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14 October 2024

Warwick Pascoe / Mark Ross
Auckland Council
Private Bag 92300
Victoria Street West
Auckland 1142

Dear Warwick / Mark,

Beachlands Wastewater Treatment Plant Discharge Consent – DIS60433803

The following sets out Watercare's response to the Section 92 requests received by email on 30th July in relation to the Beachlands Wastewater Treatment Plant discharge consent.

The only technical report that has been updated based on the s92 questions and discussion with the Council Specialist (on 06/09) is the Ecology Assessment prepared by Streamlined. This report can be found in Attachment 1 of the s92 response. Additionally, see clarification below on the average flow and maximum flow.

A set of definitions is provided in the draft conditions.

Clarifications:

Average flow is referred to as the Annual Average Dry Weather Flow

Annual Average Dry Weather Flow (ADWF):
Annual Average Dry Weather Flow (**ADWF**): Average dry-weather flow means the flow in the wastewater network that would occur during a normal day in a dry weather period (i.e. three consecutive days of less than 5mm rainfall per day), including wastewater, trade waste and an allowance for groundwater infiltration.

For the purposes of compliance, the annual average dry weather flow shall be calculated every Calendar year based on the average dry weather flow recorded during the past year.

Maximum flow is referred to as the Peak Wet Weather Flow

Peak Dry Weather Flow (PDWF):
Peak dry weather flow is the peak flow to the wastewater treatment plant that would occur during a normal dry weather day.
Peak Wet Weather Flow (PWWF):
Peak wet weather flow is the peak flow to the wastewater treatment plant that would occur during wet weather.

Attachments:

1. Response to Q1 – Ecological Assessment v4 – October 2024
2. Response to Q6 – Vegetation Map
3. Response to Q8 – EOC sediment & biodata accumulation
4. Response to Q24 – DHI Te Puru
5. Response to Q30 – Beachlands FDC's and Methodology
6. Response to Q31 – CSM Schematic
7. Response to Q32 – OLFP Performance Investigation

8. Response to Q36 – Human Health Risks from EOC’s
9. WSL Draft Consent conditions

Note: A draft s92 response was shared prior to the meeting with Auckland Council specialists on 06/09/2024. Following our discussions, a number of the s92 matters were resolved and these are marked as closed in the responses below.

I trust that the information and responses provided satisfies the further information request. However, if there are any further queries please do not hesitate to get in contact.

Yours faithfully,

Anshita Jerath

Senior Planner

Watercare Services Limited

<table>
<tr><th></th><th>Request</th><th>Response</th><th>Completed</th></tr>
<tr><td colspan="4">Freshwater Ecology</td></tr>
<tr><td>1.</td><td>The submitted water quality, ecological, and human health effects assessment from Streamlined Environmental Limited, version F3, dated 27 May 2024, (the ecological report) states that the levels of a number of key nutrients are trending upwards due to increased discharge volumes in the current system. The primary ecological concern is that there appears to be limited certainty in respect of the length of time that Stages 1 and 2, and Stages 3 and 4 will be implemented. The noted issues of concern are:
• The assessment of actual and potential affects for Stages 1 and 2 apply the same operational limit of contaminant assessed, despite increased volume and load (coupled with increasing contaminant concentrations for several parameters).
• Stages 3 and 4 also apply the same operational limit for the assessment of actual and potential effects, also with an increased volume and contaminant loads. This Stage 3 and 4 effects envelope forms the focus of much of the assessment.
In addition, for all stages, it appears that an envelope of assessment that treats all discharges at maximum daily discharge flow has been applied. An indication of the average daily discharge flow and the maximum daily discharge flow would be useful in order to contextualise the likelihood / frequency of these different volumetric discharges, and how different these might occur in</td><td>In response to Q1 a, b and c - The Streamlined Ecological Effects assessment report has been updated to clearly delineate all four stages of the assessment. Refer to Attachment 1 for the report.

The table below provided an indication of the dry weather and wet weather discharges over the last 6 years.

<table>
<tr><th>Year</th><th>Average Dry Weather Flow</th><th>Peak Wet Weather Flow</th><th>Days above 2,200m³/d</th></tr>
<tr><td></td><td>m³/d</td><td>m³/d</td><td>days</td></tr>
<tr><td>2019</td><td>1,830</td><td>3,420</td><td>117</td></tr>
<tr><td>2020</td><td>1,675</td><td>3,801</td><td>81</td></tr>
<tr><td>2021</td><td>1,809</td><td>3,601</td><td>88</td></tr>
<tr><td>2022</td><td>1,970</td><td>4,257</td><td>132</td></tr>
<tr><td>2023</td><td>2,063</td><td>4,331</td><td>144</td></tr>
<tr><td>2024</td><td>1,997</td><td>3,922</td><td>85</td></tr>
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	practice so that the ecological implications can be assessed. Accordingly, please provide: a. an updated ecological impact assessment that considers effects associated with the stage 1 and 2 average daily and maximum daily flow states; b. an updated ecological impact assessment that considers effects associated with the stage 3 and 4 average daily flow states and how those relate to the maximum daily flow states (as only the maximum daily flow has been considered in the envelope of effects approach); and c. clarification of what population will trigger the proposed upgrades that will take flows from stage 2 and beyond. For example, the assessment of environmental effects (AEE) states that upgrades will be initiated prior to population equivalent (PE) 18,000 but does not state when and only notes that they will be operational at PE 24,000. As such, there is a potential period of time between these two triggers that has not been adequately assessed. In the response, please include details as to when such upgrades will occur and an associated assessment.		
2.	The baseline condition of the upstream reaches of the subject stream system (baseline condition) is reported to be degraded by existing land practices. However, the submitted ecological report suggests that the stream's ecological values might be moderate, which is characteristic of a valued freshwater system. Accordingly, please provide further evidence beyond water quality, macroinvertebrate, and fish data and analyse it to determine the baseline ecological value of the stream	A moderate value stream can be degraded through the land use practices, which the expanded stream value assessment from Boffa Miskell recognises "a watercourse which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues. Moderate to high degradation e.g. high-intensity agricultural catchment". The Te Puru Stream tributaries range from low to moderate ecological values, based on the presence of / lack of riparian vegetation; hard substrate; sustained water; fish habitat; macroinvertebrate habitat; erosion; ecological connectivity etc. It is acknowledged that the stream surrounding land use practices have degraded the quality of water.	

	using a value assessment framework that provides line of sight on the key contributors to ecological value. Furthermore, the National Policy Statement for Freshwater Management (NPSFM) requires assessing the effect on the potential ecological values of freshwater features. Please update the ecological report to assess the potential ecological value of potentially impacted freshwater ecosystems and consider effects on the potential ecological values. Note: the EIANZ provides a framework to determine freshwater ecological values. In addition, Boffa Miskel has advanced the EIANZ Ecology Impact Assessment framework for rivers and stream, which has been subsequently adopted by several consultancies. Council can provide this advanced framework if required.	Site A and Site E, which is outside the influences of the WWTP experienced high faecal coliform concentrations; also, to note is that despite the conductivity at these two sites being below the highly elevated levels of that at the influenced sites, these were still elevated and above the ANZG 80th percentile DGV. pH at Site A was very low and well below the DGV values. Only 3 to 4 fish species were sampled within the community, overall: thus, no clear trend of a higher diversity above the influences of the WWTP vs. below. The potential of streams is an estimate of the values or increase in ecological values under good land use practices i.e. in a rural environment such as this, fencing from stock and some degree of riparian planting. With good land use practices the potential of the stream would be or remain moderate. Stock are already excluded from most of the stream, and parts of the stream have been planted, for example the area downstream of the discharge from the large pond and downstream of the access road into the WWTP. Additional riparian planting will result in some ecological benefits such as an increase in shading, reducing the macrophyte growth and providing some temperature control in summer; additional aquatic habitat inputs, such as leaf litter, woody debris and woody habitat; and increase in filtration resulting in some reduction of nutrient inputs and other contaminants from the surrounding farmland.	
3.	Please provide the stream ecological value (SEV) scores for each survey site identified in Figure 29 of the ecological report. This will allow for a review of the various positions and justifications presented within the ecological report, such as shading, vegetation coverage, benthic structure, water depths, and stream profiles. Please also ensure that the SEV calculator is included.	No SEV's were undertaken. No reference to SEV's have been made in the EcIA or AEE. The biomonitoring measures many of the functions that are included within the SEV, i.e. widths, depths, flow, substrate, macrophytes, macroinvertebrates, fish, and records general information on the riparian vegetation. This information is readily available in the Biomonitoring Reports, including photographs of the site, from which parameters such as the quality of the riparian vegetation and degree of shading can be easily determined. This detailed information should be more than sufficient for an experience freshwater ecologist (both from Council and the Applicant) to verify the various positions and justifications presented within the ecological report.	
4.	It has been assessed that the farm pond may throttle high flow discharges. Please provide an explanation and assessment of whether fish passage over the structure	The farm pond provides continuous unimpeded flow via the stream outlet. No fish passage structure is required or proposed as the proposal will not impact the stream outlet from the pond.	Closed

	is available, and a description of the passage structure if proposed. It should be noted that in order to comply with applicable regulations under the Auckland Unitary Plan (Operative in Part) (AUP(OP)), dams higher than 4m should provide fish passage.		
5.	Please provide an ecological value and effect assessment of the discharge on various significant ecological areas at each stage.	Discharges should be confined to the stream banks, with the SEA-Terrestrial (SEA_T_428) experiencing no direct or permanent/consistent effects from the discharge. Effects of the discharge to the SEA will occur through uptake of nutrients via riparian yard root zone or overtopping banks during flood events. Given that uptake through the root zone would be limited to those species immediately along stream edges, should there be any affects, it is expected to be limited to those specific species. SEA_T_428 is based on the area meeting Criteria 2B, threatened species, and Criteria 3A, habitat diversity. The listed threatened species for the site are longfin eel (classified as 'At Risk – declining) and koura (classified as 'Not Threatened'. Both species are present throughout the catchment and not uncommon within the district. The habitat diversity criteria are *VS2, UC*. VS2 is 'kanuka scrub and forest ecosystem' which is listed as a regenerating ecosystem with a threat status of 'Least Concern', the entirety of which is located well above the discharge point from the pond; and UC, unclassified, much of which is shown on the GeoMaps biodiversity layer as 'planted'. Refer figure below). The ecological effects of the discharge on the terrestrial values of the SEA-T will be negligible, primarily due to the low threat status and lack of proximity of the discharge to the VS2 habitats, and on the aquatic values i.e. native eels, will be low, as neither of the main triggers for their decline, i.e. habitat loss and overfishing will be changed with the proposal. It should also be noted that the tributary that originates above the pond would be dry for some of the year without the input from the WWTP. Figure 1: SEA_T_428 Ecosystem Extent and point of discharge from the pond (purple dot). Source Map – Auckland Council GeoMaps.	

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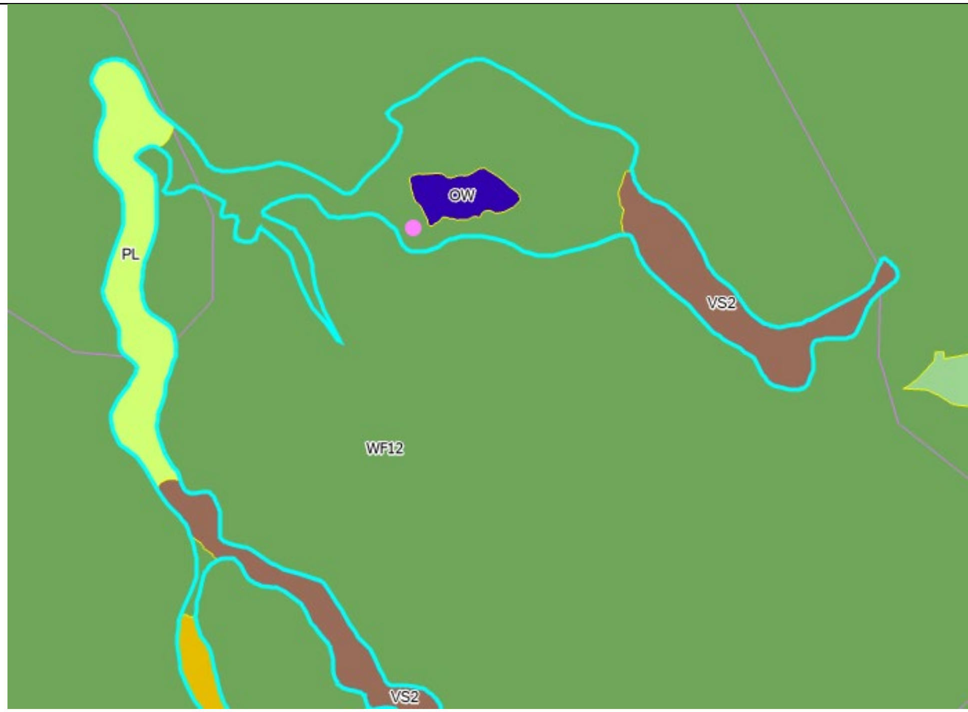
<td>
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<td>6.</td>
<td>It is understood that the land disposal element of the proposed discharge system will avoid natural inland wetlands, in that it will be located a minimum of 100m from them. Please provide further evidence, which could include mapping the extent of the disposal area against landscape features, to confirm that there will be adequate land available to achieve this set back from all natural inland wetlands. Alternatively, please provide an addendum that addresses this, including any necessary consents under the National Environmental Standards for Freshwater and an associated effects assessment.</td>
<td>The discharge of wastewater to the overland flow slopes may occur within 100 m of a natural inland wetland. However, there will be no hydrological link between the discharge and any natural inland wetlands. Any wastewater discharged to new overland flow areas will be captured and conveyed to a controlled discharge point in the farm pond.

PDP has surveyed vegetation within the vicinity of the existing and proposed discharge areas. The results are provided in Figure 1 of Attachment 2. The following vegetation types were identified:

1) Exotic Pasture Grassland
2) Soft Rush - Mercer Grass - (Water Pepper) Rushland
3) Ti Kouka - Kohuhu / Harakeke Herbfield</td>
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		4) Crack Willow (>50%) - [Kanuka] / Water Pepper - Creeping Buttercup Treeland 5) Creeping Buttercup - Water Pepper - (Soft Rush) Herbfield 6) Kanuka / Manuka / (Woolly Nightshade) Shrubland 7) Pine (>50%) / Kanuka / Manuka - Woolly Nightshade Forest 8) Carex Geminata Sedgeland 9) Raupo Reedland 10) Grey Willow / Harakeke - Raupo Treeland 11) Poplar - Oak Exotic Treeland 12) Kahikatea / Kanuka - Manuka Forest The vegetation types names follow Atkinson (1985), thus the order and symbols reflect dominance. This is relevant because the mix of dominant species determines whether an area is a wetland or not, i.e. if a species is an obligate (OBL) or facultative wetland (FACW) species (Clarkson et al., 2021). Areas with vegetation types 2, 4, 8, 9 and 10 on the map were identified as wetlands under the RMA based on the Rapid Test or Dominance and Prevalence tests (MfE, 2022). Areas with vegetation type 5 could also possibly be wetlands but the balance of wetland to non-wetland dominant species was marginal. Vegetation areas 9 and 10 are thought to be constructed or induced wetlands. In vegetation area 2 (Soft Rush - Mercer Grass - (Water Pepper) Rushland), in the gully between areas B1 and B2, three representative samples (2 x 2 m plots) were taken. The results for the sample at the gully head came out as “improved pasture” so the extent of this wetland area could be reduced by approximately 75 m back towards the stream. The catchment for the wetland area between B1 and B2 has also been mapped and is included in Figure 1. Area B2 is the preferred expansion area. If, during the detailed design, any impact on the hydrology of the existing natural wetlands cannot be avoided, then a consent will be sought at that time, along with any other relevant construction phase consents including earthworks or vegetation clearance consents. Wetland delineation data sheets for the wetlands in the catchment – provided. The wetlands that meet the MfE Wetland Delineation Protocols (2024) are provided, including a summary of the plots and where appropriate, hydric soil and hydrology data. The plans accompanying	

		the wetland delineation data sheets identify the location of the wetland plots and they are all further than 100m from the deliberately constructed water body where treated wastewater has been discharged since the construction of the Beachlands WWTP. Beachlands/Maraetai WWTP constructed treatment pond and associated wetlands are constructed wetlands under NPS-FW definition 3.21. **NPS-FM natural inland wetland 3.21** Natural inland wetland means a wetland (as defined in the Act) that is not: a. in the coastal marine area; or b. a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland; or c. a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or d. a geothermal wetland; or e. a wetland that: (i) (ii) (iii) is within an area of pasture used for grazing: The WWTP pond is "a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body;" Auckland Council have provided no evidence that these constructed wetlands surrounding the constructed pond have been induced and PDP staff (and other consultants) in the field have not observed that the constructed wetland area is notably "higher" up than the pond. Consequently, the wetlands around the constructed wastewater discharge pond are not natural inland wetlands (NPS-FW 3.12 (c)). PDP's ground-truthing has identified NPS-FM natural inland wetlands on the site, and we consider that treated wastewater from the overland flow area will avoid these natural inland wetlands as it is directed to the constructed treatment pond. AC have also raised the matter of whether the constructed wastewater discharge pond is a SEA under the Auckland Unitary Plan. Beachlands/Maraetai WWTP constructed treatment pond and associated wetlands have been in place well before the Council's SEA surveys in 2012-3.	

