Far North District Council

Whatuwhiwhi Wastewater Treatment Plant Water Quality Assessment

12 May 2025

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REV	DATE	DETAILS
1	2/05/2025	Whatuwhiwhi Wastewater Treatment Plant Water Quality Assessment

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ABBREVIATIONS

BOD	Biological Oxygen Demand
BPO	Best Practicable Option
DAF	Dissolved Air Floatation
DIN	Dissolved Inorganic Nitrogen
DO	Dissolved Oxygen
DRP	Dissolved Reactive Phosphorus
FNDC	Far North District Council
IDEAL	Intermittently Decanted Extended Aeration Lagoon
MCA	Multi Criteria Analysis
NPSFM	National Policy Statement for Freshwater Management
NRC	Northland Regional Council
ONL	Outstanding Natural Landscape
PRPN	Proposed Regional Plan for Northland
RPN	Regional Water and Soil Plan for Northland
SBR	Sequencing Batch Reactor
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UV	Ultra Violet
VSS	Volatile Suspended Solids
W-WWTP	Whatuwhiwhi Waste Water Treatment Plant

1 PROJECT BACKGROUND

1.1 BACKGROUND

The Far North District Council (FNDC) holds resource consents AUT.007203.02.02 and AUT.007203.03.02 from Northland Regional Council (NRC) for discharges to land and air associated with the operation of the Whatuwhiwhi Wastewater Treatment Plant (W-WWTP). These consents were issued on 8 July 2011 and will expire on 30 November 2025. FNDC is seeking replacement consents to enable the lawful operation of the Whatuwhiwhi wastewater scheme.

The W-WWTP is located off Inland Road on the Karikari Peninsula, on the east coast of the Far North District approximately 1.5km to the west of the coastal settlement of Whatuwhiwhi (Figure 3-1-1). It receives wastewater from urban settlements in Tokerau Beach and Whatuwhiwhi.

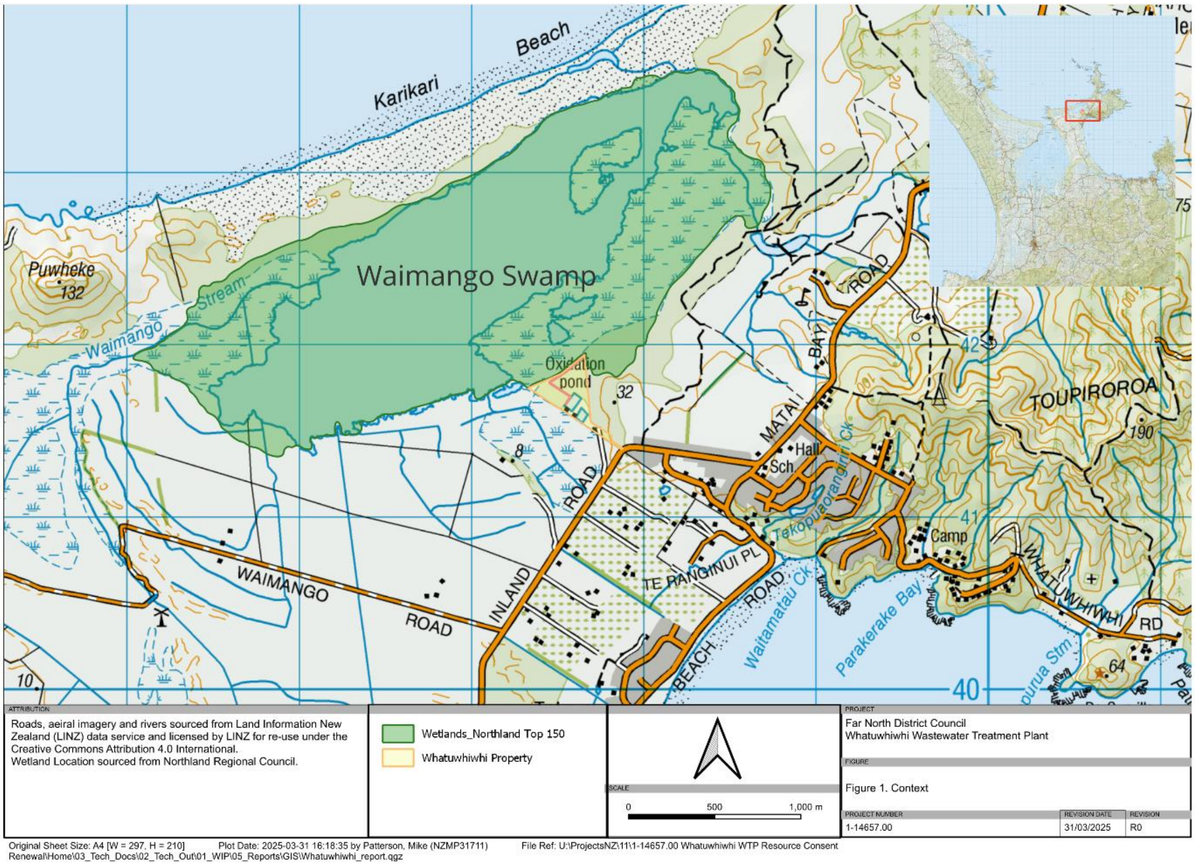

Figure 3-1-1: WWTP General location on the Karikari Peninsula.

Sewage enters the W-WWTP via an influent screen, then through two oxidation ponds with a designed residence time of 20 to 40 days. Both ponds include AquaMats, which are suspended mats that provide an increased growth area for bacteria which play a significant role in the breakdown of biological oxygen demand (BOD) and ammonia. Mechanical aeration provides oxygen to the process and creates water columns, encouraging mixing of the pond effluent. Finally, wastewater is directed through a UV filter for microbial treatment, before being discharged from the treatment plant.

1.2 THE RECEIVING ENVIRONMENT

The W-WWTP sits adjacent to the Waimango Swamp, which is listed as a top 150 Wetland by NRC. This wetland is described as *"a freshwater wetland ponded between coastal foredune belt and consolidated foredunes, and is a good example of a formerly widespread coastal wetland complex which is habitat for many threatened plants and animals"* in Wildlands (2011). They additionally note the site supports seven threatened species, seven "At Risk" species, and one regionally significant species.

It is understood that discharged wastewater flows broadly from the northwest side of pond two where it is discharged, along a shallow channel in a southeast to northwest direction towards the Waimango Swamp. It is understood that the drain is lost into the Waimango Swamp, ultimately joining a number of shallow pools and being overtaken by vegetation at, or just past the property boundary as displayed in Figure 1-2.

