REPORT

Tonkin+Taylor

Hahei WWTP Ecological Monitoring of the Wigmore Stream 2024 - 2025

Prepared for
Veolia Water Services (ANZ) Pty Limited

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Executive summary

Thames-Coromandel District Council (TCDC) hold Waikato Regional Council (WRC) resource consent AUTH135636.01.01 to discharge treated municipal wastewater from the Hahei Wastewater Treatment Plant (WWTP) to the Wigmore Stream in Hahei. Wigmore Stream is a small brackish stream with a catchment of approximately 3.3 km^2. The upper catchment is dominated by grazed pasture and the lower catchment is predominantly residential. Treated municipal wastewater from the Hahei WWTP discharges directly to the Wigmore Stream at an average rate of 127 m^3/day (February 2023 – January 2025). The Hahei WWTP services 25% of the residential properties in Hahei Township and the Hahei Holiday Park. The remainder of the properties are serviced by private on-site wastewater treatment and disposal systems (i.e., septic tanks).

The Hahei WWTP discharge consent requires annual ecological monitoring of the instream macroinvertebrate populations, physical habitat and aquatic vegetation to be carried out in January or February at sites upstream (US) and downstream (DS) of the discharge point. Fish surveys are also required in January or February once every five years. This commenced in 2019 and was undertaken again in 2024. Reporting to WRC is required on a two-yearly basis.

This report presents the results of annual ecological monitoring undertaken US and DS of the Hahei WWTP discharge point in the Wigmore Stream on 30-31 January 2024 and 12 February 2025. It also presents the results of water quality monitoring undertaken by Veolia between 2 February 2023 and 31 January 2025.

Water quality was generally similar at the US and DS sites across both monitoring periods. However, median nitrate nitrogen, soluble reactive phosphorous, and total phosphorus concentrations were substantially higher at the DS site compared to US, and several orders of magnitude greater at the discharge outlet. Despite this, water quality does not appear to be having a significant impact on macroinvertebrate metrics as there were no significant differences between the US and DS sites during 2024 and 2025 surveys.

As found in previous assessments, median *Escherichia coli (E. coli)* concentrations at both the US and DS sites were similarly elevated above the recommended national bottom line recreational limit. *E. coli* concentrations in the outlet discharge were, however, lower than at US and DS sites, suggesting that the WWTP is unlikely to be the source of contamination.

Macroinvertebrate metrics have generally remained low (‘poor’ to ‘fair’) over time and have shown no significant differences between the US and DS sites over the long-term. Wider catchment influences on water quality, the soft bottomed nature of the habitat and brackish surface water are the likely limiting factors with respect to diversity and richness of freshwater macroinvertebrates.

Freshwater fish surveys have shown considerable variability between surveys both in the species encountered and in their Catch Per Unit Effort (CPUE). The species observed during the 2024 survey are relatively consistent with those encountered during previous surveys, and differences between the US and DS site are more likely due to variation in instream habitat between the reaches as opposed to effects from the WWTP discharge.

Overall, the data indicates that the Hahei WWTP discharge has not had a measurable adverse effect on downstream water quality or ecology as similar results and values have generally been recorded at US and DS sites.

1 Introduction

This report presents and discusses the results of annual ecological monitoring of the Hahei Wastewater Treatment Plant (WWTP) discharge to the Wigmore Stream, located in Hahei Township, Coromandel, undertaken in 2024 and 2025.

1.1 Background

Veolia Water Services Limited (Veolia) operates the Hahei WWTP for the Thames-Coromandel District Council (TCDC). TCDC holds resource consent number AUTH135636.01.01 (Appendix A, hereafter 'the Consent') to discharge treated wastewater to Wigmore Stream and any associated seepage discharge to groundwater from the Hahei WWTP treatment ponds.

Condition 16 of the Consent details the water quality sampling and analysis required, which is undertaken by Veolia. Conditions 16 and 19 require annual ecological monitoring of the instream macroinvertebrate population, physical habitat and aquatic vegetation to be carried out in January or February at sites upstream and downstream of the discharge point. Fish surveys are also required once every five years in January or February (last completed 2024). Reporting to WRC is required on a two-yearly basis.

Veolia engaged Tonkin & Taylor Ltd (T+T) to complete the summer 2024 and 2025 ecological monitoring and prepare an ecological monitoring report detailing the findings of the surveys. This report has been prepared in accordance with the T+T offer of service dated 25 October 2024.

1.2 Report Scope

This report presents and discusses the results of the ecological monitoring programme of Wigmore Stream, Hahei as described above. The sampling methods and analyses are consistent with previous surveys undertaken and as summarised in the report titled "Hahei Wastewater Treatment Plant Assessment of Ecological Effects" by Kessels Ecology, dated 24 May 2017. The scope of this report is as follows:

- To present the results of ecological monitoring undertaken at survey sites upstream and downstream of the discharge on two occasions comprising:
  - Collection of habitat parameters following the WRC Qualitative Habitat Assessment (QHA) field sheets (Collier & Kelly, 2005);
  - An assessment of aquatic vegetation following the WRC guidelines (Collier, Hamer, & Champion, 2014);
  - Stream morphology measurements;
  - Spot water quality measurements; and
  - An assessment of aquatic macroinvertebrates.
- Five yearly fish survey undertaken in 2024 only;
- To present long-term trends in fish survey data;
- To analyse and present long-term trends in macroinvertebrate community metrics; and
- To assess the ecological effects of the discharge of treated municipal wastewater on in-stream ecological values.

2 Site location and catchment description

2.1 Hahei Wastewater Treatment Plant (Hahei WWTP)

Hahei WWTP is located approximately 500 m inland from Hahei Beach and is accessed from Pa Road. Wastewater from Hahei Township is reticulated to and treated in an aerated pond, followed by a retention pond, then a membrane filtration unit (MFU) before it is discharged into the Wigmore Stream via a perforated pipe diffuser. The perforated pipe diffuser is secured parallel to the stream bank (see Appendix B for discharge location). The consent allows a daily discharge of up to 700 m^3 over a 24-hour period at a maximum rate of 8.1 L/s. No 24-hour discharge rate exceedances occurred during the monitoring period between February 2023 and January 2025. The average daily discharge for this period was 127 m^3/day (Appendix D Figure 1).

2.2 Catchment description

Wigmore Stream has its headwaters approximately 1 km inland from Hahei and flows in a general northeast direction before flowing into the sea on the south-eastern end of Hahei beach. Wave action at the beach can at times cause sand build up at the Wigmore Stream mouth entrance that can limit or temporarily block the stream's discharge to the sea. Closure is more frequent in the summer and is dependent on rainfall and prevailing wind conditions. The stream mouth was frequently closed during the summer seasons within the monitoring period, including during the 12 February 2025 ecological survey. Operators were frequently required to clear the mouth to ensure the stream remained free flowing.

The total Wigmore Stream catchment area is approximately 3.3 km^2, reaching a maximum elevation of 8.8 m RL (Waikato Regional Council, 2017). Land use in the upper catchment is dominated by grazed pasture with the lower catchment comprising predominantly residential areas. The Hahei WWTP services 25% of the residential properties in Hahei Township and the Hahei Holiday Park. The remainder of the properties in Hahei Township are serviced by private on-site wastewater treatment and disposal systems (i.e., septic tanks). These private wastewater systems are also a potential source of contaminants to Wigmore Stream.

3 Methodology

3.1 Survey sites

Two sites in Wigmore Stream were surveyed on two occasions (2025). Survey sites comprised 100 m long stream reaches located upstream (US) and downstream (DS) of the discharge and as monitored in previous surveys. The DS reach began approximately 70 m below the Hahei WWTP discharge point extending downstream, and the US reach began approximately 50 m above the discharge extending upstream (Appendix B Figure 1 and Table 3.1). Both sites are located within the tidally influenced reach of Wigmore Stream (Kessels Ecology Ltd, 2017). Due to the tidal influence, there is a potential that the WWTP discharge may drift upstream during high tide, and this may impact water quality at the US site. We have considered this in our interpretation of results.

Table 3.1: Monitoring locations with associated GPS coordinates for Wigmore Stream sampling sites (World Geodetic System 1984)

Site	Location	Latitude	Longitude
US	50-200 m above the WWTP discharge	-36.848103	175.805150
DS	70-220 m below the WWTP discharge	-36.846156	175.806600

* GPS locations are for the upstream end of the site

3.2 Hydrology

The Waiwawa River flow gauge is the closest flow monitoring site to the Wigmore Stream. Data from the Waiwawa River was inspected to broadly assess flow conditions leading up to the ecological monitoring. Median flow for February 2024 to February 2025 was estimated at 3.39 m^3/s.

Flow in the Waiwawa River was elevated above the median flow on four occasions during the two weeks prior to the January 2024 survey (Figure 3.1), but was below the median flow during the survey. The flow conditions were appropriate for macroinvertebrate sampling as the data indicates no large floods occurred within two weeks prior to the survey, and the flow was less than three times the median flow during the 10 days prior to sampling (Stark et al., 2001; Collier & Kelly, 2005).

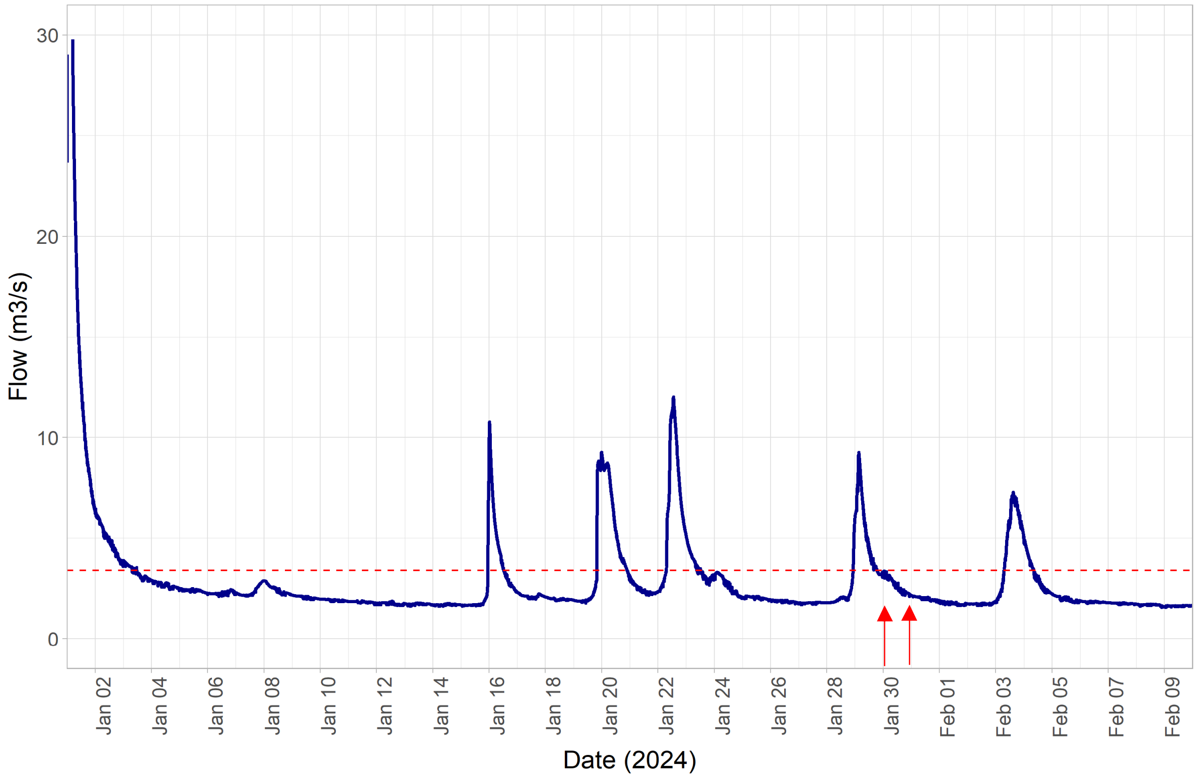

Figure 3.1: 5-minute flow data recorded at the Waiwawa River gauge (Site #1257) from 1 January to 10 February 2024. Data sourced from the Waikato Regional Council. The dashed red line indicates the median flow from February 2020 to February 2025. The red arrow shows the dates of sampling in Wigmore Stream (30-31 January).

Flow in the Waiwawa River was below the median flow during the two weeks prior to, and during, the February 2025 survey (Figure 3.2). The flow conditions were appropriate for macroinvertebrate sampling as the data indicates no large floods occurred within two weeks prior to the survey, and the flow was less than three times the median flow during the 10 days prior to sampling (Stark et al., 2001; Collier & Kelly, 2005).

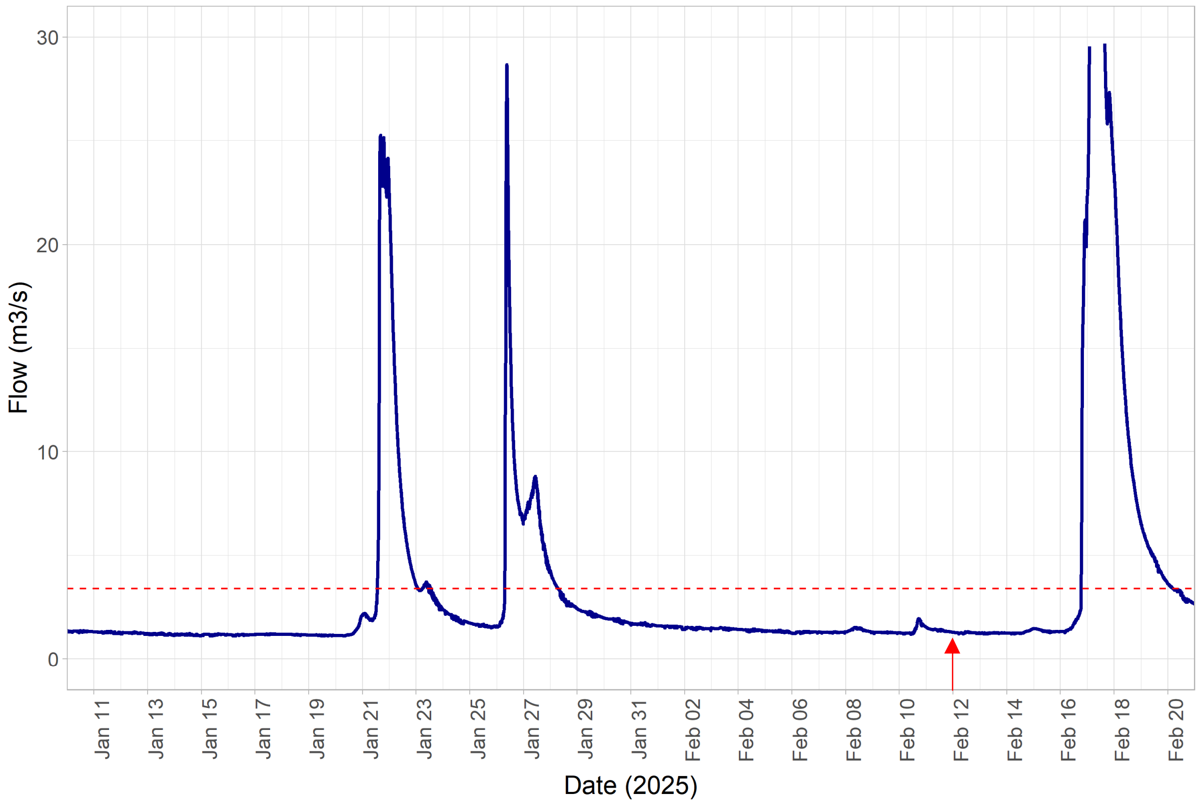

Figure 3.2: 5-minute flow data recorded at the Waiwawa River gauge (Site #1257) from 10 January to 21 February 2025. Data sourced from the Waikato Regional Council. The dashed red line indicates the median flow from February 2020 to February 2025. The red arrow shows the date of sampling in Wigmore Stream (12 February).

3.3 Water quality

Temperature, pH, dissolved oxygen, and conductivity were measured at each site using a calibrated YSI ProDSS Water Quality Meter.

As required by condition 16 of the consent, Veolia take regular surface water samples at US and DS site locations (Appendix B Figure 1) within one hour either side of low tide. Water samples are tested for the following parameters:

- Nitrate nitrogen (mg/L);
- Ammoniacal nitrogen (mg/L);
- Total Kjeldahl nitrogen (mg/L);
- Total phosphorus (mg/L);
- Total suspended solids (mg/L);
- Total carbonaceous biochemical oxygen demand (CBOD) (mg/L);
- Soluble reactive phosphorous (mg/L);
- Turbidity (NTU);
- Conductivity (µS/cm);
- pH;
- *E.Coli* (cfu/100 ml); and
- Enterococci (cfu/100 ml).

Surface water samples assessed in this report were collected between 2 February 2023 and 31 January 2025 on a total of 36 occasions at the US and DS locations, and at the outlet discharge location. Wastewater outlet discharge quality results are taken after the filter unit and before reaching the Wigmore Stream. Data provided to T+T are included in Appendix D, Table 1).

Australian & New Zealand guideline values for freshwater and marine water quality (ANZG) physical and chemical (PC) stressor guidelines (2018), and the Waikato Regional Council's (WRC) guidelines (Moke, 2023) were used to assess water quality conditions. Toxicant guidelines are defined in terms of the proportion of species protected under varying levels of ecosystem disturbance. A 95% protection threshold for a slightly to moderately disturbed system was selected for the Wigmore Stream. Reference conditions for the ANZG (2018) PC stressor values are defined as the chemical and physical conditions that can be expected in rivers and streams with minimal or no anthropogenic influence. The 80th percentile values are provided for PC stressors (indicators) that are harmful at high concentrations (ANZG, 2018). WRC guidelines are based on a range of national standards and guidelines for the protection of human and ecological health.

We have also compared the water quality data collected by Veolia to the National Objectives Framework (NOF) of the National Policy Statement for Freshwater Management 2020 (Ministry for the Environment, 2020). The NOF provides numerical attribute states to be used by Regional Councils to set objectives and limits for freshwater management. The NOF allows waterways to be assessed against a nationally consistent set of environmental bottom lines, with a grading system to indicate the relative level of ecosystem degradation. Attributes are included to assess the state of the waterway for human health and ecosystem health purposes.

3.4 Habitat assessment

A qualitative habitat assessment (QHA) was conducted at each site using a soft bottomed field assessment form provided in WRC guidelines (Collier & Kelly, 2005). Assessments involved the measurement of riparian, bank and channel condition on a scale from 1 to 20 (where 1 is the lowest condition and 20 is the highest). Scores are interpreted as follows:

- Scores between 1 and 5 labelled as "poor";
- Scores ranging from 6-10 labelled as "marginal".
- Scores ranging from 11-15 labelled as "suboptimal"; and
- Scores ranging from 16-20 labelled as "optimal".

Stream morphology was measured at five transects within the 100 m reach, 20 m apart to record wetted width, channel width and depth (five depth measurements at each transect) (Collier, Hamer & Champion, 2014). Percentage substrate composition was estimated by undertaking a modified Wolman assessment with 50 points sampled across five evenly spaced transects (10 per transect).

QHA classifications are provided in Appendix C Table 1.

3.5 Aquatic vegetation

Periphyton assessment could not be completed during the 30-31 January 2024 and 12 February 2025 surveys as the disturbance of the bed during the surveys created plumes of black sediment which emitted a sulphurous odour (anoxic sediment) and obscured any view of the bed material. Additionally, no macrophytes were observed during either survey and very low levels of periphyton and macrophyte coverage were reported between 2017 and 2019. It is, therefore, difficult to determine the effects of the Hahei WWTP discharge on the growth of freshwater aquatic vegetation within Wigmore Stream relative to tidal and saline influence at the survey sites. Consequently, neither periphyton nor aquatic vegetation results are included in this report.

3.6 Aquatic macroinvertebrates

Four replicate macroinvertebrate samples were collected at each sampling reach. Samples were collected and processed in accordance with national protocol C2 (soft bottom streams semi-quantitative) for macroinvertebrate sampling in wadeable streams (Stark et al., 2001). Under this sampling method, a D-net (0.5 mm mesh) was used to sample woody debris, bank margins, and aquatic macrophytes. Single samples were collected from a fixed area of approximately 3 m^2 (10 replicate unit efforts of 0.3 m^2), with habitats sampled in proportion to their occurrence.

Samples were processed by Brett Stansfield from Environmental Impact Assessments Ltd using protocol P2 (200 count with scan for rare taxa) (Stark et al., 2001). The following metrics were calculated:

- EPT taxa: The number of taxa of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) in the sample (EPT). These taxa are highly sensitive to environmental perturbations, and samples with higher numbers of these taxa indicate high environmental quality. The percentage of EPT taxa and the percentage of EPT individuals were also calculated. The family Hydroptilidae is not included in these indices because this taxon present in more degraded environments than other EPT taxa;
- Number of taxa: The number of invertebrate taxonomic groups present in each sample. Reflects the diversity of the community however generally does not determine higher water quality;
- MCI-sb: The Macroinvertebrate Community Index soft-bottom (MCI-sb) Assesses organic enrichment in a stream by scoring the occurrence of specific macroinvertebrate taxa. Invertebrates are assigned a score from 1 to 10 based on tolerance to organic pollution. Taxa with a high score are classified as the least tolerant taxa to organic pollution – Refer to Table 3.2 for interpretation of MCI-sb scores (Stark & Maxted, 2007); and
- QMCI-sb: The Semi-Quantitative Macroinvertebrate Community Index soft-bottom (QMCI-sb) is similar to MCI-sb but includes a weighting for taxa abundance within the community. Refer to Table 3.2 for interpretation of QMCI-sb scores.

Table 3.2: Interpretation of macroinvertebrate community index values (Stark & Maxted, 2007)

Quality Class A	Quality Class B	MCI-sb	QMCI-sb
Clean water	Excellent	> 119	> 5.99
Doubtful quality	Good	100 – 119	5.00 – 5.99
Probable moderate pollution	Fair	80 – 99	4.00 – 4.99
Probable severe pollution	Poor	< 80	< 4.00

Statistical analyses were completed on the 2024 and 2025 macroinvertebrate metric data and findings were compared with previously collected data to identify emerging trends. The analyses included determining mean values for the number of taxa (Numtax), % EPT, MCI-sb, and QMCI-sb from the four replicate samples collected at the two monitoring sites. The data were checked for normality (Shapiro-Wilk normality test) and equal variances (Bartlett test of homogeneity of variances). The residual distributions of each variable were non-normal (Shapiro-Wilk test p-value < 0.05) except for the number of taxa, and none could be corrected using a basic transformation (e.g. inverse, log10, square-root). The assumption of equal variance was also not met for each variable (Bartlett test p-value < 0.05) aside from % EPT and number of taxa.

