Porirua Wastewater Treatment Plant

Assessment of effects of elevated total ammonia nitrogen concentrations in the treated wastewater discharge to coastal waters

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1 Introduction

Porirua City Council (PCC) holds coastal discharge permit WGN200229 [36816] to discharge treated wastewater to the coastal marine area from the operation of the Porirua Wastewater Treatment Plant (WWTP). Condition 9 of the consent requires that the consent holder, on at least one occasion each week, obtain a representative 24-hour flow-proportioned composite sample of wastewater, and that each sample is analysed for total ammonia nitrogen (TAN). Conditions 30 to 33 require the consent holder to conduct a monitoring and technology review of the WWTP if, amongst other things, the concentration of TAN exceeds 6 g/m^3 in more than 5 of 26 consecutive weekly wastewater samples.

Condition 35 of the consent states that:

"*Notwithstanding the scope of the review set out in condition 31, if the monitoring and technology review is undertaken in response to the concentration of total ammonia nitrogen in the treated wastewater, then it shall be limited to the consideration of the adverse effects of the total ammonia nitrogen and the technological options or other methods which may be available to reduce those adverse effects.*"

This report assesses the effects on the marine receiving environment of elevated TAN concentrations which first exceeded the threshold in June 2024.

2 Treated wastewater ammonia concentrations

Based on weekly samples collected from July 2023 to June 2024 (42 samples) the 95th percentile concentration of TAN in Porirua treated wastewater was 3.1 mg/L, comfortably below the 6 mg/L threshold trigger shown as a dashed red line in Figure 2-1. However, from the beginning of June 2024 the concentration increased 10-fold and has remained elevated in the 30 samples collected since then, with a 95th percentile concentration of 34.9 mg/L.

A report to WWL (Memo from Louis Ortenzio and Sylvia Chia, 21 January 2025) identified low oxygen levels within the treatment process as a contributing factor to elevated TAN concentrations and has made several recommendations to address the problem.

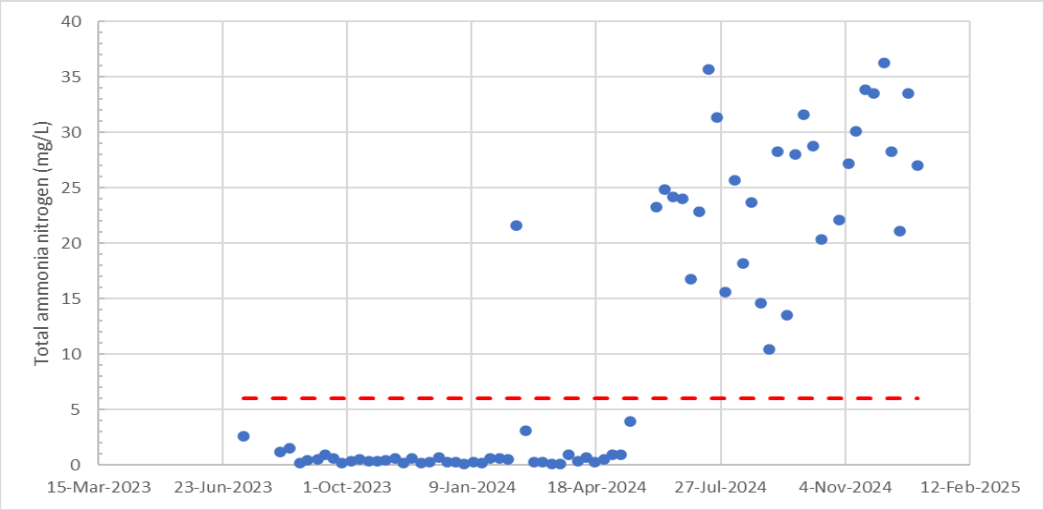

Figure 2-1: Treated wastewater TAN concentrations (mg/L) from weekly samples

3 Receiving water ammonia concentrations

3.1 Coastal water monitoring results

Shoreline coastal water samples were collected once each month from knee-deep water at sites located 140 m east of the outfall, 200 m south-west of the outfall, and at a control site 3,800 m northeast of the outfall at Whitireia Park. The results summarised in Table 3-1 and Figure 3-1 show that during the period from 1 July 2023 to 1 June 2024 when the treated wastewater concentration of TAN was within its permitted range, receiving water concentrations remained consistently below the ANZG (2018) 95% protection trigger value (TV) of 1.32 mg/L[1]

The sharp increase in treated wastewater TAN concentrations from June 2024 is reflected in increased receiving water concentrations at the 200m southwest site (but noting that there was no exceedance of TVs), but no change at the 140m east site. Interestingly TAN concentrations increased at the control site after June 2024, but this is unlikely to be related to the WWTP discharge.