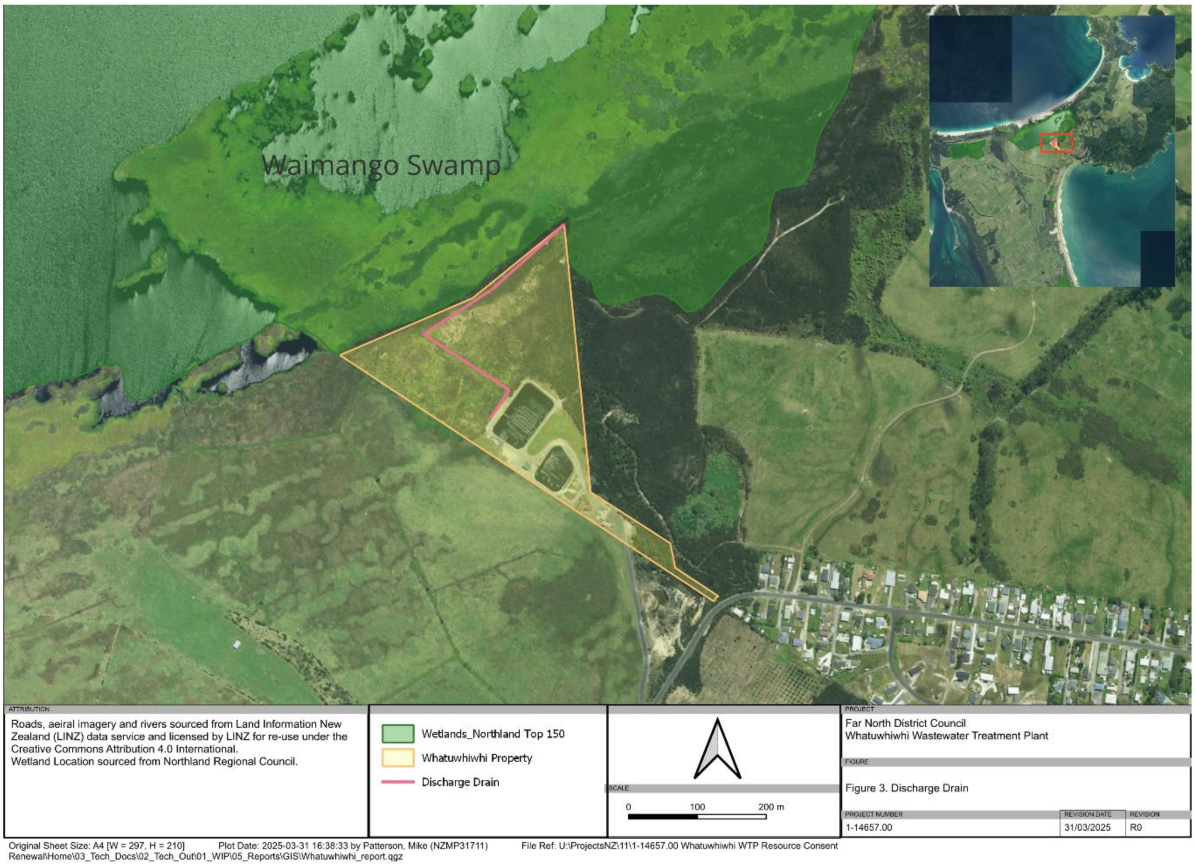

Figure 1-2: Discharge drain showing direction of flow from the W-WWTP to the Waimango Swamp.

1.3 THE PROPOSAL

At time of writing, the Best Practicable Option (BPO)[1] process is being undertaken. The BPO assess a range of treatment options based on relevant water quality information, discharge standards, community requirements and the local context. In the BPO, the basis of design states that "future flows and loads to the plant were considered based on population growth as well as the holiday seasonal fluctuations. The basis of design was used to assess the current treatment plants capacity for treating the future flows and loads and is the baseline against the best practicable options will be assessed".

Several assumptions[1] were made to inform the BPO process, and these include:

- The site location remains the same;
- The discharge location remains the same;
- Phosphorus removal is not required, but can be added if necessary.

Based on these assumptions, six options were identified for the site, and a multi criteria analysis (MCA) was undertaken to identify the three most appropriate options[2]. These three include:

- Refurbishment to the existing plant with an upgrade to include Dissolved Air Floatation (DAF) for solids removal;
- Packaged sequencing batch reactor (SBR);
- Intermittently decanted extended aeration lagoon (IDEAL).

This BPO process additionally provided some estimated effluent qualities, which are reproduced in Table 1-1. If it were deemed necessary, the addition of phosphorus removal could be added which would result in a significant additional reduction in TP.

Table 1-1: Expected effluent quality of several options considered during the BPO, reduced to the top three options only (from Whatuwhiwhi WWTP Longlist Options, P. Shoebridge 1 January 2025).

Expected effluent quality						
	BOD5	NH3-N	TN	TSS	TP	Faecal Coliform
Current median consent limit	30	30	NA	30	NA	500
Existing plant upgrade	25	20	35	10	16	<100
Sequencing Batch reactor (SBR)	10	3	10	5	14	<100
Intermittent Decanting Extended Aeration Lagoon (IDEAL)	20	5	20	5	14	<100

1.4 SCOPE OF WORKS

This report addresses available surface water, water quality information to ascertain the potential effect of the W-WWTP on the receiving environment. It considers issues of toxicity, eutrophication, and effects on public health via contact recreation. It was not informed by a comprehensive or targeted monitoring programme, and as such draws from available information to infer likely effects.

1.5 DATA AVAILABLE

There are several data sources available for use. These include:

- Discharge monitoring undertaken approximately monthly by the FNDC from December 2009, until November 2024;

[1] Detailed in the memorandum from P. Shoebridge 13 January 2025. “Whatuwhiwhi WWTP Long list Options”.

[2] More detail provided in the memorandum from P. Shoebridge 12 March 2025. “Whatuwhiwhi WWTP Longlist MCA Memo”.

- Wastewater sampling results provided by NRC for limited parameters from July 2023 until November 2024;
- Receiving environment monitoring for limited water quality parameters at various intervals from 2009 until November 2024 by NRC at the Natural Wetland Outlet Boundary;
- Receiving environment water quality samples taken during November 2024, and January 2025;
  - two rounds of sampling undertaken at point of discharge;
  - two rounds of sampling at the first safely accessible location from the point of discharge. This is at approximately 270m from the discharge location as the drain flows, or approximately 180m in a straight line[3];
  - two rounds of sampling undertaken at the point it leaves the property and enters the Waimango Swamp;
- Water quality data for the nearby Waiporohita Lake available on the LAWA website[4], which is monitored by NRC. This site is utilised to indicate surrounding landscape nutrient contributions to provide context only.
- Findings from previous vegetation surveys:
  - Wildland Consultants, 2016;
  - Wildland Consultants, 2019.

1.5.1 WASTEWATER SAMPLING

Results are available from FNDC monitoring at the W-WWTP discharge post UV treatment, undertaken approximately monthly from December 2009 until November 2024. Results were also available approximately quarterly from the NRC at the same monitoring point and over similar time frames.

