due to proprietary design.
<ul> <li>Proximity to known and potential hazards, e.g., flood plains, climate change hazard</li> </ul>	0 S	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for construct works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.
	R C	Medium to high comparative capital costs.	0	Medium comparative capital costs.	R	High comparative capital costs.	R	High comparative capital costs. Would require effluent quality requirements for re-use
l · Operations and maintenance Costs requirements (e.g., chemical costs, sludge removal)	R	High comparative O&M costs.	0	Medium comparative O&M costs.	R	High comparative O&M costs.	R	High comparative O&M costs.
	ive O	Medium comparative rate impact.	0	Medium comparative rate impact.	R	Web	R	High comparative rate impact.
	Proximity to known and potential hazards, e.g., flood plains, climate change hazard Cost of implementation -Site investigations and procurement of land -Ability to reuse existing FND assets -Operations and maintenance str equirements (e.g., chemical costs, sludge removal) -Power cost	Proximity to known and potential bazards, eg., flood plains, climate change hazards -Cost of implementation     -Site investigations and procurement of land -Ability to reuse existing FNDC assets     -Operations and maintenance     requirements (eg., chemical costs, sludge removal) -Power cost	Compliance requirements     Compliance to arrow, which hairs site.     Proximity to known and     potential hazards, e.g., flood     plains, climate change hazards     Cost of implementation     -Site investigations and     procurement of land     -Ability to reuse existing FNDC     assets     costs, sudge removal)     -Deperations and maintenance     requirements (e.g., chemical     costs, sudge removal)     -Dewr cost     -Dever cost	Compliance requirements     Compliance requirements     Proximity to known and     potential hazards, e.g., flood     plants, climate change hazards     Cost of implementation     -Sute investigations and     procurement of land     -Abity to reuse existing PDDC     assets     -Operations and maintenance     -Operations and maintenance     requirements (e.g., chemical     costs, sudge removal)     -Dower cost     -Dower c	Compliance requirements     Georehnical rake associated with plant site.     0     Plant is in a valley. Access hazard for construction       Proximity to known and potential hazards, e.g., flood     0     Plant is in a valley. Access hazard for construction     0       Version and potential hazards, e.g., flood     0     Plant is in a valley. Access hazard for construction     0       Version and potential hazards, e.g., flood     0     Version and numbers     0     Plant is in a valley. Access hazard for construction       Site security issues with fencing and gates.       - Site investigations and maintenance     Nedium to high comparative capital costs.     0     Medium comparative capital costs.       - Operations and maintenance     N     High comparative OAM costs.     0     Medium comparative OAM costs.       sts     requirements (e.g. chemical cost cost cost)     -Plower cost     0     Medium comparative rate impact.	Compliance requirements     Concencent of risk associated with plant site.     Procent plants is in a valley. Access hazard for construction potential hazards, e.g., flood plains, climate charge hazards     Process hazard for construction process hazard for construction potential hazards, e.g., flood plains, climate charge hazards     Process hazard for construction process hazard for construction process hazard for construction process hazard for construction process hazards     Process hazard for construction process hazard for construction process hazard for construction process hazards     Process hazard for construction process hazards     Process	Compliance requirements     Coorechnical risk associated with plant site.     Coorechnical risk associated with plant site.     Coorechnical risk associated with plant site.       -Proceeding to be point in a valley, Access hazard for construction in potential hazards, e.g., flood plains, clinate change hazards     Plant is in a valley, Access hazard for construction in the step access.     O     Plant is in a valley, Access hazard for construction in the step access.     O     Plant is in a valley, Access hazard for construction in the step access.     O     Plant is in a valley, Access hazard for construction in the step access.     O     Plant is in a valley, Access hazard for construction in the step access.     O     Plant is in a valley, Access hazard for construction in the step access.     O     Plant is in a valley, Access hazard for construction in the step access.     O     Plant is in a valley, Access hazard for construction in the step access.     O     Plant is in a valley, Access hazard for construction in the step access.     O     Plant is in a valley, Access hazard for access.     O     Plant is in a valley.     Plant is in a valley.     O     Plant is in a valley.     O     Plant is in a valley.     Plant is in a v	Compliance requirements       Concentrative risks associated with plant site.       Concentrative risks ass