Of the long-term datasets (2010-2025), only MCI-sb was normally distributed (Shapiro-Wilk test p-value = 0.1365). The remaining variables were not normally distributed and could not be corrected with a standard transformation to achieve a normal distribution of residuals. An inverse transformation of QMCI-sb did, however, improve the normality of the distribution of residuals. Additionally, the histograms for QMCI-sb and the number of taxa variables visually approximated normal distributions. The assumption of equal variance was met for each dataset aside from % EPT (Bartlett test p-value > 0.05).

Where the assumptions of equal variance and normality were met, the statistical analysis was based on a nested ANOVA (processed using the R statistical software package) to determine if there was any significant variation between the two monitoring sites over sampling years (2010-2025). ANOVA models included variables for site, year and the interaction between site and year. A Post-hoc (Tukey) test to determine the difference between samples was then completed if the ANOVA p-value was statistically significant (less than 0.05).

However, where the distribution of residuals was non-normal, Wilcoxon-Mann-Whitney tests were performed as a non-parametric alternative to ANOVA tests as they are not reliant on the assumption of normally distributed residuals or equal variance. Wilcoxon-Mann-Whitney tests were performed to assess the significance of differences between two independent groups. This included differences between the US site and the DS site, and differences between 2024 data and 2025 data. For comparisons between different years using the long-term dataset (i.e. more than two groups), Kruskal-Wallis tests were performed to determine whether there were any significant differences between groups (i.e. years). Dunn's Post-hoc tests were then performed as a non-parametric alternative to the Tukey test where the Kruskal-Wallis p-value was statistically significant (less than 0.05).

3.7 Fish survey

Fish surveys consisted of netting 150 m sections at the US and DS sites in general accordance with the New Zealand Freshwater Fish Monitoring Protocols (Joy *et al*, 2013). Six un-baited, fine-mesh fyke nets and 12 gee minnow traps were set within each survey site overnight. The fykes and traps were cleared the following day, and fish species were identified. The first 50 individuals of each species were measured to the nearest mm, after which point only the first ten individuals of each species from each fyke net were measured. The remaining individuals were identified and added to the overall species count. All fish captured were released back to the same section of stream from which they were caught. Nets and traps were set on the 30 January 2024 and were retrieved on the 31 January 2024.

We present the full results of the 2024 survey and make comparison to earlier surveys in 2019, 2014, and 2010.

4 Results

This section presents and discusses aquatic habitat, water quality, aquatic vegetation and aquatic macroinvertebrates for the summer 2024 and 2025 monitoring rounds.

4.1 Site descriptions (physical habitat assessment)

4.1.1 Upstream Reach

The US reach (Photograph 4.1) in 2024 had an average wetted width of 5.00 ± 1.83 m and an average depth of 0.75 ± 0.22 m, and in 2025 it had an average wetted width of 5.28 ± 3.63 m and an average depth of 0.82 ± 0.18. The US reach was dominated by silt across both surveys (68-72%), with a smaller proportion of cobbles and boulders (16-18%), and minor proportions of sand and gravel. Theses results indicate a slight increase in the proportion of silt compared to the 2022-2023 monitoring period (46-60%). Banks were relatively stable with minimal alterations to the channel evident. Abundance and diversity of structural habitat was low, with small amounts of woody debris present and small areas of undercut banks. Shrimp were also observed along the reach.

Riparian vegetation was a mixture of indigenous and exotic regenerating species. Exotic wattle trees (*Acacia lophantha*) were present in the canopy. Indigenous species included raupo (*Typha orientalis*), wiwi (*Juncus gregiflorus*) and flax (*Phormium tenax*). There were various urban garden plantings on the true right bank. Exotic weeds were common on both banks, including kikuyu grass (*Pennisetum clandestinum*) and blackberry (*Rubus fruticosus*). This is consistent with previous surveys at the site.

The qualitative habitat assessment (QHA) scores were 79 in 2024 and 78 in 2025 (Appendix C, Table 1). These are lower than those recorded in 2020 (93) and 2021 (83), but slightly higher than those recorded in 2022 (73) and 2023 (71). The 2017-2019 surveys scored an average of 112, though these surveys included periphyton assessments which added 9 – 10 points to the scores so are less comparable. Periphyton assessments have not since been completed as the disturbance of the bed during the surveys created plumes of anoxic sediment (black with a sulphurous odour) that obscure any view of the bed material. Where the bed could be inspected, periphyton coverage was typically low, as there is a lack of hard substrate in the stream bed for periphyton to colonise. Excluding the periphyton scores, the site still shows a reduction in habitat quality over time, though the differences between years have generally been small.

In both years, the reach scored 'poor' in sediment deposition, and 'marginal' in pool variability, abundance and diversity of habitat, vegetation protection, and channel sinuosity. Bank stability and riparian vegetation zone width were 'suboptimal' in both years, whilst periphyton varied from 'marginal' in 2024 to 'suboptimal' in 2025.


Photograph 4.1: Typical stream channel present within the Wigmore Stream at the US sample reach facing downstream in January 2024 (left) and downstream in February 2025 (right).

4.1.2 Downstream Reach

The DS reach (Photograph 4.2) in 2024 had an average wetted width of 8.14 ± 0.90 m and an average depth of 0.70 ± 0.25 m, and in 2025 it had an average wetted width of 7.68 ± 1.17 m and an average depth of 1.06 ± 0.29 m. In 2025, the river was too deep to measure all of the depths across three of the five transects, despite monitoring being undertaken close to low tide. As such, the actual mean depth may be greater than what has been reported. This may have been due to the river mouth being closed at the time of monitoring in 2025.

The DS reach was heavily dominated by silt in 2024 (63%) and 2025 (88%) (Appendix C Table 1). The difference in proportions is due to 24% of substrates being classified as sand in 2024, whilst no sand was recorded in 2025. This suggests a slight shift towards finer sediments may have occurred between years. Small percentage of gravels and cobbles were also recorded during both surveys. Banks were relatively stable with minimal evidence of fresh erosion, whilst the abundance and diversity of habitat was low, with very little MCI-sb habitat. Shrimp were also observed.

The riparian zone at the DS site has been planted with indigenous vegetation and has a greater diversity of plant species and increased shading than the US site. Indigenous plant species include Karo (*Pittosporum crassifolium*), bracken (*Pteridium*), akeake (*Dodonaea viscosa*), saltmarsh ribbonwood (*Plagianthus divaricatus*), raupo, wiwi and cabbage trees (*Cordyline australis*). However, this section was overgrown with exotic weeds during both surveys, particularly on the left bank. This is consistent with previous surveys at the site.

The qualitative habitat assessment (QHA) scores were 72 in 2024 and 73 in 2025 (Appendix C Table 1) which is consistent with scores recorded in 2022 and 2023. As with the US reach, periphyton assessments were not competed in 2024 and 2025 as the disturbance of the bed during the recent surveys has created plumes of anoxic sediment (black with a sulphurous odour) that obscure any view of the bed material. Where the bed could be inspected, periphyton coverage was typically low, as there is a lack of hard substrate in the stream bed for periphyton to colonise. Excluding the periphyton scores, the site still shows a slight reduction in habitat quality from 2019 – 2020, though the differences between years have generally been relatively small.

The reach scored 'poor' in sediment deposition, pool variability, abundance and diversity of habitat, and periphyton in both surveys. Riparian vegetation zone width, vegetation protection, channel sinuosity, and channel alteration were classified as 'marginal' or 'suboptimal' during both surveys.


Photograph 4.2: Typical stream channel present within the Wigmore Stream at the US sample reach facing upstream in January 2024 (left) and upstream in February 2025 (right).

4.2 Water quality

Water quality results include spot water quality measurements taken during the two ecological surveys, and monthly water quality monitoring information provided by Veolia (2023 - 2025).

4.2.1 Spot water quality

Spot water quality parameters were measured during ecological surveys in 2024 and 2025. Data are summarised below and presented in Table 4.1:

- Stream temperatures exceeded the WRC 'satisfactory' water quality guidelines in the upstream and downstream reaches of the Wigmore Stream during both the 2024 and 2025 surveys. Temperatures above 20°C are likely to cause stress to sensitive fish and macroinvertebrates (Richardson et al., 1994). Temperatures above 24°C are considered to be the upper end of the thermal tolerance for both longfin and shortfin eels (Olsen et al., 2012). These results are consistent with previous surveys;

- Conductivity was two orders of magnitude higher at the DS site during the 2024 survey than at the DS site in 2024, and compared to the US site during both surveys. Conductivity is highly dependent on the time samples are taken in relation to the tidal cycle. The lower conductivity observed at the DS site in 2025 was likely due to the closure of the river mouth at the time of the survey which restricted the tidal influx of the higher conductivity seawater;
- Low dissolved oxygen (DO) concentrations were recorded at the US and DS site during the 2024 survey, most likely due to tidal influence. Higher concentrations were recorded during the 2025 survey which was undertaken when the river mouth was closed. DO concentrations were below the WRC 'satisfactory' concentrations at both sites during the 2024 survey. Habitat for aquatic biota is considered impaired at DO concentrations below 6 mg/L (Franklin, 2012). A minimum threshold of 80 % saturation is also recognised as a guideline for ecological protection of species by WRC (Moke, 2023) and the Resource Management Act (RMA); and
- The pH recorded at US and DS sites was similar between the US and DS sites during both monitoring rounds and was within the WRC 'excellent' range (Moke, 2023).

Overall, the differences in spot water quality results between the sites over the two sampling occasions cannot be attributed to an effect of the Hahei WWTP discharge. Water quality conditions were generally similar or better at the DS site compared to the US site.

Table 4.1: Spot water quality measurements collected in the Wigmore Stream in 2024 and 2025. WRC ecological health standards are included (Moke, 2023).

	30 January 2024		12 February 2025		Ecological health standards	
	DS	US	DS	US	Satisfactory	Excellent
Time taken	16:15	14:15	15:31	10:32	-	-
Water temperature (°C)	27.6	29.1	32.5	32.2	<20°C (October-April)	<16°C (October-April)
pH	7.1	7.1	7.8	7.2	6.5-9	7-8
Specific conductivity (µS/cm)	55,152	323	477	473	-	-
Dissolved oxygen (%)	52	26	117	87	80-90	>90
Dissolved oxygen (mg/L) [1]	3.3	2.0	7.2	5.4	-	-

1. Concentration manually converted from % based on water temperature at sea level.

4.2.2 Veolia water quality monitoring

Veolia carries out water quality monitoring of the Hahei WWTP discharge as well as stream monitoring at locations US and DS of the discharge point to the Wigmore Stream. Surface water quality sampling was undertaken one hour either side of low tide. Samples were collected between 2 February 2023 and 31 January 2025 at monthly intervals, and at weekly intervals during the period from the start of the third week of December to the start of the third week of February for analytes specified under condition 16 of the resource consent (Appendix A).

Results for the 2023 – 2025 monitoring period are presented in Table 4.1. Results are compared to guideline values (Appendix E, Table 1) and summarised below:

- Median pH values at the US and DS sites were similar and generally within the WRC 'satisfactory' range across both monitoring periods. Median values were, however, outside the recommended ANZG range for physical and chemical (PC) stressors. In contrast, the median pH value at the discharge outlet was within the WRC 'excellent' range and the ANZG range for physical and chemical (PC) stressors;

- The median nitrate nitrogen value at the DS site was higher than at the US site and exceeded the ANZG PC stressors guideline at the DS site and discharge outlet only (before reasonable mixing). Some individual sample exceedances did, however, occur at the US site. The median concentration at the discharge outlet was an order of magnitude higher than at the DS site, and two orders higher than at the US site. In contrast, the median total Kjeldahl nitrogen (TKN) concentrations were very similar at the DS and US sites, but were still nearly an order of magnitude higher at the discharge outlet;
- The median concentration of ammoniacal nitrogen was slightly higher at the DS site than at the US site. Both sites were within the WRC 'excellent' range, though the median values exceeded the ANZG PC stressors guideline. The median discharge outlet concentration was within the WRC 'satisfactory' range and was two orders of magnitude higher than at the DS and US sites. Although median values at all sites were below the ANZG toxicant guideline (0.9 mg/L), almost half of the individual discharge outlet samples exceeded the guideline (before reasonable mixing). In contrast, only 2 – 3 samples exceeded the guideline at the DS and US sites;
- Median total phosphorus (TP) concentrations were an order of magnitude higher at the DS site than the US site, and more than an order of magnitude higher at the discharge outlet than at the DS site. Median concentrations at the DS site and the discharge outlet (before reasonable mixing) exceeded both the ANZG PC stressor and the WRC 'satisfactory' guideline, whilst the median value at the US site exceeded the ANZG PC stressors guideline but was within the WRC 'excellent' range. The maximum concentration recorded at the US site was, however, higher than at the DS site;
- Median Soluble Reactive Phosphorous (SRP) concentrations were slightly higher at the DS site compared to the US site, and were two orders of magnitude higher at the discharge outlet. Concentrations at the discharge outlet (before reasonable mixing) and the DS site exceeded the ANZG PC stressors guideline. The maximum concentration recorded at the US site was, however, greater than at the DS site;
- Median turbidity values and suspended solids (SS) concentrations at US and DS sites were relatively similar and were an order of magnitude higher than at the discharge outlet. Values were within the WRC 'satisfactory' range and were below the ANZG PC stressors guideline, though some exceedances occurred at both sites;
- Both the US and DS sites were within NOF Band E for *E.coli*, and concentrations were similar between sites, meaning they both posed the highest infection classification risk for campylobacter infection with human contact. The median enterococci concentrations were similar to the *E. coli* concentrations recorded at each site;
- *E.coli* concentrations at the discharge site were far lower than those at both US and DS sites. The high *E.coli* concentrations measured in the Wigmore Stream are therefore likely due to the wider catchment contamination either from land use, or discharges from private wastewater treatment devices. There is also potential for upstream movement of pathogens and other water quality parameters during the tidal cycle (i.e. on the incoming tide);
- Median conductivity values were relatively consistent between monitoring rounds at the US site and the discharge outlet, with higher values recorded at the outlet. The median value at the DS site was lower than at the other two sites but the maximum value was also higher than at the other two sites. The substantial variation between monitoring rounds is likely due the tidal influence on the DS site and is not expected to be related to the WWTP; and

- The median and carbonaceous biochemical oxygen demand (CBOD) concentrations were slightly higher at the discharge outlet than at the US and DS sites.

Overall, the discharge from the WWTP had minimal impact on most aspects of downstream water quality, as the parameters measured showed similarities between the US and DS sites. However, elevated concentrations of TP, SRP, and nitrate nitrogen were observed at the DS site compared to the US site which correlated with discharge concentrations that were several orders of magnitude higher. This indicates a slight influence of the WWTP discharge on downstream conditions and is consistent with previous monitoring reports.

Table 4.1: Summary of water quality measurements taken between 1 February 2023 and 31 January 2025 US and DS of the Hahei WWTP and from the discharge outlet[1].

2024-2025	Upstream		Wastewater discharge outlet[2]		Downstream	
	Median	Min – Max	Median	Min – Max	Median	Min-Max
pH	6.72	5.42 – 7.71	7.56	6.03 – 8.42	6.88	5.59 – 7.61
Nitrate Nitrogen (mg/L)	0.039	0.0028 – 6	3.6	0.0058 – 17	0.185	0.018 – 1.1
Total Ammoniacal Nitrogen (mg/L)	0.040	0.0025 – 2.6	0.54	0.017 – 28	0.052	0.012 – 5.6
Total Phosphorous (mg/L)	0.030	0.006 – 3.71	7.79	0.017 – 14	0.127	0.012 – 1.72
Soluble Reactive Phosphorous (mg/L)	0.012	0.006 – 3.85	5.75	0.008 – 9.89	0.097	0.007 – 1.38
Turbidity (NTU)	4.0	1.4 – 19	0.28	0.1 – 1.0	4.5	1.5 – 25
Suspended Solids (mg/L)	12.5	1.0 – 104	1	1.0 – 4.6	22.2	1.0 – 97.8
E. coli (no./100 ml)	565 E[3]	48 – 11000	1.6	1.6 – 70	355 E[3]	1.6 – 6900
Enterococci (no./100 ml)	325	3.3 – 24000	1.6	1.6 – 68	405	18 – 12000
Total Kjeldahl Nitrogen (mg/L)	0.42	0.19 – 3.25	2.18	0.24 – 28.5	0.42	0.11 – 6.08
Conductivity (µS/cm)	144	2.3 – 648	611	0.65 – 1407	42.2	3.2 – 4050
$Cbod_5$ (mg/L)	1.2	0.25 – 10	1.7	0.5 – 7.6	1.2	0.5 – 3.2

1. Table shows parameters exceeding ANZG (2018) physical and chemical stressor guidelines (yellow) and maximum guideline/objectives values (red text) from Table 4.3.
2. As ANZG (2018) guidelines only apply after reasonable mixing has occurred. A comparison of discharge data (i.e. before mixing) has been made only to support the interpretation of Upstream and Downstream data.
3. *E. coli* NPS:NOF infection risk attribute band listed next to median value.

4.3 Aquatic macroinvertebrates

4.3.1 2024-2025 surveys

Macroinvertebrate results collected in 2024 and 2025 are presented in Table 4.2 and are summarised below. See Appendix F for raw macroinvertebrate results and Appendix G for statistical outputs.

- At the US and DS sites during 2024 and 2025 monitoring, the mean MCI-sb scores were 'fair' and the mean QMCI-sb scores were 'poor', indicating probable moderate pollution both upstream and downstream of the WWTP discharge (Stark & Maxted, 2007);
- The Wilcoxon-Mann-Whitney tests determined that the scores in 2025 were significantly greater at the DS site compared to the US site;
- The Wilcoxon-Mann-Whitney tests determined that only the QMCI-sb scores in 2024 were significantly greater at the US site compared to the DS site;
- The % EPT taxa is typically low at US and DS sites. EPT taxa were observed at both sites in 2024, but at neither site in 2025 due to the absence of a single taxa (*Hudsonemia*) typically found in macrophytes and woody debris. The Wilcoxon-Mann-Whitney tests determined that the only significant reduction in % EPT taxa between 2024 and 2025 was at the DS site;
- The Wilcoxon-Mann-Whitney tests determined that the only significant difference was the reduction in the number of taxa at the DS site from 2024 to 2025; and
- The dominant taxa at both sites across both years was Mollusc *Potamopyrgus* (MCI-sb 2.1). The abundance of this tolerant taxa is not unsurprising considering the low MCI-sb and QMCI-sb scores recorded.

In summary, macroinvertebrate indices indicate reduced habitat and water quality at both sites. The statistical analyses indicated some significant differences in MCI-sb and QMCI-sb indices between sites and years, though the values suggest water quality class is relatively similar at US and DS sites in 2024 and 2025.

Table 4.2: Summary results (mean ± standard error) of macroinvertebrate community metrics for the Wigmore Stream monitoring US and DS sites in January 2024 and February 2025.

Macroinvertebrate Community Metric	Upstream (US)		Downstream (DS)	
	2024	2025	2024	2025
Number of Taxa	6.8 (± 2.2)	5.5 (± 1.0)	11.0 (± 1.4)	6.3 (± 0.8)
EPT Taxa	5.9 (± 6.8)	0.0 (± 0.0)	9.2 (± 1.3)	0.0 (± 0.0)
Number of Individuals	222.5 (± 7.1)	205.3 (± 0.3)	210.8 (± 2.5)	205.8 (± 0.5)
% EPT Taxa	5.9 (± 3.4)	0.0 (± 0.0)	9.2 (± 0.7)	0.0 (± 0.0)
MCI-sb Value	86.8 (± 13.8)	89.4 (± 3.7)	95.3 (± 2.7)	97.9 (± 0.5)
QMCI-sb Value	3.36 (± 0.32)	2.65 (± 0.29)	2.39 (± 0.11)	2.33 (± 0.03)
Dominant Taxa	Mollusc *Potamopyrgus*	Mollusc *Potamopyrgus*	Mollusc *Potamopyrgus*	Mollusc *Potamopyrgus*
Quality Class: MCI-sb (1) QMCI-sb (2)	Fair Poor	Fair Poor	Fair Poor	Fair Poor

4.3.2 Long term analysis (2010 – 2025)

Long term data analysis has been undertaken on the data collected from 2009 to 2025 and is presented in Figure 4.1 to Figure 4.4. Trends in the macroinvertebrate data based on the plots and statistical analyses of Wigmore Stream data (2010-2025) are summarised below. Complete statistical analyses are presented in Appendix G.

Trends in MCI-sb data are shown in Figure 4.1:

- MCI-sb scores have fluctuated gradually over time. Scores declined at US and DS Sites from 2010 to 2015-16, before increasing again to 2020, and declining again to 2023. During this time, the quality class varied from 'fair' to 'poor';
- Scores at both sites increased sharply in 2024 at US and DS Sites and were relatively similar in 2025 with both sites in the 'fair' quality class;
- Long-term trends are relatively subtle, though a post-hoc Tukey test determined that the MCI-sb scores for 2025 are significantly higher than the 2022 and 2023 scores; and
- US and DS MCI-sb values are similar within each sampling period and no significant differences were detected between sites (p-value = 0.062).