Over this period there have been significant changes undertaken in the treatment process, therefore the last five years of results (from approximately November 2019 until November 2024) have been utilised for this assessment. An assessment of the available FNDC and NRC data was briefly undertaken, and summary statistics of this data appears broadly similar, so the datasets were combined.

Both sets of data were for limited parameters only (in line with the requirements of the existing consent) including:

- Temperature;
- Dissolved Oxygen (DO);
- pH
- Faecal coliforms;
- Biological Oxygen Demand (BOD);
- Total ammoniacal nitrogen; and
- Total Suspended Solids (TSS).

The complete data set used is linked in Appendix A, and a summary of the data is in Table 2-1.

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[3] A location representing reasonable mixing was unable to be accurately accessed.

[4] As at September 2024: https://www.lawa.org.nz/explore-data/northland-region/lakes/lake-waiporohita

1.5.2 RECEIVING ENVIRONMENT SAMPLING

Two rounds of monitoring were undertaken in the receiving environment on the 19th of November 2024, and the 29th of January 2025. On each occasion samples were taken for a range of parameters at three sites, as identified in Figure 1-3. Results are replicated in Appendix B. Samples taken on the 19th of November 2024 did not reach the processing laboratory (Hills Laboratory) within 36 hours and below 10 degrees Celsius, so results from that date, in particular *E. coli* results are to be treated with care.

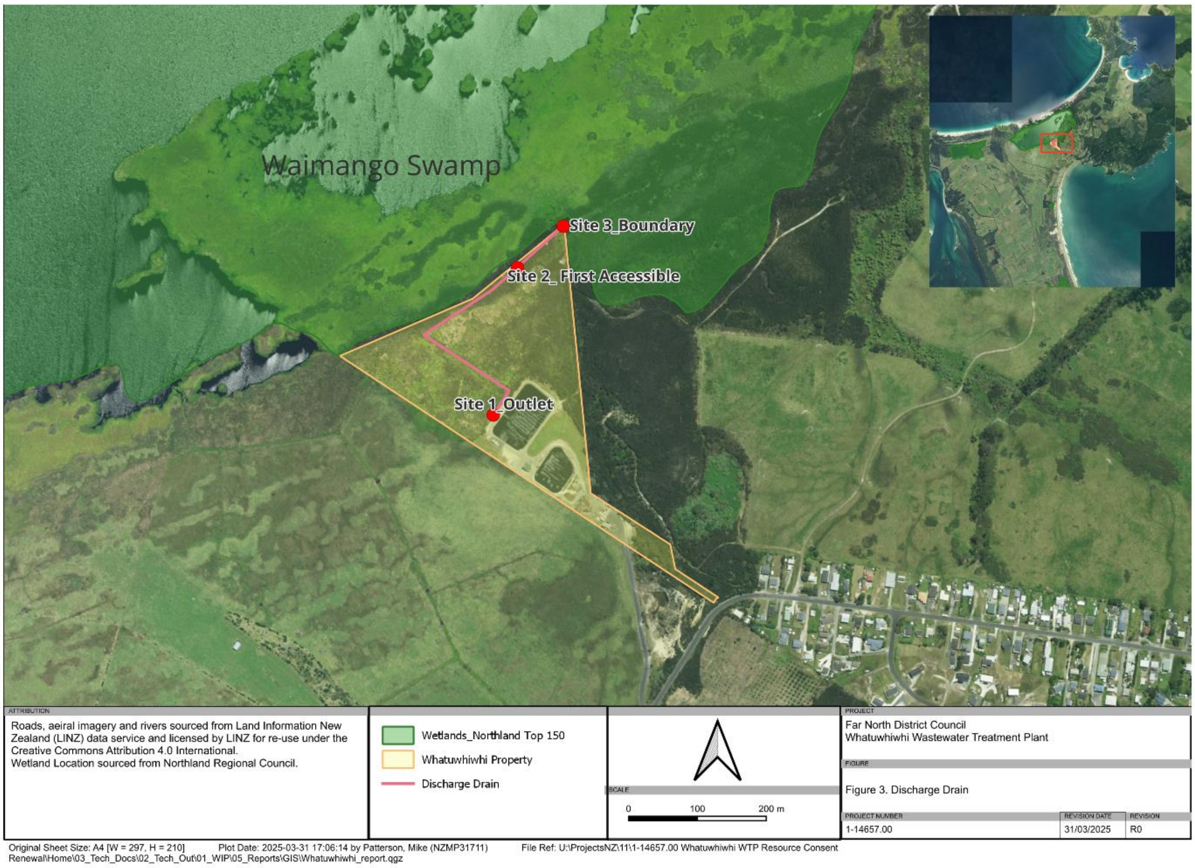

Figure 1-3: sample locations for receiving environment sampling.

Field staff identified that due to deep water, and heavily overgrown vegetation, it was not possible to access the discharge drain at a location closer to the discharge. The Northland Regional Water and Soil Plan does not stipulate a distance for reasonable mixing, though outlines a number of factors Council will take into account including:

(a) The characteristics of the discharge and the sensitivity of the receiving water;

(b) The assimilative capacity of the receiving water body;

(c) The proximity and effects of other discharges;

(d) The proximity of, and likely effects on, downstream uses;

(e) The desirability of keeping the mixing zone as small as practicable;

(f) The availability and cost-effectiveness of current treatment technology.

The Proposed Northland Plan in Section B “definitions” outlines reasonable mixing for a flowing surface water body as:

a distance equal to seven times the bed width of the surface water body, but which must not be less than 50 metres from the point of discharge, or

2) in relation to a lake, wetland or coastal water, a distance 20 metres from the point of discharge.

It is understood that water in the discharge drain is flowing albeit slowly at most times, so it is likely 50 m is the appropriate monitoring location to represent reasonable mixing in this instance.

Additionally, NRC have periodically undertaken water quality sampling in the receiving environment during the life of the consent. This is intermittent and for limited parameters but can be relied upon in some instances. This is undertaken at the Natural Wetland Boundary, understood to broadly align with Site 3 on Figure 1-3. These results are displayed in Appendix A.

1.5.3 VEGETATION SURVEYS

As a condition of the existing discharge permit there may be no more than a minor increase in the extent of eutrophication wetland vegetation adjacent to the W-WWTP property and discharge drains (condition 9). Since the granting of the consent, vegetation surveys have been conducted by Wildlands in 2013, 2016 and 2019. It is understood that survey locations and methodologies changed between 2013 and 2016 (Wildlands, 2016), with a new baseline monitoring approach being established to allow "accurate year to year analysis of wetland vegetation change". This included the establishment of vegetation plots being established in both control and impact sites, and nutrient concentrations within plant tissue samples being calculated. These results are discussed in detail in Wildlands 2016 and Wildland 2019 and are addressed further in section 2.6.