		SEA wetland (Ch L Schedule 3, Auckland Unitary Plan only) SEA_T_428 appears to have only been mapped from aerial coverage with no ground-truthing to verify that it meets any of the SEA factors or sub-factors. Auckland Council SEA assessors appear to have been unaware that the WWTP constructed pond and wetland were part of the existing infrastructure, deliberately constructed water body and NOT a "natural ecosystem".	
Water Quality – Emerging Contaminants			
7.	Section 5.3.5 of the ecological report refers to the concentration and resulting high risk quotient for venlafaxine as being an anomaly. Please indicate how this value compares to other wastewater treatment plants (WWTP) as reported in Table 5 (if data are available), or other applicable data sets in New Zealand.	To clarify we stated in Section 5.3.5 that "As shown in **Table 17**, the only RQ >1 in the outlet is venlafaxine with an RQ of 1.7. Interestingly the RQ for venlafaxine in the farm pond is 23.1, but at the Bridge site it is 0.34 (**Table 17**). There is large variation in the two venlafaxine measurements (600 ng/L on 10th November and 40,000 ng/L on 11th November), with the latter value driving the high RQ at this site. This is likely an anomaly as there is a general significant attenuation between the farm pond discharge point and the Bridge site for PPCPs with an average of 2.9-fold reduction (see Section 4.4.1.5)." The anomaly is the value of 40,000 ng/L and is clearly an outlier based on the other measurements and the general attenuation observed from discharge and through the receiving environment. To our knowledge there are no publicly available data on venlafaxine in wastewater in New Zealand. However, Watercare have undertaken measurements of venlafaxine in effluents from 4 WWTPs: Army Bay; Mangere; Rosedale; and Warkworth. These data were provided to Streamlined Environmental Ltd for another project. Average concentrations (N=2) ranged from 200-700 ng/L at these WWTPs. The average concentration (N=2) from Beachlands WWTP effluent is 1500 ng/L. Internationally, a review by Melchor-Martínez et al (2021[1]) reported venlafaxine of 788–2982 ng/L in effluent from 5 sewage treatment plants in Canada.	Closed

[1] https://www.sciencedirect.com/science/article/pii/S2666016420300724

		This provides strong evidence that 40,000 ng/L for venlafaxine for one sample from the farm pond is an anomaly.	
8.	Sediment bioaccumulation risks of emerging organic contaminants (EOCs): Based on the authors' knowledge about sediment bioaccumulation of EOCs and available data, please provide an assessment as to the risk / potential of analysed personal care products and pharmaceuticals (PCPPs) (and other EOCs, where applicable) in the Beachlands WWTP discharge to sediment bioaccumulation in the downstream receiving environment, both at the Bridge Site (Site 15) and estuary.	Response has been prepared as an attachment. Refer to **Attachment 3**	Closed
Water Quality – Staged Assessment			
9.	Table 6 of the ecological report sets out the operational limits for key contaminants, with footnote 13 cross referencing Stantec and Watercare. Please provide the rationale / justification for the Operational Limits presented in Table 6. Please include the process by which these limits were reached.	The proposed operational / consent concentrations have been based on the effluent quality that can be reliably achieved with the treatment technology at a given stage of the WWTP upgrade. The current operational limits are a rollover of the existing consent. The short-term upgrade limits are based on an improved concentration limit. These limits reflect the fact that the short-term upgrade will include capacity and minor upgrades to the existing plant. The long-term Stage 1 and Stage 2 operating limits reflect the improvement in treatment performance that is anticipated with the implementation of the new membrane bioreactor (MBR) technology that will be built as part of the long-term upgrade. These proposed operating limits proposed are in line with other WWTPs with a similar treatment technology. The operating limits on flow reflect the population growth that is anticipated at various stages. The proposed operational / consent concentration values were reached by a combination of local Watercare operational experience and known wastewater treatment technology performance.	

		Because the proposed operational / consent concentrations are technology based, the values do not change within a given technology (i.e. current WWTP or new WWTP). The WWTP upgrades will be designed to ensure that these limits will be met at all populations up to their respective design populations.	
10.	Please explain why there is no differentiation in the operational limits between: • 'Current and Short Term', noting this represents an increase from PE 11,000 to PE 18,000; and • 'Long term Stage 1 and Stage 2 ', noting this represents a PE 24,000 to PE 30,000	A staged approach to the upgrade of the Beachlands WWTP has been adopted to facilitate the anticipated growth that is expected in the existing WWTP catchment and the new Beachlands South development. Two sets of operational limits have been proposed to reflect the effluent quality of the treatment technologies at the different stages of the upgrade. In the short term an upgrade of the existing plant will be completed to increase the current capacity of 11,000 PE to 18,000 PE. This will facilitate growth in the short term while the design and construction of Stage 1 of the long-term upgrade is completed. The proposed 'Short Term' consent limits reflect the expected effluent quality based on the treatment process of the existing plant and have been based on the current consent conditions. The long-term upgrade strategy for the WWTP is to build a new treatment plant that includes a membrane bioreactor (MBR) technology. The proposed 'Long term Stage 1 and Stage 2' operational limits reflect the improved effluent quality that can be achieved with the MBR. The new MBR plant will be built in two stages to align the capacity of the plant with the anticipated population growth. As the treatment technology for Stage 1 and 2 of the long-term upgrades is the same, the proposed operational / consent limits for the two stages are also the same.	
11.	The last bullet point on page 10 of the ecological report refers to TN, Amm-N and Nitrate-N concentrations are at Attribute Band B; and dissolved inorganic nitrogen (DIN) at levels expected to contribute to eutrophication (noting here that DIN is the sum of nitrite-nitrate-nitrogen (NNN), ammoniacal-nitrogen (Amm-N) and nitrate-nitrogen (Nitrate-N). Noting the current state assessment has been provided for PE 11,000, what are the expected concentrations (median, average, 95th percentile) and	This is related to Q1 and will be provided in the updated effects assessment report. Note: Table 16 has this for nitrate and DRP. Ammonia is not applicable, and we discussed this in the report.	

	annual average loads of all key contaminants at the following stages: • PE 18,000 (prior to the long-term upgrades being operational). • PE 24,000 • PE 30,000 In the response, please provide an assessment of the water quality (with corresponding attribute state and other relevant benchmarking) at each PE threshold (PE 18,000, PE24,000 and PE30,000), for the following locations: • The treated effluent discharged from the WWTP (prior to overland distribution) • Treated effluent after overland flow, prior to discharge to the Farm Pond (noting this is also pending the final PDP assessment) • Farm Pond (Site B) • Discharge to the Te Puru Stream (exiting the farm pond) • At the Bridge Site (Site 15, zone of mixing) • Quarry Site Te Puru Estuary		
12.	What is the expected percentage increase in DIN (noting that is it over 90% Nitrate-N), and what is the proportional increase in risks to eutrophication at the mixing zone (Site 15) and Te Puru Estuary.	There will be a decrease in nitrate-N (and by inference DIN) from the current situation once the operational limits are introduced. We covered this in section 5.3.2.3 of the effects assessment report (V3 submitted) and have provided further clarification in the updated report (V4: to be submitted alongside these responses). We stated "The currently measured median DIN concentration in the WWTP discharge and the Bridge Site is 5.5 mg/L and 1.7 mg/L, respectively. The Bridge Site concentration is well above the accepted threshold for a degraded water body and eutrophication (1 mg/L). The proposed operational maximum DIN in the WWTP discharge during all stages of the upgrade: 4.1 mg/L for the Existing and Short-Term Stages and 2.5 mg/L for the new MBR Long-Term Stage 1 and 2 Stages, will be a reduction on what is presently in the WWTP	

		discharge (5.5 mg/L). This will result in a mean DIN concentration at the Bridge site from the proposed discharge of 1.3 mg/L for the Current and Short-Term Stages and 0.8 mg/L for the new MBR WWTP (Long-Term Stages 1 and 2), respectively (Table 17). We note that these proposed operational medians will require an improvement on the present DIN WWTP concentration of 5.5 mg/L. DIN would still be above the accepted threshold for a degraded water body and eutrophication for the Current and Short-Term Stages (but an improvement on current state) but below the same threshold for the new MBR WWTP (Long-Term Stages 1 and 2)." Te Puru Estuary site is covered in Section 5.5.1, stating (in V4 of the report which now has future stages included) "Concentrations of nitrogen (TN and nitrate-N) and phosphorus (TP and DRP) show a clear decrease in concentration down Te Puru stream with increasing distance from the WWTP due to dilution (See Section 4.4.1.2). Concentrations will be further decreased by rapid mixing with coastal waters. The levels of dilution in coastal surface waters predicted by DHI for the current WWTP discharge and proposed for the upgraded Short-Term, Long-Term Stage 1 and Long-Term Stage 2 are shown in Table 21." At the existing Short-Term Stage, the 50th percentile dilution factor at Te Puru stream mouth is 1,352×, which increases to 13,302× midway down Te Maraetai/Kellys Beach (northern transect), and to over 675,000× by the neighbouring bays (Shelly Bay, Pohutukawa Bay, and Omana Beach). Given a median discharge concentration of 7 mg/L for TN in the treated wastewater, concentrations due to the WWTP will be approximately 0.005 mg/L at Te Puru stream mouth, 0.0005 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.00001 mg/L in the neighbouring bays. Similarly, the concentration of TP will be diluted from 1.0 mg/L in the treated discharge to approximately 0.0007 mg/L at the Te Puru stream mouth, 0.00008 mg/L at the northern transect on Te Maraetai/Kellys Beach, and <0.000001 mg/L in the neighbouring bays. At Long-Term Stage 1, the 50th percentile dilution factor at Te Puru stream mouth is 831×, which increases to 7,928× midway down Te Maraetai/Kellys Beach (northern transect), and to over 427,000× by the neighbouring bays (Shelly Bay, Pohutukawa Bay,	

		and Omana Beach). Given a median discharge concentration of 5 mg/L for TN in the MBR treated wastewater, concentrations will be approximately 0.006 mg/L at Te Puru stream mouth, 0.001 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.00001 mg/L in the neighbouring bays. Similarly, the concentration of TP will be diluted from 0.5 mg/L in the treated discharge to approximately 0.0006 mg/L at the Te Puru stream mouth, 0.00006 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.000001 mg/L in the neighbouring bays. At Long-Term Stage 2, the 50th percentile dilution factor at Te Puru stream mouth is 309×, which increases to 2554× midway down Te Maraetai/Kellys Beach (northern transect), and to over 180,000× by the neighbouring bays (Shelly Bay, Pohutukawa Bay, and Omana Beach). Given a median discharge concentration of 5 mg/L for TN in the treated wastewater, concentrations will be approximately 0.016 mg/L at Te Puru stream mouth, 0.002 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.000028 mg/L in the neighbouring bays. Similarly, the concentration of TP will be diluted from 0.5 mg/L in the treated discharge to approximately 0.0015 mg/L at the Te Puru stream mouth, 0.00019 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.000003 mg/L in the neighbouring bays." We note that DIN was not included in the discussion. However, using the same 50th percentile dilution of 309x at Te Puru Stream mouth, and Short-Term and New WWTP (MBR) operational limits for DIN of 4.1 mg/L and 2.5 mg/L, respectively, concentrations at Te Puru Stream mouth will be approximately 0.013 mg/L (existing) and 0.008 mg/L (New WWTP (MBR). Therefore, DIN concentrations at this site (attributable to Beachlands WWTP) will be extremely low, lower than present, and expected to contribute a negligible amount to eutrophication in the estuary. As a side note, the design population for the Short-Term Upgrade (18,000 PE) was selected to accommodate the highest expected initial development rate of the Private Plan Change 60 housing development. This population also aligns with the maximum	

		that can be catered for by the existing WWTP without constructing major new civil infrastructure.	
13.	What are the likely drivers of significant trends in increasing Nitrate-N and dissolved reactive phosphorus (DRP) in the discharge quality? Please provide an assessment of how this is likely to track up to PE 18,000 and up to the new long-term upgrades becoming operational.	In 2022 carbon dosing source was changed from Methanol to Acetic Acid. The dosing regimen also changed from continuous to a setpoint based dose. The current setpoint is based on meeting the consent condition. Nitrate can be controlled by increasing the carbon dose. We will dose the appropriate volumes to meet the consent conditions, and this will be covered in the OMP. Part of the upgrade to the WWTP will include review of the chemical dosing and chemical storage.	
14.	Two bullet points on page 15 of the ecological report appear contradictory in that the first point refers to Amm-N as having an overall low contribution of 0.5% and unlikely to be significantly contributing to Amm-N downstream, but the second point refers to pond processes will increase Amm-N. Based on these statements, please provide: • a detailed explanation of the processes in the pond (likely ammonification processes – what is driving this, and can it be mitigated?) that will continue to increase Amm-N; • an estimate of Amm-N concentrations in the downstream receiving environment; and an assessment of how Amm-N concentration and loads in the farm pond will likely change over time as a result of increasing loads at PE 18,000, PE 24,000 and PE 30,000, and the capacity of the farm pond and upgraded overland flow system (OFS) to attenuate elevated Amm-N loads.	P52 of the affects assessment report discusses this. "With low concentrations of ammoniacal-N in the existing WWTP discharge it is clear that the farm pond is forming ammoniacal-N, presumably from nitrogen cycling processes such as ammonification of organic nitrogen formed from decomposition in the pond. It is only in the farm pond that concentrations of ammoniacal-N could be potentially toxic. Further, the WWTP is providing a low proportion of ammoniacal-N to total nitrogen (ca. 0.5%) being discharge from the WWTP. Therefore, the existing discharge from the Beachlands WWTP is unlikely to be significantly contributing to ammoniacal-N concentrations downstream." Regarding the first point, this was described on p51 in detail " The nitrogen cycle is complex with multiple species of N present, such as inorganic nitrogen – ammoniacal-N, nitrate-N, and nitrite-N – and organic nitrogen (consisting of many organic nitrogenous chemicals including amino acids, proteins, and other biological metabolites). Further, the nitrogen cycle (see Figure 1 below) will interconvert inorganic nitrogen species through processes such as nitrification, denitrification, and dissimilatory nitrate reduction to ammoniacal-N. Ammoniacal-N can also be formed from ammonification of organic nitrogen formed from decomposition of organic material." In terms of mitigation, we do not consider this necessary as the trend data (2020 to 2023) shows a 0% annual change in ammoniacal-N concentrations at the farm pond site. Further, there is low toxicity from site 15 which reduces further downstream (see next point). Finally, with population increase, a new overland flow system will be constructed. How this affects concentrations of all toxicants is unknown at this stage but we expect that treatment efficiency will be at the same level as current.	Closed