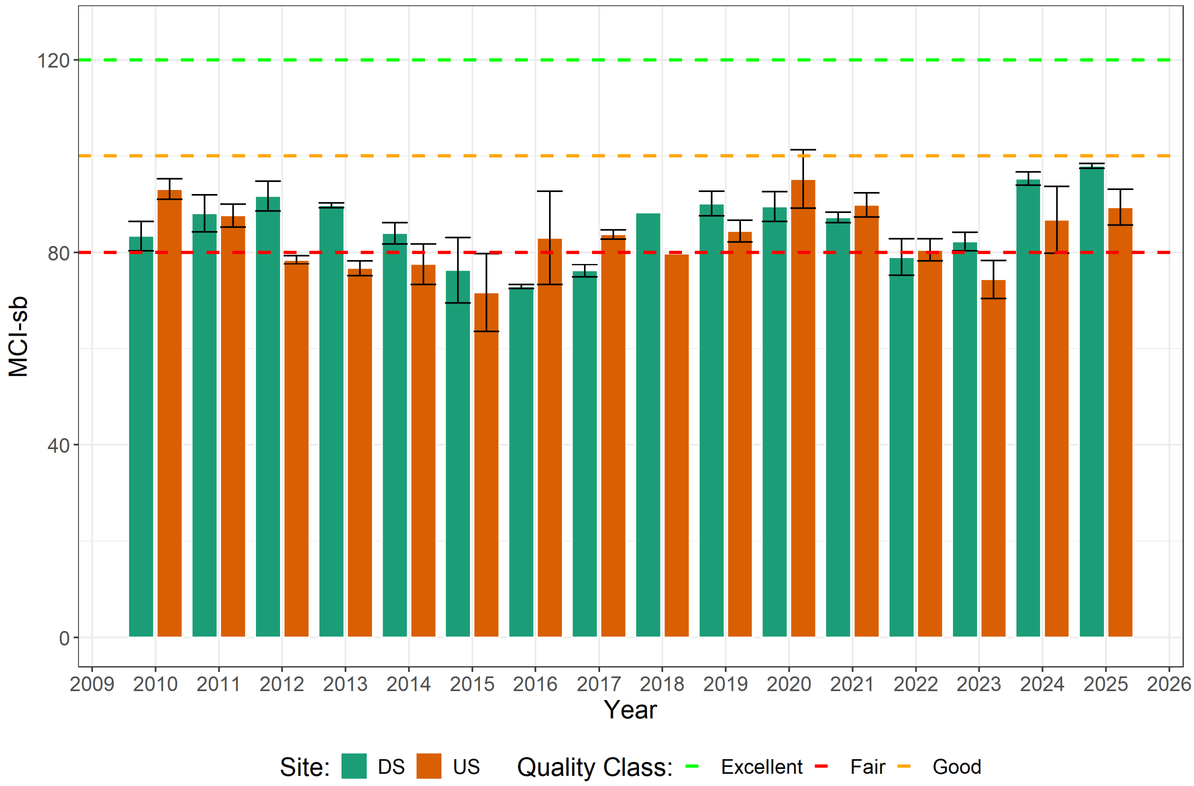

Figure 4.1: Long term MCI-sb scores for Wigmore Stream US and DS sites. Error bars show standard error (missing from 2018 as single samples). Dotted lines indicate boundaries between MCI-sb quality classes.

Trends in QMCI-sb data are shown in Figure 4.2:

- Since monitoring began, mean QMCI-sb scores at US and DS sites have generally been classified as 'poor', with occasional improvements to higher quality classes;
- There appears to be a weak decreasing trend in scores for both sites from 2014 to 2025, with the lowest scores recorded in 2025. Highest scores occurred in 2018, 2020, and 2021;

- No significant differences were detected between sites using the Wilcoxon-Mann-Whitney tests ($p = 0.053$), though significant differences were detected between years for both sites using the Kursukal-Wallis test ($p < 0.001$); and
- Dunn's Post-hoc test confirmed a large number of significant differences between various years for both sites, though none between the last four years of monitoring.

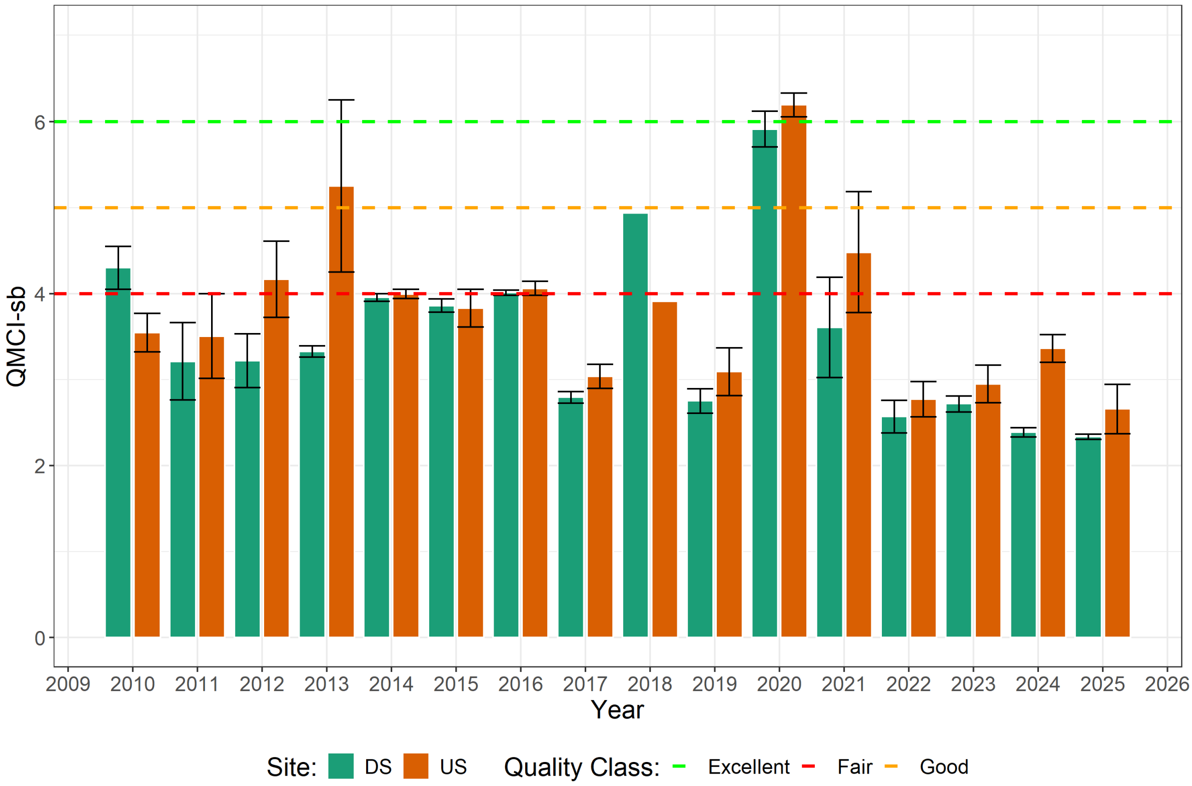

Figure 4.2: Long term QMCI-sb scores for Wigmore Stream US and DS sites. Error bars show standard error (missing from 2018 as single samples). Dotted lines indicate boundaries between QMCI-sb quality classes.

Trends in number of taxa data are shown in Figure 4.3:

- The mean number of taxa recorded at US and DS sites has remained low since monitoring began in 2010. Although counts have fluctuated considerably between years, there does appear to be a weak long-term decline at both sites, with the lowest historical counts generally recorded since 2020;
- No significant differences were detected between sites using the Wilcoxon-Mann-Whitney tests ($p = 0.406$), though significant differences were detected between years for both sites using the Kursukal-Wallis test ($p < 0.001$);and
- Dunn's Post-hoc test confirmed a large number of significant differences between various years. Counts at the DS site in 2024 were either significantly greater than, or not significantly different to, all other years. In contrast, counts at the DS site in 2025 were significantly lower than those recorded in 2011 – 2019 (excluding 2013).

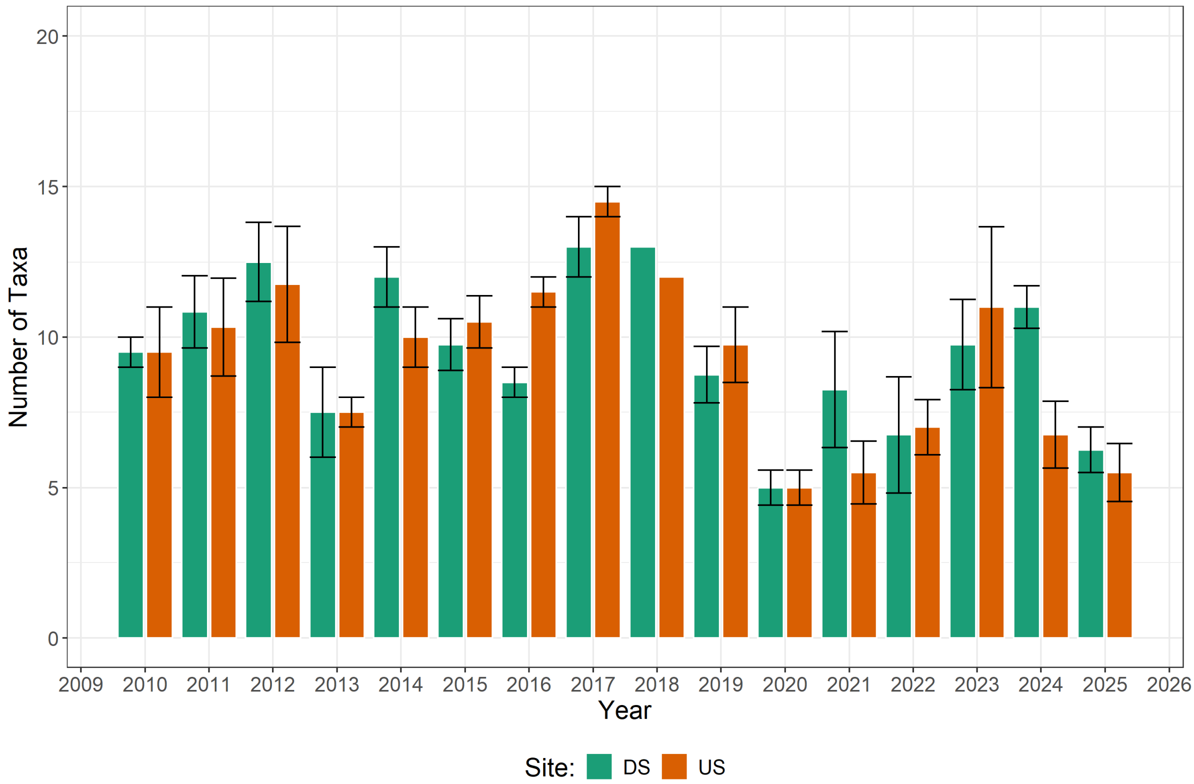

Figure 4.3: Long term number of taxa data for Wigmore Stream US and DS sites. Error bars show standard error (missing from 2018 as single samples).

Trends in percentage EPT (excluding *Hydroptilldae, Oxyethira and Paroxyethira*) taxa (% EPT) data are shown in Figure 4.4:

- The % EPT taxa has generally remained low at both sites over time, indicating limited habitat and water quality conditions suitable to support EPT taxa. No long-term increasing or decreasing trends are visible;
- EPT taxa were absent in the 2025 survey and no significant differences were detected between sites using the Wilcoxon-Mann-Whitney tests (p = 0.721), though significant differences were detected between years for both sites using the Kursukal-Wallis test (p < 0.01). Dunn's Post-hoc test confirmed that these significant differences were due to the presence or absence of EPT taxa in a given year.

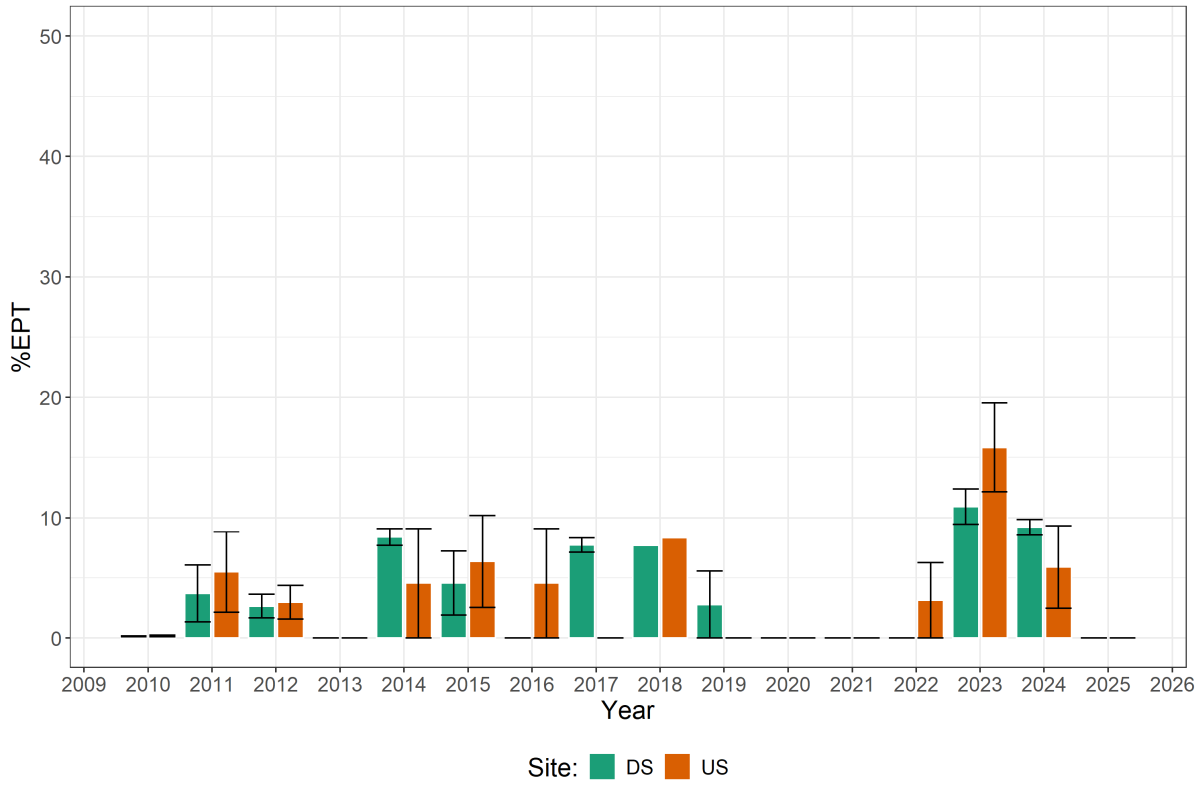

Figure 4.4: Long term percentage of EPT taxa data for Wigmore Stream US and DS sites. Error bars show standard error (missing from 2018 as single samples).

4.4 Freshwater fish

4.4.1 2024 survey

Table 4.3 presents the results of the fish surveys of the US and DS sites. An assessment of the 2024 survey results is as follows:

- The fish community within Wigmore Stream was typical of a low elevation coastal stream. High numbers of fish were captured in 2024 which is expected due to the proximity of the sites to the coast. Many of the species captured were diadromous, meaning they utilise both marine and freshwater habitats to complete their lifecycles. These results are consistent with the findings of previous surveys;
- Fish communities were generally similar between the two sites, though marine species including dart goby (*Parioglossus marginalis*) and giant bully (*Gobiomorphus gobioides*) were less common at the US site, likely due to the reduced salinity;
- Freshwater species were generally similarly abundant, or more abundant, at the US site than at the DS site. However, gambusia (*Gambusia affinis*) pest fish were more common at the DS site, likely due to their greater salinity tolerance as a euryhaline species;
- Common bullies (*Gobiomorphus cotidianus*) were a dominant species at both the US and DS site, though īnanga (*Galaxias maculatus)* were the most dominant species at the US site; and
- Three 'At risk' species were identified across both the US and DS sites, with the two 'At risk – Declining' species (īnanga and longfin eels (*Anguilla dieffenbachia*)) more abundant at the US site.

Overall, the fish species present at the US and DS sites are typical of a coastal/ estuarine stream. The differences in fish species found between US and DS sites are more likely due to differences in local habitat and salinity conditions between the sites than due to effects from the WWTP discharge.

Table 4.3: Results of fish surveys conducted for Wigmore Stream ecological monitoring sites on 30 January – 31 January 2024

Species	Conservation status (Dunn *et al*, 2018)	US	DS
Freshwater species			
Common Bully (*Gobiomorphus cotidianus)*	Not threatened	213	132
Elver	-	4	9
Gambusia *(Gambusia affinis)*	Introduced and naturalised	9	78
Īnanga (*Galaxias maculatus*)	At risk – Declining	355	13
Longfin eel (*Anguilla dieffenbachia*)	At risk – Declining	11	5
Shortfin eel (*Anguilla australis)*	Not threatened	3	6
Unidentified eel	-	0	5
Marine species			
Dart goby *(Parioglossus marginalis)*	Coloniser	0	6
Giant Bully (*Gobiomorphus gobioides)*	At risk – Naturally uncommon	1	5
Total		596	259

4.4.2 Long term analysis (2010 – 2024)

The catch per unit effort (CPUE) results for surveys undertaken in 2010, 2014, 2019, and 2024 are presented in Table 4.4. An assessment of the long-term survey results is as follows:

- The species observed during the 2024 survey are relatively consistent with those encountered during previous surveys;
- Īnanga, common bullies and gambusia have had the highest CPUE across the four surveys;
  - The CPUE for common bullies was lower in the 2014 survey than in the 2019 and 2024 surveys which had similarly high CPUEs at both sites.
  - The CPUE for gambusia is relatively similar across surveys at the DS site, but has been lower in surveys undertaken since 2010 at the DS site .
  - Īnanga have been variably present at both sites, with none recorded during the 2010 and 2019 surveys, and very high CPUE results recorded during the 2014 and 2024 surveys at the US site.
- The CPUE for shortfin eels (*Anguilla australis*) was higher during the 2010 and 2014 surveys at the US site than during the 2019 and 2024 surveys, and is relatively similar between surveys at the DS site. The CPUE for longfin eels (*Anguilla dieffenbachia*) has been relatively low during all surveys at both sites; and
- The diversity of species observed during the 2024 survey has decreased slightly from the 2014 and 2019 surveys at both sites. In particular, native freshwater smelt (*Retropinna retropinna*) and redfin bullies (*Gobiomorphus huttoni*) were observed during the 2019 survey but not during the 2024 survey.

Overall, there is considerable variability between surveys both in the species encountered and in their CPUEs. The WWTP is not expected to be influencing the observed variation between years.

Table 4.4: Catch per unit effort (average number of fish per trap per night) in Wigmore Stream for the DS and US sites in 2010, 2014, 2019, and 2024.

Species	2010		2014		2019		2024	
	Fyke	Minnow	Fyke	Minnow	Fyke	Minnow	Fyke	Minnow
DS								
Cockabully (*Gobiomorphus cotidianus*)	0.5		1.8	0.2				
Common bully *Gobiomorphus cotidianus*)			0.2		58.8	6.7	19.5	1.3
Crans bully (*Gobiomorphus basalis*)			0.5					
Dart goby (*Parioglossus marginalis*)					3		0.8	
Gambusia (*Gambusia affinis*)	5	9.2	2	3.8	0.5	3.3	7.3	2.8
Giant bully (*Gobiomorphus gobioides*)			1.2		0.7		0.7	0.1
Sand goby (*Favonigobius lentiginosus*)			0.7					
Īnanga (*Galaxias maculatus*)			8.3				1.5	0.3
Longfin eel (*Anguilla dieffenbachii*)	0.5		0.5		0.7		0.8	
Parore (*Girella tricuspidata*)	1		3.8	0.2	0.2			
Shortfin eel (*Anguilla australis*)	7.5	0.5	6.3	1.7	2.3	0.1	1.0	
Smelt (*Retropinna retropinna*)			0.2		1.8	1.7		
Estuarine triplefin (*Forsterygion nigripenne*)					1.3	1.2		
Unidentified fish larvae (various species)			0.2					
Yellow-eyed mullet (*Aldrichetta forsteri*)			0.3		0.8			
US								
Australian longfin (*Anguilla reinhardtii*)					0.2			
Cockabully (*Gobiomorphus cotidianus*)			2.3	0.3				
Common bully (*Gobiomorphus cotidianus*)	17	1			70	7.6	31.8	1.8
Crans bully (*Gobiomorphus basalis*)			0.5					
Dart goby (*Parioglossus marginalis*)					0.5			

Gambusia (*Gambusia affinis*)	1.5	20.5	2.7	2.5		0.9	1.3	0.1
Giant bully (*Gobiomorphus gobioides*)			0.5		0.2		0.2	
Goby (Various species)			0.3					
Īnanga (*Galaxias maculatus*)			31.5	40.5			55.5	1.8
Longfin eel (*Anguilla dieffenbachii*)	0.5		0.7		3		1.8	
Redfin bully (*Gobiomorphus huttoni*)					0.2	0.1		
Shortfin eel (*Anguilla australis*)	1	0.2	0.7		5		0.3	0.1
Smelt (*Retropinna retropinna*)					14.8	17.7		

Note: Catch per unit effort for freshwater shrimp has not been included in this table.

5 Discussion and conclusions

This report has presented the results of the 2024 and 2025 Hahei Wastewater Treatment Plant monitoring, which is undertaken annually during summer low flows as per conditions 16 and 19 of the Consent. The report also analyses the long-term aquatic results and indices for the US and DS ecological monitoring sample sites in the Wigmore Stream dating back to 2010.

Spot water quality samples were generally similar or better at the DS site compared to the US site across both monitoring periods. Water quality monitoring undertaken by Veolia has shown median concentrations of contaminants at the discharge outlet including TP, SRP, nitrate nitrogen, total ammoniacal nitrogen, and TKN were generally elevated by one to two orders of magnitude above the stream sites. The difference between concentrations at the discharge outlet and at the DS site suggests that discharged contaminants are rapidly mixed and diluted by the river.

Of the elevated discharge contaminants, only TP, SRP, and nitrate nitrogen were substantially elevated at the DS site compared to the US site, suggesting the WWTP may contribute to excess nutrient loads in Wigmore Stream and downstream receiving environment. However phosphorous and nitrogen are also issues for the wider catchment, with median concentrations of TP and ammoniacal nitrogen exceeding the ANZG (2018) physical and chemical stressors guidelines at US and DS sites. The ranges of concentrations recorded for phosphorus and nitrogen contaminants were similar between US and DS sites, with higher maximum concentrations generally recorded at the US site.

E. coli and enterococci concentrations at both US and DS monitoring sites during both monitoring periods were far higher than those at the discharge outlet. This suggests other catchment or local contamination contributions either from land use, or discharges from private wastewater treatment devices. Median US and DS concentrations for both monitoring periods were above WRC 'satisfactory' guidelines and fell within the NPS:NOF Band E classification which represents the greatest predicted average infection risk. This data indicates that coliform bacteria concentrations at both sites pose a significant risk to human health via primary or secondary contact, in addition to potential risks also associated with any shellfish harvesting that may occur at Hahei Beach. This is consistent with the findings from previous reports.