1.6 ASSESSMENT APPROACH

It is anticipated that a discharge of wastewater to water can have several key consequences. These would include directly toxic effects, such as nitrate or ammoniacal nitrogen toxicity resulting in chronic or acute toxicity effects; eutrophication effects where excess nutrients result in changes to primary productivity within the receiving environment, with subsequent effects occurring in along the trophic cascade; and effects to values such as the ability to safely interact with the water for contact recreation or food harvesting purposes. Additionally, it is possible that heavy metals from the discharge could have detrimental effects on the aquatic life of the receiving environment.

1.6.1 TOXICITY EFFECTS - NITROGEN

Wastewater treatment plants can be directly toxic to aquatic life in some instances, with high concentrations of ammoniacal nitrogen and nitrate both being capable of having significant adverse effects, both acutely and chronically toxic to aquatic organisms. The National Policy Statement for Freshwater Management (NPSFM) 2020 includes toxicity thresholds for both nitrate nitrogen and ammoniacal nitrogen which can be used to indicate likelihood of acutely toxic or chronically toxic effects on aquatic life.

The Regional Water and Soil Plan for Northland 2014 (RPN) includes toxicity standards for ammonium toxicity under 7.6.7.e. These are based on older science than that outlined in the NPSFM[5]. The Proposed Regional Plan for Northland (PRPN) (February 2024) does not set an ammoniacal nitrogen target for wetlands but uses

[5] The RPN was updated to reflect the 2011 version of the NPSFM in 2014. Ammoniacal nitrogen toxicity was not added to the NPSFM in the 2011 version, so standards in the RPN were based on science predating this. Ammoniacal nitrogen was added to the NPSFM in the 2014 version and was again amended in 2017.

those identified in the NPSFM for rivers and lakes, and specifically at the A band[6] attribute state for lakes[7]. Neither plan assigns nitrate toxicity values for wetlands or lakes, though the NPSFM (2020) aligned thresholds are applied for continually or intermittently flowing rivers.

In this assessment both ammonia toxicity and nitrate toxicity as outlined in the NPSFM (2020) are referred to and are referenced in Appendix C for ease of use.

1.6.2 EUTROPHICATION EFFECTS

Monitoring of wetlands for impacts of nutrients is not as well researched in New Zealand or internationally as for other receiving environments such as rivers, streams and lakes.

Guidance produced by Ministry for the Environment (2023) note a relative lack of information for wetlands relating to nutrient enrichment. They identify that “Hydrological disturbance is the primary cause of loss of natural character in wetlands… wetlands are also sensitive to the amount of nutrients they receive”. Burge et al, (2020) indicate that nutrient enrichment results in reduced heterogeneity of vegetation, with those species best able to utilise nutrients rapidly coming to dominate the community composition.

The extensive review of nutrient effects of treated municipal wastewater into natural non-constructed wetlands by Sloey et al. (2020) address the many and varied drivers of change that can influence these wetlands beyond eutrophication, and the confounding and conflicting results that are measured in different studies. They note that “studies from a variety of systems throughout the United States provide conflicting evidence of the responses of wetland ecosystems to increased inundation and nutrient enrichment”.

For these reasons, assigning an environmental effect via eutrophication to a wetland can be difficult. Vegetation surveys have been relied upon to indicate effect in the current iteration of this discharge permit, with conditions of consent defining monitoring. These results are used in this assessment to inform eutrophication effect on the receiving environment. Additionally, comparison with nearby monitoring sites (which may represent likely concentrations as a result of landscape contributions) are utilised to provide context to available data.

The NRP provides some generic dissolved reactive phosphorus (DRP) and dissolved inorganic nitrogen (DIN) targets that apply in 7.6.7 f such that:

“Until such time as a water body is classified and associated water quality standards set in place, the Council will use the following guidelines for the management of waters for aquatic ecosystem purposes:

After reasonable mixing the contaminant either by itself or in combination with other contaminants, is not likely to;

…..

(f) Cause the level of nutrients to fall outside the range of:

Dissolved Reactive Phosphorus 50 – 30 mg/m³

Dissolved Inorganic Nitrogen (NO3-N+NH4-N) 40 – 100 mg/m³”

The PNRP does not provide specific eutrophication targets for wetlands but does provide water quality standards for lakes including shallow lakes after reasonable mixing. These can be used to provide some context to the nutrient concentrations measured from the W-WWTP. These include:

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[6] Note the NPSFM broadly represents attributes with a series of bands, usual A to D or A to E, with A representing best quality. They also sometimes apply a national bottom line, that all sites should achieve (with some limited caveats).

[7] Though note with some minor amendments as the NPSFM outlines an annual median and a 95th percentile while the PRPN outlines an annual median and annual maximum concentration.

- Total nitrogen annual median ≤ 800 mg/m^3 (equivalent to 0.8 mg/L);
- Total phosphorus annual median of ≤ 20 mg/m^3 (equivalent to 0.02 mg/L).

Where relevant, these concentrations are used to provide context.

1.6.3 CONTACT RECREATION

The safe interaction with the waterway, either for contact recreation purposes, or for the purpose of gathering food is generally not recommended downstream of any municipal discharge (MfE, 2003). This is due to the high risk of pathogen loading that can eventuate, even with effective ultraviolet or other means of microbial sterilisation. Additionally, given site accessibility issues, it is considered unlikely that contact recreation would regularly be engaged in at this site, however *E. coli* can be used to indicate effective treatment of the wastewater before discharge. The NPSFM provides indicative *E. coli* concentrations in Table 9, that can provide context to monitoring results.

The NRP provides some generic standards for *E. coli* that apply in 7.6.8d for contact recreation purposes. Again it is unlikely this is undertaken here, however for infrequent use they provide an upper limit of 576 *E. coli* / 100 mL.

1.6.4 SUSPENDED SOLIDS AND BIOLOGICAL OXYGEN DEMAND

Suspended solids measured as Total Suspended Solids (TSS) are measured as a condition of the discharge permit and are regularly non-compliant against their consented standards. Assessment of the TSS composition (whether volatile or not) in the discharge and the receiving environment is used to inform likely drivers and possible effects of this high TSS load.

Biological Oxygen Demand (BOD) is a measure of the oxygen removed from the water column as biological organisms digest or otherwise break down organic material. This depletion of instream oxygen can be detrimental to aquatic life and managing BOD is a means of protecting aquatic life in the receiving environment. There is little available guidance in New Zealand as to setting appropriate BOD concentrations instream, rather monitoring typically focuses on direct measures of dissolved oxygen (DO), and high BOD is a measure of potential contamination and a driver of low DO.