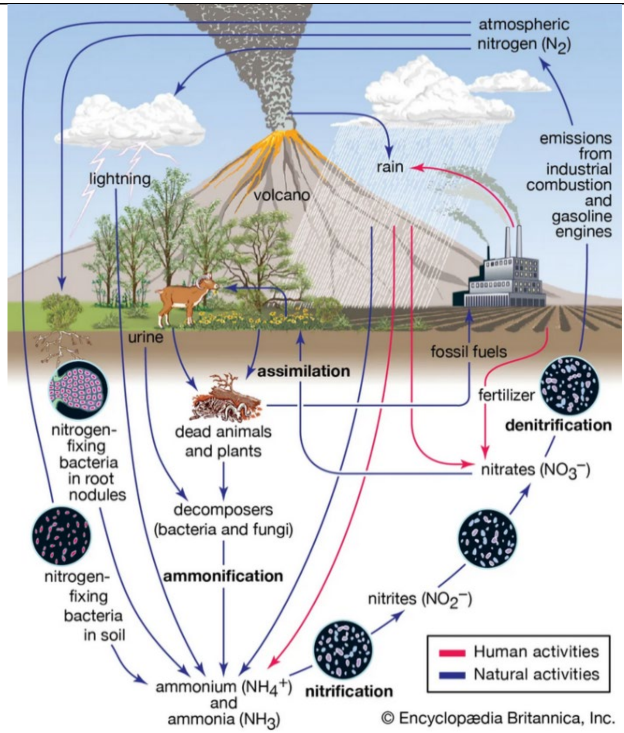

Figure 2: The nitrogen cycle.[2]

Regarding point 2, ammoniacal-N has been measured at downstream receiving environments so no need to estimate it (see Figure 19 of report). We reiterate the above statement that only in the farm pond that concentrations of ammoniacal-N could be potentially toxic, with concentrations at site 15 (proposed mixing zone) in NPS-FM attribute band B.

Regarding point 3, the Beachlands WWTP currently produces effluent with a very low level of ammoniacal-N. Based on the overland performance investigation, the overland

[2] https://www.britannica.com/science/nitrogen-cycle

flow slopes are effective at further reducing ammoniacal-N concentrations (see table below).

Table 1: Nitrogen Removal Efficiency by Overland Flow Slope Zone			
Parameter	**Zone A**	**Zone B**	**Zone C**
Nitrate-N	21%	14%	4%
Total Nitrogen	24%	17%	6%
Ammoniacal-N	36%	55%	26%
Notes:			

As discussed above, ammoniacal-N concentrations increase in the farm pond. The results from the performance investigation are presented below.

Table 2: Median Ammoniacal-N Concentrations (g/m³) Across Overland Flow System				
WWTP Effluent	**Zone A**	**Zone B**	**Zone C**	**Pond Outlet**
0.057	0.030	0.030	0.044	0.102
Notes:				

It is expected that in the future, the overland system expansion will continue to enable the slopes to efficiently reduce ammoniacal-N concentrations. This combined with low ammoniacal-N concentrations in the WWTP effluent is expected to result in very low concentrations of ammoniacal-N in the run-off from the slopes.

The effects of the increasing flows/loads on nitrogen cycling in the pond are difficult quantify. It also appears that the level of ammoniacal-N generation in the pond varies significantly as evidenced by the differences between the median concentrations reported in PDP Memorandum 2 and in the Performance Investigation Report (data presented above). It is possible that the generation of ammoniacal-N in the pond reduces as increasing wastewater flows reduce the residence time in the pond.

15.

With section 3.4 of the ecological report, the second bullet point makes reference to marked increases in DRP and Nitrate-N and refers to 'operational changes and constraints'. Please provide details on what these 'operational changes and constraints' were, how these result in significantly increasing trends in DRP and Nitrate-N and explain what process will be put in place to mitigate the 'operational changes and constraints' prior to the upgrades being commissioned.

Refer to response in Q13.

The second part of the question is around how these changes affect trends. Trends are described in Section 3.1.5 of the effects assessment report, with nitrate (23.5% annual median increase between 2018-2023) and DRP (77.4% annual median increase between 2018-2023) the only significant increases over this time. It is clear from Table 2 and Figure 4 of the report that marked increases have occurred since 2022 for nitrate and 2021 for DRP.

Temporal trend analysis, using the same methodology as in the effects assessment report, was undertaken for DRP between 2018-2020 and 2021-2023, while for nitrate between 2018-2021 and 2022-2023 and results (Table 1) compared with the full dataset (2018-2023). The results show that DRP had a negative percent annual change between 2018-2023 (-3%) with an increase of 11% per year between 2021-2023, however none of these trends were significant. For nitrate-N there was a similar trend with an annual reduction of –4% between 2018-2020 and a 36% annual increase between 2021-2023. Only the 2021-2023 trend was significant (P<0.05).

The number of datapoints for each trend do not appear to influence the significance. For example, nitrate-N between 2018-2023 (N=48) has a non-significant trend, while between 2021-2023 (N=24) has a significant trend.

Therefore, the recent increases in DRP and nitrate-N are contributing to significant increases calculated between 2018-2023.

Table 1. Temporal trend analysis of DRP and Nitrate-N. Red highlighted text are significant (P<0.05).

Parameter/Date range	**Method**	**N**	**Mean**	**Median**	**P**	**Percent annual change**
DRP 2018-2023	Seasonal Kendall	72	0.35	0.28	0.000	24
DRP 2018-2020	Seasonal Kendall	36	0.22	0.20	0.880	-3

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<tr><td>DRP 2021-2023</td><td>Seasonal Kendall</td><td>36</td><td>0.47</td><td>0.49</td><td>0.299</td><td>11</td></tr>
<tr><td>NO3-N 2018-2023</td><td>Mann-Kendall</td><td>72</td><td>2.09</td><td>1.18</td><td>0.000</td><td>77</td></tr>
<tr><td>NO3-N 2018-2020</td><td>Mann-Kendall</td><td>48</td><td>0.86</td><td>0.37</td><td>0.715</td><td>-4</td></tr>
<tr><td>NO3-N 2021-2023</td><td>Seasonal Kendall</td><td>24</td><td>4.56</td><td>4.50</td><td>0.001</td><td>36</td></tr>
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<td>16.</td>
<td>Please confirm if the Amm-N data in Table 8 are adjusted for pH? If not, please either make this adjustment or explain why it is not necessary to do so.</td>
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Ammoniacal-N concentrations in Table 8 of the effects assessment report were not adjusted for pH. We note that the NPS-FM attribute state for ammoniacal-N toxicity is based on pH 8 and a temperature of 20°C and that compliance with the numeric attribute states should be undertaken after pH adjustment but that a method for converting to standard temperature is not currently available.
The pH adjustment is required because unionised ammonia (NH_3) is more toxic than the ammonium ion ($NH4^+$) but the method of analysis does not differentiate between these two ammoniacal-N species. Therefore, the lower the pH, the lower the toxicity (a higher proportion of ammonium ion).
The Ministry for the Environment provides a guide to attributes in the NPS-FM, and specifically and appendix on ammonia adjustment calculations. The formula for pH adjustment is shown below. The ratio is a conversion ratio of the pH measured to pH 8 and is provided in a look up Table in pH increments of 0.1 from 6.0 to >9. Effectively, the ratio is >1 below pH 8 (reduces toxicity) and <1 above pH 8 (increases toxicity).
$$Conc_{pH\,8} = \frac{Conc_{pH\,sample}}{Ratio} \qquad \text{Equation (1)}$$
It would be time consuming to perform ammoniacal-N adjustments for pH for each monitoring event as pH varies for each event. We note that for all sites where the receiving monitoring programme was undertaken between September 2023 and January 2024 median and 80th percentile pH ranges are 6.7-7.6 and 6.8-7.7, respectively.
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		pH was below 8 on all but two occasions: pH 8.9 at the Quarry site on 13th November and pH 8.0 at Te Puru Park on 27th November. In summary, pH is almost always below pH 8 at the receiving environment sites, so an adjustment of ammoniacal-N to pH 8 will reduce concentration for attribute state comparison (and hence toxicity) accordingly. However, as the ecological effects assessment report is being updated, we will modify Table 8 to include pH adjusted ammoniacal-N concentrations (based on median pH at each site).	
Coastal Ecology			
17.	Based on the operational results provided for the existing discharge quality, it appears that the existing discharge volume has exceeded the consent limit, with potential adverse effects on the coastal environment resulting due to the exceedance in discharge quality. Without additional treatment for the existing discharge quality, the proposal may not be supportable. Accordingly, please provide the discharge volume (not average volume) and discharge quality for all four stages along with an assessment of the likely adverse effects.	Volume has exceeded consent limit not quality. In respect to effects, refer to Q1 above.	
18.	The submitted ecological report clearly identifies the current discharge quality and exceedances in respect of the ANZECC quality guidelines, as set out below: • Dissolved reactive phosphorus and nitrate-N have shown a marked increase in concentration between 2018-2023, with median annual increases of 24% and 77%, respectively. • Volume of discharge exceeded the maximum consented volume of 2,800m3/day. Table 1(section 3.13 Ecological Report) indicates the volume discharged was 5619m3 in 2018 and 4.331m3/day. • The discharge contains total copper, and total and dissolved zinc at concentrations above the	**Copper and zinc in freshwater and marine receiving environment** a. The daily volume of discharge from 2018 to 2023 almost doubled. Copper and zinc are toxic to marine life, with both exceeding the ANZEC guideline value in the existing discharge. We note that metal concentrations are not breaches as there are currently no consent conditions for metals in the discharge. It is not appropriate to compare WWTP discharge concentrations with ANZG (2018) DGVs as the DGVs are calculated for freshwater and marine species in their environment. Despite this, we note that "For the outlet, only total copper, and total and dissolved zinc exceed the DGV, at 1.3-fold, 2.0-fold, and 3.4-fold, respectively (Table 4)." These are minor exceedances. Further, metals were measured at the receiving environment sites (Table 9). We noted that "All metal concentrations were below the applicable ANZG 95% DGV.	Closed

	Australian and New Zealand Guidelines (ANZG) 2018 default guideline values. To achieve these standards some dilution and/or attenuation is required in the wastewater treatment system prior to discharge to the coastal receiving environment in order to meet these standards. • After attenuation through the overland and stream system, Total Nitrogen (TN) and Total Phosphorus (TP) loads contribute 32% and 44% of total load from the catchment to the marine coastal environment. In respect of these matters, please provide answers to the following questions: a. The daily volume of discharge from 2018 to 2023 almost doubled. Copper and zinc are toxic to marine life, with both exceeding the ANZEC guideline value in the existing discharge. There is no assessment in the AEE or ecological report to assist with understanding how the above breaches, including the exceedance of copper and zinc, could be avoided within the WWTP treatment during stages 1 and 2. Please provide this. b. While Membrane Bioreactor (MBR) treatment will reduce the nutrient level in the discharge, what is proposed to manage the exceedance in the total copper and zinc? c. Please provide the background level of TN and TP for the immediate receiving coastal waters and sediment. d. Please provide an assessment to understand the effects of TN and TP on the coastal marine	Chromium (total only), copper (total and dissolved) and zinc (total and dissolved) concentrations at the farm pond (B) site were more than 50% of the ANZG 95% DGV, but all had reduced to 50% or below by the Bridge site (15) site". So, an assessment of potential effects for metals was made based on monitoring data. We do not expect metal concentrations to increase over time and are likely to reduce once the MBR WWTP is commissioned (see next point). **Management of zinc and copper levels** b. While Membrane Bioreactor (MBR) treatment will reduce the nutrient level in the discharge, what is proposed to manage the exceedance in the total copper and zinc? As for the first point, we note that metal concentrations are not breaches as there are currently no consent conditions for metals in the discharge. We note that both copper and zinc have markedly higher total vs dissolved concentrations in the discharge (Table 4: copper 1.9/1.4 µg/L and zinc 28/16 µg/L for total/dissolved), so reducing particulate matter in the discharge will reduce discharge total metal concentrations. Total suspended sediment (TSS) will reduce from around 7 mg/L currently to 5 mg/L with MBR so, notwithstanding potential reductions from the MBR process over the current activated sludge process, total metal concentrations will reduce accordingly. **Background levels of TN and TP** c. Please provide the background level of TN and TP for the immediate receiving coastal waters and sediment. The nearest Auckland Council marine water quality monitoring site is at the mouth of the Wairoa River, approximately 13 km from Kellys Beach. Median TN concentrations for the last three years of available data (2018–2022) were 0.18 mg/L (25^{th}–75^{th} quartiles: 0.14–0.21), while median TP concentrations were 0.024 mg/L	

	environment, and mainly in respect of algal blooms. Will the estimated TN and TP availability from all four stages be likely to enhance plant growth at the immediate receiving environment?	(25th–75th quartiles:0.02–0.029) (Kelly & Kamke, 2023).[3] Historically water quality in the mouth of Turanga Estuary, Whitford was also monitored by Auckland Council. Turanga Estuary was last monitored in 2015, when median TN was 0.005 mg/L and median TP was 0.019 mg/L (Williams *et al.*, 2017)[4] (Note that the Turanga Estuary medians were only based on 6 months of data). Marine sediment concentrations of TN and TP in the vicinity of Kellys Beach are not routinely monitored by Auckland Council or other agencies. Coast and Catchment collected marine sediment data from the Wairoa Embayment in 2018 and 2021 as part of new marine farm applications. Mean TN concentrations at the unfarmed control sites were 0.04 g/100 g in 2018 and 0.058 ± 0.009 S.E. g/100 g in 2021 (Sim-Smith *et al.*, 2018; Sim-Smith & Kelly, 2021)[5]. No information could be found on background sediment concentrations of TP in the area. **Effects of TP and TN on algal blooms (also see response to Q.26 on *Lyngbya*)** d. Please provide an assessment to understand the effects of TN and TP on the coastal marine environment, and mainly in respect of algal blooms. Will the estimated TN and TP availability from all four stages be likely to enhance plant growth at the immediate receiving environment?	

[3] Kelly, S.; Kamke, J. (2023). Coastal and estuarine water quality in Tāmaki Makaurau / Auckland 2021–2022 annual data report. Auckland Council Technical report 2023/19. Auckland Council, Auckland. 61 pp.

[4] Williams, P.; Vaughan, M.; Walker, J. (2017). Marine water quality annual report 2015. Auckland Council Technical Report no. 2017/015. Auckland Council, Auckland. 48 pp.

[5] Sim-Smith, C.; Kelly, S.; Bramley, G. (2018). Ecological assessment of Kauri Bay oyster farm to support a farm extension. Coast and Catchment report no. 2018-11 prepared for Pahiki Marine Farms. 32 pp.

Sim-Smith, C.; Kelly, S. (2021). Ecological assessment of a proposed oyster farm: Wairoa Estuary, Clevedon. Coast and Catchment report no. 2021-01 prepared for Pakihi Marine Farms Ltd. 38 pp.