Table 3-1: Summary statistics of TAN (mg/L) routine monitoring results[2] at coastal water sites 140m east and 200m south-west of the outfall, before and after June 2024

	140m east of Outfall		200m south-west of Outfall		Control	
	Before June 2024	**After June 2024**	**Before June 2024**	**After June 2024**	**Before June 2024**	**After June 2024**
N samples	10	8	10	9	8	9
median	0.040	0.055	0.040	0.280	0.010	0.020
75th percentile[3]	0.210	0.225	0.130	0.503	0.020	0.158
Maximum	0.590	0.320	0.340	1.090	0.150	0.290
% of samples exceeding TV	0%	0%	0%	0%	0%	0%
ANZG (2018) TV @ pH 7.8	1.320					

None of the samples collected from the coastal water sites since July 2023 have exceeded the ANZG (2018) TV, indicating negligible risk of ammonia toxicity beyond the 200m mixing zone. It is noted that the coastal water monitoring dataset is currently too small to characterise the range of ammonia

[1] The ANZG default trigger value for TAN is based on a pH of 8 which close to the normal pH of seawater. It is noted however that the pH of Porirua WWTP treated wastewater has a median value of 7.2 and the discharge plume has a predicted pH of 7.8 at a distance of 200m from the outfall. The pH adjusted ANZG (2018) trigger value for marine water at pH 7.8 is 1.32 mg/L (Table 8.3.7 in ANZG 2018).

[2] The data summarised in Table 3-1 is from routine monthly monitoring only, not WWTP overflow monitoring

[3] The 75th percentile values are included here because there are too few data points to calculate 95th percentiles.

concentrations with a high degree of confidence, nevertheless, this monitoring is ongoing, and the level of confidence will increase over time.

The coastal water monitoring results are consistently lower that the mass balance predictions summarised in the next section. That is because the mass balance predictions do not take account of the nitrification process which converts ammonia to nitrite and nitrate in a well oxygenated receiving environment.