1.6.5 HEAVY METALS

Heavy metals can enter waterways via a range of anthropogenic sources, including galvanised roofs, copper spouting, discharges from roads, pesticides and herbicides associated with agriculture, and a range of industrial sources. These metals can have both chronic (long term) and acute toxicity to aquatic life. As part of receiving environment monitoring, Lead, Zinc and Copper were sampled as indicative heavy metals regularly measured in freshwater environments and typically found in wastewater. It was assumed that limited industrial processes are present in Whatuwhiwhi township, but that old or degraded roofing, spouting or plumbing material may be present.

These three metals are compared to species protection guidelines provided in the Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018). These guidelines provide contaminant guidelines based on species protection percentages, i.e. the percentage of species that will not be affected by a contaminant at a given threshold. These are typically displayed at 99%, 95%, 90% and 80% species protection levels. It is unclear which species protection levels would apply in this instance, however generally higher species protection percentages are applied to higher value environments, with 99% species protection being applied to highest value environments. It would be anticipated that either 99% or 95% species protection would be typical in a regionally significant wetland.

Many contaminants will be more or less toxic in water as a result of other factors, such as pH, hardness or dissolved inorganic carbon. Lead and Zinc were toxicity adjusted for hardness (measured as CaCo3) and copper was toxicity adjusted for dissolved organic carbon, as per latest guidelines.

2 RESULTS

2.1 SUMMARY STATISTICS – WASTEWATER DISCHARGE

Combined results from FNDC and NRC from the W-WWTP are outlined in Appendix A, with summary statistics for the measured parameters displayed in Table 2-1.

Table 2-1: combined FNDC and NRC summary statistics for wastewater discharge parameters from November 2019 until November 2024 Inclusive.

Date	pH	Temperature [deg C]	DO [g/m3]	BOD [g/m3]	TSS [g/m3]	Faecal coliforms [cfu/100 mL] censors removed	E.coli [MPN/100 mL] censors removed	NH4-N [g/m3] (censors removed)
Count	64	65	65	59	63	37	45	65
Average (mean)	6.78	19.7	7.12	10.6	51.5	99.3	48.4	2.83
Median	6.92	20.3	7.29	9.9	46	5.0	5.0	0.49
95th percentile							102.8	14.31
Max	7.96	27.5	10.39	23.0	122	3200.0	1515.0	27.00

2.2 SUMMARY STATISTICS – NATURAL WETLAND BOUNDARY

Results available from NRC monitoring at the Natural Wetland Boundary, from November 2019 until November 2024 are outlined in Appendix A, with summary statistics for the measured parameters displayed in Table 2-2.

Table 2-2: Natural Wetland Boundary NRC summary statistics for wastewater discharge parameters from November 2019 until November 2024 Inclusive.

Date	NWL DO (mg/L)	NWL BOD (mg/L)	NWL TSS (mg/L)	NWL Faecal coliforms (cfu/100 mL)	NWL Ammoniacal N (mg/L)
Count	11	11	10	9	11
Average (mean)	8.57	16.9	61.5	3396	2.70
Median	8.90	15.0	61.5	3400	0.21
Max	10.57	30.0	90.0	9000	12

2.3 TOXICITY EFFECTS – AMMONIACAL NITROGEN

Discharge data for approximately five years is available for ammoniacal nitrogen, though not for total nitrogen. This, combined with the summary statistics in Table 2-1 indicate that the median concentrations from the discharge are generally very low, but that at times these concentrations can peak, particularly during the winter months July through October (see Figure 2-1).

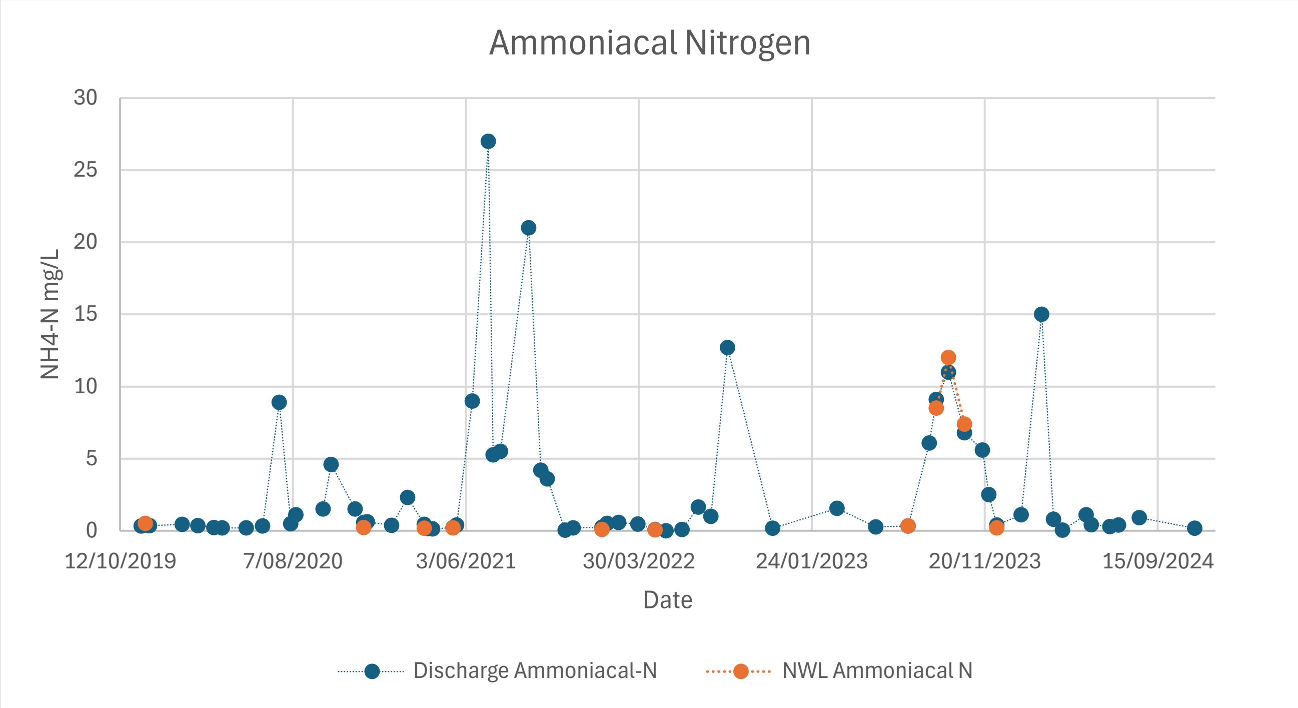

Figure 2-1: Ammoniacal nitrogen discharge from the W-WWTP discharge post UV treatment in blue, and at the Northland Wetland Site (point at which discharge leaves boundary).

Limited monitoring of the receiving environment appears to indicate that ammoniacal nitrogen levels closely match at the outlet and in the receiving environment Figure 2-1. This is particularly notable during late 2023 when monitoring at outlet and receiving environment closely matched. Interestingly, this was not visible in the monitoring results from November 2024 and January 2025, where ammoniacal nitrogen at sites two and three were significantly lower than the discharge (Figure 2-3).