# APPENDIX 3 PRELIMINARY LONG LIST OF OPTIONS

TABLE 18: PRE	LIMINARY LONG LIST OF OPTIONS
UPGRADE PURPOSE	OPTIONS
BOD / Nitrogen Removal	<ul> <li>Do nothing (status quo)</li> <li>Additional aeration<sup>1,3</sup></li> <li>Mechanical mixers</li> <li>Floating treatment wetlands partitioning into nitrification zone and anoxic zone<sup>1</sup></li> <li>Bioreef/Aquamats partitioning into anoxic zone with recycle<sup>2</sup></li> <li>Replacing existing ponds with:         <ul> <li>Intermittent Decanting Aerated Lagoon (IDAL) plant</li> <li>Sequencing Batch Reactor (SBR) plant<sup>4</sup></li> <li>Biological Nutrient Removal (BNR) plant</li> <li>Membrane Aerated Biofilm Reactor (MABR) modules</li> </ul> </li> </ul>
Solids Removal	<ul> <li>Do nothing (status quo)</li> <li>Sand filter<sup>4</sup></li> <li>Disc filter</li> <li>Dissolved Air Flotation (DAF)</li> <li>Actiflo (sand-ballasted Clarifier)</li> <li>Clarifier</li> <li>Rock filters</li> </ul>
Phosphorus Removal	<ul> <li>Do nothing (status quo)</li> <li>Chemical dosing &amp; Rock Filter</li> <li>Clarifier</li> <li>Actiflo (sand-ballasted Clarifier)</li> <li>Mechanical Plant</li> </ul>
Algae Removal Algae Removal	<ul> <li>Do nothing (status quo)</li> <li>Surface mixers</li> <li>Inlet/outlet pipe reconfiguration</li> </ul>
Disinfection	<ul> <li>Do nothing (status quo)</li> <li>UV disinfection<sup>2,3,4</sup></li> </ul>
Sludge Handling	Sludge lagoon <sup>4</sup>
Other Plant Modifications	<ul> <li>Upgrade constructed wetlands<sup>4</sup></li> <li>Abandon constructed wetlands<sup>3</sup></li> <li>Baffle curtains<sup>3,4</sup></li> <li>De-sludging of ponds</li> <li>Inflow &amp; infiltration (I&amp;I) reduction<sup>5</sup></li> <li>Electrocoagulation and Clarifier after pond 2</li> </ul>
Trade Waste	<ul><li>Do nothing (status quo)</li><li>Discontinue trade waste.</li></ul>

<sup>1</sup>Kauri Park (2010) – Kaikohe Waste Water Treatment Plant Upgrade Options

<sup>2</sup> OPUS (2008) – Bioreef Investigation Prelim Design and Costing

<sup>3</sup> OPUS (2006) – Kaikohe WWTP Optimisation

<sup>4</sup> VK Consulting Engineers (2003) – Kaikohe WWTP Upgrade Options

<sup>5</sup>It was assumed that I&I reduction options are being explored separately from the WWTP upgrade.

This option will not be considered further.