The QHA scores for the DS reach have been very consistent between surveys from 2022 to 2025 (71 – 73), whilst scores for the US reach increased slightly from 2022 – 2023 (71 – 73) to 2024 – 2025 (79 – 78). Upon review of the QHA scores, the increase at the US site was primarily due to minor improvements to the density of riparian vegetation. As such, the lack of improvement of DS site scores is not indicative of any downstream effects from the wastewater treatment plant.

Macroinvertebrate metrics have generally remained low ('poor' to 'fair') over time and have shown no significant differences between the US and DS sites over the long-term. Wider catchment influences on water quality, the soft bottomed nature of the habitat and brackish surface water are the likely limiting factors with respect to diversity and richness of freshwater macroinvertebrates. While some weak declining trends in QMCI-sb and number of taxa are visible, it is unlikely that discharge from the WWTP is responsible for this possible trend as there were no significant differences in macroinvertebrate indices between the US and DS sites.

Freshwater fish surveys have shown considerable variability between surveys both in the species encountered and in their CPUEs. The species observed during the 2024 survey are relatively consistent with those encountered during previous surveys, though the diversity in 2024 was slightly lower compared to 2014 and 2019, with smelt and redfin bullies both absent. Īnanga have been observed intermittently within the stream and at much higher CPUEs at the US site. Although this species is sensitive to contaminants, the lower CPUEs at the DS site are likely due to there being less suitable instream habitat as opposed to effects from the WWTP discharge. Overall, the variation between years is not expected to have been influenced by the operation of the WWTP.

In summary, it appears that the Hahei WWTP discharge has not generally had a notable adverse effect on downstream water quality for most parameters. However, the water quality data indicates that the discharge of nitrate nitrogen, TP, and SRP from the WWTP does increase downstream contaminant concentrations. Despite these adverse differences in quality, there is no apparent impact on macroinvertebrate communities, with similar results and values recorded at the US and DS sites. Monitoring aquatic vegetation has generally not been appropriate or possible during recent monitoring rounds due to the nature of the habitats at the monitoring sites.

To investigate potential contaminant contributions to the Wigmore Stream from additional sources, a new water quality sampling site has been established along the tributary (culvert) which enters Wigmore Stream between the US and DS site locations. As sampling at this location began more recently than the period covered in this assessment, sample data will be included in the next monitoring report.

Our only recommendation based on the results of our assessments is that Veolia notify TCDC of the high coliform bacteria concentrations results so that signage can be checked and reviewed for warnings of swimming and shellfish collection in the estuary mouth.

6 Applicability

This report has been prepared for the exclusive use of our client Veolia Water Services (ANZ) Pty Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be used by Thames Coromandel District Council (TCDC) in undertaking its regulatory functions in connection with the wastewater treatment plant.

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Technical Review: Dean Miller – Principal Environmental Scientist

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Appendix A Hahei WTP resource consent AUTH135636.01.01

Consent Evaluation Report

Applicant:	Thames Coromandel District Council	**File No.:**	60 25 05A
Address of Site:	Pa Rd, Hahei (Hahei WWTP)	**Project Code:**	RC4766
Application Number:	APP135636		

1 Introduction

Thames Coromandel District Council (TCDC) own and operate the Hahei Wastewater Treatment Plant (WWTP), which provides treatment and disposal of wastewater for part of the Hahei community. On 30 June 2015 TCDC applied for the following resource consent:

Application No	Purpose	Location
AUTH135636.01.01	Discharge of treated wastewater to the Wigmore Stream and associated seepage to groundwater	Pa Rd - Hahei

This application is to replace existing consent AUTH117888, which expired on 31 December 2015. The application was lodged within six months of expiry.

The application document references are as follows:

- Application for resource consent. Waikato Regional Council document 3442348.
- Letter from Harrison Grierson (the applicant's consultant) dated 21 March 2017, titled "Water quality and ecological effects of the discharge from the Hahei WWTP to the Wigmore Stream". Received via email on 18 April 2017. Waikato Regional Council document 10373921.
- Letter from Harrison Grierson dated 12 May 2017, titled "Hahei WWTP resource consent application". Received via email on 12 May 2017. Waikato Regional Council document 10487506.
- Technical memo from Harrison Grierson dated 14 June 2017, titled "Hahei WWTP Consent – Ammoniacal Nitrogen Reduction". Received via email from TCDC dated 14 June 2017. Waikato Regional Council document 10628287 (memo) and 10629575 (email).

2 Background and Description of Proposal

The Hahei WWTP is located at 20 Pa Road, Hahei. It is bordered by farmland to the south, privately owned residential properties to the west and north, and the Wigmore Stream to the east. Part of the site has recently been tar sealed and is utilised as 'Park and Ride' carparking for visitors to Cathedral Cove. The location of the WWTP and key features around the site are shown on Figure 1.

The WWTP services up to 25% of residential properties and the Hahei Holiday Park (campground), with the remainder of properties in Hahei serviced by private on-site wastewater treatment systems. The applicant has applied for resource consent to discharge up to 700 cubic metres per day (m^3/day) of treated wastewater to the Wigmore Stream. This volume remains unchanged from the volume authorised by expired consent AUTH117888. Current flows to the WWTP are 92 m^3/day off-peak average and 312 m^3/day peak period maximum, and are projected to increase over the next 30 years to 109 m^3/day off-peak average and 392 m^3/day peak period maximum.

The WWTP uses an "oxidation pond" treatment system to provide aerobic breakdown of contaminants. There is an aeration pond and a retention pond. Raw effluent enters the plant from the Pa Road pump station, where it is discharged directly to the aeration pond without primary screening. There is a single operational aerator in the aeration pond and another in the retention pond. The retention pond has baffle curtains installed to minimise short-circuiting between the inlet and outlet. Together, the two ponds have a total retention time of 55 days, however this decreases to 20-23 days during the summer peak.

A membrane filtration unit (MFU) was retrofitted to the existing pond system in January 2007. It was installed to address water quality issues in the Wigmore Stream associated with use of the former land disposal beds and poor discharge quality. The MFU is a membrane filter that sits inside a tank in a portable shipping container on site. It operates by filtering wastewater from the retention pond and capturing solids and pathogens before discharging the treated wastewater directly to the Wigmore Stream. The MFU is periodically backwashed and the sludge is recycled back to the retention pond.

The discharge to the Wigmore Stream from the MFU is via a perforated pipe diffuser secured parallel to the stream bank. The Wigmore Stream is a small, soft-bottomed, slow-flowing waterway that is tidal influenced. The 3.3 km^2 catchment is predominantly grazed pasture, with residential areas in the lower reaches in proximity to the WWTP. The mouth of the stream is at the south-eastern end of Hahei Beach, approximately 1 km downstream of the WWTP discharge outlet.

Figure 1. Hahei WWTP and surrounding environment.

3 Status of Activities under the Plans

The discharge of treated wastewater to the Wigmore Stream and associated seepage to groundwater is a **discretionary activity** under Rule 3.5.4.5 of the Waikato Regional Plan, as follows:

> ***3.5.4.5 Discretionary Activity Rule – Discharges – General Rule***
> *Any discharge of a contaminant into water, or onto or into land, in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water, that is not specifically provided for by any rule, or does not meet the conditions of a permitted or a controlled activity rule in this Plan, is a* ***discretionary activity*** *(requiring resource consent).*

4 Consultation/Affected Party Approvals

4.1 Prior to notification

4.1.1 Iwi

The activity occurs in the rohe (area) of Hauraki iwi, specifically Ngati Hei, Ngati Maru, Ngati Tamatera, and Ngati Hako.

The applicant did not consult with iwi prior to lodgement of the application. The applicant stated in the application that they would undertake consultation with iwi and other key stakeholders coinciding with notification of the application.

4.1.2 Other Parties

The applicant has undertaken consultation with Mr John North, a resident in Hahei with an active interest in safeguarding the quality of the Wigmore Stream. This consultation involved collaboration with Mr North to undertake additional bacteriological sampling of the stream during the 2015/16 summer (document 3934003), and provision of the consultant's s.92 response letter dated 21 March 2017 (document 10373921). Mr North was a submitter during the consent process for resource consent AUTH117888. Condition 17 of resource consent AUTH117888 requires TCDC to seek comment from Mr North and Mr Ron Egan, another Hahei resident and submitter, prior to making any changes to the monitoring program specified in the conditions of consent.

Mr North has stated in a letter to WRC dated 8 May 2017 (document 10955212), that "*the Hahei Waste Treatment effluent disposal transformation from soakage/evaporation beds to filtration has resulted in a quantum improvement to both plant performance and community confidence that the Hahei waste treatment plant is no longer having a negative impact on the stream (Bacteriological)*".

In addition to Mr North, Waikato Regional Council were also consulted during the application development process.

The applicant has not consulted with any other parties. As noted above, the applicant stated in the application that they would undertake consultation with affected parties and key stakeholders during the notification period of the existing consent.

4.2 Reasons for Notification

In a process completed prior and separate to the writing of this report it was considered appropriate that the application be processed on a limited notification basis. This decision was made based on the environmental effects considered to be no more than minor, and the identification of potentially affected parties.

4.3 Notification and Submissions

Limited notification of the application to adjacent landowners, iwi, Mercury Bay Community Board and the Waikato District Health Board occurred on 12 July 2017. Due to an administrative oversight, some of these parties were not notified on this date. An updated letter was sent to all parties on 25 July 2017, with a revised closing date for submissions of 24 August 2017.

No submissions were received during the notification period.

4.4 Consultation following notification

The applicant did not undertake any consultation during the period of notification.

On the basis that no submissions were received, and with agreement from the applicant on the proposed conditions of consent, in accordance with section 100 of the Resource Management Act 1991 the consent process can be determined without the need to hold a hearing.

5 Process Matters

The significant process matters are summarised below:

Date	Process Detail
30/06/2015	Application lodged and deemed complete under section 88 of the Resource Management Act 1991 (RMA)
1/07/2015 to 5/07/2015	Active, 3 working days
6/07/2015 to 26/06/2017	Processing timeframe placed on hold under section 92(2) – commissioning of a report
27/06/2017 to 11/07/2017	Active, 11 working days
12/7/2017 to 24/08/2017	Limited notification
25/08/2016 to 31/08/2017	Active, 5 working days
1/09/2017 to 7/12/2017	Processing timeframe extended under section 37A(5)(a) – review of draft conditions

6 Statutory Considerations

Section 104 of the Resource Management Act 1991 (RMA) outlines the matters that a consent authority must have regard to when considering the outcome of a resource consent application. Matters that are relevant to this application are discussed below.

6.1 Assessment of Environmental Effect

Section 104(1)(a) provides that when considering a consent application the consent authority must, subject to Part 2 of the RMA, have regard to the actual and potential effects on the environment of allowing the activity. Case law has determined that the "environment" must be read as the environment which exists at the time of the assessment and as the environment may be in the future as modified by the utilisation of permitted activities under the plan and by the exercise of existing resource consents.

6.1.1 Existing environment

The receiving environment is the Wigmore Stream. The stream is a soft-bottomed, slow-flowing waterway that is tidal influenced. The saltwater interface can extend to the monitoring site upstream of the WWTP discharge outlet (see Figure 1). The stream is popular for recreational use, and is classified under the Waikato Regional Plan (Chapter 3.2.3) as a Surface Water and Contact Recreation water body.

The Wigmore Stream is currently monitored under the conditions of existing consent AUTH117888 for water level and instantaneous flow, upstream and downstream water quality, and aquatic ecology. Water quality measurements summarised in the applicant's Assessment of Environmental Effect (AEE) show elevated temperature, pH, turbidity and suspended solids, nutrients and faecal bacteria, and low dissolved oxygen both upstream and/or downstream of the WWTP discharge compared to National Objectives Framework[1] and Waikato Regional Council guideline values. Comparison of elevated parameters in the stream to the quality of the treated wastewater (discussed further below) suggests that these parameters can be partly attributed to other contaminant sources in the stream. It is generally accepted that these other discharge sources include sediment runoff, stormwater and septic tank contamination.

The stream has observed fish and invertebrate species classed as "at risk" or "threatened" including Inanga and Longfin Eel, and is a likely habitat of some "at risk" or "threatened" birds including Northern New Zealand Dotterel, Variable Oystercatcher, Red-Billed Gull, and Black Shag.

Section 104(2) of the RMA provides that when forming an opinion about the actual and potential effects of the activity, the consent holder may disregard an adverse effect of the activity on the environment if the regional plan permits an activity with that effect. In this case, no permitted baseline effects have been discounted from the following assessment of effects of the activity.

In my assessment of the application, I have considered the possible environmental effects of the proposed discharge via the outfall structure or seepage to groundwater from the ponds on:

- Hydrology,
- Water quality of Wigmore Stream,
- Aquatic ecosystems,
- Groundwater quality.

6.1.2 Hydrology

The one in five year low flow (Q_5) of the Wigmore Stream was estimated by Waikato Regional Council's hydrologist Dr Edmund Brown as 3 litres per second (L/s), as part of the previous evaluation report for consent AUTH117888. When compared to the maximum consented discharge rate of 8.1 L/s of treated wastewater to the stream, there is potential during summer low flow periods for the volume of wastewater in the stream to be nearly three times greater than the volume of freshwater. This has implications for the level of dilution and zone of reasonable mixing, with subsequent potential adverse effects on water quality and aquatic ecosystems.

The applicant has assessed nutrient loads to the stream for a range of flow and discharge scenarios. The worst-case scenario used in the application (Q_5 low flow of 3 L/s, peak (measured) discharge flow of 2.8 L/s, and peak ammoniacal-nitrogen concentrations in the discharge), compared to actual stream monitoring data, indicates that a mass balance approach overestimates the downstream concentrations in the stream. The applicant concluded that there are other influences on the stream reducing the contaminant concentrations, such as dilution from seawater. The applicant comments that the frequency of the low flow period where the worst-case mass balance scenario could occur is thought to be very infrequent as:

- The driest month (in terms of rainfall) is typically February, which is outside the peak period of discharge (27th December to 5th January);
- The stream flow is tidal influenced and therefore the lowest flow period is likely to occur for only a small period of the day at low tide;

[1] National Policy Statement for Freshwater Management 2014

- The Q_5 is, by definition, a one in five year low flow, which does not occur every year.

I am also of the opinion that the likelihood of occurrence of this extreme scenario is low. I consider that consent limits around the discharge quality and discharge rates will minimise potential adverse effects on the stream during low flow conditions. With regards to the mass balance calculations, I note that the peak discharge flow has been based on 2.8 L/s which is less than the maximum consented discharge rate of 8.1 L/s. There is thus potential for the mass balance calculations to require reassessment in future following an increase in actual discharge rates.

As part of the conditions for AUTH117888, TCDC were required to install a flow recorder upstream of the WWTP discharge on the Wigmore Stream and to correlate the flow record from the stream to flows in the Opitonui River. The purpose of this monitoring was to provide information to understand stream flows in relation to low flow events and frequency, and to allow calculation of dilution factors. TCDC collected flow data from a temporary weir installed approximately 550 metres upstream of the WWTP over the period January 2015 to April 2017, and provided Council with a flow correlation to the Opitonui River for Waikato Regional Council approval (document 10630455). The derived correlations (one for low flows and one for high flows) had an associated error of ±30%, and the applicant's consultant, Jacobs New Zealand Ltd, recommended that monitoring continue in the short term to enable the regression model to be further validated and/or refined.

The flow correlation was reviewed by Waikato Regional Council hydrologists Dr Sung Soo Koh and Mr Doug Stewart. Dr Koh commented that the Jacob's model appears to overestimate Q_5 and mean daily flow compared to other analysis methods, and so, for the flow correlation model to be used to calculate daily mean flow and dilution factors in the Wigmore Stream it is recommended that an additional summer season of monitoring be undertaken for model validation (document 11015479 and 10757849). Dr Koh advised that, despite the collection of additional data to validate the model, the correlation will still have a moderate level of uncertainty due to climatic differences between the two sites. Mr Stewart recommended including spot stream flow gauging to check the weir calibration (document 11014996).

I note that the existing consent to install and use a temporary weir in the Wigmore Stream for the purposes of flow monitoring has expired (AUTH121137), and I am aware that TCDC has been approached by the landowner to request that the weir be removed to enable them to undertake fencing and riparian planting on their property.

If possible, I consider that flow monitoring should continue at this site for the upcoming summer season, to maximise the potential use of the flow data collected to date. I recommend a condition of consent requiring monitoring of stream flow for a minimum period of six months, to enable validation of the flow regression model for assessment of future contaminant dilution factors in the Wigmore Stream. In addition to recording flow at 15 minute intervals, the consent holder should also undertake spot flow gauging for verification of the weir flow data. Once the updated flow correlation data is provided to Waikato Regional Council, the necessity for continued flow monitoring can be reviewed.

I have considered whether an alternative method and location of flow monitoring would suffice, e.g. spot flow gauging only at a point further downstream near the WWTP discharge site, however this data would be within the zone of tidal influence. This would result in variable flow speeds and direction, which would complicate analysis of the flow data. This was the reasoning behind the current location of the weir.

6.1.3 Water quality of Wigmore Stream

The applicant has summarised potential water quality effects in Section 9.2.2 and Appendix 2 of the AEE. Waikato Regional Council scientist, Mr Bill Vant, has reviewed this information and commented on the key parameters of concern. His comments are recorded in document 3465637, 10546985 and 10671807. Responses to questions raised by Mr Vant in document 3465637 have been addressed by the applicant in documents 10487506 and 10628287.

The key parameters highlighted by Mr Vant in his review include dissolved oxygen, ammoniacal nitrogen, turbidity/suspended solids and *E. coli*.

Depletion of dissolved oxygen

Dissolved oxygen in the stream has been measured by the applicant's consultant (Kessels Ecology) using point measurements every four months from March 2010 to March 2015 during ecological surveys. The Kessels report (Appendix 2 of the AEE) states that measurements from both upstream and downstream sites in the Wigmore Stream are often below 80% saturation, and below the 4 mg/L National Objectives Framework bottom line (1-day minimum) guideline at both sites on several occasions, most notably during March surveys. On average, dissolved oxygen concentrations were 0.48% higher at the downstream site than the upstream monitoring site.

The applicant has also reviewed monthly Biochemical Oxygen Demand results in the stream and the WWTP discharge measured as a condition of consent by the WWTP operators. The average Carbonaceous Biochemical Oxygen Demand ($cBOD_5$) measured on a monthly basis in the WWTP discharge was 6 g/m^3 (Table 19 of Appendix 2 in the AEE), while the 95th percentile upstream concentration was 3 g/m^3 and the downstream concentration was 2 g/m^3 (Table 7 of Appendix 2 in the AEE). While the applicant has not been able to pinpoint the source of the differences between upstream and downstream $cBOD_5$ and dissolved oxygen measurements, the application states that the results do not suggest an effect on dissolved oxygen concentrations from the WWTP discharge, and that low dissolved oxygen concentrations in the stream are due to wider catchment influences.

Mr Bill Vant agrees with the explanation provided by the applicant for the low levels of dissolved oxygen in the Wigmore Stream (refer document 10546985).

Elevated concentrations of ammoniacal-nitrogen

Ammoniacal nitrogen concentrations in the WWTP discharge is summarised in Figure 9 of the AEE and document 10628287. The WWTP generally achieves a high level of nitrification prior to discharge (i.e. average AmmN levels of <5 g/m^3), however during peak periods with high wastewater inflow the WWTP struggles to maintain the same level of treatment. The running average during peak periods increases up to 15 g/m^3 and the 90th percentile to 35 g/m^3.

Mr Vant considers that the elevated ammoniacal nitrogen has potential to have adverse effects on the Wigmore Stream. Refer document 3465637.

The applicant's consultant (Harrison Grierson) has identified a number of upgrade options for the WWTP to increase the effective aeration of the wastewater, allowing for greater nitrification (document 10628287). They have undertaken calculations to determine the additional aeration required during the peak season to reduce ammoniacal nitrogen levels to ≤10 g/m^3 (running average) and ≤15 g/m^3 (90th percentile). These options include:

- Replacement of the existing axial aerator in the aeration pond with a new 4kW diffused aerator;
- Installation of an additional 4kW diffused aerator in the aeration pond;
- Installation of a baffle curtain in the aeration pond to reduce short-circuiting between the inlet and outlet;
- Rerouting of the MFU backwash to the inlet of the aeration pond to ensure adequate aeration of the concentrated waste and reduce the chance of direct recycling back into the MFU.

In addition to the recommended upgrades, some enabling works may also be required, including:

- Installation of a 100 kVA transformer to increase capacity at the plant;
- Upgrade of the switchboard and integration of a SCADA monitoring system.

Further supporting upgrades that may improve the quality of the discharge include:

- Desludging of the aeration pond. The WWTP operators undertook a sludge survey in 2016 that indicated there is 530 m^3 of sludge in the aeration pond (approximately 25% of the total volume) and 820 m^3 of sludge in the retention pond (approximately 25% of the total volume). Desludging will assist with increasing hydraulic retention times and correct placement of baffle curtains.
- Inlet screening to remove gross solids from the raw wastewater and reduce sludge build-up in the pond.

TCDC have confirmed that they intend to address additional aeration, a baffle curtain, inlet screening, power inadequacies, and SCADA monitoring as part of their 2017/18 Capital Works program (document 10629575). Desludging of the ponds will occur at a later date dependent on the effectiveness of the other upgrades on improving wastewater discharge quality. TCDC propose a reduced consent limit for ammoniacal nitrogen to ≤10 g/m^3 (running average) and ≤15 g/m^3 (90th percentile).

Mr Vant has reviewed the applicant's revised discharge limits for ammoniacal nitrogen. This assessment is included in document 10671807. Mr Vant comments that *"historic concentrations of ammoniacal-N in the area downstream of the discharge had been as high as "greater than 2 g/m^3" (although they were typically lower than this). If we assume that these elevated concentrations were associated with the discharge of wastewater to the stream, then the proposed reduction to the consent limits would be likely to mean that concentrations of this magnitude in the stream would become increasingly rare in the future. As a result, concentrations of ammoniacal-N downstream of the discharge point would be unlikely to exceed the national bottom line of the National Policy Statement for Freshwater Management 2014, namely 2.2 g/m^3."* Mr Vant concludes "*I therefore consider that the proposed new consent limits for ammoniacal-N of June 2017 would be likely to mean that any adverse ecological effects of the discharge of this contaminant to the Wigmore Stream would be small*."