Ammoniacal nitrogen can be more or less toxic, depending on factors such as temperature and pH. As such the NPSFM requires adjustment based on these factors prior to calculating toxicity. Typically, as pH and temperature increase, the proportion of the relatively more toxic un-ionised ammonia increases, as compared to the relatively less toxic ionised ammonia (or ammonium). As is common with wetlands, pH is low in the receiving environment, with a pH of between 5 and 7 in the combined WSP and NRC receiving environment monitoring available. This low pH results in more ammonium ion being present and so toxicity to aquatic life decreasing.

For receiving environment monitoring undertaken by WSP in November 2024 and January 2025, conversion of the total ammoniacal nitrogen results were undertaken in alignment with the lookup table in Appendix A of ANZ (2023), with a pH of 6.5, and an assumed temperature (as it was not measured) of 20 degrees Celsius. The adjusted toxicity is displayed in Figure 2-2. Note the use of the logarithmic scale on the Y axis to improve visualisation.

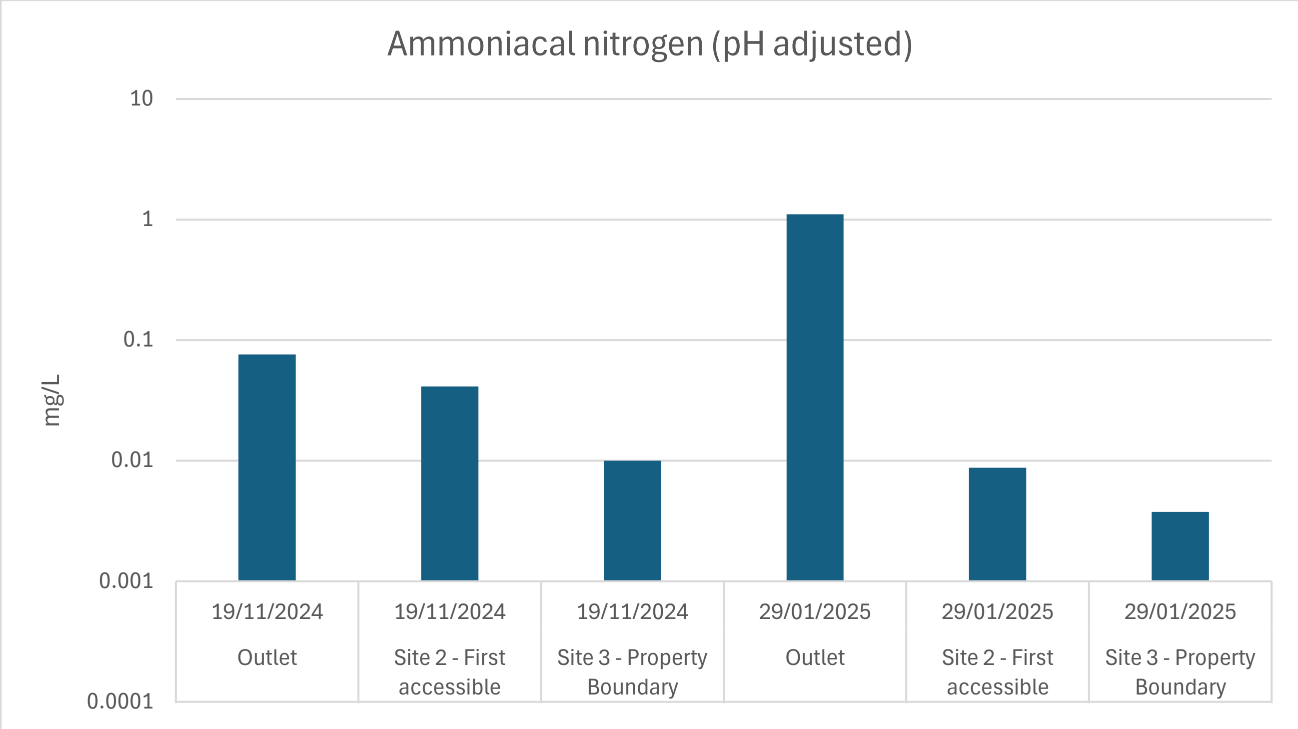

Figure 2-2: Ammoniacal nitrogen concentrations following toxicity adjustment to pH 8 as per the requirements of the NPSFM (Note: logarithmic Y axis).

When compared to the thresholds in Table 5 of the NPSFM, ammonia toxicity is likely achieving the national bottom line at the Outlet on the 19th of November 2024, but exceeds (worse than) the national bottom line at the Outlet on the 29th of January 2025. By Site 2, Band A for ammonia toxicity levels are likely being achieved.

The discharge monitoring undertaken by FNDC and NRC identifies a median total ammoniacal nitrogen of 0.49 mg/L, and a 95th percentile of 14.31 mg/L (Table 2-1). In the receiving environment, the median was 0.21 before adjustment, with a maximum of 12 mg/L (with only 11 samples it is not possible to undertake a 95th percentile).

Based on these it is likely that at the Outlet the national bottom line is not met on average, however with the significant improvement that occurs in the receiving environment, combined with the reduced toxicity as a result of the low pH, it is considered likely the national bottom line is met in the receiving environment much of the time. This would require further monitoring to confirm.

2.4 TOXICITY EFFECTS – NITRATE NITROGEN

In an environment with plentiful oxygen, ammoniacal nitrogen will rapidly change first to nitrite and then nitrate. As identified in Figure 2-3, during the November 2024 sampling the concentration of nitrate nitrogen was far higher than the concentration of ammoniacal nitrogen suggesting the discharge is well aerated at this time. During the January 2025 sampling this had inverted, with a far greater proportion of ammoniacal nitrogen than nitrate nitrogen present.