		High inputs of nutrients into coastal environments can cause excessive primary production. In New Zealand coastal waters, nitrogen (not phosphorus) is almost always the limiting nutrient for primary production (Valiela *et al.*, 1997; Neill & Rees, 2003; Howarth & Marino, 2006; Plew *et al.*, 2018)[6], therefore only the TN concentrations are considered in the assessment of effects. Plew *et al.* (2018) developed the following eutrophication risk categories for NZ estuaries based on TN (for macroalgae) and chl-*a* (for phytoplankton) concentrations: 1. <u>Macroalgae:</u> a. Minimal eutrophication <80 mg/m^3 or if salinity is < 5 ppt b. Moderate eutrophication 80–200 mg/m^3 c. High eutrophication 200–320 mg/m^3 d. Very high eutrophication ≥320 mg/m^3 2. <u>Phytoplankton (for estuaries <30 ppt salinity)</u>: a. Minimal eutrophication chl-*a*<5 µg/L b. Moderate eutrophication chl-*a* 5–10 µg/L c. High eutrophication chl-*a* 10–16 µg/L d. Very high eutrophication chl-*a* ≥16 µg/L	

[6] Valiela, I.; McClelland, J.; Hauxwell, J.; Behr, P.J.; Hersh, D.; Foreman, K. (1997). Macroalgal blooms in shallow estuaries: Controls and ecophysiological and ecosystem consequences. Limnology and Oceanography 42(5, part 2): 1105–1118.

Neill, G.B.; Rees, T.A.V. (2003). Nitrogen status and metabolism in the green seaweed Enteromorpha intestinalis: an examination of three natural populations. Marine Ecology Progress Series 249: 133–144.

Howarth, R.W.; Marino, R. (2006). Nitrogen as the limiting nutrient for eutrophication in coastal marine ecosystems: evolving views over three decades. Limnology and Oceanography 51(1, part 2): 364–376.

Plew, D.; Dudley, B.; Shankar, U.; Zeldis, J. (2018). Assessment of the eutrophication susceptibility of New Zealand estuaries. NIWA client report 2018206CH prepared for the Ministry for the Environment. 64 pp.

Water quality samples collected by Watercare at Te Puru Stream mouth between Sep 2023 and Jan 2024 show that the median TN concentration at Te Puru Park was 0.76 mg/L. This was used as the current concentration at the stream mouth. Changes in the discharged TN concentration at the stream mouth were calculated for each stage based on the effluent concentration and the changes in the dilution factor. Table 1 shows that the changes in discharged TN at the stream mouth are much smaller than the measured current TN concentration, and. TN concentrations at the stream mouth will increase by only 0.0157 mg/L (2%) from current to Long-Term Stage 2 due to less dilution in the stream during the later stages.

Table 1. Estimated TN at Te Puru Stream mouth

Stage	TN in effluent (mg/L)	Dilution factor (50%tile)	Discharged TN at stream mouth (mg/L)	Estimated total TN (0.76 +/- change in discharge) (mg/L)
Current	7	13018	0.00054	0.76*
Short-term	7	1352	0.00518	0.7646
Stage 1	5			
Stage 2	5	309	0.0162	0.7756

* Measured concentration

TN concentrations in Kellys Bay were not measured but based on the modelled dilution factors at the mid bay (Northern transect; 109,282) and stream mouth (13,018), TN concentrations in the mid bay are estimated to be 8.4 x lower than at the stream mouth, resulting in an estimated concentration of 0.090 mg/L. Table 2 gives the estimated TN concentrations in the mid bay based on changes in the effluent concentration and dilution factors for each of the stages.

Table 2. Estimated TN in Kellys Beach (northern transect).

Stage	TN in effluent (mg/L)	Dilution factor (50%tile)	Discharged TN at N transect (mg/L)	Estimated total TN (current + change in discharge) (mg/L)
Current	7	109,282	0.000064	0.090

Short-term	7	13302	0.00053	0.0905
Stage 1	5			
Stage 2	5	2554	0.00196	0.0919

Based on Table 1 above, TN concentrations (0.76 mg/L or 760 mg/m^3) at the Te Puru stream mouth correspond to the 'very high eutrophication' category in Plew *et al.* (2018). However, salinity at Te Puru Park was typically very low (median 7.8 ppt) but highly variable (range 0.1–33.7). The low salinity will inhibit the growth of marine macroalgae, and Plew *et al.* (2018) states that if salinity is <5 ppt the 'minimal eutrophication' category is applied regardless of the TN concentration.

Given the low salinity at the stream mouth, the TN concentration at mid-beach is likely to provide a better indication of the eutrophication potential of the discharge. Estimated mid-beach concentrations for all four stages were around 0.09 mg/L or 90 mg/m^3. This corresponds to the 'moderate eutrophication' category in Plew *et al.* (2018), which is described as "*Ecological communities are slightly impacted by additional macroalgae growth arising from nutrient levels that are elevated. Limited macroalgae cover (0-20%) and low biomass (50-200 g/m^2 WW) of opportunistic macroalgal blooms and with no growth of algae in the underlying sediment. Sediment quality transitional.*"

Median measured chl-*a* concentrations at Te Puru Park were 1.4 µg/L (Table 8 in effects assessment report), well below the 'minimal eutrophication' limit of 5 µg/L. Furthermore, there is little potential for TN concentrations in the discharge to increase phytoplankton growth due to the similarity in the TN concentrations in the immediate receiving coastal environment (stream mouth and mid-beach) during all four stages (Tables 1 and 2). Furthermore, the Te Puru tidal creek has a very short flushing time (4–5.5 hrs; Zeldis *et al.*, 2001)[7], and therefore phytoplankton will be flushed from the estuary faster than they grow (Plew *et al.*, 2018). The figure below from Plew *et al.* (2018) shows the impact of TN and flushing times on phytoplankton

[7] Zeldis, J.; Pattinson, P.; Gray, S.; Walshe, C.; Hamilton, D.J.; Hawes, I. (2001). Assessment of effects of sewage plant inflow on Te Puru Stream, Estuary and adjacent Tamaki Strait waters. NIWA client report no. CHC01/84 prepared for Earth Consult Ltd and Manukau Water Ltd. 34 pp.

		growth. The figure clearly illustrates that when the flushing times are ≤3 days, phytoplankton will be flushed from the estuary faster than they can grow, and therefore TN concentrations can be very high and still have a negligible effect on phytoplankton concentrations, thus the estuary will fall into the 'A) minimal eutrophication' category. Overall, given the lack of change in TN concentrations in the immediate receiving coastal environment during all four stages it is most unlikely that marine plant growth will be increased in the immediate coastal receiving environment. The effect of the upgraded WWTP on marine plant growth is assessed as **less than minor.**	
19.	Please provide the follow details: a. Chlorophil a (chla) concentration and the trend analysis result for chla for the period between 2018-2023. The measures proposed to monitor or manage the potential occurrence of algal blooms / plants related to the proposed discharges at all stages.	Chla was not measured in WWTP between 2018 and 2023 so no state or trend can be undertaken. This was stated in Section 4.4.1.2 of the effects assessment report. We presented chla in the receiving environment sites (between September 2023 and January 2024) in Figure 24 and Table 8. This would be through a consent condition for coastal receiving environment monitoring.	Closed
20.	With respect to the coastal marine environment, the following assessment is provided within the ecological report: *'The proposed discharge rates by MBR Stage 2 will have negligible effects on the salinity and the marine communities of Te Maraetai/Kellys Beach due to the relatively low discharge rates compared to other nearby streams and rivers, the rapid dilution, and the tolerance of intertidal biota to low salinities. There will be no change from the current WWTP scenario.* *With respect to the proposed discharge, estimated TN concentrations will decrease by 29% to 5 mg/L in the Long-term Stages 1 and 2 of the upgraded WWTP, and TP concentrations will reduce to 0.5 mg/L. Concentrations of these nutrients will be diluted 309× (50% percentile) by the time they reach the Te Puru*	**a. Assessment of effects on Te Puru Estuary and Kellys Beach** Instead of a habitat or species-specific assessment it is more appropriate to consider the main potential effects of the discharged wastewater on the coastal receiving environment and provide an assessment of effects for each of those effects. The main potential effects of discharged wastewater on the coastal receiving environment are: i. increased dissolved nutrients, which may lead to increased phytoplankton or macroalgal growth; ii. increased concentrations of heavy metals, and other contaminants in the water, which may adversely affect marine organisms; iii. changes to the physical and chemical composition of the water (e.g., pH, dissolved oxygen, salinity, turbidity); iv. changes to the physical and chemical composition of the seabed (e.g., oxygen depletion, increased nutrients, accumulation of contaminants);	Closed

	Stream mouth, making them well below background concentrations in coastal waters. Given the rapid dilution rate, and the reduction of TN concentration in the proposed discharge from the expanded and upgraded WWTP, no increase in nutrient concentrations in coastal waters, or related adverse effects from increased nutrients, are likely to occur as a result of the proposed discharge. Other minor contaminants that are present in the treated wastewater at low concentrations will be diluted at a similar rate to TN and TP. There will be no change from the current WWTP scenario. *Potential effects on SEA-M1-42b Te Puru Stream estuary and SEA-M2-42a are anticipated to be low given the level of influence the treated wastewater discharge will have on nutrient concentrations and salinity in coastal waters.'* While this assessment is noted, neither the ecological report nor the AEE have included an assessment that supports the above in relation to the magnitude of overall effects on the coastal marine area (CMA). It is further noted that the ecological value of the immediate receiving environment is provided from an intertidal survey at 14 stations around Te Maraetai / Kellys Beach. While the survey results identified different broad scale habitats with different species such as shellfish patches, seagrass, mudflats, shell banks & mangroves, no assessment of effects on those habitats or species is	v. changes to the benthic community due to direct impacts of the wastewater, or through flow-on effects up the food chain; vi. increased risk of microbial contamination of shellfish that are consumed by humans and from water contact activities. Importantly, the effects of treated wastewater are not necessarily negative. Moderate increases in nutrient loads can increase productivity, with associated increases in the abundance and diversity of marine biota. Point i)—is assessed in the response to Q.18 (d) above. The effect of the upgraded WWTP on marine plant growth is assessed as **less than minor.** Point ii)—measurement of metal concentrations in the wastewater effluent show that only copper and zinc exceed the freshwater ANZG (2018)[8] DGVs in the discharge. Total copper concentrations were 1.9 µg/L while total zinc concentrations were 28 µ/g L at the discharge point. However, Cu and Zn concentrations had reduced to 0.4 µg/L and 1.2 µg/L, respectively, by Site 15, both of which are below the ANZG DGVs. Concentrations of metals in the wastewater are not expected to change with the upgrade. Based on that observation, it is extremely unlikely that copper or zinc in the discharge will have a tangible ecological effect on the surrounding coastal environment. This is consistent with the response to Q18 (a) and (b). This is supported by Table 3, which provides estimated concentrations of discharged total copper and zinc at the stream mouth based on the modelled dilution rates (dissolved concentrations were lower, so risks will be lower). For all four stages, the concentrations of copper and zinc at the stream mouth are well below the ANZG (2018) DGVs (1.3 µg/L for Cu and 8 µg/L for Zn) for the protection of 95% of species in marine waters. Therefore, the risk of heavy metals adversely affecting the marine community is assessed as **negligible.**	

[8] ANZG (2018). Australian and New Zealand guidelines for fresh and marine water quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia. Available from www.waterquality.gov.au/anz-guidelines (Accessed October 2021).

provided in the ecological report in relation to the proposed discharge.
In addition, the statement on SEA-M1 and SEA-M2 in the vicinity of the discharge does not include a site-specific assessment on the ecological values at the sites from the proposed discharge.

Taking the above into account, please provide the following:

a. A habitat or species-specific assessment of ecological effects from the proposed discharge for all four stages.
b. An assessment of effects on identified kaimoana species, including human health risk from the proposed discharge for all four stages. While there is no regulated, legal size limit for shellfish, such as cockles and pipi, should consent be granted for 35 years, the size and population of shellfish species would grow to harvestable size over the proposed duration. Accordingly, it is not agreed that the current size of the shellfish is a form of mitigation or reason not to consider human health effects from consuming shellfish.
c. Please confirm that the consent limits proposed for all four stages can be met without any exceedance in the discharge quality, as has occurred with the existing discharge.
d. Based on the breaches with the existing discharge quality consent limits, there is potential that the proposed discharge operational limits may exceed consented limits. Monitoring the discharge water and sediment quality, and coastal ecology is the only tool available to validate the proposal. Accordingly, please

Table 3. Concentration of total copper and zinc in the wastewater effluent and at the stream mouth.

Stage	Concentration in effluent (µg/L)		Dilution factor (50%tile)	Discharged concentration at stream mouth (µg/L)	
	Cu	Zn		Cu	Zn
Current	1.9	28	13018	0.00015	0.0022
Short-term	1.9	28	1352	0.00141	0.0207
Stage 1	1.9	28			
Stage 2	1.9	28	309	0.00615	0.0906

Similarly, Risk Quotients (RQs) based on marine predicted no-effect concentrations (PNEC) for Emerging Organic Contaminants (EOC) in the wastewater effluent were given in Table 18 of the Ecological Assessment of Effects. A RQ >1 indicates a potential effect. Table 4 lists the EOCs that had a RQ >1 at the outlet and gives the RQ at the stream mouth based on the modelled dilution factors. Given that the RQs at the stream mouth for all parameters are much less than 1, the effects of EOCs on the marine community is assessed as **negligible.**

Table 4. RQ of EOCs at the stream mouth at all four stages. RQs>1 are given in red.