On the basis of TCDC's proposed reduction in the ammoniacal nitrogen discharge limits and Mr Vant's technical comment with regards to the potential effect on the stream, I consider that the potential adverse effects of the discharge of this contaminant to the Wigmore Stream will be no more than minor. I recommend conditions of consent requiring the proposed upgrades to be undertaken within the specified timeframe and discharge limits of 10 g/m^3 (running average) and 15 g/m^3 (90th percentile). I also recommend a condition of consent requiring future upgrades, such as desludging, be considered at a later date after review of monitoring data and the effectiveness of treatment over time.

With the proposed reduction in ammoniacal nitrogen concentrations, there will also be an associated reduction in organic nitrogen concentrations. The existing consented discharge limit in AUTH117888 for Total Kjeldahl Nitrogen (TKN), of which organic nitrogen is measured as a component of, is the same as Total Ammoniacal Nitrogen at 15 g/m^3 (running average) and 40 g/m^3 (90th percentile). TCDC has proposed a reduction in the TKN discharge limit of 15 g/m^3 (running average) and 20 g/m^3 (90th percentile) to allow for organic nitrogen (document 11367735). Mr Bill Vant agrees with this proposal (document 11368436). I therefore recommend a consent discharge limit to reflect these reduced TKN discharge limits.

<u>Phosphorus</u>
Mr Vant comments that "*at times of low dilution the discharge is likely to substantially increase the total P concentration in the stream*" (document 3465637). In response, the applicant has noted the high upstream phosphorus concentrations and commented that the frequency of occurrence for a low flow/low dilution situation is very low. Mr Vant has accepted this explanation.

<u>Elevated Turbidity and Suspended Solids</u>
Suspended solids and turbidity measurements are elevated in the stream, including at the upstream monitoring site. After comparison to the quality of the treated wastewater, both the applicant and Mr Bill Vant attribute these elevated background concentrations in the stream to soil erosion within the catchment.

Bacteria
Similar to above, the Wigmore Stream has elevated background concentrations of *E.coli* and *Enterococci* that has been attributed to other sources.

6.1.4 Aquatic ecosystems

The effects of the wastewater discharge on aquatic ecosystems are summarised in the AEE (Appendix 2) and the applicant's response to technical review comments (document 10487506). Mr Vant agrees with the applicant's conclusion that effects on aquatic ecosystems from the discharge will be no more than minor.

Based on TCDC's proposed reduction in the ammoniacal nitrogen discharge limits and Mr Vant's technical comment with regards to the potential effect on the stream, I consider that the potential adverse effects of the discharge on aquatic ecosystems will be no more than minor.

6.1.5 Groundwater quality

The aeration and retention ponds are clay lined. The applicant has stated that the effects of groundwater seepage from the ponds on underlying soils and groundwater quality is expected to be less than minor. While no data has been provided to confirm existing soil or groundwater quality, the applicant considers that any effects from groundwater seepage on groundwater quality is captured within the ecological monitoring of the Wigmore Stream.

There are existing groundwater take abstractions located downgradient, i.e. seaward side, of the WWTP. The Hahei community water supply bores are the nearest abstraction bores, located approximately 275 m from the WWTP ponds on the opposite side of Pa Road. While the applicant's statement above would relate to shallow groundwater flow conditions, consideration of the potential for effects on deeper groundwater, and thus security of the downgradient community water supply, is required.

The Hahei community water takes have been recently granted replacement resource consent. In consideration of the water take applications, a hydrogeological technical review of the Hahei water supply aquifer was undertaken in 2016 by Waikato Regional Council hydrogeologist, Mr John Hadfield. In his review, recorded as Waikato Regional Council document 8971414, Mr Hadfield describes the Hahei Aquifer as confined and relatively isolated from surface contamination. With particular reference to the WWTP, Mr Hadfield states that "…*groundwater age analyses indicates a mean residence time of over a hundred years, which suggests there is relatively effective protection of the deeper aquifer from surface contamination. For example, land disposal of treated effluent immediately up-gradient of the Pa Rd community supply wells has no apparent impact on the confined aquifer at that location (Hadfield, 2005, doc 1176870)*." In this earlier report by Mr Hadfield, dated 2005, which was prior to installation of the existing MFU at the WWTP and redundancy of the land disposal beds, shallow groundwater flow conditions at the WWTP were inferred from piezometric surveying as flowing from the (now redundant) land disposal beds towards the Wigmore Stream. This supports the applicant's statement that groundwater seepage from the WWTP flows towards the stream.

I consider that the existing WWTP operations on site will have less impact on groundwater quality compared to historical use of the land disposal beds. In addition, based on Mr Hadfield's hydrogeological assessment, I consider that the potential for any adverse effects from the WWTP on the deeper Hahei Aquifer via groundwater seepage is likely to be low. I also consider that the risk of surface runoff from the WWTP site to the water supply bore heads is low. However, as mitigation against this risk, albeit low, I recommend a condition of consent that the applicant notify the Waikato Regional Council within 24 hours of any unauthorised discharge from the WWTP ponds to the Wigmore Stream (as per existing consent conditions) as well as adjacent WWTP infrastructure, i.e. redundant disposal beds or storage pond.

6.2 Section 105 Matters

Section 105(1) of the RMA states:

If an application is for a discharge permit or coastal permit to do something that would contravene Section 15 or Section 15B, the consent authority must, in addition to the matters in Section 104(1), have regard to—

(a) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and

(b) the applicant's reasons for the proposed choice; and

(c) any possible alternative methods of discharge, including discharge into any other receiving environment.

With regard to section 105(1)(c), the applicant undertook a comprehensive treatment options analysis and community consultation process in 2006, prior to selecting MFU treatment and diversion of the discharge from land disposal beds to the stream. There has been a significant improvement in discharge quality and stream quality since the MFU was installed at the site in 2007. While some treatment upgrades around screening, additional aeration and SCADA monitoring are proposed for the 2017/18 year, other treatment and relocation options have been considered and discarded due to cost.

6.3 Section 107 Restrictions

Section 107(1) of the RMA restricts granting of a discharge permit, if they would otherwise contravene Section 15 of the RMA allowing:

(a) the discharge of a contaminant or water into water; or

(b) a discharge of a contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water, …….

if, after reasonable mixing, the contaminant or water discharged (either by itself or in combination with the same, similar, or other contaminants or water), is likely to give rise to all or any of the following effects in the receiving waters:

(c) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials:

(d) any conspicuous change in the colour or visual clarity:

(e) any emission of objectionable odour:

(f) the rendering of fresh water unsuitable for consumption by farm animals:

(g) any significant adverse effects on aquatic life.

None of the effects listed in (c) to (g) are known to occur after reasonable mixing. These effects can be managed by conditions of consent on the quality of the discharge. I consider that the granting of a discharge permit will not contravene Section 15 of the RMA.

6.4 Policy Statements, Plans and Regulations

6.4.1 National Environment Standards

At the time of writing this report there are five National Environmental Standards (NES) that are in effect - the National Environmental Standards for Air Quality; Sources of Human Drinking Water; Assessing and Managing Contaminants in Soil to Protect Human Health; Electricity Transmission Activities; and Telecommunication Facilities.

The only relevant NES to this application is the NES for Sources of Human Drinking Water. A search of Waikato Regional Council's Smart Maps system has shown one registered source of drinking water, Hahei treatment plant (TP00709), located 275 metres from of the proposed activity for a plant population of 66 people. The treatment plant sources its water from groundwater. As the treatment plant serves a population of less than 501 people the NES for Sources of Human Drinking Water does not apply. Further I do not consider the effects outlined in regulation 12(1) are likely to occur, and therefore regulation 12(2) does not apply. Therefore it is my view that the proposal is consistent with this NES.

6.4.2 Other regulations

There are no regulations of relevance to this application.

6.4.3 National Policy Statements

Of relevance to this application is the National Policy Statement for Freshwater Management 2014 (NPSFM).

The objectives of the NPSFM have been addressed in the assessment of this application against the provisions of the Waikato Regional Policy Statement and the Waikato Regional Plan (see below). It is my view that this application is consistent with Objectives A1 and A2 of the NPS.

There are unlikely to be any adverse effects arising from the discharge on ecosystem health and human health for recreation (i.e. the two compulsory national values identified in the NPSFM), with key water quality parameters in the Wigmore Stream downstream of the discharge point being unlikely to exceed the national bottom line specified in the NPSFM as detailed in section 6.1 of this report.

6.4.4 Regional Policy Statement

I have reviewed the following objectives and policies of the Waikato Regional Policy Statement (RPS) with regard to this application:

- Objective 3.8 – Relationship of tangata whenua with the environment
- Objective 3.14 – Mauri and values of fresh water bodies
- Policy 4.3 – Tangata whenua
- Policy 8.1 – Approach to identifying fresh water body values and managing fresh water bodies
- Policy 8.3 – All fresh water bodies

I do not consider that the activity will be contrary to the above RPS provisions provided that the activity is carried out as per the consent conditions I have proposed (see Section 8).

6.4.5 Regional Plan

I have reviewed the following objectives and policies of the Waikato Regional Plan (WRP) with regard to this application:

WRP Chapter 3 – Water module

- Objective 3.2.2 – Management of water resources
- Policy 1: Management of water bodies
- Policy 4: Waikato Region surface water class
- Policy 6: Contact recreation water class
- Policy 8: Reasonable mixing
- Objective 3.5.2 – Discharges
- Policy 1: Enabling discharges to water that will have only minor adverse effects
- Policy 2: Managing discharges to water with more than minor adverse effects
- Policy 6: Tangata Whenua uses and values
- Objective 5.2.2 – Discharges onto or into land
- Policy 1: Low risk discharges onto or into land
- Policy 2: Other discharges onto or into land

- Discretionary Activity Rule 3.5.4.5

The purpose of the objectives in Sections 3.2.2, 3.5.2 and 5.2.2 of the WRP ensures that when considering discharges to water, the effects on water management and land management objectives, contaminant assimilative capacity, and utilisation of allocable flow for other uses are accounted for.

There are unlikely to be any adverse environmental effects from the WWTP discharge with regards to water quality, aquatic ecosystems and contact recreational uses. The Hahei WWTP has achieved a high level of compliance with regards to the conditions of consent AUTH117888, and further works are proposed in the 2017/18 year to improve the quality of the treated wastewater. The relationship tangata whenua has with water has been recognised and provided for through the notification process outlined in section 4 of this report.

6.5 Other Matters

6.5.1 Value of the Consent Holder Investment

As this application is for a replacement resource consent and is affected by section 124 of the RMA, the consent authority must have regard to the value of the investment of the existing consent holder pursuant to section 104(2A) of the RMA. The Hahei WWTP is currently valued at $934,000 and the proposed upgrades are expected to add an additional $200,000 (approximately).

6.5.2 Hauraki Gulf Marine Park Act (2000)

The Hauraki Gulf Marine Park Act (2000) recognises the Hauraki Gulf as a matter of national importance such that consent authorities, when considering a resource consent application within the Hauraki Gulf, should have regard to the life-supporting capacity of the environment of the Hauraki Gulf, its islands and catchments. I have reviewed the application and I do not consider it contravenes the purpose and principles of the Hauraki Gulf Marine Park Act, provided all consent conditions are adhered to.

6.5.3 Hauraki Iwi Environmental Plan (Whaia Te Mahere Taiao a Hauraki)

The Hauraki Iwi Environmental Plan provides a background to, and identifies, key resource-based issues for Hauraki Whanui. Key issues of relevance to this application includes water pollution and loss of aquatic habitat. I am satisfied that this proposal will not adversely affect natural resources and taonga in the area, as detailed in section 6.1 of this report. As such, I consider that the proposed activity is not inconsistent with the Hauraki Iwi Environmental Plan.

6.6 Relevant Part 2 Considerations

The proposed discharge is a continuing activity with no change to the current volume of treated wastewater to be discharged to the Wigmore Stream. The applicant has undertaken long-term monitoring of the discharge quality and water quality and ecology of the receiving environment to assess the level of effects the existing discharge has on the stream. The effects of the WWTP discharge on the Wigmore Stream are considered to be no more than minor, and potential effects can be monitored and mitigated.

The proposed activity has been considered in the context of the matters outlined in Part 2 of the Resource Management Act 1991 and, in my opinion, the activities do not compromise any of these issues and, therefore, the overall purpose of the Act.

7 Discussion/Conclusions

Thames Coromandel District Council has applied for resource consent to discharge up to 700 m^3/day of treated wastewater from the Hahei WWTP to the Wigmore Stream, and associated seepage to groundwater. This is an application to replace existing consent AUTH117888, which expired on 31 December 2015.

The proposed discharge is a discretionary activity under rule 3.5.4.5 of the Waikato Regional Plan.

During this assessment, I have considered the following:

- Flow and assimilation capacity of the stream,
- Effects on water quality of the Wigmore stream,
- Effects on aquatic ecosystems,
- Effects of seepage to groundwater from the WWTP ponds;
- Consistency of the activities with relevant policies and plans, and
- Consistency of the activities with Part 2 of the Resource Management Act 1991.

As discussed in section 6.1 of this report, the actual environmental effects of the WWTP discharge to the Wigmore Stream and associated groundwater seepage are likely to be minor or less than minor. The applicant proposes to undertake upgrades at the WWTP over the 2017/18 year, which will enable compliance with tighter ammoniacal-nitrogen discharge limits compared to the existing consent. I consider that the resource consent authorising the discharge of treated wastewater from the Hahei WWTP can be granted.

The applicant has applied for a consent duration of "10 to 15 years". TCDC have advised that they will be reviewing the long-term strategy of the WWTP reticulation scheme over the next ten years, including investigation and design works to reticulate a larger proportion of Hahei to the wastewater scheme. I consider that a consent term of 13 years provides a suitable timeframe to allow for detailed design information to be included in a replacement consent application, while not unduly delaying potential improvements in treatment effectiveness and responsiveness to population growth that a longer consent duration would. I also note the two year timeframe that has passed since expiry of consent AUTH117888.

8 Monitoring

I have proposed conditions of consent similar to consent AUTH117888, with the exception of the following changes:

- Reduction in ammoniacal nitrogen and TKN discharge limits.
- Removal of condition 11 of AUTH117888 allowing for review of the discharge limits should compliance be difficult to achieve with appropriate operation of the treatment plant. I consider that this condition is no longer relevant.
- Reduction in macroinvertebrate sampling from three times per year, as per condition 16(g) of consent AUTH117888, to once per year in January. It is considered that there is sufficient baseline of seasonal data collected since 2010 with which to compare future results. This is a recommendation arising from the AEE, but a reduction in the ecological monitoring program has also been recommended on an occasion separate to this consent application by Mr Bill Vant (document 10352483).
- Removal of the requirement for hourly sampling of *E.coli* and Enterrococci for one day in January, as per condition 16(h) of AUTH117888. This is at the request of TCDC on the basis that the WWTP does not discharge continuously over 24 hours, that half the samples are out of spec by the time they are analysed, and that historically the bacteria counts are low or undetectable. I have reviewed the historical monitoring data and agree that for the past five years the hourly sampling results provided under condition 16(h) (five hourly results in the middle of the day) have been low.
- Addition of habitat description to condition 16(g), as included in past ecological surveys.
- Addition of low flow gauging over the 2017/18 summer period to validate/calibrate the flow recorder data and flow correlation.
- Removal of condition 17 of AUTH117888 allowing for the monitoring programme to be reviewed and modified if it is deemed inadequate to characterise the discharge and identify effects on the Wigmore Stream. I consider that this condition is no longer relevant.

- A condition requiring the stream ecology sampling to be undertaken in accordance with previous survey methods, with the most relevant methodology referenced. Also, a condition requiring reporting of ecological effects on a two-yearly basis. These conditions replace condition 23 of AUTH117888.
- Reference to existing management plans, with regular updates to be provided to Waikato Regional Council (e.g. Monitoring Implementation Plan, Contingency Plan).
- Change from 1 May to 1 June for annual reporting to Waikato Regional Council, at the request of the applicant.
- Removal of conditions relating to odour, as this is not within the scope of this resource consent application. The discharge of odour is a permitted activity under Rule 6.2.18.1 of the Waikato Regional Plan.
- A condition requiring treatment plant upgrades as scheduled in the TCDC 2017/18 Long Term Plan to be implemented within one year of the commencement of this consent.
- A review condition allowing for review of the consent should future co-management legislation be enacted, where Waikato Regional Council is required to ensure consistency with the provisions of any such legislation.

9 Recommended Decision

I recommend that in accordance with s104B resource consent application 135636 be granted in accordance with the duration and conditions prescribed in the attached Resource Consent Certificate for the following reasons:

- The continuation of the discharge of treated wastewater will provide for the health and wellbeing of those residents in Hahei connected to the WWTP
- This method of discharge (to the stream via MFU) has resulted in an improvement in water quality and aquatic ecology compared to the previous land treatment and discharge system in place prior to 2007
- The activity will have no more than minor actual or potential adverse effects on the environment
- The activity is not contrary to any relevant plans or policies
- The activity is consistent with the purpose and principles of the Resource Management Act 1991

Donna Jones **7 December 2017**

Principal Planner – KTB Planning Consultants Ltd

10 Decision

That the resource consent application is granted in accordance with the above recommendations.

Hugh Keane
Team Leader - Infrastructure
Resource Use

Date: 7 December 2017

RESOURCE CONSENT CERTIFICATE

Resource Consent: AUTH135636.01.01

File Number: 60 25 05A

Pursuant to the Resource Management Act 1991, the Regional Council hereby grants consent to:

Thames Coromandel District Council
Private Bag 1001
Thames 3540

(hereinafter referred to as the Consent Holder)

Consent Type: Discharge Permit

Consent Subtype: Water - sewage

Activity authorised: Discharge of treated municipal wastewater to the Wigmore Stream and associated seepage to groundwater from treatment ponds

Location: Pa Rd - Hahei (Hahei WWTP)

Map reference: NZTM 1850282 E 5918696 N

Consent duration: This consent will commence on the date of decision notification and expire on 15 December 2030.

Subject to the conditions overleaf:

CONDITIONS

General

1) The discharge of treated wastewater authorised by this resource consent shall be undertaken:
   i) in general accordance with the application for this resource consent (as recorded on the Waikato Regional Council's electronic document management system document no. 3442348) and any documentation supporting the application, and
   ii) as specified in the resource consent conditions below.

   Where there is any disagreement between the application and the consent conditions set out below, then the consent conditions shall prevail.

2) The consent holder shall ensure contractors are made aware of the conditions of this resource consent and ensure compliance with those conditions.

3) The treatment plant and discharge to the Wigmore Stream shall be managed and operated by an appropriately trained operator.

4) The consent holder shall pay to the Waikato Regional Council any administrative charge fixed in accordance with section 36 of the Resource Management Act 1991, or any charge prescribed in accordance with regulations made under section 360 of the Resource Management Act.

Discharge Volume

5) The maximum volume of treated wastewater discharged to the Wigmore Stream shall not exceed 700 cubic metres in any 24 hour period.

6) The maximum discharge rate of treated wastewater to the Wigmore Stream shall not exceed 8.1 litres per second.

Discharge Quality

7) The consent holder shall ensure that all waste entering, and treated in, the Hahei Wastewater Treatment Plant, goes through all stages of treatment available at the plant prior to discharge. This includes the Micro Filtration Unit.

8) The following limits shall apply to the discharge to the Wigmore Stream from the commencement of this resource consent:

Parameter	**90 percentile**, *not more than one sample in each preceding 10 samples shall exceed:*	**Running average**, *over any consecutive 10 samples shall not exceed:*
a) Suspended solids (g/m^3)	20	10
b) Carbonaceous biochemical oxygen demand ($cBOD_5$) (g/m^3)	20	10
c) *Escherichia coli* (cfu/100 mL)	20	10
d) Total ammoniacal nitrogen (g/m^3)	15	10
e) Total Kjeldahl Nitrogen (g/m^3)	20	15
f) Total Phosphorus (g/m^3)	20	14

9) Notwithstanding the stated limits in condition 8, the consent holder shall make all reasonable and practical efforts to ensure that the final effluent quality is maximised within the capabilities of the treatment system in operation.

10) The point at which compliance with condition 8 of this consent shall be determined is from a grab sample taken at the point of discharge from the treatment plant and prior to discharge to the Wigmore Stream.

Metering and Monitoring

11) A flow meter shall be installed to record, on a continuous basis, the quantity of effluent discharged on a daily basis. The device shall have a reliable calibration to water flow and shall be maintained to an accuracy of +/- 5%. Access to the meter shall be made available to the staff and agents of the Waikato Regional Council at all reasonable times.

12) Calibration of the flow meter shall be undertaken by the consent holder, at the request of the Waikato Regional Council, if during the term of this consent the accuracy of the meter is considered less than that required by condition 11. The calibration shall be undertaken by an independent qualified person and evidence documenting the calibration shall be forwarded to the Waikato Regional Council within one month of the calibration being completed.

13) An alarm system shall be installed to operate in the event of any mechanical failure. The details of the alarm system shall be included within the Management Plan as required by condition 25 of this consent.

14) Within 3 months of the commencement of this consent the consent holder shall install and monitor a flow recorder which shall, as a minimum, record flow in the Wigmore Stream in litres per second every 15 minutes at a suitable location upstream of the discharge authorised by this consent. The purpose of the flow monitoring is to establish a reliable correlation to flows in the Opitonui River. The datalogger shall be linked by telemetry to the Waikato Regional Council. It shall be cross referenced to the Waikato Regional Council flow recorder on the Opitonui River downstream of Awaroa Stream Confluence (Waikato Regional Council Site Number 660.1, Map Reference NZTM 1832431E 5926826N). The necessity for flow recording may be modified at any time following approval in writing from the Waikato Regional Council following a request in writing from the consent holder to do so. The approval process will consider a written report by the consent holder with data and explanation to show that sufficient flow monitoring of the Wigmore Stream has been obtained to have a scientifically reliable correlation to flows in the Opitonui River, or which demonstrates the inability to obtain a scientifically reliable correlation following the collection of sufficient flow data. The minimum period of flow monitoring shall include a summer/autumn period with a prolonged low flow recession.