# APPENDIX 4 MCA (SHORT LIST OF OPTIONS) AND SENSITIVITY ANALYSIS

# ti Criteria Analysis

					Status Quo		Minor Upgrades		Minor Upgrades	Minor Upgrades		Major Upgrades
		Impacts on Maori cultural     GRess effect to Te Wai.       values and practices.			Do Nothing	Chei	anical mixers + Baffle curtains + mical dosing + Rock filter + UV	Che	ional aerators + Baffle curtains + mical dosing + Sand filter + UV	Mechanical mixers + Baffle curtains + Chemical dosing + Rock filter + UV + Remove constructed wetlands	+ Surface	vetland + Chemical dosing + Clarifie mixers + UV + Upgrade constructe wetlands
	ategory		Description	Score	Comment	Score	Comment	Score	Comment	Score Comment	Score	Comment
CI	läori ultural alues		Wai. •Acceptability of process to	R	Maintaining existing wetland aligns with cultural values. No improvements in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing werland, introducing rock filter to treatment process and making minor improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing wetland and some improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultural values.	Introducing rock filter to treatment process and making minor improvement in the quality of the efficient being ducharged to the waterbody. In attract we have a strength of the strength of the natural vetandes still remain. Location of WYTP was potentially contentious. Reflects some cultural values. Discharge to waterbody does not reflect cultural values.	R	Additional floating wetlands, upgrade of constructed wetlands with some improvemen in the quality of the effluent being discharge the waterbody. Location of WWTP was potentially contentiou Discharge to waterbody does not reflect cultu values.
	nvironment al values	Land Use Effects	· Visual, Noise, Traffic impacts	G	No visual, noise and traffic impact.	G	Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	G	Minimum visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area with few nearby farms.	G Minimum visual, noise and traffic impact. The Kaikobe WWTP is in a remote rural area with few nearby farms.	0	Small visual, noise and traffic impact. Construction of new clarifier and UV may res in some disruption to the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.
		Odour	<ul> <li>The degree to which odour can be expected to be discharged beyond the property boundary.</li> </ul>	0	Historical odour complaints from adjacent farm.	0	Historical odour complaints from adjacent farm.	0	Historical odour complaints from adjacent farm.	O Historical odour complaints from adjacent farm.	0	Historical odour complaints from adjacent fa
		-	<ul> <li>The degree to which the effluent quality exceeds the minimum environmental and consent requirements.</li> </ul>	R	High risk of exceeding the nitrate, ammonia, DO and E. coli limits of the PRP. Additional may also exceed guidelines in NPS-FM for phosphorus limits.	R	Potential for insufficient nitrification. High risk of exceeding the nitrate, ammonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.	0	Risk of exceeding the nitrate, ammonia and DO limits of the PRP.	Potential for insufficient nitrification. High risk of exceeding the nitrate, anmonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.	R	Potential for insufficient nitrification. High ri of exceeding the nitrate, ammonia and DO limits of the PRP. Risk of exceeding NPS-FM guidelines for phosphorus.
		Carbon Footprint	<ul> <li>Level of energy consumption, secondary discharges and chemicals required.</li> </ul>	G	No change from current system. Power requirements of pond based treatment system are relatively low.	0	Additional power requirements for mechanical mixers, UV unit and other equipment.	0	Additional power requirements for aerators, sand filter, UV units, and other equipment.	O Additional power requirements for mechanical mixers, UV unit and other equipment.	0	Some power requirements for mechanical mixers, UV units, and other equipment.
		Public Health	<ul> <li>Impacts on mahinga kai</li> <li>Recreational use of the receiving environment</li> <li>Impact of spills and failure</li> </ul>	R	Risk to public health due to pathogens and viruses in the treated effluent. High concentrations of nutrients in the effluent can impact on food gathering activities.	R	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in the effluent can impact on food gathering activities.	0	Risk to public health will be significantly reduced with UV disinfection treatment. Improved effluent quality with minor control is unlikely to have major impacts on food gathering activities.	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in the effluent can impact on food gathering activities.	R	Risk to public health will be significantly reduced with UV disinfection treatment. Potential high concentrations of nutrients in effluent can impact on food gathering activiti