Analyte	**RQ Outlet**	**Current**	**Short-term**	**Stage 2**
Diclofenac	10.0	0.0007	0.007	0.032
Diltiazem	1.3	0.0001	0.0009	0.004
Lamotrigine	2.5	0.0002	0.0018	0.008
Sucralose	3.4	0.0003	0.0025	0.011
Sulfamethoxazole	2.5	0.0002	0.0018	0.008
Triclosan	1.4	0.0001	0.0010	0.0045
Venlafaxine	17.0	0.0013	0.0136	0.055

	provide a draft monitoring plan for all four stages, that contains, but that is not necessarily limited to, the details below: • The spatial and temporal extent of the key habitats (as appropriate) within the zone of influence in the immediate receiving environment of the proposed discharge. • Benthic community (fauna and flora) abundance and diversity. • A water quality analysis of key nutrients, chla etc. (if it is not monitored or included in the discharge quality). • A sediment quality analysis (heavy metals, grain size, organic content, anoxic layer / redox potential). • Spatial and temporal extent of algal blooms, should they arise. • Suitability of kaimoana species for harvesting and human consumption, including species, size and number of samples to monitor. • Reporting procedures. Monitoring design for the above aspects to include the number of samples, spacing of sample stations in relation to the proposed discharge location, frequency of sampling, methodology and reporting. The monitoring programme must be designed to deliver ecologically meaningful results and be statistically robust enough to detect potential changes to those matters listed above.	Point iii)—Most of the physical parameters e.g., pH, DO, in the discharged WWTP are not expected to markedly change with the upgrade. Median operational limits for BOD_5 and TSS will be reduced from 7 mg/L to 5 mg/L, which, if anything, will improve the quality of the discharge. The increased volume of the discharge will result in an increased flow rate from 23 L/s currently to 69 L/s at Long-Term Stage 2. This is likely to result in a very small decrease in salinity. However, intertidal species, particularly those living near estuary mouths, are highly tolerant of low salinity. Salinity measurements in Te Puru Park varied from 0.1–33.7 ppt, therefore, the marine biota inhabiting that area are highly tolerant of low and variable salinities. Overall, the effect of changes to physical parameters in stream water on the marine community is assessed as **negligible.** Points iv & v)—Given that the effects on the water quality at the stream mouth and Kellys Beach are assessed as negligible to less than minor, the seabed and seabed community are highly unlikely to change. Therefore, the effects of the seabed and seabed community is assessed as **less than minor.** Point vi)—is assessed in the response to b) iii) below. Overall, the effects of the wastewater discharge on the marine environment and community of Te Puru Estuary and Kellys Beach is assessed as **less than minor.** **b. Assessment of effects on kai moana species.** Several kai moana species are present in Kelly's Beach (cockles, pipis, Pacific oysters, blue mussels). Potential adverse effects on shellfish can be caused by high nutrient or high suspended solid concentrations, and potential adverse human health effects can occur if shellfish have high levels of faecal bacteria in their flesh. i. <u>Effects of nutrients on shellfish</u> Moderate increases in nutrient concentrations can increase productivity, with associated increases in the abundance and growth of shellfish. However, excessive	

		concentrations of some nutrients can be toxic to shellfish or result in anoxic seabed conditions. Ammoniacal-N is the only nutrient with a recommended guideline for marine waters in the Australia and New Zealand guidelines for fresh and marine and waters (ANZG, 2018). The default guideline value (DGV) for ammoniacal-N for 95% protection of species is 0.91 mg/L. Concentrations of ammoniacal-N (NH_3-NH_4-N) at Te Puru Park are much lower than the DGV, with a median of 0.04 mg/L and a 95%ile of 0.22 mg/L. Note that ammoniacal-N is the sum of ammonia and ammonium, so the concentration of ammonia in ambient seawater conditions is lower than that of ammoniacal-N. The Canadian guideline for the long-term exposure to nitrates in marine waters is 45 mg/L (CCME, 2012)[9], which is 90 times higher than the median nitrate concentration at Te Puru Park (0.5 mg/L). Given the concentrations of ammoniacal-N, nitrates in Te Puru Park are much lower than the guideline values, and that further dilution will occur before the water reaches the mid to lower beach where the shellfish occur, the effects of discharged nutrients on kai moana species is assessed as **negligible.** ii. <u>Effects of TSS on shellfish</u> High total suspended sediment (TSS) concentrations can result in reduced filtration and clearance rates, growth and survival of shellfish. For example, adult pipis, cockles and scallops can continue to feed at high concentrations of suspended sediment for short durations (<1 week), but in the long term, show adverse effects at TSS concentrations of more than 60–70 mg/l, 300–350 mg/l, and 100 mg/l, respectively (Wilber & Clarke, 2001; Nicholls *et al.*, 2003; Hewitt & Norkko, 2007;	

[9] CCME (2012). Canadian water quality guidelines for the protection of aquatic life: nitrate. Canadian Council of Ministers of the Environment, Winnipeg, Canada.

		Coppede Cussioli, 2018)[10]. These concentrations are much higher than the TSS concentration in the wastewater effluent (median 7.8 mg/L; 80th percentile 10.2 mg/L), and therefore the effects of discharged TSS on kai moana species is assessed as **negligible.** iii. <u>Human health risks associated with shellfish consumption</u> Cockles and pipis were found throughout most of the mid to lower intertidal at Kellys Beach. However, all were well below harvestable size (~30 mm for cockles and ~50 mm for pipi). Council state that these shellfish will grow to harvestable size over the duration of the consent, however, monitoring of numerous shellfish populations around the Auckland Region (and further afield) indicates that factors other than harvesting are preventing the growth of cockles and pipis to harvestable size. Complete harvest bans are in place at Umupuia, Whangateau, Eastern Beach, Cheltenham Beach and Cockle Bay, but even in these areas the increase in the harvestable population is very slow or non-existent (Berkenbusch *et al.*, 2023; Hauraki Gulf Forum, 2023; Berkenbuisch & Hill-Moana, 2024)[11].	

[10] Wilber, D.H.; Clarke, D.G. (2001). Biological effects of suspended sediments: a review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21(4): 855–875.

Nicholls, P.; Hewitt, J.; Halliday, J. (2003). Effects of suspended sediment concentrations on suspension and deposit feeding marine macrofauna. NIWA client report HAM2003-077 for Auckland Regional Council. National Institute of Water and Atmospheric Research, Hamilton.

Hewitt, J.E.; Norkko, J. (2007). Incorporating temporal variability of stressors into studies: An example using suspension-feeding bivalves and elevated suspended sediment concentrations. Journal of Experimental Marine Biology and Ecology 341(1): 131–141.

Coppede Cussioli, M. (2018). Ecological effects of turbidity variations in and around dredging areas in the Port of Tauranga. PhD thesis. The University of Waikato, Hamilton, New Zealand.

[11] Berkenbuisch, K.; Hill-Moana, T. (2024). Intertiday shellfish monitoring in the northern North Island region, 2023–24. New Zealand Fisheries Assessment Report 2024/35. Fisheries New Zealand, Wellington, New Zealand. 110 pp.

		Given the current lack of harvestable shellfish at Kellys Beach, and the general lack of harvestable shellfish populations around the Auckland Region, it is unlikely that Kellys Beach will sustain a harvestable shellfish population in the future. See response to Q.37 for details on the human health risks. If the shellfish exposure route is present or may be present in the future, a QMRA would be the most appropriate way to estimate public health risks. Shellfish are filter feeders and can bioaccumulate pathogens. The end effect of the bioaccumulation process is that a person consuming shellfish will tend to receive a higher dose of pathogens, if present, than someone swimming in the same water in which the shellfish is grown. **c. Consent limits** The existing Consent limits will be rolled over until the short-term upgrade is completed. Proposed consent limits for the short -term upgrade and long-term upgrade stages 1 and 2 can be met without exceedance in the discharge quality. **d. Draft monitoring plan** Consent conditions are being proposed that require the provision of a monitoring plan to be submitted to Council for certification. The conditions specify the parameters, frequency and locations to be monitored. A detailed monitoring plan will be provided to Council for certification if consent is granted.	

Berkenbusch, K.; Neubauer, P.; Hill-Moana, T. (2023). Intertidal shellfish monitoring in the northern North Island region, 2022–23. New Zealand Fisheries Assessment Report 2023/32. Fisheries New Zealand, Wellington. 129 pp.

Hauraki Gulf Forum (2023). State of our Gulf 2023: Hauraki Gulf / Tīkapa Moana / Te Moananui-ā-Toi state of the environment report 2023. Prepared by Kelly, S.; Sim-Smith, C.; Lee, S.; Van Kampen, P. Hauraki Gulf Forum, Auckland. 194 pp.

<table>
<tr><td></td><td></td><td>It is recommended that an ecological monitoring plan for Kellys Beach and Te Puru Stream include:
• Regular water quality sampling at Te Puru Park for nitrogen, phosphorus, physical parameters, chl-*a*, TSS, *E. coli,* faecal coliforms and enterococci.
• An annual summer survey of Kellys Beach for nuisance macroalgae and cyanobacteria.
• A shellfish survey of Kellys Beach every 3 years to determine the abundance and mean size of pipis and cockles.
• Analysis of sediment quality in Te Puru Estuary and Kellys Beach every 3 years for grainsize, total phosphorus, total nitrogen, total organic carbon, and key heavy metals.

Given that the cumulative effects on the coastal receiving environment are assessed as less than minor (see below), the monitoring of the spatial extent of marine habitats and benthic macrofaunal communities is not warranted.</td><td></td></tr>
<tr><td>21.</td><td>Please provide an assessment on cumulative effects on the ecology of the immediate receiving environment in the CMA (Te Puru Stream and Kellys Beach) in relation to the existing discharge and from the proposed discharge for all four stages.</td><td>Table 5 summarises the assessment of ecological effects of the WWTP upgrade on individual areas for the immediate receiving coastal environment. The assessment of effects is the same for all four stages. Overall, the cumulative effects on Te Puru Estuary and Kellys Beach is assessed as **less than minor.**

Table 5. Assessment of Effects for the WWTP upgrade on Te Puru Estuary and Kellys Beach.
<table><tr><th>Area</th><th>Assessment</th></tr><tr><td>Marine primary production</td><td>Less than minor</td></tr><tr><td>Heavy metals</td><td>Negligible</td></tr><tr><td>EOCs</td><td>Negligible</td></tr><tr><td>Physical parameters</td><td>Negligible</td></tr><tr><td>Seabed and its community</td><td>Less than minor</td></tr><tr><td>Cyanobacteria</td><td>Less than minor</td></tr><tr><td>Shellfish growth and survival</td><td>Negligible</td></tr></table></td><td>Closed</td></tr>
</table>

22.	With respect to the modelling within the Assessment of Proposed Te Puru Stream Discharge by DHI Water & Environment Limited, dated 28 March 2024 (the modelling report), please provide the modelled zone of influence and reasonable mixing zone for each stage of proposed discharges at the different sites identified in the modelling report.	The marine model focused on assessing the level of dilution that could be achieved within the marine receiving environment and was never intended to do in-stream near-field modelling. As stated in the DHI report the marine model extends upstream into the Te Puru stream where it is influenced by tides. This is well below the point of discharge so the marine model cannot address the mixing zone question.	Closed
23.	The modelling report states: *'The higher levels of dilution that are achieved in the wider marine receiving environment (compared to the in-stream dilutions) mean that changes in nutrient concentrations in the wider marine receiving environment due to the proposed WWTP discharges would remain below detectable limits.'* What are the detectable limits referred in the statement above for key contaminants in the discharge?	The Watercare Laboratory Services minimum detection limit for TN is 0.01 mg/L and TP is 0.004 mg/L. The DHI report states that the current TN and TP concentrations immediately downstream of the Whitford-Maraetai Road bridge is estimated as 0.12 mg/L and 0.01 mg/L, respectively. TN concentrations are estimated to increase to 0.23 mg/L and 0.44 mg/L, while TP concentrations are estimated to increase to 0.04 mg/L and 0.0.7 mg/L under short-term and long-term stage 2, respectively. Minimum dilutions near the Te Puru Stream Mouth and at Kellys Beach are estimated to be 10 to 20-fold (current), 5 to 10-fold (short-term), and 3 to 6-fold (long-term Stage 2). Whether these changes could be observed (based on dilutions and MDL) is borderline at these sites. However, the statement specifies the <u>wider</u> marine receiving environment. Minimum dilutions in Shelley Bay, Omana and Pohutukawa Bay are estimated to range from 5000 to 6000-fold (current), 2000 to 3000-fold (short-term) and 1000 to 1500-fold (long-term Stage 2). Even at the long-term Stage 2 scenario (lowest dilutions (1000-fold) and maximum concentrations) TN and TP would be estimated to be 0.00044 mg/L, and 0.00007 mg/L, respectively, or 23-fold and 57-fold lower than the MDL at Shelley Bay, Omana and Pohutukawa Bay.	Closed

<table>
<tr>
<td>24.</td>
<td>In respect of TN and TP in the estuary, please answer the following questions:
a. What is the residence time of the TN and TP footprints for the Te Puru Estuary and Kelly Beach for each stage proposed.

b. Please explain how the TN and TP loads in the table below were derived? What is the total load for TN and TP estimated for different discharge scenarios and why are there only three scenarios?

Table 1. Discharge Scenario data.
<table>
<tr><th></th><th>Current</th><th>Short-Term</th><th>Long-Term Stage 2</th></tr>
<tr><td>Average daily dry weather discharge (m^3)</td><td>2,000</td><td>3,600</td><td>6,000</td></tr>
<tr><td>Average daily dry weather discharge (m^3/s)</td><td>0.023</td><td>0.042</td><td>0.069</td></tr>
<tr><td>Median TN load (kg/day)</td><td>14.0</td><td>25.0</td><td>30.0</td></tr>
<tr><td>Median TP load (kg/day)</td><td>2.0</td><td>3.6</td><td>6.0</td></tr>
</table>
</td>
<td>a) Residence time could be quantified by modelling a one-off release of contaminants and tracking how dilution reduces over time but quantifying this would add nothing to the assessment of effects which is based on dilution for a continuous release
b) Refer to attachment 4 for a detailed response

<table>
<tr><th></th><th>Current</th><th>Short-Term</th><th>Long-Term Stage 1</th><th>Long-Term Stage 2</th></tr>
<tr><td colspan="5">Attenuated WWTP loads</td></tr>
<tr><td>Mean annual TN load (kg/yr)</td><td>1979</td><td>3239</td><td>617</td><td>771</td></tr>
<tr><td>Mean annual TP load (kg/yr)</td><td>233</td><td>382</td><td>255</td><td>318</td></tr>
<tr><td colspan="5">Te Puru Catchment</td></tr>
<tr><td>Mean annual TN load (kg/yr)</td><td>3,825</td><td>3,825</td><td>3,825</td><td>3,825</td></tr>
<tr><td>Mean annual TP load (kg/yr)</td><td>270</td><td>270</td><td>270</td><td>270</td></tr>
<tr><td colspan="5">Combined</td></tr>
<tr><td>Mean annual TN load (kg/yr)</td><td>5805</td><td>7064</td><td>4442</td><td>4597</td></tr>
<tr><td>Mean annual TP load (kg/yr)</td><td>504</td><td>652</td><td>525</td><td>589</td></tr>
<tr><td colspan="5">WWTP percentage of total load</td></tr>
<tr><td>TN</td><td>34%</td><td>46%</td><td>14%</td><td>17%</td></tr>
<tr><td>TP</td><td>46%</td><td>59%</td><td>49%</td><td>54%</td></tr>
</table>
</td>
<td>Closed</td>
</tr>
<tr>
<td>25.</td>
<td>There is a difference between the tide being in (mixing will occur in the estuary and beach area) and low tide when undiluted river water will be within the channel within the intertidal area and mixing will occur at the tide line. Has this been considered in modelling of the nutrient footprint?</td>
<td>Figure 6 of the DHI report shows the different sites that are used at different stages of the tide to extract an appropriate dilution at the water's edge as the tide rises and falls up and down Kellys Beach. So, the QMRA for Kellys Beach considers a "tide-line" worst case dilution for all states of tide.</td>
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<td>26.</td>
<td>The ecological report shows after the MBR is operational within the WWTP, attenuated TN and TP loads through the overland and stream system will contribute 50% and 70% of total catchment load to the marine coastal environment respectively, being approximately two-fold</td>
<td>Occasional blooms of the nuisance cyanobacteria Okeania spp. (previously called Lyngbya majuscula) have been reported from the Beachlands-Maraetai coastline. The cyanobacteria produces toxins that can cause seaweed dermatitis if the cyanobacteria</td>
<td>Closed</td>
</tr>
</table>

	and three-fold increases as compared to the current situation of 32% and 44% respectively. Sufficient nutrients in water are known to be one of the conditions leading to toxic algae blooms, which is likely to have adverse effects on people involved in contact recreation, particularly those who eat watercress collected from Te Puru Stream. The ecological report indicates that occasional blooms of toxic cyanobacteria have been reported from the Beachlands-Maraetai coastline and blooms were also observed in Te Maraetai / Kellys Beach during the intertidal survey. However, the health risk from cyanobacteria as a result of the proposed increase in nutrient loads has not been assessed in detail in either the ecological or health risk reports. Please provide further assessment in this regard.	is abraded against the skin or breathing issues if dried material or aerosolised toxins are inhaled (Wilcox, 2007; Smith *et al.*, 2024)[12]. In the late 1970s *Okeania* spp. were reported as seasonally dominant species around Motukaraka/Flat Island, and throughout the 2000's there were regular occurrences of *Okeania* spp. blooms around the Beachlands and Omana area (Sutherland & Hawes, 2002[13]; Wilcox, 2007). However, no *Okeania* spp. blooms have been recorded from the Beachlands area since 2007. Note that the ecological reports states that **NO** *Okeania* spp. were observed in Te Maraetai/Kellys Beach during the intertidal survey (the statement by Council under Q.26 of this document saying the cyanobacteria were observed during the intertidal survey is incorrect). Little is known about the drivers of *Okeania* spp. blooms and Auckland Council states that "*The drivers of cyanobacterial blooms are complex and it is very difficult to predict or explain where they may occur, as well as their size and duration. This is because numerous environmental conditions need to be met to enable the rapid growth of the cyanobacteria (calm weather conditions, plenty of light, warm seawater temperatures and sufficient nutrients to sustain their growth), followed by the right conditions to dislodge blooms (i.e., stormy weather*)" (Auckland Council, 2024)[14].	