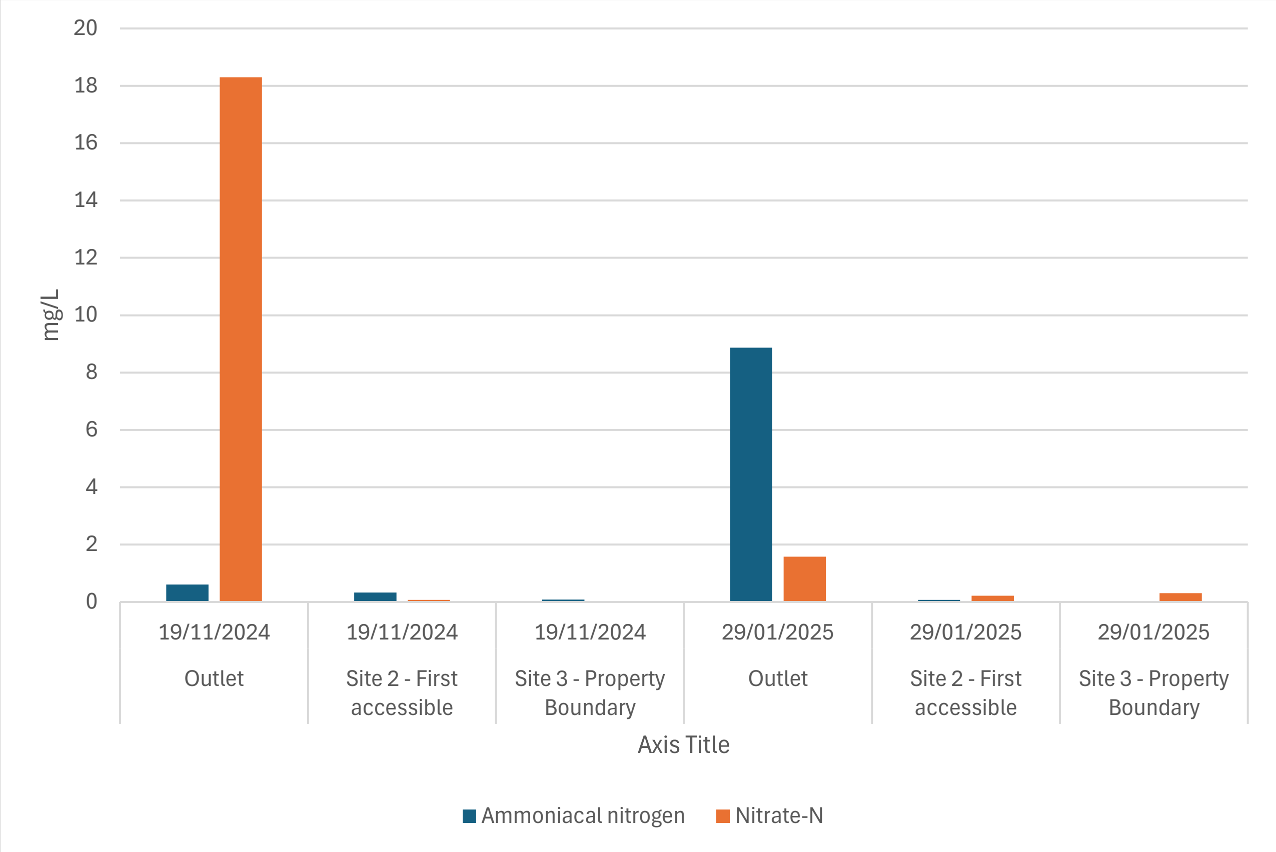

Figure 2-3: Ammoniacal nitrogen and Nitrate nitrogen concentrations at three sites on two dates in absolute concentrations.

It is possible that this switching between ammoniacal-N dominant and nitrate-N dominant conditions are regularly occurring as the nitrate concentrations moving in the inverse direction to the ammoniacal nitrogen concentrations seen in Figure 2-1.

It is notable in Figure 2-3 that on both sampling occasions in the receiving environment both ammoniacal-N concentrations and nitrate-N concentrations are very much reduced by the first accessible site (Site 2) and the property boundary (site 3). Table 6 of the NPSFM (Nitrate Toxicity) provide context to these results in the receiving environment. It is important to note that the NPSFM is based on monthly monitoring for at least a year, and as such these results can only provide indicative guidance.

For nitrate toxicity, on those occasions when the discharge is generally well aerated and most nitrogen is in the form of nitrate, it is likely that the discharge is exceeding that national bottom line for nitrate toxicity, as displayed on the 19th of November 2024 monitoring, where the outlet concentration was 18.3 mg/L as compared to an annual median target of 2.4 mg/L from the NPSFM. However, at Site 2, both receiving environment samples were meeting the A band NPSFM targets for nitrate toxicity.

2.5 EUTROPHICATION

Nitrogen and phosphorus in a waterway can result in increased growth in algae, phytoplankton, or macrophytes. If these proliferate to excess, they can detrimentally impact measures of water quality including decreased dissolved oxygen, loss of habitat for aquatic life, or loss of aesthetic values.

For the purposes of eutrophication, both nitrogen and phosphorus are commonly measured in two ways in a receiving waterway. That is their total measure available in all forms in a waterway (i.e. total nitrogen or total phosphorus); and the fraction of that total measure that is immediately plant available, which for nitrogen is called Dissolved Inorganic Nitrogen (DIN) and for phosphorus is called Dissolved Reactive Phosphorus (DRP).

2.5.1 NITROGEN

For nitrogen, Figure 2-4 indicates at the outlet on both sampling dates the total nitrogen concentration is primarily in the form of plant available, DIN. By Site 2, total nitrogen concentration reduces around 3 – 5-fold, and it changes form such that the majority of the DIN has been removed. This likely represents the uptake of DIN by algae or plants, such that nitrogen in organic material is primarily present.