n	racticabilit	Constructshility	Complexity of construction	G	No construction/commissioning required.	0	Will require small scale construction works.	0	Will require small scale construction works.	0 Will require small scale construction works.	0	Will require medium scale construction work
P	у	Constructability	process · Distance from networks and services · Time taken to commission option	u	to consu ac non/commissioning required.	0	Easy to commission.	0	Easy to commission.	Easy to commission.	0	Moderate to high difficulty to commission.
		Regulations and Planning	Complexity to obtain a consent or other authorisations	r	No additional consents required. Challenging consent process as does not achieve freshwater target standards.		Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not achieve freshwater target standards.	0	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate.	Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not achieve freshwater target standards.	R	Building consent required (chemical plant ar tertiary treatment). Chemicals might require a compliance certificate. Challenging consent process as does not ach freshwater target standards.
		Staging	Can the option be staged?	G	No construction required.	0	Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	0	Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	O Only minor upgrades are required which could be staged. It is likely to be more cost-effective to build them in one stage.	R	Major upgrades are required. It is cost-effect to build them in one stage.
(	Operability	The ease of operation and maintenance	<ul> <li>H&amp;S risks of plant process.</li> <li>Sludge management</li> <li>Reliance on and complexity of plant consumables and</li> </ul>	G	No change from current system. De-sludging ponds is a laborious task. Poor- quality sludge.	G	Simple operation. Additional equipment would have to be maintained. Des-ludging ponds is a laborious task. Poor- quality sludge.	G	Simple operation. Additional equipment would have to be maintained. De-sludging ponds is a laborious task. Poor- quality sludge.	G Simple operation. Additional equipment would have to be minimized. and the state of the state of the state of the state of the equipment of the state of the state of the current heavy maintenance requirements.	G	Simple operation. Desludging ponds is a laborious task. Poor- quality sludge. Excess of sludge would also h removed from clarifier.
			Known performance of others with similar technologies Consistency of quality in the discharge Ability to maintain compliance	R	No change from current system. Compliance issues related to nutrients and Ecoli removal.	R	Very limited process control with pond-based treatment system. Consistency in effluent quality may have some improvements as a result of the treatment upgrade.	o	Limited process control with pond-based treatment system with aeration. Consistency in effluent quality will improve as a result of the treatment upgrade.	<ul> <li>Very limited process control with pond-based reatment system.</li> <li>Consistency in effluent quality may have some improvements as a result of the treatment upgrade.</li> </ul>	0	Limited process control with pond-based treatment system. Consistency in effluent quality will improve result of the treatment upgrade.
		proofing	<ul> <li>The potential for the site to allow for extensions to the treatment process</li> <li>Proofing against changes in compliance requirements</li> </ul>	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Aerators and chemical dosing add limited flexibility to deal with changes in compliance requirements.	R Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the plant.	R	Pond-based technology is land intensive. Low flexibility to deal with changes in compliance requirements or to expand the pl
		Hazards	<ul> <li>Proximity to known and potential hazards, e.g., flood plains, climate change hazards</li> </ul>	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	O Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy an steep access. Risk of avian botulism. Site security issues with fencing and gates.
					,							
	Financial	Capital Cost	Cost of implementation     Site investigations and procurement of land     Ability to reuse existing FNDC assets	G	No additional costs associated with this option.	0	Medium comparative capital costs.	0	Medium comparative capital costs.	O Medium comparative capital costs.	0	Medium comparative capital costs.
		Operating and Maintenance Costs	Operations and maintenance requirements (e.g., chemical costs, sludge removal) Power cost	G	No additional costs associated with this option.	0	Medium comparative O&M costs.	R	Medium to high comparative O&M costs.	O Medium comparative O&M costs.	G	Low comparative O&M costs.
		Rating impact	·Impact on targeted rate relative to other options	G	No additional costs associated with this option.	0	Medium comparative rate impact.	0	Medium comparative rate impact.	O Medium comparative rate impact.	0	Medium comparative rate impact.