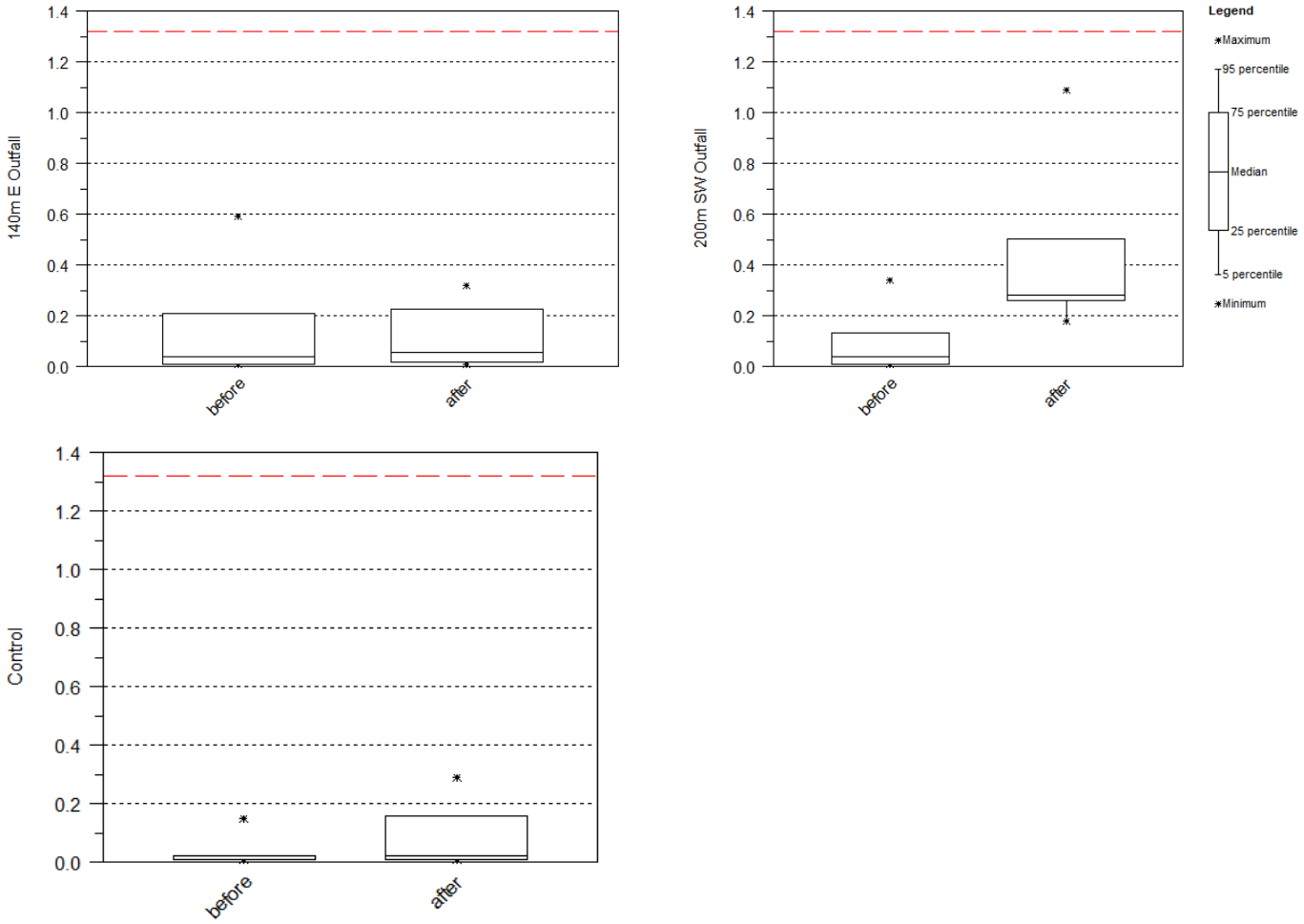

Figure 3-1: Box plots of total ammonia nitrogen (mg/L) monitoring results at coastal water sites 140m east, 200m south-west of the outfall, and the control site, before and after June 2024 (ANZG TV (at pH 7.8) indicated by dashed red line)

3.2 Mass balance predictions

The potential effects of the wastewater discharge on receiving water TAN concentrations can be determined by mass balance calculation. The predicted receiving water contaminant concentration (Cx) at any location x is given by equation 1:

$$Cx = ((Co - Cb)/TD) + Cb \quad (1)$$

Where: Co = the wastewater concentration of the contaminant.
Cb = the background concentration in the ocean, and
TD = the total dilution[1].

In other words, the contaminant concentration at a given location in the receiving waters is determined from the discharge concentration, the background concentration, and the total dilution at that location[4]. This predictive approach is complementary to the weekly monitoring of receiving waters.

The assessment in Table 3-2 below is based on equation (1) and inputs including estimated background TAN concentrations, the median and 95th percentile treated wastewater TAN concentrations post June 2024, and the 50th percentile dilution value.

Table 3-2: Predicted TAN (mg/L) median and 95th%ile concentrations in Porirua coastal waters based on post June 2024 discharge concentrations

Discharge median to 95th percentile concentration range	Background seawater concentration	Nearshore coastal water 140m east of outfall		Nearshore coastal water 200m south-west of outfall	
		Dilution	Median to 95th percentile concentration range	Dilution	Median to 95th percentile concentration range
25.3 - 34.9	0.02	29	0.89 - 1.22	9	2.82 - 3.90

The predicted TAN concentrations exceed the ANZG (2018) TV at the 200m south-east site due to low dilutions as the plume moves in that direction. It is emphasised here that this is a conservative estimate of the theoretical concentration in the receiving environment and does not account for the nitrification process where ammonia is converted to nitrites and then nitrates.

As discussed in the preceding section the TAN concentrations determined by monthly monitoring are lower than the predicted range and no TV exceedance has been detected to date.

[4] Dilution values were obtained from modelling described in (WWL, 2020): Porirua WWTP – Discharge of Treated Wastewater Assessment of Environmental Effects

4 Assessment of effects on marine biota

Routine monthly coastal water monitoring results have yet to detect any exceedance of the ANZG (2018) TV beyond 200m from the outfall. Mass-balance predictions suggest, however, that the post June 2024 discharge might, in the worst case, cause an exceedance of the coastal water TV. It is noted that intertidal areas and rocky reef habitats are intermittently rather than continuously exposed to the discharge plume due to variable wind and tide conditions, and that for habitats more that 200m from the outfall any exposure to elevated TAN concentrations is likely to be infrequent and brief. Table 4-1 summarises the expected level of adverse effect based on what is known about the discharge and the receiving environment.

The overall level of adverse effect during the post June 2024 discharge is assessed as Low for biota on intertidal rocky habitats, subtidal rocky habitats, and sandy sediments.

Table 4-1: Determination of level of effect

Feature	Factors considered in determining the 'Magnitude of effect'		Factors considered in determining the 'Leve of effect'		Level of effect
	Spatial scale	Duration	Magnitude	Ecological value	
Biota of intertidal rocky substrate	Medium	Short	Low	Moderate	Low
Biota of subtidal rock substrata	Medium	Short	Low	High	Low
Biota of sandy sediments	Medium	Short	Low	Moderate	Low

Definition of terms

- Spatial scale of effect: Small (tens of metres), Medium (hundreds of metres), Large (>1km)
- Duration of effect: Short (days to weeks), Moderate (weeks to months), Persistent (years or more)
- Magnitude of effect: Negligible (no or very slight change from existing condition, Low (minor change from existing conditions, minor effect on population or range of feature), Moderate / Medium (loss or alternation to key elements of existing conditions, moderate effect on population or range of the feature), High / Severe (major or total loss of key elements of existing conditions, large effect on population or range of the feature).

References

ANZG. (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Toxicant default guideline valies.*

WWL. (2020). *Porirua WWTP - Discharge of Treated Wastewater - Consent Application and Assessment of Environmental Effects.*

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