[12] Wilcox, M. (2007). A summer bloom of the marine benthic cyanobacterium Lyngbya majuscula at Musick Point, Eastern Beach and Howick. Auckland Botanical Society Journal 62(1): 102–103.

Smith, K.; Puddick, J.; Biessy, L.; Rhodes, L.; Cressey, P. (2024). Managing marine harmful algal blooms in recreational settings: a review of international approaches to guide risk management practice in Aotearoa New Zealand Cawthron report no. 4038 prepared for Health New Zealand/Te Whatu Ora. Cawthron Institute, Nelson. 50 pp.

[13] Sutherland, D.; Hawes, I. (2002). Survey of Lyngbya majuscula in Te Puru Estuary and adjacent Tamaki Strait waters. NIWA client report CHC02/35 prepared for Earth Consult Ltd and Manakau Water Ltd. National Institute of Water and Atmospheric Research, Christchurch, New Zealand. 9 pp.

[14] Auckland Council (2024) Auckland Council warms public to avoid black algae on two Waiheke Island beaches and Kawakawa Bay. Our Auckland. Available from: https://ourauckland.aucklandcouncil.govt.nz/news/2023/12/algae-on-waiheke-island-december-2023/ (accessed 1 March 2024).

		Growth of phytoplankton and cyanobacteria are affected by the <u>concentration</u> of nutrients, not annual <u>loads</u>. Despite the fact that annual TN and TP loads are increasing by 50% and 70%, respectively, the resulting concentrations of TN and TP in the water downstream of the discharge will be very similar to current concentrations due to the proportional increase in the discharge volume and the decrease in the TN (from 7 to 5 mg/L) and TP (from 1 to 0.5 mg/L) concentrations in the discharged effluent (see Tables 1 & 2 in our response to Q18(d)). Therefore, based on nutrient concentrations, there is no increase in the ecological or health risks from *Okeania* spp. over current conditions. Given that no *Okeania* spp. blooms have been recorded from the Beachlands area for the last 17 years, it is highly unlikely that current conditions significantly increase the chances of an *Okeania* spp. bloom occurring. This concurs with the conclusions of Zeldis *et al.* (2001) who stated that "*The low nutrient and chl-a levels we have recorded in Kelly's Cove, and the shore residence time of water within the estuary, do not suggest that excessive nutrient loading of the water column would cause L. majuscula outgrowth, in the water column of either environment*." A subsequent survey to document the occurrence of *Okeania* spp. around the Beachlands-Maraetai area also found no evidence that nutrients from the WWTP discharge were causing the cyanobacteria growth, with much higher densities of *Okeania* spp. found around Motukaraka than Kellys Beach and Te Puru Estuary (Sutherland & Hawes, 2002). Overall, the increase in the occurrence of cyanobacteria blooms due to the upgraded WWTP is assessed as **less than minor.**	
27.	The ecological report states that the estimated loads from the upgraded WWTP represent a very small percentage of the TN and TP loads entering the inner Hauraki Gulf and Firth of Thames. Thus, the effects of the increased loads from the upgraded WWTP are assessed as being low. Please justify the reasons that the inner Hauraki Gulf and Firth of Thames are used instead of the immediate receiving environment for assessing the effect.	Te Puru Estuary and Kelly's Beach have very short flushing times (4–5.5 hrs for the estuary; Zeldis *et al.*, 2001) due to their small size. Estuary water will quickly enter the Tamaki Strait where currents of ≤0.2m/s will disperse and transport the nutrients into to the inner Hauraki Gulf and Firth of Thames within approximately 3-8 days (J. Oldman, DHI, pers. comm.). Uptake of nutrients by phytoplankton is not instantaneous—it depends on the nitrogen concentration, the specific growth rate of plankton, the half saturation coefficient for TN, and the ratio of chl-*a* to tissue N content of phytoplankton (see p. 21 of Plew *et al.*, 2018 for more details). The figure given above in response to Q.18 shows that when the flushing time is ≤3 days, phytoplankton growth is essentially independent of TN	Closed

		concentration because the phytoplankton will be flushed from the estuary before they can grow. Given the very short flushing time of Te Puru Estuary, it is more appropriate to compare the discharged TN and TP loads with the inner Hauraki Gulf and Firth of Thames, where phytoplankton will have time to assimilate the discharged nutrients, rather than the immediate receiving coastal environment.	
28.	On 11 July 2024, Watercare Services Limited (WSL) provided a preliminary assessment of the Estuarine Trophic Index (ETI) for Te Puru Stream Estuary, based on ETI Tool 3, and applying the current state assessments. Please provide an assessment of the ETI at each of the anticipated states at PE 18,000, PE 24,000, and PE 30,000.	The ETI score for the current state of Te Puru Stream Estuary (which mostly consists of a muddy, mangrove lined tidal creek) was calculated using Tool 3 (https://shiny.niwa.co.nz/Estuaries-Screening-Tool-3/), which allows the ETI to be calculated when no or few values are known for the primary indicator nodes and secondary indicator nodes. Input parameters were: • Tidal river estuary • 5–40% intertidal (the estuary is defined as the portion of the stream that has marine influence that is landward of Kelly's Beach) • 0–3 days flushing time (from Zeldis *et al.*, 2001) • 5–30 ppt salinity • 1.4 mg chl-*a*/m^3 (Table 8 in the effects assessment report); • 500–600 mg/m^3 TN for all four Stages (see Table 1 in Q.18). (There were minimal differences in the TN concentrations for all four Stages). Seasonality, water column stratification, closure duration and sediment loads were left at the default values as no information was available for these parameters. The overall ETI score was 0.25 for all four stages, which puts it at the upper limit of band 'A'–"*Ecological communities are slightly healthy and resilient*" (Zeldis & Plew, 2022)[15]. Note that the preliminary assessment provided on 11 July was based on a TN concentration of 600–700 mg/m^3, which was taken from Fig. 18 of the effects assessment report. More accurate calculations of the TN concentrations (Table 1 in	Closed

[15] Zeldis, J. & Plew, D. (2022) Predicting and scoring estuary ecological health using a Bayesian Belief Network. *Frontiers in Marine Science*, 9, 898992. 10.3389/fmars/2022.898992

		Q.18) show that TN concentrations are in the 500–600 mg/m^3 band, which improves the ETI band from 'B' to 'A'.	
Hydrology and Stream Flow			
29.	The stream hydraulic assessment report uses 6,000 m3/d discharge from the WWTP, converted to an average discharge rate of 0.07 m3/s. It then uses this rate as an estimate of wastewater discharge contributions during wet weather events without any adjustment of the discharge from the WWTP due to wet weather flows (outflows would be expected to be greater when it's raining). The report also only provides an assessment at high stream flows, not at low. Noting the above, please provide an assessment of the effects of the discharge (the current, the maximum proposed, and a range of discharges, not just an average) under a range of climatic conditions (e.g. dry weather and a range of rainfall events, including the rainfall event resulting in maximum discharge from the plant and a relevant climate change scenario) on the depth, velocity and flow of water in both the tributary and the main stem of Te Puru Stream after confluence. Alterations in the rate of discharge and stream baseflows should be considered for dry and wet weather, and include consideration of climate change effects on high and low stream and discharge flows. Please also provide an assessment of the efficacy of the 'storm buffer ponds' under current and future growth projections, assessing a range of storm events and a consideration of a climate change scenario relevant to the duration sought for this consent.	Our assessment indicates that, during the lowest flow event that was considered (i.e., 90th percentile rainfall event with existing wastewater discharges, the increase in velocity due to the increase in average wastewater discharge was minimal (up 0.3 m/s to 1.1 m/s as per Table 3). Therefore, it is our assessment that during lower flow events, the effect of erosion would be even less during average wastewater discharges. We can update our assessment to include the scenario of low stream flow and maximum wastewater discharge if necessary. We consider that it would be unreasonable for the pond outlet to see 36,200 m^3/d due to the attenuation within the Farm Pond. If this is the case, the pond outlet would need to be redesigned to throttle the flows. We would anticipate that the Farm Pond volume and outlet would require modification to reduce downstream flows that the stream would receive. Our initial assessment is that this future maximum discharge flow and velocities would be less than the present day 2-year ARI stormwater peak flow that we have analysed and outlined in Table 2 (i.e., 0.4 m^3/s vs. 0.62 m^3/s). During our stream gauging (see table below), we measured normal (i.e., low) stream flows of approx. 0.014-0.018 m^3/s, immediately downstream of the Farm Pond. This compares to a present average wastewater discharge of 0.021 m^3/s (see Table 1), indicating that the majority of flow within the tributary is currently wastewater during dry periods. This would indicate that it can be assumed for future low stream flows the majority, if not all, stream flow would consist of wastewater for the tributary immediately downstream of the Farm Pond. As part of our assessment, we have assessed a range of rainfall events including 90th percentile, 2-year ARI, 5-year ARI and 10-year ARI (refer Table 2 and 3). The climate change scenario we have applied is RCP8.5 for the period of 2081-2100 as outlined in Table 2.	

		We would anticipate that wastewater discharges from wet weather flows would not coincide with high stream flows caused by rainfall within the upstream catchment. We would expect that the wastewater network, the storage within the WWTP itself, the overland flow and the storage within the Farm Pond would result in attenuation. This attenuation would result in the wastewater discharge not coinciding with the peak runoff from the catchment. It is therefore our assessment that high stream flow and maximum wastewater discharge would not be seen by the stream concurrently and reduce peaks however it is unclear if amendments are required to the pond outlet to control volumes. In regard to other items raised: • We have not assessed the main stem after the confluence as further down the stream the wastewater discharge is a minor proportion of flow during high/wet weather stream flows. As shown in Table 2, the wastewater discharge at the bridge contributes to 1% of flow during a 10-year ARI storm event. • The 'storm buffer ponds' are assumed to be the post-treatment buffer Lagoon. Both the lagoon and WWTP Buffer Pond upstream of the plant will reduce the discharge volumes. The Storm Buffer Pond will continue to be used as it is currently, ie to store peak wet weather influent flows in excess of the WWTP hydraulic capacity. The Post-Treatment Buffer Lagoon will mainly be used as a buffer for maintenance and servicing. It will be used less for stormwater buffering. <u>Further Information</u> Further to the discussion on Thursday 12/09/24 with Helen, we have provided additional information for low flows particularly with respect to downstream points Point C and the Quarry. Table 2 of the stream hydraulic assessment (dated 26 March 2024) showing wastewater contributions has been updated to include the downstream points, the low flows have	

been added to a separate Table 2A and a table of the stream gauging (Table 2B) has now been included.

Table 2A: Wastewater Contributions to Typical/Low Stream Flow

Scenario[1]	Location[2]	Estimated Wastewater Discharge (m^3/s)	Estimated Low Stream Flow (m^3/s)	Estimated % Wastewater Contribution
Existing	Reach between pond outlet and bridge	0.021	0.021 [3]	~100%
Future		0.07	0.07 [3]	~100%
Existing	Bridge	0.021	0.025 [4]	~85%
Future		0.07	0.075 [4]	>95%
Existing	Confluence/Point C	0.021	0.046 [4]	~45%
Future		0.07	0.096 [5]	>70%
Existing	Quarry/Point Q	0.021	0.056 [4]	~40%
Future		0.07	0.106 [5]	>65%

Notes:

1. The existing scenario assumes existing ADF WWTP discharge as per A02803201L001. The future scenario assumes future ADF WWTP as per A02803201L001.

2. Refer to A02803201L001 Appendix A for specific locations of these points.

3. Refer to A02803201L001 Table 1.

4. Gaugings as per A02803201L001 Appendix C and gauging results Table 2B.

5. Includes an estimated contribution of the larger separate catchment, being the difference of the flow gauging at the location and the estimated upstream 0.021m^3/s.

Table 2B: Gauging Results

Location[1]	Flow Gauging (m^3/s) 19/01/2024
Bridge	0.025
Point C	0.046
Quarry	0.056

Notes:

1. Refer to A02803201L001 Appendix A for specific locations of these points.

The following limitations and assumptions apply to this assessment:

1. Wastewater flows are estimated to be contributing 100% of stream low flow at the pond due to:
    a. constant WWTP discharges
    b. no runoff (surface and ground) occurring.

		2. The above wastewater contribution percentages are estimates and are indicative only. They are based on: a. pond discharges equating to existing WWTP averaged daily flow (totalised from hourly data) and future average daily discharge of 6000 m3/d. b. single round flow gaugings at Bridge, Point C Confluence and the Quarry sites. c. single round flow gaugings (Jan 2024) have been used to calculate wastewater % contributions in the low flow scenario. 3. No assessment has been made to modify stream flows by modifying the pond outlet.	
30.	While there are flow duration curves (naturalised) in the appendix to the stream hydraulic assessment report by Pattle Delamore Partners, they have no headings or graph labels, and there is no explanation of them in the report. The report also refers to a methodology in Appendix C but that appendix cannot be located and data from the gauging and water level recorder cannot be located. Please address these matters.	**Attachment 5** has been recompiled and is attached to this response. The explanation of the FDCs is contained within the methodology included with attachment 5. This document is attached with these responses. Water level recorder data was used to determine the relationship between rainfall and stream flow. We used this data to compare against our surrogate catchment. We can attach a graph showing the water level recorder data. Results show little variation in flow indicating the pond likely acts as a buffer limiting the natural stream variation from rainfall events. A summary of the gauging data will be provided in the final response.	
Overland Flow System and groundwater			
31.	Please provide a detailed and comprehensive conceptual site model (CSM) of the current site, hydraulic connectivity, and key transport pathways. It is noted that this is likely to change when the design of the upgraded OFS is finalised, however it is appropriate and expected that a detailed CSM is provided given the period of time before the upgraded OFS is operational.	A conceptual site model for the existing overland flow system has been prepared and is attached to this response (**Attachment 6**). As acknowledged in PDP Memorandum 4, this may change in the future with improvements.	Closed
32.	It is acknowledged that the AEE and ecological report have provided an assessment that is based on the data available. In accordance with the initial review provided to	The full report on the Overland Flow Performance (A028030001R001) is attached to this response. – Refer to **Attachment 7**	Closed

<table>
<tr><td></td><td>WSL, please provide a complete assessment for the OFS when the full analytical data are available and incorporated into the assessment. Given the reliance on this assessment to both the assessment of the current treatment pathway (e.g., mass/flow ratios described in PDP 2 April 2024 memo) and the assumptions adopted in the ecological report, the current assessment of the overland flow system needs to be updated.
Following this updated assessment, the findings and conclusions need to be incorporated into the AEE and ecological report to inform their assumptions and also to provide an updated assessment of the current attenuation pathway and treatment ratios provided by the overland flow system (currently regarded as incomplete).</td><td>While there is some variability in the results, as expected with a natural system, the more detailed sampling regime shows largely similar trends to those set out in PDP Memorandum 2. In particular, the results of the additional sampling confirm that the dilution assessment completed in Memorandum 2 are valid and that there is no substantial variation in electrical conductivity through the system (other than due to dilution).</td><td></td></tr>
<tr><td>33.</td><td>The overland flow system memorandum 4 from Pattle Delamore Partners, dated 17 May 2024, states that: ‘any potential contaminants form overland flow site migrating downwards through the regolith into GW expected to have flow path lengths no longer than hundreds of metres to the nearest stream discharge zone, no existing bores or GW takes occur within this area.’ However no details on groundwater use in the immediate environment have been provided. Please address this and provide further information on groundwater take and use, including any groundwater quality monitoring data in the vicinity of the WWTP.</td><td>PDP is not aware of any groundwater use within the vicinity of the WWTP. As presented in Figure 2 attached to PDP Memorandum 4, the closest known bores are
Bore 8953 approximately 0.7 km northeast of the overland flow site (upgradient)
Bore 20029 approximately 1.5 km to the west of the overland flow site (cross gradient)
Bore 20412 approximately 2 km west-northwest of the overland flow site (downgradient).
PDP has requested an updated bore search from Auckland Council and any new bores will be included in the final s92 response.