15) In addition to the flow monitoring required by condition 14 of this consent, the consent holder shall undertake manual low-flow gauging in the Wigmore Stream at least once during each calendar year when flows are at a seasonal summer low and the flow recorder site is operational. Where there is a prolonged period of summer low flows, the consent holder will repeat the low-flow gauging to ensure data at lower stream flows are measured. The low-flow gauging shall be undertaken at a suitable location upstream of the discharge authorised by this consent at or near the flow recorder site. The purpose of the low-flow gauging is to verify the flow records measured by the flow recorder. The low-flow gauging shall be undertaken by an appropriately qualified and experienced person. A copy of the results of the gauging(s) shall be forwarded to Waikato Regional Council with the written report required in condition 14 and 21 of this consent. The requirement for manual stream flow monitoring under this condition can cease when approval in writing from the Waikato Regional Council under condition 14 has been provided.

Discharge and Surface Water Monitoring

16) The consent holder shall measure and characterise the quality, quantity and variability of treated effluent being discharged to the Wigmore Stream and the effects of the discharge on the quality and variability of surface water. To this end, the consent holder shall undertake sampling and analysis of

the discharge and surface water as follows:

Frequency	Sample type and/or location	Parameter
a) Every 15 minutes	Wigmore Stream Refer to condition 14.	• Water level • Instantaneous flow
b) Daily	Treatment Plant	• Rainfall
c) Daily	Discharge	• Volume • Instantaneous peak flow • Average flow
d) Weekly - during the period from the start of the third week of December to the start of the third week of February - monthly otherwise.	• Inlet of MFU • Discharge, following all treatment stages and prior to entering the Wigmore Stream • Wigmore Stream 50 metres upstream of discharge • Wigmore Stream downstream at Pa Road bridge Downstream samples to be collected within the period 1 hour either side of local low tide during daylight hours and while discharge is operating.	• Total Ammoniacal Nitrogen • *Escherichia coli* • Enterococci • Conductivity • pH • Sample date and time • Time of low tide occurrence closest to sample time
e) Monthly – to coincide with d)	• Inlet of MFU • Discharge, following all treatment stages and prior to entering the Wigmore Stream • Wigmore Stream 50 metres upstream of the discharge • Wigmore Stream downstream at Pa Road bridge Downstream samples to be collected within the period 1 hour either side of local low tide during daylight hours and while discharge is operating.	• $cBOD_5$ • Nitrate Nitrogen • Suspended solids • Total Kjeldahl Nitrogen • Soluble Reactive Phosphorus • Total Phosphorus by Persulphate Digestion • Turbidity • Sample date and time • Time of low tide occurrence closest to sample time
f) Once per year in January or February	• Wigmore Stream 50 metres upstream of the discharge • Wigmore Stream downstream at Pa Road bridge Refer to condition 19 for sampling and assessment methodology.	• Aquatic Macroinvertebrate assessment • Habitat and aquatic plant assessment • Sample date and time • Time of low tide occurrence closest to assessment time
g) At least once per year – to coincide with summer low flows	Wigmore Stream Additional gauging each summer may be required if low flow conditions are prolonged, to capture a series of low flow records. Refer to condition 15.	• Flow (via flow gauging) • Sample date and time
h) Once every five years in January or February, commencing 2019	• Wigmore Stream 50 metres upstream of the discharge • Wigmore Stream downstream at Pa Road bridge	• Fish populations

17) All samples taken in relation to monitoring under this consent shall be collected by a suitably qualified and experienced person(s) with relevant training in the sampling and transporting of water quality samples and in accordance with the Monitoring Implementation Plan titled "Wastewater Sampling at Hahei WWTP and Wigmore Stream" by United Water, dated 1-04-2009 (Waikato Regional Council document number 1472702), or any subsequent update. This plan shall detail methods and map locations for how, when and where sampling will take place. An updated Monitoring Implementation Plan shall be provided to the Waikato Regional Council within three months of commencement of this consent, and at two yearly intervals thereafter, or more often if any method or location changes. The Waikato Regional Council shall be provided with an updated copy of the Monitoring Implementation Plan within one month of any update to the Plan.

18) All sample analyses shall be undertaken in accordance with the methods detailed in the "Standard Methods for the Examination of Water and Waste Water, 2017" 23rd edition A.P.H.A and A.W.W.A. and W.E.F., or any other method approved by the Waikato Regional Council.

19) All ecological surveys carried out in relation to monitoring under this consent shall be undertaken by a suitably qualified and experienced person(s) with relevant training in ecological monitoring and assessment. The sampling and analysis methodology shall be consistent with previous surveys undertaken at this site, as summarised in the report titled "Hahei Wastewater Treatment Plant Assessment of Ecological Effects" by Kessels Ecology, dated 24 May 2017 (Waikato Regional Council document number 11016880). The sampling and analysis methodology may be modified following approval in writing from the Waikato Regional Council.

Periodic Reporting

20) The consent holder shall provide to the Waikato Regional Council a data report by 1 December each year that this consent is current. This report shall include all data collected under condition 16 of this consent for the period 1 April to 30 September of the current year and shall identify any non-compliance within that period.

21) The consent holder shall provide to the Waikato Regional Council a written monitoring report by 1 June each year that this consent is current for the 12 month period from 1 April of the preceding year to 31 March of the current year. As a minimum this report shall include the following:
    a) a summary of the monitoring results required by condition 16 of this consent for the 12 month period from 1 April of the preceding year to 31 March of the current year and a critical analysis of the information in terms of compliance and environmental effects;
    b) a comparison of data with previously collected data identifying any emerging trends;
    c) comment on compliance, and any reasons for non-compliance or difficulties in achieving compliance, with condition 8 of this consent;
    d) comment on any works that have been undertaken, or that are proposed to be undertaken in the upcoming year, to improve the environmental performance of the treatment and/or disposal system;
    e) report on and discuss any complaints received regarding the treatment and/or discharge of treated effluent; and
    f) any other issues considered important by the consent holder.

22) The consent holder shall provide to the Waikato Regional Council an ecological assessment report by 1 June every two years for the duration of this consent. This report shall be prepared by a suitably qualified person or persons with relevant training in ecological monitoring and assessment. As a minimum this report shall include the following:

a) a summary of the ecological monitoring and water quality results required by condition 16 for the preceding two years;
b) a comparison of data with previously collected data identifying any emerging trends;
c) a critical analysis of the current ecological health of the Wigmore Stream, the potential causes of any degradation of the stream, the effects of the discharge authorised by this consent on the Wigmore Stream and downstream coastal waters;
d) any other issues considered important by the ecologist.

Contingency Plan

23) In the event of any bypasses, other extraordinary events or failure of any critical part of the treatment plant, the consent holder shall manage the treatment plant and discharge to the Wigmore Stream in accordance with the Contingency Plan titled "Hahei Wastewater Treatment Plant Contingency Plan 2015" by Veolia (Waikato Regional Council document number 3584298 and 3584310), or any subsequent update. An updated plan shall be provided to the Waikato Regional Council by 1 June 2018, and at three yearly intervals thereafter. The consent holder shall engage appropriately experienced persons to compile any update to the Contingency Plan, and it shall identify measures and notification protocols to be undertaken by the consent holder that will take into account any potential adverse effects on the Wigmore Stream and users, including but not limited to ecological effects, downstream recreational use, and the Medical Officer of Health.

Management Plan

24) The consent holder shall provide the Waikato Regional Council with a Management Plan which details the procedures that will be implemented to operate in accordance with the conditions of this resource consent and the procedures that will be put into place to maximise wastewater treatment and minimise odour production. This plan shall be lodged with the Waikato Regional Council within 3 months of the commencement of this consent, and shall be reviewed and updated as a minimum annually. The plan shall address, but may not be limited to, the following:
    a) a description of the entire treatment and disposal system facility and how it is operated;
    b) a description of routine maintenance procedures to be undertaken;
    c) an outline of the methods to be utilised to monitor the treatment plant in an operational sense including: monitoring of influent waste water and monitoring of treatment performance;
    d) a description of the methods to be used to ensure that sampling of the discharge as required by condition 16 of this consent is representative of overall discharge quality;
    e) specific management procedures for the efficient functioning of the treatment system including Micro Filtration Unit, including measures to ensure compliance with condition 8 of this consent relating to discharge quality parameters;
    f) procedures for recording routine maintenance and all repairs that are undertaken;
    g) contingency measures in place to deal with unusual events;
    h) chain of command and responsibility, including contact details;
    i) other actions necessary to comply with the requirements of this resource consent;
    j) procedures for improving and/or reviewing the management plan.

25) The consent holder shall manage the wastewater treatment and discharge in accordance with the Management Plan referred to in condition 24 of this consent. Any changes to the Management Plan shall be advised to the Waikato Regional Council in writing after consultation between the consent holder and the Waikato Regional Council.

Unauthorised Discharge

26) The consent holder shall notify the Waikato Regional Council as soon as practicable, and as a minimum requirement within 24 hours, of any discharge to Wigmore Stream from a source that

has bypassed any part of the treatment system, or any discharge to the redundant disposal beds and/or redundant storage pond. The consent holder shall, within 7 days of the discharge occurring, provide a written report to the Waikato Regional Council, identifying the extent of the discharge, possible causes, steps undertaken to remedy the effects of the discharge and measures that will be undertaken to ensure future compliance with this consent.

Complaints

27) The consent holder shall maintain and keep a complaints register for all complaints, including discharge, water quality and odour complaints regarding operations at the site received by the consent holder. The register shall record:
    a) the date, time and duration of the event that has resulted in a complaint,
    b) any corrective action undertaken by the consent holder in response to the complaint, including actions taken to prevent similar events in the future.
    c) the location of the complainant when the event was detected,
    d) the possible cause of the event, and
    e) the weather conditions and wind direction at the site when the event allegedly occurred.

28) The register outlined in condition 27 shall be available to the Waikato Regional Council at all reasonable times. Waikato Regional Council shall be informed of complaints received by the consent holder which may infer non-compliance with the conditions of this resource consent to the Waikato Regional Council within 24 hours of the complaint being received. In addition, the consent holder shall provide written information on the incident including all of the details required by (a) to (e) of condition 27 of this consent, which shall be forwarded to the Waikato Regional Council within 5 days of the complaint being received.

Wigmore Stream Mouth

29) The consent holder shall be responsible for ensuring that the Wigmore Stream, from the treated wastewater discharge point to its mouth, is kept clear of debris and that the stream mouth is not blocked by sand, to the extent that the flow of the Wigmore Stream is unimpeded into the coastal marine area. The consent holder's obligations in respect of this condition are limited to the works that can be undertaken without the need for resource consent under the relevant rule(s) of the Waikato Regional Coastal Plan.

Upgrade Works and Reporting

30) The consent holder shall implement the treatment plant upgrade works detailed in the Technical Memo titled "Hahei WWTP Consent Ammonical Nitrogen Reduction" by Harrison Grierson, dated 14 June 2017 (Waikato Regional Council document number 10628287), or equivalent upgrades, to ensure the wastewater discharge limits in condition 8 are met. The works shall include, as a minimum, installation of additional aeration in the Aeration Pond. These works shall be fully implemented within one year of the commencement of this consent.

31) The consent holder shall provide a written report on or before the fifth and tenth anniversaries of the commencement of this consent that shall outline:
    a) what investigations have been undertaken to date to identify the long-term strategy for wastewater treatment and disposal options at Hahei upon the expiry of this consent,
    b) what investigations have been undertaken or identified in relation to potential effects of disposal options being considered for wastewater at Hahei upon the expiry of this consent,
    c) what consultation has been undertaken in relation to potential treatment and disposal options for wastewater at Hahei upon the expiry of this consent.

Review

32) The Waikato Regional Council may, within the six month period following receipt of the monitoring information required by condition 22 of this consent, serve notice on the consent

holder under section 128(1) of the Resource Management Act 1991 and commence a review of the conditions of this resource consent for the purpose of reviewing the compliance limit(s) of any contaminant and/or, if necessary and appropriate, to require the holder of this resource consent to adopt the best practicable option to remove or reduce adverse effects on surface water quality or ecology due to the discharge.

33) The Waikato Regional Council may, within the year of the second, fifth and tenth anniversary of the commencement of this consent, serve notice on the consent holder under section 128 (1) of the Resource Management Act 1991, of its intention to review the conditions of this resource consent for the following purposes:
    i) to review the effectiveness of the conditions of this resource consent in avoiding or mitigating any adverse effects on ground or surface water quality from the exercise of this resource consent and if necessary to avoid, remedy or mitigate such effects by way of further or amended conditions; or
    ii) if necessary and appropriate, to require the holder of this resource consent to adopt the best practicable option to remove or reduce adverse effects on surface water quality due to the discharge; or
    iii) to review the adequacy of and the necessity for monitoring undertaken by the consent holder.

    Costs associated with any review of the conditions of this resource consent will be recovered from the consent holder in accordance with the provisions of section 36 of the Resource Management Act 1991.

34) Within 12 months of any co-management legislation commencing for the Hauraki Gulf catchment, the Waikato Regional Council may, following service of notice on the consent holder pursuant to section 129 of the Resource Management Act 1991, commence a review of the conditions of this consent pursuant to section 128 of the Resource Management Act 1991, for the purpose of ensuring that this consent is consistent with the provisions of any such legislation.

Access

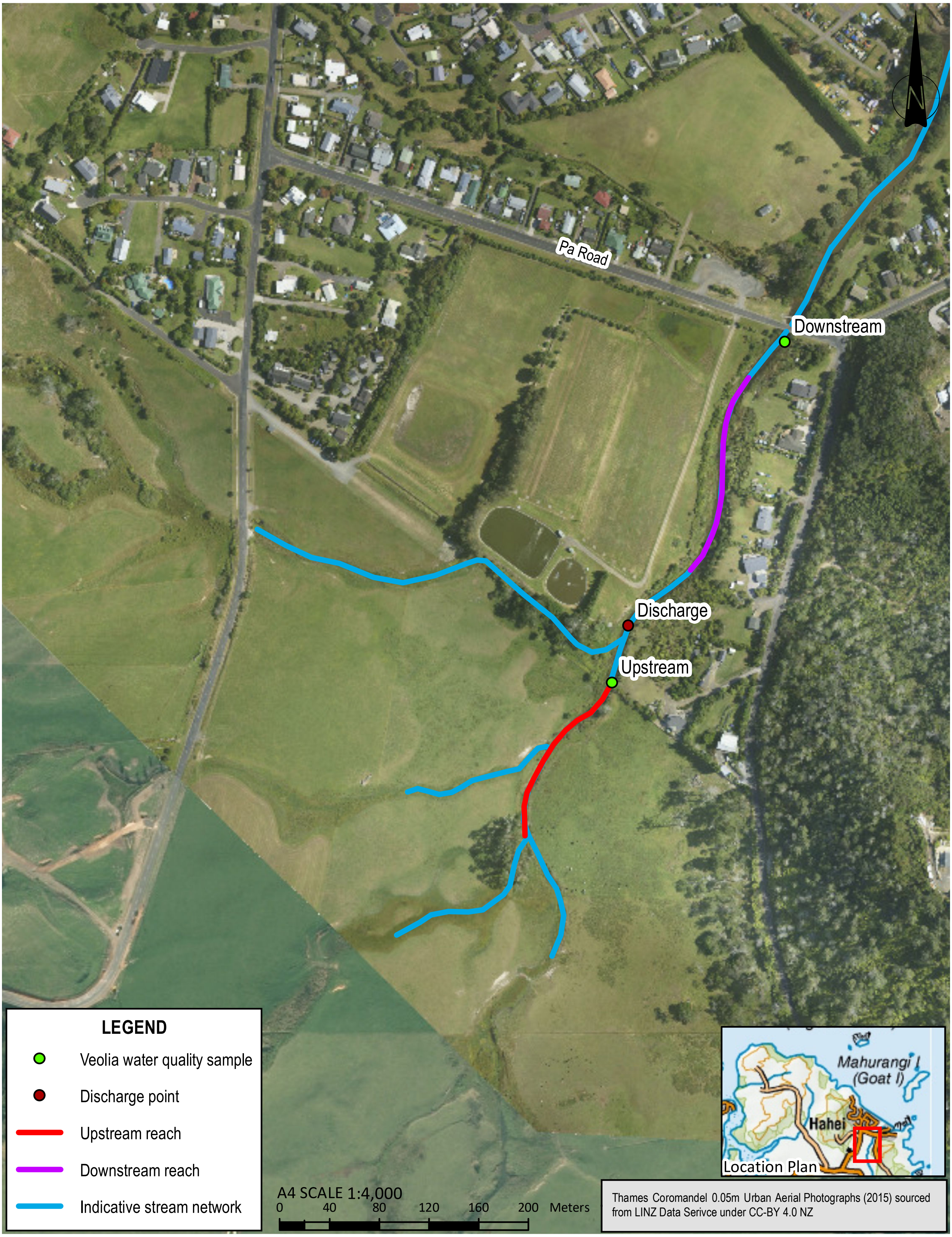
35) This resource consent is granted by the Waikato Regional Council subject to its officers or agents being permitted access to the property at all reasonable times for the purpose of carrying out inspections, surveys, investigations, tests, measurements or taking samples.

Advice notes

1. This resource consent does not give any right of access over private or public property. Arrangements for access must be made between the consent holder and the property owner.
2. The consent holder may apply to change the conditions of the resource consent under s.127 RMA.
3. The reasonable costs incurred by Waikato Regional Council arising from supervision and monitoring of this consent will be charged to the consent holder. This may include but not be limited to routine inspection of the site by Waikato Regional Council officers or agents, liaison with the consent holder, responding to complaints or enquiries relating to the site, and review and assessment of compliance with the conditions of consent.
4. Note that pursuant to s333 of the RMA 1991, enforcement officers may at all reasonable times go onto the property that is the subject of this consent, for the purpose of carrying out inspections, surveys, investigations, tests, measurements or taking samples.
5. If you intend to replace this consent upon its expiry, please note that an application for a new consent made at least 6 months prior to this consent's expiry gives you the right to continue exercising this consent after it expires in the event that your application is not processed prior to this consent's expiry.

In terms of s116 of the Resource Management Act 1991, this consent commences on 7 December 2017.

Appendix B Site location plan



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SCALE (AT A4 SIZE)
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PROJECT No.
1007585.0002

VEOLIA WATER SERVICES LIMITED
HAHEI WWTP
ECOLOGICAL MONITORING LOCATIONS

FIGURE No. Figure 1.

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Appendix C Physical habitat assessments

Appendix C Table 1: Qualitative habitat parameters for Wigmore Stream WWTP Upstream (US) and Downstream (DS) monitoring sites.

Habitat Parameter	Upstream (US)		Downstream (DS)	
	2024	2025	2024	2025
Riparian vegetation zone width	Suboptimal	Suboptimal	Suboptimal	Suboptimal
Vegetation protection	Marginal	Marginal	Marginal	Suboptimal
Bank stability	Suboptimal	Suboptimal	Optimal	Optimal
Channel sinuosity	Marginal	Marginal	Marginal	Marginal
Channel alteration	Optimal	Optimal	Suboptimal	Suboptimal
Sediment deposition	Poor	Poor	Poor	Poor
Pool variability	Marginal	Marginal	Poor	Poor
Abundance and diversity of habitat	Marginal	Marginal	Poor	Poor
Periphyton	NA	NA	NA	NA
Total habitat score	79	78	72	73

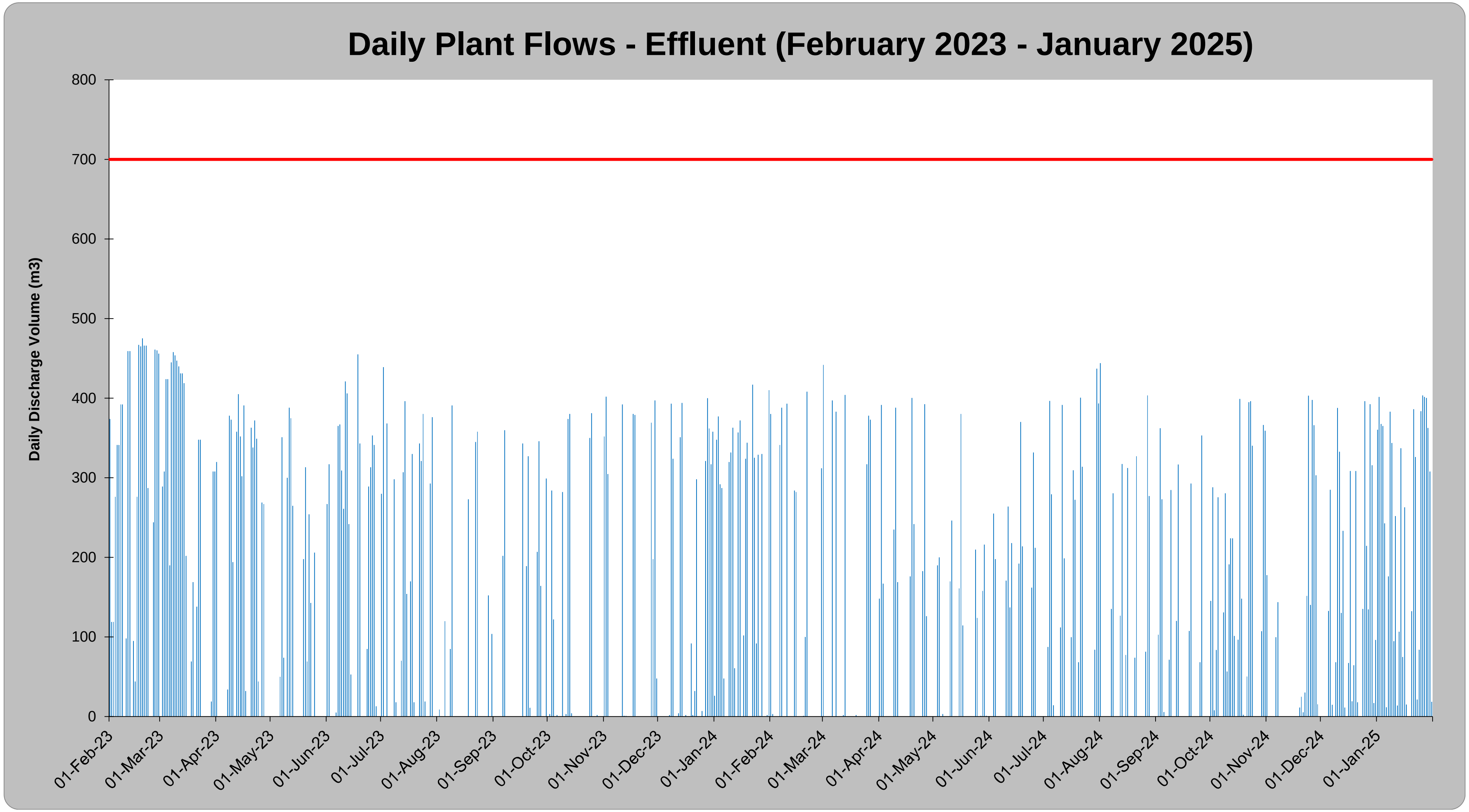
Appendix D Veolia water quality and effluent discharge data

Appendix D Table 1:	Wigmore Stream and Hahei WWTP effluent discharge water quality results for samples collected by Veolia over the period 2 February 2023 and 31 January 2025.
Appendix D Figure 1:	Daily effluent discharge volumes from the Hahei WWTP over the period 1 February 2023 and 31 January 2025.