# KAIKOHE WWTP OPTIONS - Long List

			Major Upgrades	Major Upgrades	М	lechanical Plant		Mechanical Plant		Mechanical Plant
			Bioreef/Aquamats + Chemical dosing + Actifle + UV + Remove all wetlands	Bioreef/Aquamats + Chemical dosing + DAF UV + Remove all wetlands	+	SBR		MABR		IDAL
Category	<ul> <li>Criteria</li> </ul>	Description	Score Comment	Score Comment	Score	Comment	Score	Comment	Score	Comment
Māori cultural values	Impacts on Māori cultural values and practices.	- Gives effect to Te Mana o te Wai. -Acceptability of process to local ivi	Some improvement in the quality of the effluer being discharged to the waterbody. Removal of all wetlands. Minimal upgrade with cultural impact. Location of WWTP was potentially contentious. Discharge to waterbody does not reflect cultura values.	all wetlands. Minimal upgrade with cultural impact. Location of WWTP was potentially contentiou	f Significant being disci effluent we s. gathering a ral Location o therefore r	<ol> <li>vetland) are decommissioned. improvement in the quality of the effluent harged to the waterbody. High quality ould be unlikely to effect potential food activities and flora and fauna. (WWTP was potentially contentious major land changes could be opposed. to waterbody does not reflect cultural values.</li> </ol>	R	Ponds funcl, wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WTV was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Ponds finel. wetland) are decommissioned. Significant improvement in the quality of the fifth being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WVTP was potentially contentious. Discharge to waterbody does not reflect cultural w
Environme al values		·Visual, Noise, Traffic impacts	O Small visual, noise and traffic impact. Installation and construction of biored/agumats, Actiflo and UV may result in some disruption to the community. The Kaikobe WWTP is in a remote rural area with few neutry farms.	some disruption to the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	construction some disru The Kaikol nearby farm		0	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	0	Small visual, noise and traffic impact. Installation construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with nearby farms.
_	Odour Ecological Effects	<ul> <li>The degree to which odour can be expected to be discharged beyond the property boundary.</li> <li>The degree to which the effluent quality exceeds the</li> </ul>	O Risk of exceeding the nitrate, ammonia and DO limits of the PRP. Ability to denitrify through	O Risk of exceeding the nitrate, ammonia and I limits of the PRP. Ability to denitrify through	0 G Low risk o limits of th	odour complaints from adjacent farm. of exceeding the nitrate, ammonia and E. coli he PRP and NPS-FM guidelines for	G	Historical odour complaints from adjacent farm. Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for	G	Historical odour complaints from adjacent farm. Low risk of exceeding the nitrate, ammonia and E. limits of the PRP and NPS-FM guidelines for
_	Carbon Footprint	minimum environmental and consent requirements. •Level of energy consumption,	denitrification zone.	denitrification zone.		<ol> <li>Ability to denitrify.</li> <li>t additional power requirements for</li> </ol>	R	phosphorus. Ability to denitrify.	R	phosphorus. Ability to denitrify. Significant additional power requirements for
	Public Health	secondary discharges and chemicals required.	bioreef/aquamats aerations, Actiflo, UV units, and other equipment.	bioreef/aquamats aerations, DAF, UV units, a other equipment. Power upgrade likely to be required. O Risk to public health will be significantly	be require	al plant. Significant power upgrade likely to d. lth risks will be significantly reduced with	6	mechanical plant. Significant power upgrade likely to be required. Public health risks will be significantly reduced with	6	mechanical plant. Significant power upgrade likely be required. Public health risks will be significantly reduced w
	rubic rieann	Impacts of maninga kai     Recreational use of the     receiving environment     Impact of spills and failure	<ul> <li>reduced with UV disinfection treatment, reduced with UV disinfection treatment. Improved effluent quality with minor control is unlikely to have major impacts on food gathering activities.</li> </ul>	s Improved effluent quality with minor control unlikely to have major impacts on food gathering activities.	tertiary tre	eatment.	0	tertiary treatment.	u	tertiary treatment.
Practicabi y	lit Constructability	Complexity of construction process Distance from networks and services Time taken to commission option	8 Will require medium scale construction works. Moderate to high difficulty to commission.	Will require medium scale construction work Moderate to high difficulty to commission. Plant is in a valley. Challenging for construct works due to narrow, windy and steep access	High diffic Plant is in	re large scale construction works. ulty to commission. a valley. Challenging for construction works row, windy and steep access.	R	Will require large scale construction works. High difficulty to commission. Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.	o	Will require medium scale construction works. Medium difficulty to commission. Plant is in a valley. Challenging for construction v due to narrow, windy and steep access.