PDP is unaware of any groundwater quality data for the aquifer in the vicinity of the WWTP. For wider context we have provided groundwater quality information from other bores in the Beachlands Waitemata aquifer:

<table><tr><th colspan="4">Beachlands Waitemata Aquifer Quality</th></tr><tr><th>Parameter</th><th>Bore 1911 KWL (28/2/2000) mg/L</th><th>Bore 23094 PDP (4/4/2008) mg/L</th><th>Bore 20758 GWE (2020) mg/L</th></tr><tr><td>pH</td><td>7.06</td><td>7.7</td><td>7.6</td></tr></table></td><td></td></tr>
</table>

Boron	0.13	0.032	0.026
Iron	0.69	0.48	1.8
Dissolved Arsenic		< 0.0010	< 0.0001
Dissolved Cadmium		< 0.00005	
Dissolved Chromium		< 0.0005	
Dissolved Copper	<0.05	< 0.0005	< 0.0002
Dissolved Lead		< 0.00010	0.0026
Dissolved Nickel		< 0.00050	
Dissolved Zinc	<0.05	0.053	
Total Hardness	230	180	180
Li	-	0.03	
Mg	8	9.6	9
Mn	0.12	0.094	
Sodium	35	36	30
Potassium	4	2.3	2.3
Chloride	31	37	30
Nitrite-N		< 0.0020	
Nitrate-N	0.07	< 0.0020	0.0032
Ammonia-N	0.19	0.04	
Sulphate	13	6.6	5.5
Total coliforms	-	<2/100ml	

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<tr><td>Faecal coliforms</td><td>-</td><td><2/100ml)</td><td></td></tr>
<tr><td>Escherichia coli</td><td>-</td><td><2/100ml)</td><td><1 MPN/100 mL</td></tr>
</table>
In general, the Beachlands Waitemata aquifer is considered high quality.
It should be noted that the impact of the overland flow system on groundwater is considered minor. An assessment of the flow pathways for any infiltration of the wastewater into the soil has been carried out to support this statement. The existing and proposed OLF areas are in the headwaters of the Te Puru Stream tributary. Most of the catchment is over Waitemata Group rocks with some sitting on basement greywacke. Percolation beneath the OLF areas is expected to go both shallow to perched systems in the Waitemata Group feeding the stream and deep to the regional groundwater system: a 90:10% split is assumed. Shallow groundwater flow paths from beneath the OLF areas are expected to enter the Te Puru Stream upstream of the junction with the main stem at monitoring point C, approximately 950m downstream of the bridge into the treatment plant site, giving a shallow groundwater catchment area of 3.4km^2. For a maximum sized OLF system of 11.25ha at a PE of 30,000 this covers 3.3% of the local catchment. Based in typical infiltration rates for a saturated soil (158mm/yr), some 1% of the ADWF sent to the OLF system is expected to return to the Te Puru stream tributary above Point C via the shallow groundwater system. The component that recharges the deep groundwater system is expected to mix with the groundwater throughflow of 2,700m^3/d (PDP, 2012) and raise the background N concentration by 0.005 g/m^3. This is similar to background N in the regional groundwater as shown in the table above.
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<td>34.</td>
<td>The overland flow system memorandum 2 from Pattle Delamore Partners, dated 2 April 2024 (memorandum 2), states: ‘the removal mechanisms for nitrogen and phosphorus in an overland flow system are relatively complex and are heavily influenced by the nature of the wastewater applied, the flowrate/loading rate, and the soils present at the site.’
In respect of this statement, please provide answers to the following questions:</td>
<td>
Part A:
a. Under the proposed short term upgrades wastewater quality is intended to remain constant until the long-term upgrades are completed at PE 18,000. Increasing flows over this period are expected to drive higher nutrient loads.
Improvements to the overland flow system are expected to be carried out as part of the short-term upgrades as per Section 10.5 of the AEE. Further description of the potential improvements is provided in the response to question b. in Part B below.
</td>
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	a. With regard to significantly increasing trends in Nitrate-N and DRP in the discharge, provide an assessment of how increasing concentrations an loads up to PE 18,000 will influence the treatment performance of the OSF. In the response, please provide an assessment to identify any critical processes that may be modified, such as the processes of nitrogen attenuation / removal in the OFS (e.g. volatilisation, biological nitrification – denitrification). b. Is there an upper limit as to the treatment efficacy after which it does not function, or declines? c. Please provide the information indicated in footnote 6, Table 1. d. The cross references supplied in Table 1 footnotes are not understood. Please address this by providing more updated applicable citations and cross-references to support the comparison. In respect of memorandum 2 and the overland flow system memorandum 3 (Interim) from Pattle Delamore Partners, dated 2 April 2024 (memorandum 3), please provide answers to the following questions: a. Confirm when the OSF upgrades will be operational and provide an assessment of the anticipated performance at the end of Stage 1, prior to the main WWTP upgrades being operational. b. How will the upgrades to the OFS serve to reduce and manage the significantly increasing trends of Nitrate-N and DRP discharging into the farm pond? c. How will the OFS affect the 95th percentile of data?, noting these data are of great interest given these are	It is anticipated that the current slope removal efficiencies can be maintained or improved through improvements to the existing overland flow slopes and/or expansion of the overland flow slopes. The details of any improvement or expansion will form part of the Overland Flow Design and Operation Management Plan. b. The efficacy of overland flow treatment varies based on the construction of the slope, the distribution of wastewater, the quality and quantity of wastewater applied and a range of environmental factors. In general, lower loading rates (both volume and concentration) are expected to result in higher quality effluent. However, net removal efficiency may be greater at higher concentrations, i.e., a higher percentage of nutrients may be removed when concentrations are higher at the same hydraulic loading rate. For Beachlands, the main factor which can be controlled, outside of WWTP effluent quality, is the hydraulic loading rate. The hydraulic loading rate can be modified by improving the existing dispersal system to maximise distribution across all of the slope area or by constructing new overland flow areas. The details of proposed upgrades/expansions will be provided in the Overland Flow Design and Operation Management Plan to ensure that treatment efficacy does not decline. c. Please refer to Table 6 of the *Beachlands Wastewater Treatment Plant – water quality, ecological and human health effects assessment* prepared by Aquatic Environmental Services, Coast & Catchment and Streamlined Environmental and submitted with the Consent Application. d. Full references for each of the overland flow system results presented are supplied in the final section of Memorandum 2. **Part B:** a. Improvements to the overland flow system are anticipated to be completed at the same time as the short-term WWTP upgrades. The exact nature and timing of the upgrades will be set out in the Overland Flow Design and Operation Management Plan to be provided within 6 months of the commencement of the consent.	

at levels that present toxic concentrations in the receiving environment.

d. Noting the above, please add the 95th percentile to Table 3, and incorporate into the assessment of the performance of the OFS.

e. In respect of Table 4, please explain the derivation of the ratios, and a justification for applying the conductivity when earlier the report refers to this as being relatively inert, whereas the nutrients undergo attenuation pathway processes.

f. The conductivity ratio from Table 3 equates to 141/122 = 1.15, but the ratio in Table 5 is 1.19. Please explain the differences.

g. Table 4 note 2 references future scenarios. Please indicate which scenarios incorporating climate change scenarios have been accounted for. If not, please update the assessment to provide for the consideration of climate change, appropriate to the purpose and duration of the consent applied for.

h. Page 6 of the memo states: ‘flow ratios can then be used to determine the ‘fraction’ of each parameter which has been ‘removed by treatment process’ vs simple dilution.’ However, the data do not include the point of an assessment before the discharge reaches the pond itself – it includes only the data from the farm pond to the Site 15 (mixing zone), thus it does not account for the efficacy of the OFS itself. Please address this.

i. In respect of the Table 5 header, please state what processes other that dilution include. In the response, please provide specific details.

j. Page 7 states: ‘it remain unclear what fractions of this reduction are attributable to the overland flow system vs.

b. Based on the results of the overland flow performance investigation, there is a clear trend that increased residence times on the overland flow slopes promotes higher treatment efficiency. It is acknowledged that the existing dispersal system is not performing optimally. Wastewater is not dispersed evenly both across the four zones of the existing system and within each individual zone. Replacement of the dispersal system is expected to promote greater removal efficiencies in the overland flow system. For reference, the relative removal efficiencies from the three zones samples in the Performance Investigation are re-produced below. Zones A and B have lower flows and better dispersion compared to Zone C and the increase in nitrogen removal efficiency is clear.

Table 1: Nitrogen Removal Efficiency by Zone

Parameter	Zone A	Zone B	Zone C
Nitrate-N	21%	14%	4%
Total Nitrogen	24%	17%	6%
Ammoniacal-N	36%	55%	26%

Notes:

Similarly, the overall loading rate to the system can be reduced by expanding the overland flow area to Area B2 identified in PDP Memorandum 1. This is the preferred expansion area. Area B2 has even and gentle slopes which make it highly suited to overland flow. The grade of Area B2 is significantly flatter than the current overland flow system. It is expected that a new overland flow system could outperform the existing slopes, noting that the Zone C results are most representative of the current overall performance.

There is sufficient available space within Area B2 to provide an additional 500 m of overland flow slope width as set out in the land requirement assessment completed by PDP (Memorandum 1). This remains true if the potential wetland catchment is excluded (refer response to Question 6).

	natural biological processes in the pond'. This is repeated in the memo summary on page 8. On the basis of these statements and memorandum 3 (an incomplete assessment of the OFS), it is evident that the OFS assessment needs to be fully completed, with corresponding ecological, water quality, and modelling assessments updated accordingly, noting that the outcomes of the performance assessment of the OFS has a strong bearing on the assumptions incorporated into the ecological and modelling reports. Please address this.	c. We have assessed the performance of the overland flow slopes under 95th percentile conditions by comparing the median performance of the overland flow system to the performance under the highest concentrations in the effluent applied to the top of the slopes. It should be noted that this assessment has only 10 data points available and therefore the highest concentration recorded for each parameter has been used. Generally, the overland flow slopes perform worse for nitrogen but significantly better for phosphorus species under elevated concentrations as shown below. Note that negative removal values indicate an increase in concentrations and Pond Outlet % changes have been calculated relative to the effluent applied to the top of the overland flow slopes.	

Table 2: Removal Efficiency at Median vs. Max Concentration

Parameter	Zone A	Zone B	Zone C	Pond Outlet
Median:				
Nitrate-N	21%	14%	4%	36%
Total Nitrogen	24%	17%	6%	29%
Ammoniacal-N	36%	55%	26%	-95%
Total Phosphorus	-17%	-7%	-10%	21%
DRP	-30%	-4%	-11%	26%
Max Concentration (95th Percentile):				
Nitrate-N	14%	12%	4%	39%
Total Nitrogen	17%	16%	8%	36%
Ammoniacal-N	37%	45%	60%	-130%
Total Phosphorus	8%	31%	15%	45%
DRP	8%	26%	7%	60%
Notes:				

It should be noted that the peak nitrate-N and total nitrogen concentrations occurred under elevated wet weather flows. The reduced performance is most likely due to the higher flows increasing the discharge to Zones A and B. This reduces the residence time and therefore the treatment capacity. The performance of Zone C, which treats a higher volume of flow under dry weather flows, appears to be generally unaffected. Overall, the performance of the combined slope/pond system does not appear to be adversely affected by increased nitrogen concentrations.

For both total and dissolved reactive phosphorus, the system performs significantly better than under median concentrations. For DRP, under median conditions, the concentration of DRP increased by between 4% - 30% across the overland flow slopes. Under peak concentrations, there was a 8% - 26% decrease in DRP concentration across the slopes with an overall combined system reduction of 60%. This is thought to be due to the equilibrium between dissolved phosphorus in the wastewater and adsorbed phosphorus in the surface soils. When concentrations are high, phosphorus is adsorbed, and when concentrations are low, it is desorbed.

For reference, the absolute median and max values from the Performance Investigation Data set are provided below.

Table 3: Absolute Median and Max Concentration

Parameter (g/m³)	WWTP	Zone A	Zone B	Zone C	Pond Outlet
Median:					
Nitrate-N	3.4	2.2	2.7	3.3	2.3
Total Nitrogen	4.7	3.2	3.8	4.4	3.6
Ammoniacal-N	0.057	0.03	0.03	0.044	0.102
Total Phosphorus	0.35	0.5	0.48	0.33	0.27
DRP	0.23	0.33	0.28	0.25	0.19
Max Concentration (95th Percentile):					
Nitrate-N	5.1	4.4	4.5	4.9	3.1
Total Nitrogen	6.4	5.3	5.4	5.9	4.1
Ammoniacal-N	0.11	0.068	0.06	0.044	0.25
Total Phosphorus	1.24	1.14	0.86	1.05	0.48

DRP	0.98	0.9	0.73	0.91	0.39
Notes:					

d. Table 3 has been reproduced below using the 95th percentiles for contaminants assessed in Memorandum 2. Note that these statistics have been taken from the Sep 2023 – Feb 2024 (n=62) data set and not the Overland Flow Performance Investigation data set (n=10) as was used in the response to c. above.

The 95th percentile data indicates that the overland flow/pond system currently provides similar levels of removal as a percentage of the influent wastewater at the 95th percentile concentrations as well as median concentrations.

However, while these statistics provide a useful comparison, and demonstrate the effectiveness of the system under higher concentrations, we do not consider that it is appropriate to repeat the dilution assessment using the 95th percentile data. Since electrical conductivity is not affected by treatment processes, the 95th percentile electrical conductivity is unlikely to be linked to high nitrogen or phosphorous loads/concentrations. Instead, it could indicate a low level of dilution from inflow and infiltration in the reticulation network, or alternatively, an increase in the intrusion of saline groundwater.

Table 4: 95th Percentile concentrations across the Overland Flow/Pond system

Parameter	WWTP Effluent	U/S Pond (Site A)[2]	Farm Pond (Site B)	Tributary (Site E)[2]	Site 15
Nitrate-N (mg/L)	6.33	0.12	3.75	0.15	2.13
Total Nitrogen (mg/L)	7.60	0.40	4.80	0.43	2.70
Ammoniacal-N[1] (mg/L)	0.32	0.06	0.48	0.03	0.33
Total Phosphorus (mg/L)	2.55	0.07	0.79	0.05	0.4

Dissolved Reactive Phosphorus (mg/L)	1.51	0.03	0.64	0.03	0.36
Conductivity (µS/cm)	232	24	209	19	134

Notes:

1. *N=26 for ammoniacal nitrogen due to insufficient detection limits on WWTP samples prior to 4/12/23.*
2. *N = 20*
3. *N = 62 for all other samples*

e. Conductivity has been used to derive the flows through the system precisely because it is inert. As confirmed by the Overland Flow Performance Investigation, conductivity is not influenced by any processes in the overland flow slope or ponds. Therefore, the only way the electrical conductivity of the wastewater can change as if flows through the system is by dilution with fresh water from the environment.