Date	Effluent Discharge											
	CBOD mg/L	SS mg/l	Nitrate mg/l	Ammonical N mg/L	TKN mg/L	T P mg/L	SR P mg/L	Enterococci /100mL	E. Coli /100mL	Turbidity NTU	Conductivity µS/cm	pH units
7/01/2023	5.4	2	5.5	11	12.8	6.79	6.02	15	9.8	0.6		
13/01/2023	4.5	3	9.7	0.087	1.78	6.12	5.66	1.6	1.6	2		
18/01/2023	5	2.4	6.1	2.5	2.66	6.23	5.84	11	21	1.2		
25/01/2023	4.7	2	8.8	3.5	4.6	8.83	7.04	1.6	1.6	1.3		
2/02/2023	0.63	1	8.1	0.017	1.16	6.39	5.21	1.6	15	0.4		
7/02/2023	0.89	4	1.7	0.23	1.16	5.95	5.49	1.6	1.6	0.15	414	7.68
20/02/2023	1.5	3.4	1.1	0.026	0.802	5.36	3.91	1.6	1.6	0.5		
6/03/2023	1.5	2.6	0.42	0.42	1.16	5.57	5.34	8.2	15	0.35	337	7.4
11/04/2023	0.76	1	4.7	0.034	1.02	5.2	4.87	1.6	9.8	0.25		
9/05/2023	0.5	1.4	4.2	0.022	0.791	4.66	4.52	1.6	3.3	0.75	505	7.35
13/06/2023	1.9	1	4	0.052	0.8	3.04	2.93	6.6	9.8	0.6	6.45	7.46
24/07/2023	0.99	1	6	0.023	0.784	2.84	2.34	1.6	4.9	0.15	6.41	7.41
21/08/2023	1.4	1	3.8	1.4	2.18	3.06	2.93	1.6	1.6		419	7.38
19/09/2023	1.5	1	4.6	0.067	1.18	3.79	3.55	1.6	1.6		334	8.37
16/10/2023	0.61	2.4	0.0058	0.017	0.242	0.017	0.008	68	70	0.25	537	6.03
1/11/2023	3.4	2.8	0.56	18	17.1	6.13	5.75	<1.6	<1.6	0.2	512	6.57
13/12/2023	4.5	<1.0	3	23	25.1	7.95	6.5	1.6	<1.6	1		
19/12/2023	7.6	<1.0	0.29	27	26.6	7.62	6.97	3.3	<1.6	0.3	694	7.8
29/12/2023	4.2	1	1.2	16	15.9	5.44	5.26	<1.6	<1.6	0.25		
2/01/2024	6.6	<1.0	2.6	20	18.7	9.01	7.34	<1.6	<1.6	0.95	668	7.51
12/01/2024	3.8	<1.1	0.17	28	28.5	9.58	8.23	<1.6	<1.6	0.75	867	6.95
16/01/2024	3.4	3.8	0.61	24	22.2	10.7	8.95	<1.6	1.6	0.35	795	7.96
26/01/2024	0.9	<1.0	5.3	0.27	2.18	8.43	8.15	<1.6	<1.6	0.4	626	8.42
2/02/2024	1.2	1.4	10	0.12	1.77	9.88	9.57	<1.6	<1.6		845	7.85
10/02/2024	0.52	<1.0	7	0.072	0.866	10.8	9.51	<1.6	<1.6		1067	8.09
13/02/2024	2.4	<1.0	0.67	1.9	3.52	14	9.89	<1.6	<1.6		696	7.63
8/03/2024	0.92	<1.0	6	0.069	1.42	9.83	8.82	<1.6	<1.6			
2/04/2024	0.91	1	6.9	0.16	1.81	11.4	8.31	1.6	1.6	0.1	613	8.06
27/05/2024	1.2	1	4.2	0.64	1.77	8.24	8.25	1.6	1.6	0.2	649	7.55
12/06/2024	6.9	1	3.5	3.5	5.7	8.96	8.03	1.6	1.6	0.25	0.652	7.4
10/07/2024	1.3	1	3.7	8	9.23	6.84	6.65	1.6	1.6	0.1	589	7.75
7/08/2024	2.2	1	4.5	6.1	6.47	4.82	4.38	1.6	1.6	0.1	499	7.73
5/09/2024	2.2	1.8	0.28	5.7	6.88	4.2	4.25	1.6	1.6	0.15	482	7.65
10/10/2024	3.4	<1.0	2.5	2.6	3.44	4.34		<1.6	<1.6	0.6	530	7.2
19/11/2024	5.8	<1.0	0.5	4.4	5.27	12.4		<1.7	<1.7	0.45	609	7.21
18/12/2024	1.7	<1.0	2.5	0.44	1.62	9.72		1.7	1.7	0.15	662	7.6
7/01/2025	4.4	4.6	0.74	15	15.8	12.8		<1.6	1.6	0.2	1407	7.32
14/01/2025	4	3.6	15	0.18	2.17	12.1		<1.7	<1.7	0.3	856	7.56
23/01/2025	1.7	1.4	11	0.93	3.08	12.9		<1.7	<1.7	0.55	796	7.61
31/01/2025	2	1.2	17	0.079	1.42	13.9		<1.7	<1.7	0.1	853	7.49
4/02/2025	81	5.6	1.8	15	17.3	19.6		<1.6	<1.6	2	850	7.52
11/02/2025	1.2	1.4	9	0.011	1.77	11.4		<1.6	<1.6	0.2	3.54	7.45
21/02/2025	0.69	<1.0	4.5	0.037	1.8	11.8		<1.7	<1.7	0.1		

Date	Wigmore Stream 50m Upstream											
	CBOD	SS	Nitrate	Ammonical N	TKN	T P	SR P	Enterococci	E. Coli	Turbidity	Conductivity	pH
	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/L	/100mL	/100mL	NTU	µS/cm	units
7/01/2023	0.95	1.4	0.016	0.041	0.397	0.024	0.009	160	470	3.3		
13/01/2023	1.2	8.8	0.023	0.0075	0.236	0.018	0.012	56	110	4.4		
18/01/2023	1.1	6.8	0.0028	0.0077	0.382	0.027	0.012	450	520	5.2		
25/01/2023	1	52	0.0062	0.025	0.442	0.025	0.018	70	300	17		
2/02/2023	0.5	1.6	0.038	0.013	0.337	0.022	0.009	58	130	2.7		
7/02/2023	1.1	6.4	0.019	0.005	0.337	0.033	0.01	33	160	5.4	144	6.89
20/02/2023	1	7.2	0.012	0.015	0.282	0.021	0.013	33	260	5.2		
6/03/2023	1.6	13	0.21	0.005	0.512	0.062	0.021	24000	2800	19	84	6.45
11/04/2023	0.73	5.6	0.015	0.016	0.286	0.019	0.011	470	430	2.8	325	6.54
9/05/2023	0.86	5.8	0.04	0.013	0.332	0.023	0.01	800	800	4.7	641	6.22
13/06/2023	0.64	1	0.1	0.024	0.415	0.012	0.009	28	110	2.1	6.25	6.72
24/07/2023	1.1	18.2	0.15	0.014	0.717	0.016	0.008	20	120	4.3	6.2	6.72
21/08/2023	1.2	4.6	0.062	0.02	0.3	0.015	0.01	120	560		147	6.81
19/09/2023	1.4	7.4	0.029	0.022	0.282	0.009	0.007	13	48		2.32	7.28
16/10/2023	0.86	8.2	0.0065	0.01	0.192	0.008	0.008	86	140	8	563	5.93
1/11/2023	<0.5	2.4	0.021	0.027	0.423	0.006	0.006	160	220	5.5	449	5.42
13/12/2023	0.96	13.4	0.022	0.32	0.867	0.049	0.049	96	170	7.3		
19/12/2023	1.5	11.6	0.0063	0.05	0.36	0.008	0.008	240	720	4.3	433	6.72
29/12/2023	1.3	6	0.023	0.044	0.627	0.012	0.012	9200	7200	5.1		
2/01/2024	1.3	6.2	0.15	1.4	1.8	0.36	0.36	320	630	5.9	648	6.83
12/01/2024	10	29.5	0.06	2.6	3.25	0.611	0.611	21000	7200	7.2	633	6.26
16/01/2024	1.2	53.6	0.049	<0.005	0.447	0.009	0.009	9900	5600	3.3	174	6.62
26/01/2024	3.8	31	0.072	0.098	1.37	0.119	0.119	5300	2100	4.8	379	6.64
2/02/2024	2.2	103	0.042	0.072	0.678	0.026	0.026	3500	2800		401	6.95
10/02/2024	2.2	16.6	0.22	0.086	0.681	0.246	0.246	18000	11000		353	6.55
13/02/2024	2	20.4	0.0081	0.056	0.559	0.022	0.022	4100	3800		116	6.51
8/03/2024	1.4	49.4	0.042	0.061	0.464	0.087	0.087	58	120			
2/04/2024	0.84	75.6	0.89	0.074	0.625	1.95	1.45	820	410	3.2	26.7	7.42
27/05/2024	1.1	17.4	0.11	0.045	0.45	0.16	0.131	3700	2700	2.3	7.64	6.65
12/06/2024	0.88	8.4	0.05	0.047	0.282	0.014	0.011	11	370	2.3	2.44	6.39
10/07/2024	1.3	21	0.072	0.15	0.367	0.089	0.032	3.3	78	3.1	9.77	6.59
7/08/2024	1	1	0.029	0.019	0.274	0.017	0.01	3.3	64	1.4	350	7.71
5/09/2024	0.56	6.2	0.032	0.022	0.265	0.014	0.008	13	60	1.9	599	7.55
10/10/2024	1.7	2.8	0.025	0.035	0.394	0.061	0.02	44	98	3.5	334	6.98
19/11/2024	1.6	17	0.016	0.044	0.328	0.033	0.01	330	570	3.1	6.51	6.77
18/12/2024	2.8	19	0.031	0.029	0.387	0.066	0.009	820	1100	2.6	15.17	7.02
7/01/2025	2.5	104	0.023	0.098	0.572	0.058	0.018	430	1000	4	23.3	6.45
14/01/2025	1.2	46.8	6	0.093	0.943	3.71	3.85	420	1600	2.3	19.3	7.32
23/01/2025	0.25	16	0.017	0.022	0.296	0.084	0.012	1100	1700	5.3	18.3	7.14
31/01/2025	1.7	12	0.36	0.076	0.431	0.251	0.222	480	1300	4	17.51	6.83
4/02/2025	2.4	11	1.2	0.25	0.918	2	1.64	5900	5300	2.4	17.5	6.99
11/02/2025	1.2	33.8	1.5	0.0025	0.693	2.87	2.13	86	320	2.2	32.9	7.02
21/02/2025	1.6	61.8	1.3	0.13	0.942	3.06	2.19	560	590	8.3		

Date	Wigmore Stream 50m Downstream											
	CBOD	SS	Nitrate	Ammonical N	TKN	T P	SR P	Enterococci	E. Coli	Turbidity	Conductivity	pH
	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/L	/100mL	/100mL	NTU	µS/cm	units
7/01/2023	1.4	4.8	0.42	0.06	0.322	0.022	0.009	1100	730	6.4		
13/01/2023	1.2	7.2	0.53	0.038	0.312	0.067	0.058	470	330	4.9		
18/01/2023	2	22.4	0.28	0.11	0.527	0.13	0.089	49000	51000	9.5		
25/01/2023	1	46.8	0.47	0.27	0.71	0.391	0.242	2100	1000	4.6		
2/02/2023	0.5	1	0.2	0.015	0.355	0.093	0.082	110	220	3.6		
7/02/2023	0.82	15.6	0.21	0.029	0.295	0.099	0.057	460	560	6	4050	6.54
20/02/2023	1.2	24.2	0.2	0.024	0.351	0.113	0.063	420	280	7.6		
6/03/2023	1	27	1.1	0.032	0.6	0.056	0.017	3700	2100	25	153	6.76
11/04/2023	0.71	10.8	0.24	0.023	0.334	0.216	0.186	780	720	4	654	6.68
9/05/2023	0.71	86	0.071	0.018	0.556	0.068	0.009	3000	1200	15	4.21	6.24
13/06/2023	0.51	12	0.29	0.016	0.386	0.122	0.107	76	150	2.4	6.5	6.68
24/07/2023	1.1	20.6	0.36	0.012	0.197	0.1	0.094	18	82	6.7	6.39	6.69
21/08/2023	1.1	8	0.094	0.024	0.232	0.035	0.02	90	300		169	6.58
19/09/2023	2.5	11	0.088	0.025	0.11	0.033	0.023	64	1.6		3.2	7.15
16/10/2023	0.61	22.6	0.018	0.019	0.272	0.012	0.009	38	64	7.8	627	6.07
1/11/2023	0.53	8.8	0.12	0.39	0.735	0.139	0.124	630	460	4.2	190	5.59
13/12/2023	1.5	21.8	0.05	0.9	1.37	0.292	0.277	58	81	6		
19/12/2023	1.2	20.2	0.095	0.064	0.336	0.013	0.00894	490	720	9.5	554	6.82
29/12/2023	1.3	34.4	0.15	0.85	1.4	0.397	0.209	12000	6900	3.5		
2/01/2024	1.7	16	0.38	3.2	3.22	1.24	0.885	140	550	3.8	358	7.07
12/01/2024	3.2	8	0.14	5.6	6.08	1.72	1.38	730	1600	4.2	279	6.46
16/01/2024	2.4	23.6	0.061	1.4	1.6	0.497	0.299	5700	5000	2.2	122	7.03
26/01/2024	2.5	45.8	0.31	0.028	0.582	0.468	0.385	130	220	5.5	152	7.3
2/02/2024	2.2	97	0.36	0.014	0.857	0.402	0.427	90	270		448	7.61
10/02/2024	1.7	23	0.72	0.049	1.47	1.45	1.25	1800	1500		157	6.88
13/02/2024	1.6	86.2	0.021	0.051	0.527	0.136	0.099	610	400		155	6.77
8/03/2024	1.1	63.4	0.066	0.062	0.455	0.306	0.279	74	200			
2/04/2024	0.69	80.2	0.84	0.052	0.465	1.31	1.24	420	130	1.5	25.5	7.46
27/05/2024	1.3	12	0.16	0.038	0.393	0.226	0.179	2400	380	1.9	5.81	7.24
12/06/2024	1.7	14	0.17	0.073	0.303	0.03	0.012	25	250	4.3	4.45	6.74
10/07/2024	1.1	6	0.28	0.067	0.294	0.038	0.021	390	43	5.8	1877	6.97
7/08/2024	3	11	0.33	0.42	0.683	0.286	0.249	20	62	2.2	8.5	7.45
5/09/2024	0.69	15	0.34	0.057	0.209	0.016	0.007	44	52	5.1	4.2	7.32
10/10/2024	2	42	0.043	0.071	0.376	0.049	0.016	26	250	3.8	9.1	6.96
19/11/2024	2.6	97.8	0.083	0.095	0.673	0.074	0.014	590	1200	7.2	20.22	6.95
18/12/2024	0.78	37	0.17	0.041	0.274	0.132	0.083	800	530	5.1	23.8	6.59
7/01/2025	1.1	90	0.05	0.072	0.345	0.121	0.067	510	860	5.1	35.7	6.5
14/01/2025	1.1	12	0.94	0.041	0.725	0.812	0.691	120	330	2	42.2	7.4
23/01/2025	0.64	41.6	0.24	0.067	0.356	0.07	0.023	2500	2200	4.3	3.6	7.01
31/01/2025	2.5	22.8	0.98	0.083	0.665	0.778	0.63	380	1100	4.7	20.41	7.05
4/02/2025	4.7	20	0.0088	0.019	0.761	0.182	0.114	1300	2500	4.6	12.1	7.03
11/02/2025	1.7	34.6	1.2	<0.005	0.7	1.84	1.7	110	250	2.1	28.9	7.22
21/02/2025	4.4	80	0.56	0.09	1.37	1.7	0.932	310	140	13		



Daily Plant Flows - Effluent (February 2023 - January 2025)
Daily Discharge Volume (m3)
800
700
600
500
400
300
200
100
0
01-Feb-23
01-Mar-23
01-Apr-23
01-May-23
01-Jun-23
01-Jul-23
01-Aug-23
01-Sep-23
01-Oct-23
01-Nov-23
01-Dec-23
01-Jan-24
01-Feb-24
01-Mar-24
01-Apr-24
01-May-24
01-Jun-24
01-Jul-24
01-Aug-24
01-Sep-24
01-Oct-24
01-Nov-24
01-Dec-24
01-Jan-25

Appendix E Water quality guidelines

Appendix E Table 1: Water quality guideline values including the ANZG (2018) guidelines for a 95% species protection, WRC guideline levels for ecological health and human uses, and National Objectives Framework (NOF) attribute state values for ecosystem and human health.

Guidelines	Ammoniacal N (mg/L)	Nitrate Nitrogen (mg/L)	Soluble Reactive Phosphorous (mg/L)	TP (mg/L)	pH	Turbidity (NTU)	*E. coli* (median)
ANZG (2018) toxicant [1]	0.90 (pH 8)	-	-	-	-	-	-
ANZG (2018) stressor [2]	0.01	0.065	0.014	0.024	7.26-7.7	5.2	-
WRC- "Satisfactory" (Moke, 2023)	0.88 (pH 9)	-	-	0.04	6.5-9	5	126 E. *coli* /100 ml
WRC- "Excellent" (Moke, 2023)	0.1 (pH 9)	-	-	0.01	7-8	2	23 E. *coli* /100 ml
National Objectives Framework (MfE, 2020)	-	-	-	-	-	-	D: 130 *E. coli* / 100 ml E: 260 *E. coli* / 100 ml [3]

1. ANZG (2018) toxicant guidelines for a 95% species protection (freshwater)
2. ANZG (2018) guideline values for physical and chemical stressor (80th percentile) (freshwater).
3. NOF Band D >3% and E >7% average predicted infection risk for swimmers. Note these are not guideline values.

Appendix F Macroinvertebrate data 2024-2025

Site Name			Hahei US - A	Hahei US - B	Hahei US - C	Hahei US - D	Hahei DS - A	Hahei DS - B	Hahei DS - C	Hahei DS - D
Date sampled			31/01/2024	31/01/2024	31/01/2024	31/01/2024	30/01/2024	30/01/2024	30/01/2024	30/01/2024
Taxa	MCI	MCI-sb								
	score	score								
Caddisfly Hudsonema	6	6.5	2	3			1	5	4	4
Damselfly Xanthocnemis	5	1.2							1	
Bug Microvelia	5	4.6				1		1		
Beetle Hydrophilidae	5	8.0	1					1		
True Fly Chironomus	1	3.4		1			1	1		
True Fly Limonia	6	6.3							1	
True Fly Orthocladiinae	2	3.2			1					
True Fly Tanypodinae	5	6.5					1			
Collembola	6	5.3				1				
Crustacea Amphipoda	5	5.5	1	2			1		4	
Crustacea Isopoda	5	4.5	23	13	5	4	3	9	7	5
Crustacea Paracalliope	5	0.0					3	1	3	
Crustacea Paranthura	0	4.9							2	
Crustacea Paratya	5	3.6	81	133	190	211		11	1	3
Crustacea Talitridae	5	5.0								2
MITES (Acari)	5	5.2		2			1	1		1
SPIDERS Dolomedes	5	6.2	1	1		3	1	1	1	1
Mollusc Gyraulus	3	1.7	1							
Mollusc Zemelanopsis	3	1.9					1			
Mollusc Potamopyrgus	4	2.1	133	58	15	1	193	180	190	188
Mollusc Sphaeriidae	3	2.9						1	1	1
POLYCHAETA (Paddleworms)	0	6.7		2			1	2	1	1
Number of Taxa			8	9	4	6	11	12	12	9
EPT Value			1	1	0	0	1	1	1	1
Number of Individuals			243	215	211	221	207	214	216	206
% EPT			0.82	1.40	0.00	0.00	0.48	2.34	1.85	1.94
% EPT Taxa			12.50	11.11	0.00	0.00	9.09	8.33	8.33	11.11
Sum of recorded scores			38	36	16	30	44	49	49	38
Count of recorded scores			8	8	4	6	10	11	10	8
Sum of individuals with scores			243	213	211	221	206	212	213	205
SBMCI Value			95.25	97.11	67.00	87.67	97.00	97.64	91.64	94.89
QMCI-sb Value			2.92	3.36	3.51	3.66	2.26	2.51	2.42	2.35

Site Name			Hahei US - A	Hahei US - B	Hahei US - C	Hahei US - D	Hahei DS - A	Hahei DS - B	Hahei DS - C	Hahei DS - D
Date sampled			12/02/2025	12/02/2025	12/02/2025	12/02/2025	12/02/2025	12/02/2025	12/02/2025	12/02/2025
Taxa	MCI	MCI-sb								
	score	score								
True Fly Orthocladiinae	2	3.2				1				
Crustacea Amphipoda	5	5.5			1	2	3	11	4	13
Crustacea Corophium	5	5.5						1	1	1
Crustacea Isopoda	5	4.5	10	4	32	16	5	3	2	
Crustacea Mysid shrimps	0	6.4	7	4	24	3	3	2	1	
Crustacea Ostracoda	3	1.9								
Crustacea Paratya	5	3.6	2	2	67	4	1	2	1	
Crustacea Talitridae	5	5.0					1			
SPIDERS Dolomedes	5	6.2				1				
Mollusc Potamopyrgus	4	2.1	186	195	80	177	192	185	197	190
POLYCHAETA (Paddleworms)	0	6.7			1	2	1	1	1	1
Number of Taxa			4	4	6	8	7	7	7	4
EPT Value			0	0	0	0	0	0	0	0
Number of Individuals			205	205	205	206	206	205	207	205
% EPT			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% EPT Taxa			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of recorded scores			14	14	19	26	24	24	24	14
Count of recorded scores			3	3	4	6	5	5	5	3
Sum of individuals with scores			198	201	180	201	202	201	204	203
SBMCI Value			83.00	83.00	96.00	95.50	96.57	98.00	98.00	99.00
QMCI-sb Value			2.38	2.25	3.51	2.48	2.31	2.41	2.26	2.35

Appendix G Statistical output

2024-2025 Macroinvertebrate data

Shapiro-Wilk test for normality

data: MCI
W = 0.72429, p-value = 0.0003166 *Cannot be corrected through a standard transformation.*

data: QMCI
W = 0.75394, p-value = 0.0007089 *Cannot be corrected through a standard transformation.*

data: EPT taxa
W = 0.69431, p-value = 0.0001462 *Cannot be corrected through a standard transformation.*

data: Number of taxa
W = 0.91376, p-value = 0.1338 *Normal distribution.*

Bartlett Test of Homogeneity of Variances

data: MCI by Site
Bartlett's K-squared = 10.981, df = 1, p-value = 0.0009207 *Cannot be corrected through a standard transformation.*

data: QMCI by Site
Bartlett's K-squared = 16.102, df = 1, p-value = 6.003e-05 *Cannot be corrected through a standard transformation.*

data: EPT taxa
Bartlett's K-squared = 0.054209, df = 1, p-value = 0.8159 Equal variance.

data: Number of taxa
Bartlett's K-squared = 0.77423, df = 1, p-value = 0.3789 Equal variance.