	Regulations and Planning	<ul> <li>Complexity to obtain a consent or other authorisations</li> </ul>	D Building consent required (chemical plant and tertiary treatment). Chemicals might require a compliance certificate.	O Building consent required (chemical plant an teriary treatment). Chemicals might require a compliance certificate.	d O Building or and tertiar	onsent required (sludge de-watering system ry treatment).	0	Building consent required (sludge de-watering system and tertiary treatment).	0	Building consent required (sludge de-watering sys and tertiary treatment).
	Staging	Can the option be staged?	R Major upgrades are required. It is cost-effective to build them in one stage.	Major upgrades are required. It is cost-effecti to build them in one stage.	e <mark>o Additional</mark>	SBR units can be staged as required.	R	MABR modules likely to be installed in one stage.	R	IDAL installation cannot be staged.
Operabilit	y 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	D Additional equipment (e.g. Actifio) would have to be maintained. is a laboratorial to a laboratorial task. Poor- quality sludge: Excess of sludge would also be removed from Actifio.	O Additional equipment (e.g. DAF) would have be maintained. The maintained of is a laborious task. Poor- quality shape. Excess of sludge would also b removed from DAF.	complexity require mo cause reso Removing difficulties	and maintaining the mechanical plant adds to the process. Mechanical plant is likely to ore intensive operator involvement. May urcing issues. The wetland would eliminate the current to maintain it. vel complexity sludge management.	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the welland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	o	Operating and maintaining the mechanical plant complexity to the process. Mechanical plant is like require more intensive operator involvement. May resourcing issues. Removing the welland would eliminate the curren difficulties to maintain it. Medium level complexity sludge management.
	Process reliability and resilience	<ul> <li>Known performance of others with similar technologies</li> <li>Consistency of quality in the discharge</li> <li>Ability to maintain compliance with resource consents</li> </ul>	D Limited process control with pond-based treatment system. Consistency in effuent quality will improve as result of the treatment upgrade.	result of the treatment upgrade.	of the treat is a Known tec	cy in effluent quality will improve as a result tment upgrade. -hnology with reliable performance.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Limited references of this technology.	G	Consistency in effluent quality will improve as a of the treatment upgrade. Known technology with reliable performance.
	Expandability/ future proofing	<ul> <li>The potential for the site to allow for extensions to the treatment process</li> <li>Proofing against changes in compliance requirements</li> </ul>	Pond-based technology is land intensive.     Potential to add growth media as required.     Low flexibility to deal with changes in     compliance requirements or to expand the plan		ant. Limited la Geotechnic	otprint of mechanical plant will increase future expansion of the treatment system to a pond-based system. and availability required removal of trees. cal risks associated with plant site.	0	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	0	Pond-based technology is land intensive. Limited flexibility to expand system. Some flexibility to adjust treatment according to a compliance requirements.
	Hazards	<ul> <li>Proximity to known and potential hazards, e.g., flood plains, climate change hazards</li> </ul>	O Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fercing and gates.	O Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	works due Risk of avi	a valley. Access hazard for construction to narrow, windy and steep access. ian botulism. ty issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.
Financia	Capital Cost	Cost of implementation     Site investigations and     procurement of land     Ability to reuse existing FNDC	O Medium comparative capital costs.	O Medium comparative capital costs.	R Medium to	) high comparative capital costs.	R	High comparative capital costs.	R	Medium to high comparative capital costs.
	Operating and Maintenance Costs	assets ·Operations and maintenance requirements (e.g., chemical costs, sludge removal) ·Power cost	R Medium to high comparative O&M costs.	R Medium to high comparative O&M costs.	R High comp	parative O&M costs.	R	High comparative O&M costs.	R	High comparative O&M costs.
	Rating impact	Impact on targeted rate relative	0 Medium comparative rate impact.	0 Medium comparative rate impact.	D Madama a	omparative rate impact.		High comparative rate impact.	-	Medium comparative rate impact.