The ratios have been derived by applying a mass balance to each stage of the process where:

$$c_1V_1 + c_2V_2 = c_3V_3$$

and

$$V_1 + V_2 = V_3$$

The electrical conductivity for the influent wastewater, inflows of freshwater into the pond, outflow of the pond, the tributary (Site F) and Site 15 are all known. By setting the influent wastewater (V_1) equal to an arbitrary value of 1 'flow unit' the above equations can be solved simultaneous to find the ratio of flows upstream of the pond (V_2) and out of the pond (V_3). This exercise was repeated for the confluence above Site 15.

Once the flows, and therefore dilution was identified using electrical conductivity, the dilution factor could be removed from the nitrogen and phosphorous parameters to understand the level of attenuation provided by the overland flow slope/pond system:

		$$(c_1 - c_{removed})V_1 + c_2V_2 = c_3V_3$$ $$c_{removed} = c_1 - \frac{c_3V_3 - c_2V_2}{V_1}$$ Assuming that any removal from the “freshwater” stream is negligible compared to the removal in the wastewater stream. f. Table 4 does not present the ratio of conductivity; it presents flows at different points in the system as a ratio of the influent wastewater flow. The ratio of 141/122 does not match the results presented in Table 4 because that calculation ignores the non-zero electrical conductivity of the upstream freshwater flows. g. The future scenario referenced in Table 4 was on the basis that stream flows remained consistent with the flows during the sampling period (Sep 2023 – Feb 2024). This comparison was intended to be indicative only and to demonstrate the rising proportion of wastewater in the system as flows increase. It should also be noted that the flows in the system were calculated as a ratio only, and therefore are indicative of potential median conditions over the sampling period. They are not directly comparable to specific scenarios of either wastewater or stream flow. Another aspect to note is that at times there may be zero flow within the stream. As detailed in the Overland Flow Performance Report (A028030001R001), for most of the sampling period (April – June 2024), there was negligible dilution across the farm pond indicating the stream would be dry if not for the existing wastewater discharge. h. At the time PDP memorandum 2 was prepared, no sampling had been completed at the base of the overland flow slopes. Therefore, the assessment presented in Memorandum 2 included the combination of attenuation on the overland flow slopes and within the farm pond as a single step in the treatment process.	

		PDP's report on the Overland Flow Performance Investigation (A028030001R001) provides further details on the individual contribution of the Overland Flow Slope and the Farm Pond. i. Other processes include: a. Sedimentation b. Adsorption c. Ion exchange d. Volatilisation e. Biological nitrification f. Biological denitrification g. Plant uptake h. Immobilisation i. Humification j. Leaching below the root zone PDP has completed an investigation into the performance of the Overland Flow Slopes. It is attached to this response.	
Human Health			
35.	The assessment of microbiological effects and health risk from NIWA, dated April 2024 (the health risk report) has only considered norovirus (oral digestion route) in its quantitative microbial risk assessment (QMRA) through the swimming route. Justification has not been provided as to the reason adenovirus (inhalation route) has not been included in the QMRA at the same time. Please address this.	Section 3.1.1 of the QMRA report explains why the oral ingestion route was considered and the respiratory route was not. In cases where effluent is well treated, the Individual Infection Risk (IInfR) through oral ingestion is higher than the risk of infection through inhalation. Managing the risks from the oral ingestion route will ensure risks for the respiratory route will be managed, assuming the same health-based targets are applied to both. To elaborate on the reasoning in the QMRA report, norovirus is commonly used as the reference pathogen for assessing Gastrointestinal (GI) risks and adenovirus for Acute Febrile Respiratory Illness (AFRI) risks in marine environments. The marine guidelines have distinct breakpoint risk values for AFRI and GI within each microbiological assessment category (MAC). For instance, category A represents less than 1% Individual Illness Risks (IIR) for GI and less than 0.3% IIR for AFRI. These values differ by a factor of approximately three.	

		Recent New Zealand QMRAs have indicated that, with the current modelling parameters, the absolute risks for GI are consistently higher by a factor of more than three times than for AFRI. This disparity exists because, under our specific conditions of concern, the oral ingestion route involves larger volumes of water ingested and higher pathogen concentrations compared to the inhalation route. The end result is higher GI than AFRI risks. Consequently, meeting a MAC category for GI also ensures meeting the AFRI category, but not necessarily the other way around. The reported risk also includes an extra safety factor. Instead of comparing QMRA results against marine guidelines, we use the NPS-FM values. The NPS-FM uses IInfR, unlike the marine guidelines, which use IIR. IInfR values for a given exposure are consistently higher than IIR because not all infected individuals become ill. Thus, meeting the NPS-FM bottom line of 1% would ensure compliance with the category A marine guideline for GI and AFRI risks.	
36.	The health risk report has not included emerging organic contaminant (EOCs) in its health risk assessment. The ecological report has estimated the ecological risk of EOCs in the proposed Beachlands WWTP discharge to the receiving environment based on monitoring of pharmaceuticals and personal care products at Beachlands WWTP as well as literature on EOCs in wastewater from other WWTPs. Please provide a further health risk assessment in terms of EOCs.	EOCs were outside the scope of the human health risk report by NIWA as it is a quantitative microbial risk assessment (QMRA). Consumption of drinking water or aquatic species containing EOCs are the two main potential sources of human health risk in this case. There is very little information on human health risks from EOCs. Attachment Y describes the current understanding focussed on drinking water, noting the consumption of aquatic species is covered in our response to Q8. Further response in **Attachment 8**	Closed
37.	The health risk and ecological reports show that the Kellys Beach location has been excluded from its QMRA for consumption of shellfish since juvenile cockles and pipi present there were found to not be near harvestable sizes. The reports consider that it is unlikely that shellfish are harvested from Kellys Beach for human consumption. However, the consent is for 35 years, and during this period of time, shellfish are expected to grow and reach harvestable sizes. The health risk report shows that an	See response to Q20. If the shellfish exposure pathway exists for shellfish collected from Kellys Beach, either now or in the future, a QMRA will be undertaken to assess those risks.	Closed

	increase in flow will result in a noticeable increase in risk in marine environments than freshwater and shellfish at Kellys Beach are expected to be more likely to be influenced by the discharge as compared to the other three sites being assessed. Therefore, the QMRA should also include Kellys Beach in terms of shellfish consumption. Please address this.		
38.	The health risk report QMRA assessed the log reduction of norovirus required to reduce the added risk of infection to <1% for individual exposure (swimming, or consumption of shellfish or watercress) at each of the assessment sites. The report has not assessed the overall health risk from all the potential exposure routes. Please address this and include aggregated exposures into the assessment.	Risks are reported for each individual activity and event in accordance with the standard approach for assessing microbiological effects and health risks related to the impacts of wastewater discharges in recreational settings, including shellfish gathering and swimming. The risks from dilute, well-treated wastewater are generally acute, and each activity is treated as a separate and independent event. However, there may be situations where an individual swims in contaminated water, and additionally consumes uncooked or lightly cooked watercress and shellfish. This exposes them multiple times and in close temporal proximity to risks associated with the discharge of the treated wastewater. The resulting risks will be as high or higher than any individual event. Neither the Microbiological Water Quality Guidelines nor the NPS-FM provides guidance on aggregating multiple risks. Risk aggregation is a complex task, though it is commonly carried out for drinking water. The challenges in aggregating risk include which routes to aggregate. For example, the water quality at the time of a swim controls swimming risks, while food consumption risks reflect water quality for a period leading up to the kai collection. Ignoring these and other challenges, the pragmatic approach adds up the estimated individual risks for each activity. The resulting estimates will be highly conservative and overestimate the actual risk, but they may be informative. Focusing only on the two sites in the Te Puru Stream where we have estimated multiple risks, the resulting risk estimates created by simple addition are provided below. The combined risk estimates are:	

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Log Reduction Values (LRV)

	1	2	3	4	5	6	7
Bridge	75.5	63.7	37.7	6.9	1.2	0.1	0.01
Quarry	75.1	62.6	36.2	6.6	1.2	0.1	0.01

This assumes the worst-case scenario of Stage 2 (greatest flows) and the largest meal size.

Note: These risks are unreasonably high for LRV 1 and 2, as a significant proportion of the population is expected to have immunity from norovirus.

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<tr><td>39.</td><td>

The health risk report has assessed microbiological water quality against Table 9 of the NPSFM. It states that: 'there are national targets for 80% of rivers to be suitable for swimming (blue, green and yellow category) by 2030 (Ministry for the Environment 2023)'. The report uses a 95th percentile of 1,200 cfu/100ml as a national bottom line. This does not appear to accord with the NPSFM and the Ministry for the Environment and Ministry of Health (2003) Microbiological Guidelines for Marine and Freshwater Recreational Areas (MfE/MoH guideline). Please address this.

Note:
It is noted that the NPSFM has two E. coli-based metrics associated with human contact recreation. Table 9 applies year-round across all Freshwater Management Units and is assessed against selected State of Environment data on a monthly basis. While Table 22 applies over the summer bathing season at primary recreational contact sites, it specifies 95th percentile of 540 cfu/100ml as a national bottom line for freshwater contact recreation. This latter figure is consistent with the

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The estimated risks have been assessed against the NPS-FM. The NPS-FM has set a national freshwater benchmark for human contact at the 95th percentile of *E. coli* at 540 cfu/100mL, as shown in Table 22 as the bottom line. The results of the QMRA cannot be directly connected with Table 22 as the attribute bands are not presented in terms of average individual infection risk (IInfR). However, it is possible to align the benchmark from Table 22 with Table 9, which aligns with the Blue category, representing an average infection risk of 1% or less (the bottom line). The 95th percentile of *E. coli,* equating to 1200 cfu/100mL, represents a predicted average infection risk of 3% and the yellow-orange boundary on Table 9. The QMRA report presents the results against the attribute bands (blue, green, yellow, etc.) from Table 9. The report notes the level of treatment required, expressed in terms of log reduction values (LRV), to meet the 1% IInfR, as specified by the NPS-FM in Table 22.

Figure 2.9 in the report presents the median (>260 cfu/100mL) and 95th percentile values (>1200 cfu/100mL) for NPS-FM Band E(Red). It demonstrates that the stream falls into the E band, so by definition, it would not meet the NPS-FM bottom line.

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</table>

	MfE/MoH guideline and will likely trigger a health warning if exceeded. Therefore, it is considered that using 95th percentile of 1,200 cfu/100ml as a trigger for swimmable is inappropriate, notwithstanding that it is understood that the stream is unsuitable for swimming largely due to microbiological input from the wider catchment.		
40.	With respect to human health risks from viruses in relation to coastal marine environment, the following assessment is provided within the ecological report: *'For marine sites log reductions ranged from 2-3 Kelly's Beach transect sites (depending on discharge scenario), but less than 1 for those further out in the bay and for all discharge scenarios.* *For shellfish consumption, an LRV (log reduction value) of 1 is sufficient to provide a risk of <1% for the current discharge scenario at all marine sites, while this increases but is below 2 for interim and Stage 2 discharge scenarios.'* What does this mean for the people swimming at the beach sites and how will the health risks be managed? Please also clarify and assess the risk associated with shellfish consumption.	Providing the engineered barriers in the WWTP reduces the level of pathogens in treated wastewater by a factor of 1000 below the level in untreated wastewater (i.e., 3 Log10 reduction), we expect the average risk of norovirus infection for anyone swimming on a random day to be less than a 1% chance of infection per swim. See response to Q20 regarding shellfish risks. If the shellfish exposure pathway exists for shellfish collected from Kellys Beach, either now or in the future, a QMRA will be undertaken to assess those risks.	
41.	Please provide an assessment of risk to human health for shellfish gathering, applying the MfE (2003) Section F Microbiological Guidelines for Shellfish-Gathering Waters.	According to Section F of the Guidelines, the Guidelines should only be applied to waters "…where a prior sanitary survey has shown there are no point sources of pollution of public health concern." Meeting the guidelines does not guarantee safety when wastewater discharges impact water. Given the presence of the WWTP discharge, we suggest the guidelines should not be applied in this situation as they specifically exclude situations such as this. We suggest a QMRA is the most appropriate way to assess the incremental risks from a WWTP. Though we note that no specific risk-based targets for shellfish gathering are available, we suggest the NPS-FM provides an appropriate comparator.	Closed

Environmental Management			

42.	In accordance with the proposed monitoring plans in Section 10 of the AEE, please provide draft plans for the following:
	• Environmental management plan (overarching).
	• Environmental monitoring plan.
	• Operational management and contingency plan (OMCP).
	• Overland flow design and operation management plan (noting this is a proposed co-design with Ngāi Tai ki Tāmaki), and indicate the timeframes for this development:
	  ○ Riparian management plan (for the expanded OFS).
	  ○ Earthworks management plan, including erosion and sediment control (for the expanded OFS).
	Draft consent conditions.
		Management Plans will be a requirement of the Consent Conditions. Proposed draft conditions have been provided, refer to **Attachment 9.**	

Water Quality			
43.	Section 2.4 of the AEE refers to the dosing of wastewater using acetic acid and aluminum sulphate (Alum) to assist in the removal of nitrogen and phosphorus, respectively. Please describe this process in more detail, providing a description of the 'chemical dosing strategy' (section 2.4.3, p17) that is used to manage nitrate and dissolved reactive phosphorus. In the response, please describe how / if the adjustment to the 'chemical dosing strategy' has contributed to significantly increasing trends in nitrate and DRP in the recent trend analysis period. Please also describe how the dosing strategy will be applied in the future as anticipated loads and concentration of nitrogen and phosphorus are expected to be treated up to PE 18,000, and post commissioning of the upgrade et PE 24,000.	Refer to Q13	

<table>
<tr><td>44.</td><td>Table 2-1 (p16) of the AEE, footnote 3, refers to nitrate data being excluded ‘due to steady increase in concentrations compared to previous 4 years’. As this data is relevant to the AEE, please update Table 2-1 to include this nitrate data for the period 2022-2023. It can be presented as an additional line item to allow the authors to highlight the differences if required.</td><td>Refer to Q13</td><td></td></tr>
<tr><td>45.</td><td>Figure 2-3 of the AEE provides population projections, and Figure 2-20 provides Connected Population estimate against timing of the upgrades. The relationship between the growth model and stepped staged approach is important. The year at which the PE 24000 is reached is approximately at the year 2043, as per Figure 2-3. This does not align with the stepped staged approach displayed in Figure 2-20 (which suggests this is reached around the year 2033). It would be useful to see these two figures aligned. Specifically, please indicate at what year the respective PE of 18,000, 24000, and 30,000 are expected to be reached. In the response, please also include the anticipated duration for each of the four stages 1. Current up to Short term upgrade; 2. Short term upgrade; 3. Long-term Stage 1, 4. Long term Stage 2. This information will be useful to assist with assessing the duration of the discharge conditions that will be occurring across the time periods indicated.</td><td>The population estimates presented in Figure 2-3 are outdated and therefore differ slightly from the those shown in Figure 2-20.

A summary of the upgrade timing, duration, population and capacity is presented below. Please note that the timeframes are indicative based on the latest available information from the property developer.

<table>
<tr><th></th><th>Current</th><th>Short Term Upgrade</th><th>Long term Upgrade -Stage 1</th><th>Long term Upgrade -Stage 2</th></tr>
<tr><td>Period</td><td>2023-2026</td><td>2026-2032</td><td>2032-2038</td><td>2038-2056</td></tr>
<tr><td>Duration</td><td>3 years</td><td>6 years</td><td>6 years</td><td>18 years</td></tr>
<tr><td>Population</td><td>9,704-10,124</td><td>10,124-15,603</td><td>15,603 – 22,291</td><td>22,291 – 29,238</td></tr>
<tr><td>WWTP Design Capacity</td><td>10,000</td><td>18,000</td><td>24,000</td><td>30,000</td></tr>
</table>
</td><td>Closed</td></tr>
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