Statistical Hypothesis Tests for Group Comparisons – Parametric and Non-Parametric

<table>
<tr>
<td>MCI
Exact Wilcoxon-Mann-Whitney Tests:

2024 data: MCI by Site (DS, US)
Z = 0.86603, p-value = 0.4857

2025 data: MCI by Site (DS, US)
Z = 2.3374, p-value = 0.02857

US data: MCI by Year (2024, 2025)
Z = 0, p-value = 1

DS data: MCI by Year (2024, 2025)
Z = -1.7425, p-value = 0.08571

No ANOVA as data is non-normal.</td>
<td>QMCI
Exact Wilcoxon-Mann-Whitney Tests:

2024 data: QMCI by Site (DS, US)
Z = -2.3094, p-value = 0.02857

2025 data: QMCI by Site (DS, US)
Z = -0.86603, p-value = 0.4857

US data: QMCI by Year (2024, 2025)
Z = 1.5972, p-value = 0.1429

DS data: QMCI by Year (2024, 2025)
Z = 0.87652, p-value = 0.4571

No ANOVA as data is non-normal.</td>
</tr>
<tr>
<td>EPT taxa
Exact Wilcoxon-Mann-Whitney Tests:

2024 data: EPT taxa by Site (DS, US)
Z = 0.14699, p-value = 0.8857

2025 data: EPT taxa by Site (DS, US)
NA

US data: EPT taxa by Year (2024, 2025)
Z = 1.5119, p-value = 0.4286

DS data: EPT taxa by Year (2024, 2025)
Z = 2.4773, p-value = 0.02857

No ANOVA as data is non-normal.
Comparison could not be computed for 2025 data as no EPT taxa were recorded.</td>
<td>Number of Taxa

Analysis of Variance Results:

<table>
<tr><td></td><td>Df</td><td>Sum Sq</td><td>Mean Sq</td><td>F value</td><td>Pr(>F)</td></tr>
<tr><td>Site</td><td>1</td><td>25.00</td><td>25.00</td><td>7.792</td><td>0.01630 *</td></tr>
<tr><td>Year</td><td>1</td><td>36.00</td><td>36.00</td><td>11.221</td><td>0.00578 **</td></tr>
<tr><td>Site:Year</td><td>1</td><td>12.25</td><td>12.25</td><td>3.818</td><td>0.07440 .</td></tr>
<tr><td>Residuals</td><td>12</td><td>38.50</td><td>3.21</td><td></td><td></td></tr>
</table>

Post-hoc Tukey Test Results:

Site
<table>
<tr><td></td><td>diff</td><td>lwr</td><td>upr</td><td>p adj</td></tr>
<tr><td>US-DS</td><td>-2.5</td><td>-4.45</td><td>-0.54</td><td>0.0163</td></tr>
</table>

$Year
<table>
<tr><td></td><td>diff</td><td>lwr</td><td>upr</td><td>p adj</td></tr>
<tr><td>2025-2024</td><td>-3</td><td>-4.95</td><td>-1.04</td><td>0.0057</td></tr>
</table>
</td>
</tr>
</table>

Site:Year

	diff	lwr	upr	p adj
US:2024-DS:2024	-4.25	-8.010283	-0.4897175	0.0254981
DS:2025-DS:2024	-4.75	-8.510283	-0.9897175	0.0127672
US:2025-DS:2024	-5.50	-9.260283	-1.7397175	0.0045772
DS:2025-US:2024	-0.50	-4.260283	3.2602825	0.9781843
US:2025-US:2024	-1.25	-5.010283	2.5102825	0.7594352
US:2025-DS:2025	-0.75	-4.510283	3.0102825	0.9325323

2010-2025 Macroinvertebrate data

Shapiro-Wilk test for normality

data: MCI
W = 0.98112, p-value = 0.1365 — *Normal distribution.*
data: QMCI
W = 0.9635, p-value = 0.005179 — *Inverse transformation applied, closer to normal distribution.*
data: EPT taxa
W = 0.70217, p-value = 2.326e-13 — *Cannot be corrected through a standard transformation.*
data: Number of taxa
W = 0.97345, p-value = 0.03178 — *Cannot be corrected through a standard transformation.*

Bartlett Test of Homogeneity of Variances

data: MCI by Site
Bartlett's K-squared = 0.85266, df = 1, p-value = 0.3558 — *Equal variance.*
data: QMCI by Site
Bartlett's K-squared = 0.20555, df = 1, p-value = 0.6503 — *Using inverse transformed variable.*
data: EPT taxa
Bartlett's K-squared = 4.4151, df = 1, p-value = 0.03562 — *Cannot be corrected through a standard transformation.*
data: Number of taxa
Bartlett's K-squared = 0.91424, df = 1, p-value = 0.339 — *Equal variance.*

Statistical Hypothesis Tests for Group Comparisons – Parametric and Non-Parametric

MCI

Analysis of Variance Results:

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Site	1	212	212.24	3.600	0.0617
Year	15	3531	235.38	3.992	3.09e-05 ***
Site:Year	15	1246	83.04	1.408	0.1661
Residuals	74	4363	58.96		

Post-hoc Tukey Test Results:

Site

	diff	lwr	upr	p adj
US-DS	-2.83	-5.8021	0.1420	0.0617

Year – significant comparisons

	diff	lwr	upr	p adj
2015-01-01-2011-01-01	-13.911	-26.340	-1.481	0.014
2020-01-01-2015-01-01	18.366	4.750	31.982	0.001
2021-01-01-2015-01-01	14.563	0.947	28.178	0.024
2024-01-01-2015-01-01	17.038	3.422	30.653	0.003
2025-01-01-2015-01-01	19.646	6.030	33.262	0.000
2023-01-01-2020-01-01	-14.014	-27.630	-0.398	0.037
2025-01-01-2022-01-01	13.831	0.215	27.447	0.043
2025-01-01-2023-01-01	15.294	1.678	28.910	0.014

QMCI

Exact Wilcoxon-Mann-Whitney Tests:

All data: QMCI by Site (DS, US)
Z = -1.9305, p-value = 0.05349

Kruskal-Wallis Rank Sum Test Results:

US data: QMCI by Year
Kruskal-Wallis chi-squared = 31.638, df = 15, p-value = 0.00721

DS data: QMCI by Year
Kruskal-Wallis chi-squared = 36.78, df = 15, p-value = 0.001363

Dunn's Post-hoc (US, Year) – significant comparisons:

Comparisons	Z	P. adjusted
2010-01-01 - 2020-01-01	-1.813382637	0.034886413
2011-01-01 - 2013-01-01	-1.791191486	0.036631286
2011-01-01 - 2020-01-01	-2.667002358	0.003826557
2012-01-01 - 2022-01-01	2.083553904	0.018600382
2012-01-01 - 2023-01-01	1.797351445	0.036139922
2012-01-01 - 2025-01-01	2.209482986	0.013570532
2013-01-01 - 2017-01-01	1.910426606	0.028039154
2013-01-01 - 2019-01-01	2.224665297	0.013051858
2013-01-01 - 2022-01-01	2.626600624	0.004312124
2013-01-01 - 2023-01-01	2.392917294	0.008357504
2013-01-01 - 2024-01-01	1.766645971	0.038643768
2013-01-01 - 2025-01-01	2.729421289	0.00317228
2014-01-01 - 2022-01-01	1.897508636	0.02888042
2014-01-01 - 2023-01-01	1.663825306	0.048073673

Comparisons	Z	P. adjusted
2014-01-01 - 2025-01-01	2.000329301	0.022732359
2015-01-01 - 2022-01-01	1.946176723	0.025816757
2015-01-01 - 2023-01-01	1.659974264	0.048459815
2015-01-01 - 2025-01-01	2.072105806	0.019127788
2016-01-01 - 2022-01-01	2.009676634	0.022232712
2016-01-01 - 2023-01-01	1.775993304	0.03786701
2016-01-01 - 2025-01-01	2.112497299	0.017321909
2017-01-01 - 2020-01-01	-2.505085292	0.006121093
2019-01-01 - 2020-01-01	-3.090986561	0.000997463
2019-01-01 - 2021-01-01	-1.659974264	0.048459815
2020-01-01 - 2022-01-01	3.583254791	0.00016967
2020-01-01 - 2023-01-01	3.297052332	0.000488526
2020-01-01 - 2024-01-01	2.530029741	0.005702643
2020-01-01 - 2025-01-01	3.709183873	0.000103964
2021-01-01 - 2022-01-01	2.152242494	0.01568913
2021-01-01 - 2023-01-01	1.866040035	0.031017882
2021-01-01 - 2025-01-01	2.278171576	0.011358179

Dunn's Post-hoc (DS, Year) – significant comparisons:

Comparisons	Z	P. adjusted
2010-01-01 - 2011-01-01	1.738420142	0.041068405
2010-01-01 - 2019-01-01	1.850883931	0.032093127
2010-01-01 - 2022-01-01	2.355670457	0.009244656
2010-01-01 - 2023-01-01	1.850883931	0.032093127
2010-01-01 - 2024-01-01	2.636107416	0.004193159
2010-01-01 - 2025-01-01	2.823065389	0.002378343
2011-01-01 - 2020-01-01	-2.85110602	0.002178372
2012-01-01 - 2020-01-01	-1.99208962	0.023180613
2012-01-01 - 2024-01-01	1.831806547	0.033490124
2012-01-01 - 2025-01-01	2.060782365	0.019661904
2013-01-01 - 2024-01-01	1.663925958	0.048063613
2013-01-01 - 2025-01-01	1.850883931	0.032093127
2014-01-01 - 2022-01-01	1.963058714	0.024819676
2014-01-01 - 2024-01-01	2.243495674	0.012432434
2014-01-01 - 2025-01-01	2.430453646	0.007539967
2015-01-01 - 2022-01-01	2.186719065	0.014381519
2015-01-01 - 2024-01-01	2.530182793	0.005700156
2015-01-01 - 2025-01-01	2.759158611	0.00289752
2016-01-01 - 2022-01-01	2.112625093	0.017316435
2016-01-01 - 2024-01-01	2.393062052	0.008354208
2016-01-01 - 2025-01-01	2.580020025	0.004939729
2017-01-01 - 2020-01-01	-2.168712484	0.015052259
2018-01-01 - 2022-01-01	1.940548108	0.026156557
2018-01-01 - 2024-01-01	2.157773643	0.015472718
2018-01-01 - 2025-01-01	2.302590666	0.010650942
2019-01-01 - 2020-01-01	-2.862197729	0.002103572
2020-01-01 - 2021-01-01	1.854704129	0.031819244
2020-01-01 - 2022-01-01	3.480432439	0.000250303
2020-01-01 - 2023-01-01	2.862197729	0.002103572
2021-01-01 - 2024-01-01	1.969192038	0.024465521
2021-01-01 - 2025-01-01	2.198167856	0.013968573

EPT taxa

Exact Wilcoxon-Mann-Whitney Tests:

All data: EPT taxa by Site (DS, US)
Z = 0.35954, p-value = 0.7214

Kruskal-Wallis Rank Sum Test Results:

US data: EPT taxa by Year
Kruskal-Wallis chi-squared = 31.274, df = 15, p-value = 0.008071

DS data: EPT taxa by Year
Kruskal-Wallis chi-squared = 39.611, df = 15, p-value = 0.000519

Dunn's Post-hoc (US, Year) – significant comparisons:

Comparisons	Z	P. adjusted
2011-01-01 - 2013-01-01	2.066960801	0.019368924
2011-01-01 - 2017-01-01	2.066960801	0.019368924
2011-01-01 - 2019-01-01	2.614521586	0.004467626
2011-01-01 - 2020-01-01	2.614521586	0.004467626
2011-01-01 - 2021-01-01	2.614521586	0.004467626
2011-01-01 - 2022-01-01	1.695782358	0.044963552
2011-01-01 - 2025-01-01	2.614521586	0.004467626
2012-01-01 - 2013-01-01	1.737521257	0.041147603
2012-01-01 - 2017-01-01	1.737521257	0.041147603

Number of Taxa

Exact Wilcoxon-Mann-Whitney Tests:

data: Num taxa by Site (DS, US)
Z = 0.83494, p-value = 0.4062

Kruskal-Wallis Rank Sum Test Results:

US data: Num taxa by Year
Kruskal-Wallis chi-squared = 29.996, df = 15, p-value = 0.01193

DS data: EPT taxa by Year
Kruskal-Wallis chi-squared = 28.605, df = 15, p-value = 0.01807

Dunn's Post-hoc (US, Year) – significant comparisons:

Comparisons	Z	P. adjusted
2010-01-01 - 2020-01-01	1.651905904	0.049276867
2011-01-01 - 2020-01-01	2.417742912	0.007808553
2011-01-01 - 2021-01-01	2.153302281	0.015647465
2011-01-01 - 2025-01-01	2.178487103	0.014684896
2012-01-01 - 2020-01-01	2.678392302	0.003698826
2012-01-01 - 2021-01-01	2.436992137	0.007405001
2012-01-01 - 2022-01-01	1.781763119	0.037393934
2012-01-01 - 2024-01-01	1.885220333	0.029700048
2012-01-01 - 2025-01-01	2.459982629	0.006947187

2012-01-01 - 2019-01-01	2.128020249	0.016667702
2012-01-01 - 2020-01-01	2.128020249	0.016667702
2012-01-01 - 2021-01-01	2.128020249	0.016667702
2012-01-01 - 2025-01-01	2.128020249	0.016667702
2013-01-01 - 2023-01-01	-2.688047592	0.003593558
2015-01-01 - 2023-01-01	-1.689898433	0.045523694
2017-01-01 - 2023-01-01	-2.688047592	0.003593558
2019-01-01 - 2023-01-01	-3.292172503	0.000497083
2020-01-01 - 2023-01-01	-3.292172503	0.000497083
2021-01-01 - 2023-01-01	-3.292172503	0.000497083
2022-01-01 - 2023-01-01	-2.453482169	0.007074028
2023-01-01 - 2024-01-01	1.702416199	0.044338688
2023-01-01 - 2025-01-01	3.292172503	0.000497083

Dunn's Post-hoc (DS, Year) – significant comparisons:

Comparisons	Z	P. adjusted
2011-01-01 - 2013-01-01	1.844659084	0.032543573
2011-01-01 - 2016-01-01	1.844659084	0.032543573
2011-01-01 - 2020-01-01	2.333329685	0.009815424
2011-01-01 - 2021-01-01	2.333329685	0.009815424
2011-01-01 - 2022-01-01	2.333329685	0.009815424
2011-01-01 - 2025-01-01	2.333329685	0.009815424
2012-01-01 - 2020-01-01	1.83957036	0.03291567
2012-01-01 - 2021-01-01	1.83957036	0.03291567
2012-01-01 - 2022-01-01	1.83957036	0.03291567
2012-01-01 - 2025-01-01	1.83957036	0.03291567
2013-01-01 - 2014-01-01	-2.053851593	0.019995029
2013-01-01 - 2017-01-01	-1.865581864	0.031049944
2013-01-01 - 2023-01-01	-2.697676278	0.003491265
2013-01-01 - 2024-01-01	-2.539570708	0.00554943
2014-01-01 - 2016-01-01	2.053851593	0.019995029
2014-01-01 - 2019-01-01	1.65022688	0.04944827
2014-01-01 - 2020-01-01	2.371583541	0.008856021
2014-01-01 - 2021-01-01	2.371583541	0.008856021
2014-01-01 - 2022-01-01	2.371583541	0.008856021
2014-01-01 - 2025-01-01	2.371583541	0.008856021
2015-01-01 - 2023-01-01	-1.80326305	0.035673456
2016-01-01 - 2017-01-01	-1.865581864	0.031049944
2016-01-01 - 2023-01-01	-2.697676278	0.003491265
2016-01-01 - 2024-01-01	-2.539570708	0.00554943
2017-01-01 - 2020-01-01	2.154188383	0.015612701
2017-01-01 - 2021-01-01	2.154188383	0.015612701
2017-01-01 - 2022-01-01	2.154188383	0.015612701
2017-01-01 - 2025-01-01	2.154188383	0.015612701
2019-01-01 - 2023-01-01	-2.420487315	0.00774986
2019-01-01 - 2024-01-01	-2.22684833	0.012978706
2020-01-01 - 2023-01-01	-3.303965186	0.000476638
2020-01-01 - 2024-01-01	-3.1103262	0.000934404
2021-01-01 - 2023-01-01	-3.303965186	0.000476638
2021-01-01 - 2024-01-01	-3.1103262	0.000934404
2022-01-01 - 2023-01-01	-3.303965186	0.000476638
2022-01-01 - 2024-01-01	-3.1103262	0.000934404
2023-01-01 - 2025-01-01	3.303965186	0.000476638
2024-01-01 - 2025-01-01	3.1103262	0.000934404
2013-01-01 - 2017-01-01	-1.86952426	0.030774956
2014-01-01 - 2020-01-01	1.895937458	0.028984158
2014-01-01 - 2021-01-01	1.698835049	0.044675134
2014-01-01 - 2025-01-01	1.717606707	0.042934188
2015-01-01 - 2020-01-01	2.494468367	0.006307298
2015-01-01 - 2021-01-01	2.253068202	0.012127425
2015-01-01 - 2024-01-01	1.701296398	0.044443672
2015-01-01 - 2025-01-01	2.276058694	0.011421248
2016-01-01 - 2020-01-01	2.402772224	0.008135659
2016-01-01 - 2021-01-01	2.205669815	0.013703563
2016-01-01 - 2022-01-01	1.670677562	0.047392692
2016-01-01 - 2024-01-01	1.755150023	0.039616825
2016-01-01 - 2025-01-01	2.224441473	0.013059378
2017-01-01 - 2020-01-01	3.022236938	0.00125457
2017-01-01 - 2021-01-01	2.825134529	0.002363038
2017-01-01 - 2022-01-01	2.290142276	0.011006535
2017-01-01 - 2024-01-01	2.374614737	0.008783638
2017-01-01 - 2025-01-01	2.843906187	0.002228208
2018-01-01 - 2020-01-01	1.977503072	0.023992397
2018-01-01 - 2021-01-01	1.824828202	0.034013479
2018-01-01 - 2025-01-01	1.839368666	0.03293049
2019-01-01 - 2020-01-01	2.115125251	0.017209637
2019-01-01 - 2021-01-01	1.873725087	0.030484163
2019-01-01 - 2025-01-01	1.896715579	0.028932743
2020-01-01 - 2023-01-01	-2.379515908	0.008667697
2021-01-01 - 2023-01-01	-2.138115743	0.016253675
2023-01-01 - 2025-01-01	2.161106235	0.015343567

Dunn's Post-hoc (DS, Year) – significant comparisons:

Comparisons	Z	P. adjusted
2011-01-01 - 2020-01-01	2.837123444	0.0022761
2011-01-01 - 2022-01-01	1.877384356	0.030232717
2011-01-01 - 2025-01-01	2.319369462	0.010187506
2012-01-01 - 2013-01-01	1.938967628	0.02625264
2012-01-01 - 2019-01-01	1.706124357	0.043992464
2012-01-01 - 2020-01-01	3.273914306	0.000530344
2012-01-01 - 2021-01-01	1.752235826	0.039866633
2012-01-01 - 2022-01-01	2.397796393	0.008247015
2012-01-01 - 2025-01-01	2.801271748	0.002545082
2013-01-01 - 2014-01-01	-1.662892357	0.048166992
2013-01-01 - 2017-01-01	-1.956343949	0.025212325
2013-01-01 - 2018-01-01	-1.650593084	0.049410846
2014-01-01 - 2020-01-01	2.654314909	0.003973481
2014-01-01 - 2022-01-01	1.938967628	0.02625264
2014-01-01 - 2025-01-01	2.268403876	0.011652301
2015-01-01 - 2020-01-01	2.02890464	0.021234002
2016-01-01 - 2017-01-01	-1.69549809	0.044990486
2017-01-01 - 2019-01-01	1.713068487	0.04334997
2017-01-01 - 2020-01-01	2.993163621	0.001380508
2017-01-01 - 2021-01-01	1.750718344	0.039997219
2017-01-01 - 2022-01-01	2.27781634	0.011368761
2017-01-01 - 2025-01-01	2.607252588	0.0045636
2018-01-01 - 2020-01-01	2.376821478	0.008731269
2018-01-01 - 2022-01-01	1.822715858	0.034173219
2018-01-01 - 2025-01-01	2.077896078	0.018859466
2020-01-01 - 2023-01-01	-1.948209569	0.025694946
2020-01-01 - 2024-01-01	-2.743632411	0.003038177
2022-01-01 - 2024-01-01	-1.867514499	0.030914887
2024-01-01 - 2025-01-01	2.270989853	0.011573796