# KAIKOHE WWTP OPTIONS - Long List

			11		12		13		14	i			
				Mechanical Plant		Side Stream Treatment Plant		Industrial Re-use	Alternative Upgrades				
				BNR	plant. Rep	of effluent treated through a mechanical maining effluent treated through existing system. Final effluents are blended for discharge.	and re-use take wast	f effluent treated by mechanical plant d by industry close by that is willing to water. Remaining wastewater treated hrough existing pond system.	Followin	g oxidation pond, Electrocoagulation Clarifier			
No Category	' Criteria	Description	Score	Comment	Score	Comment	Score	Comment	Score	Comment			
Māori cultural values	Impacts on Māori cultural values and practices.	- Gives effect to Te Mana o te Wai. - Acceptability of process to local ivi	R	Ponds incl. wetland) are decommissioned. Significant improvement in the quality of the effluent being discharged to the waterbody. High quality effluent would be unlikely to effect potential food gathering activities and flora and fauna. Location of WTV was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Maintaining existing welland and some improvement in the quality of the effluent being discharged to the waterbody. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	Ponds tincl, wetland) are decommissioned. Effluent would not be discharged to the water body. No effect on food gathering activities and flora and fanan of the Warror River. Location of WWTP was potentially contentious therefore major land changes could be opposed. Discharge to waterbody does not reflect cultural values.	R	werland is maintained, but in poor conditions. Minimal evidence of technology used for treatm of municipal wastewater therefore uncertain gragarding the quality of the effluence bring discharged to the waterbody. Location of WWTP was potentially contentious therefore major land changes could be opposed Discharge to waterbody does not reflect cultura values.			
Environme al values	nt Land Use Effects	·Visual, Noise, Traffic impacts	0	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	0	Small visual, noise and traffic impact. Installation and construction of the mechanical plant may result in some disruption for the community. The Kaikohe WWTP is in a remote rural area with few nearby farms.	R	Medium visual, noise and traffic impact, mostly related to building a pipeline from the WWTP to the industry.	0	Small visual, noise and traffic impact. The Kaikohe WWTP is in a remote rural area w few nearby farms.			
	Odour	<ul> <li>The degree to which odour can be expected to be discharged beyond the property boundary.</li> </ul>	o	Historical odour complaints from adjacent farm.	0	Historical odour complaints from adjacent farm.	0	Part of wastewater still treated through existing pond system. Historical odour complaints from adjacent farm.	0	Part of wastewater still treated through open treatment system. Options doesn't resolve odo issue.			
	Ecological Effects	• The degree to which the effluent quality exceeds the minimum environmental and consent requirements.	G	Low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Ability to denitrify.	0	low risk of exceeding the nitrate, ammonia and E. coli limits of the PRP and NPS-FM guidelines for phosphorus. Part of treatment undertaken through pond system which may impact final effluent quality. Ability to denitrify in part.	0	A portion of discharge will still go to the river. Therefore, may lead to some ecological effects.	R	High risk of exceeding the nitrate, ammonia au Coli limits of the PRP. Plant is likely to do not have enough BOD rem capacity to deal with increasing loads in the fu Algae blooms in Summer.			
	Carbon Footprint	<ul> <li>Level of energy consumption, secondary discharges and chemicals required.</li> </ul>	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant and pump station. Significant power upgrade likely to be required.	R	Significant additional power requirements for mechanical plant. No chemical dosing required. Significant power upgrade likely to be require			
	Public Health	<ul> <li>Impacts on mahinga kai</li> <li>Recreational use of the receiving environment</li> <li>Impact of spills and failure</li> </ul>	G	Public health risks will be significantly reduced with tertiary treatment.	0	Public health risks will be reduced with partial tertiary treatment.	0	Risk to public health will be significantly reduced with UV disinfection treatment. A portion of the effluent will still be discharged to the river. Therefore, some effect on food gathering activities.	R	Risk to public health due to pathogens and viri in the treated effluent. High concentrations of nutrients in the effluen algae blooms can impact on food gathering activities.			
Practicabil y	it Constructability	Complexity of construction     process	R	Will require large scale construction works. High difficulty to commission.	R	Will require medium to large scale construction works. High difficulty to commission.	R	Will require large scale construction works. High difficulty to commission.	R	Will require medium scale construction work: High difficulty to commission due to limited			
		Distance from networks and services     Time taken to commission option				Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.		Plant is in a valley. Challenging for construction works due to narrow, windy and steep access.		experience or exposure of technology in NZ			
	Regulations and Planning	<ul> <li>Complexity to obtain a consent or other authorisations</li> </ul>	0	Building consent required (sludge de-watering system and tertiary treatment).	0	Building consent required (sludge de-watering system and tertiary treatment).	R	Building consent required (sludge de-watering system). Consents will be required for the construction of pipeline and pump station. FNDC would need to obtain permission of owners to cross private land (if required).	0	No additional consents required. Potentially challenging consent process due to freshwater target standards and limited exam technology adopted in NZ for municipal wast treatment.			
	Staging	Can the option be staged?	0	BNR streams can be added to the system as required.	0	Modular mechanical plants can be added to the system as required.	R	Modular mechanical plants can be added to the system as required. Due to pipeline construction likely to be completed in one struct	R	Electrocoagulation cannot be staged.			
								in one stage.					
Operabilit	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	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the verland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the mechanical plant adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing lissues. Odds of two WWTFM Odds work of the operator involvement of the difficulties to maintain it. Medium level complexity shudge management.	R	Operating and maintaining the mechanical plant and long pipeline adds complexity to the process. Mechanical plant is likely to require more intensive operator involvement. May cause resourcing issues. Removing the wetland would eliminate the current difficulties to maintain it. Medium level complexity sludge management.	R	Operating and maintaining the electrocoagula system adds complexity to the process. This is is likely to require more intensive operator involvement. May cause resourcing issues. Medium to high level complexity sludge management especially with chemical sludge.			
	Process reliability and resilience	Known performance of others with similar technologies Consistency of quality in the discharge Ability to maintain compliance	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.	G	Consistency in effluent quality will improve as a result of the treatment upgrade. Known technology with reliable performance.	G	Resource consent to discharge treated effluent to the Wairoro River could be surrendered. Known technology with reliable performance.	R	Limited knowledge on technology and perform for large scale municipal wastewater treatmer NZ.			
	Expandability/ future proofing	with resource consents • The potential for the site to allow for extensions to the treatment process • Proofing against changes in compliance requirements	0	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	0	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	0	Modularity and smaller footprint of mechanical plant will increase options for future expansion of the treatment system compared to a pond-based system. Limited land availability required removal of trees. Geotechnical risks associated with plant site.	R	Smaller footprint of electrocoagulation plant. Uncertain on sizing due to proprietary design			
	Hazards	<ul> <li>Proximity to known and potential hazards, e.g., flood plains, climate change hazards</li> </ul>	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for construction works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.	0	Plant is in a valley. Access hazard for constru works due to narrow, windy and steep access. Risk of avian botulism. Site security issues with fencing and gates.			
Financial	Capital Cost	Cost of implementation     Site investigations and     procurement of land     Ability to reuse existing FNDC     exacts	R	Medium to high comparative capital costs.	0	Medium comparative capital costs.	R	High comparative capital costs.	R	High comparative capital costs. Would require effluent quality requirements for re-use			
	Operating and Maintenance Costs	assets ·Operations and maintenance requirements (e.g., chemical costs, sludge removal)	R	High comparative O&M costs.	0	Medium comparative O&M costs.	R	High comparative O&M costs.	R	High comparative O&M costs.			
	Rating impact	Power cost     Impact on targeted rate relative to other options	o	Medium comparative rate impact.	0	Medium comparative rate impact.	R	High comparative rate impact.	R	High comparative rate impact.			



### KAIKOHE WWTP OPTIONS - Short List Assessment

#### Risk Matrix

N:\1014\147856\_01-Kaikohe and Kaitaia WWTP\400 Tech\421 MCA\Risk Analysis\[Kaikohe WWTP Short List Risk Matrix-Rev0.4MSM.xlsx]General (2) DATE:06/10/20

HG PROJECT NUMBER: 1014-147856-01						Baffle curi ilter + UV	ains +			ef/Aquam · UV + Rei			osing +			Option 3	B: IDAL		
Risks	Descriptions	Likeli		Conse	quence	Risk	Risk	Likeli		Consec		Risk	Risk	Likeli		Consec		Risk	Risk
		Rating	Score	Rating	Score	Grade	Score	Rating	Score	Rating	Score	Grade	Score	Rating	Score	Rating	Score	Grade	Scor
Non-performance of the overall treatment scheme	Treatment and disposal systems not operating to design objectives. Assumptions about the Wairoro Stream flow to calculate the required effluent quality are incorrect. Breach of Consent.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12	Unlikely	2	Major	4	High	8
Option not acceptable to iwi	Scheme may not have iwi endorsement; difficult to progress the scheme.	Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	e 16
Option not acceptable to community (negative perception and social unacceptance)	Public opposition to preferred option.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	e 12
Local expertise not available to operate the plant	Plant operations and performance affected if expertise are not available to operate it correctly.	Unlikely	2	Moderate	3	Medium	6	Unlikely	2	Moderate	3	Medium	6	Unlikely	2	Moderate	3	Medium	6
Disruptions to existing WWTPs during construction	Effluent quality affected; breach of consents.	Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	e 16
Consenting difficulties	Required consent are not granted (land disposal options). Options selection process does not meet the requirements of the existing consent.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12	Unlikely	2	Major	4	High	8
Capacity/future proofing	Option is unable to meet the long term needs of the community. Insufficient capacity for future industry. Unable to deal with changes on the compliance requirements.	Likely	4	Major	4	Extreme	16	Possible	3	Major	4	Extreme	12	Unlikely	2	Major	4	High	8
Failure of equipment at the WWTPs	Failure of equipment at the WWTPs. Power loss.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	12
Option unaffordable		Unlikely	2	Major	4	High	8	Likely	4	Major	4	Extreme	16	Possible	3	Major	4	Extreme	12
Availability of suitable land	Risk that suitable land is unavailable to build WWTP upgrades (i.e. land has to be purchased), or the ground conditions of existing land are not appropriate.	Unlikely	2	Moderate	3	Medium	6	Possible	3	Moderate	3	High	9	Possible	3	Moderate	3	High	9
Odour issues and wastewater sprays	WWTP odour issues affecting nearby residents. Wastewater spray from ponds to beyond property boundary.	Possible	3	Minor	2	Medium	6	Possible	3	Minor	2	Medium	6	Possible	3	Minor	2	Medium	6
Cyanobacteria	Risk of discharging cyanobacteria to the waterbody.	Unlikely	2	Major	4	High	8	Unlikely	2	Major	4	High	8	Rare	1	Major	4	High	4
Other risks	Avian botulism. Steep site access.	Possible	3	Moderate	3	High	9	Possible	3	Moderate	3	High	9	Possible	3	Moderate	3	High	9



## KAIKOHE WWTP OPTIONS - Short List Assessment

#### Risk Matrix

N:\1014\147856\_01-Kaikohe and Kaitaia WWTP\400 Tech\421 MCA\Risk Analysis\[Kaikohe WWTP Short List Risk Matrix-Rev0.4MSM.xlsx]General (3) DATE: 06/10/20

HG PROJECT NUMBER: 1014-147856-01		Option	n 4A: Side	e Stream T	reatmen	t Plant (B	NR)	Option 4B: BNR Plant							
Risks	Descriptions	Likelih	ood	Conse	Consequence		Risk	Likelih	nood	Conse	quence	Risk	Risk		
NISK5	Descriptions	Rating	Score Rating		Score	Grade	Score	Rating	Score	Rating	Score	Grade	Score		
Non-performance of the overall treatment scheme	Treatment and disposal systems not operating to design objectives. Assumptions about the Wairoro Stream flow to calculate the required effluent quality are incorrect. Breach of Consent.	Unlikely	2	Major	4	High	8	Unlikely	2	Major	4	High	٤		
Dption not acceptable to iwi	Scheme may not have iwi endorsement; difficult to progress the scheme.	Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme	1		
Option not acceptable to community (negative perception and social unacceptance)	Public opposition to preferred option.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	1		
Local expertise not available to operate the plant	Plant operations and performance affected if expertise are not available to operate it correctly.	Unlikely	2	Moderate	3	Medium	6	Unlikely	2	Moderate	3	Medium	1		
Disruptions to existing WWTPs during construction	Effluent quality affected; breach of consents.	Unlikely	2	Major	4	High	8	Unlikely	2	Major	4	High			
Consenting difficulties	Required consent are not granted (land disposal options). Options selection process does not meet the requirements of the existing consent.	Unlikely	2	Major	4	High	8	Unlikely	2	Major	4	High			
Capacity/future proofing	Option is unable to meet the long term needs of the community. Insufficient capacity for future industry. Unable to deal with changes on the compliance requirements.	Unlikely	2	Major	4	High	8	Unlikely	2	Major	4	High			
Failure of equipment at the WWTPs	Failure of equipment at the WWTPs. Power loss.	Possible	3	Major	4	Extreme	12	Possible	3	Major	4	Extreme	:		
Option unaffordable		Likely	4	Major	4	Extreme	16	Likely	4	Major	4	Extreme			
Availability of suitable land	Risk that suitable land is unavailable to build WWTP upgrades (i.e. land has to be purchased), or the ground conditions of existing land are not appropriate.	Likely	4	Moderate	3	High	12	Likely	4	Moderate	3	High	1		
Ddour issues and wastewater sprays	WWTP odour issues affecting nearby residents. Wastewater spray from ponds to beyond property boundary.	Unlikely	2	Minor	2	Low	4	Rare	1	Minor	2	Low			
Cyanobacteria	Risk of discharging cyanobacteria to the waterbody.	Unlikely	2	Major	4	High	8	Rare	1	Major	4	High			
Dther risks	Avian botulism. Steep site access.	Possible	3	Moderate	3	High	9	Rare	1	Moderate	3	Medium			
	1		1	1	1	Total	106		1	L		Total	L		