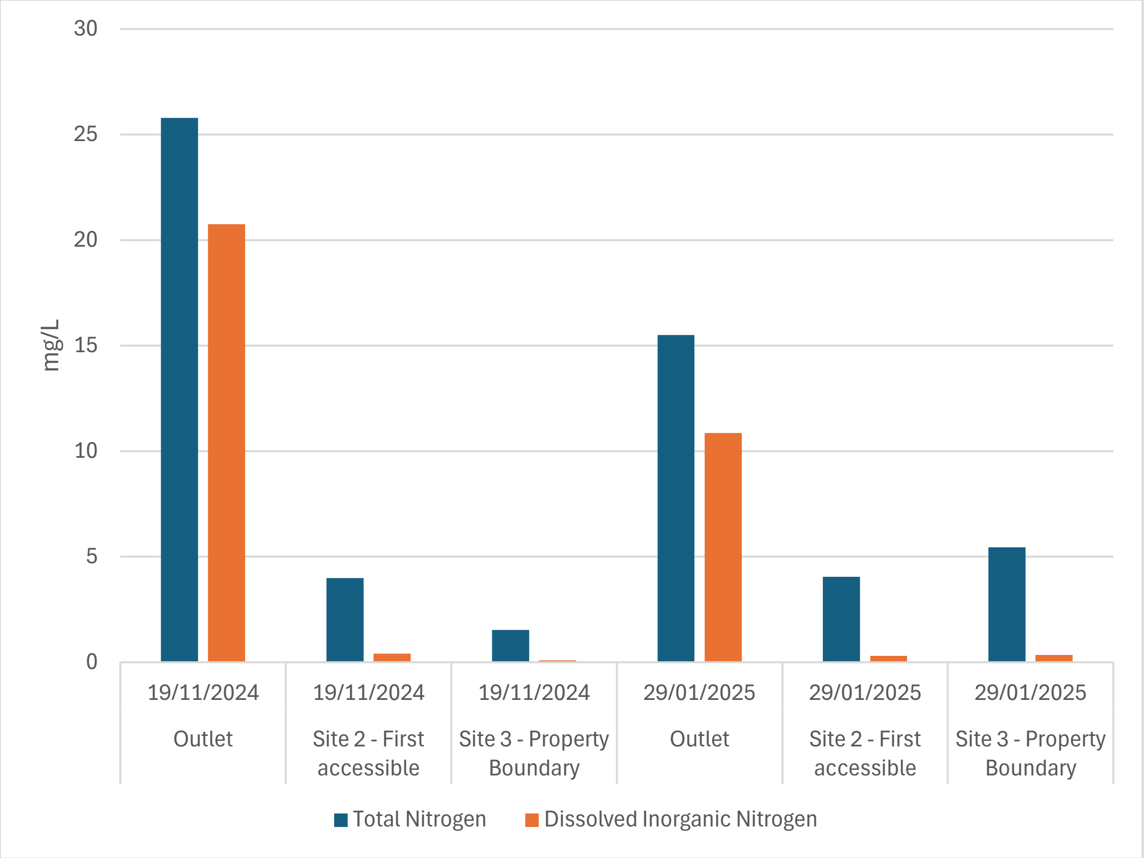

Figure 2-4: Nitrogen concentrations, as Total Nitrogen and Dissolved Inorganic nitrogen at three sites on two dates.

By the time the wastewater reaches the first accessible location, concentrations of TN remain between 3.99 and 4.05 mg/L. This is well above the TN standard for shallow lakes in the PRPN, of ≤ 0.8 mg/L. However, the nearby Lake Waiporohita is monitored by NRC monthly, and over the monitoring period from 2021 – 2023 inclusive, averaged a median total nitrogen of 1.35 mg/L, suggesting that landuse activities in the surrounding landscape may be contributing to TN concentrations significantly higher than these standards. Nonetheless, this may suggest that at times the discharge at a point beyond reasonable mixing has an up to three times higher concentrations than the surrounding landscape.

At Site 2, DIN is at 0.405 and 0.3 mg/L on the two sample dates. This is beyond the 0.1 mg/L upper range identified in the RPN, however it is considered likely that this concentration is also exceeded in the surrounding landscape.

2.5.2 PHOSPHORUS

For phosphorus, Figure 2-5 indicates that phosphorus remains primarily in its plant available DRP form from when it leaves the outlet, until it leaves the property boundary. This would indicate that there is not a significant portion being converted into organic material and may indicate an oversupply of phosphorus relative to what the local primary producers in the discharge channel in the wetland can utilise (i.e. as opposed to nitrogen which appears to be being readily utilised, phosphorus may be present in such excess that additional phosphorus is unable to result in additional growth). It is noteworthy that phosphorus concentrations still decrease 2 – 4-fold between the outlet and the property boundary, which may represent dilution with other non-discharge water, given it does not appear to be representing significant biological uptake.

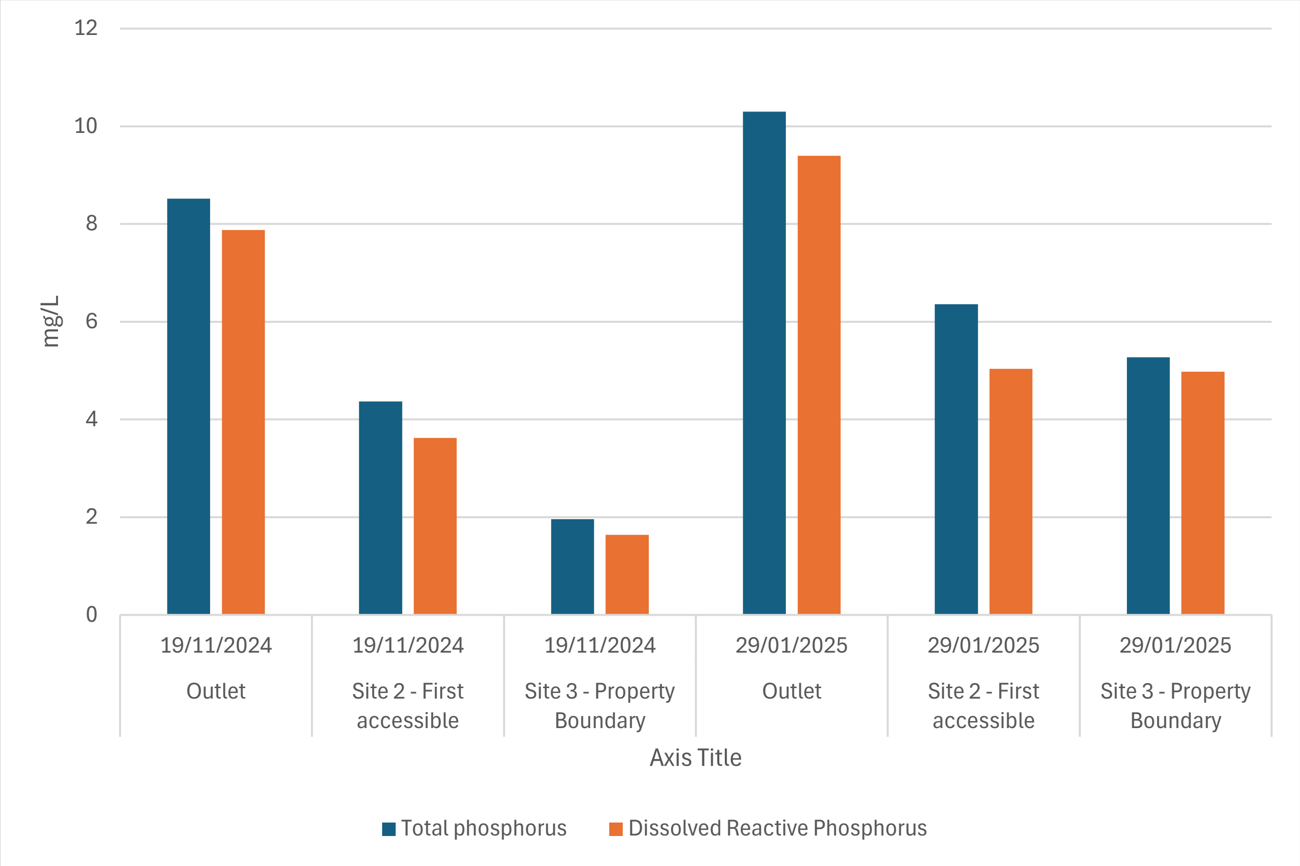

Figure 2-5: Phosphorus concentrations, as Total Phosphorus and Dissolved Reactive Phosphorus at three sites on two dates.

By the time the wastewater reaches the first accessible location, concentrations of TP remain between 4.37 and 6.36 mg/L. This is well above the TP standard for shallow lakes in the PRPN, of ≤ 0.02 mg/L. The nearby Lake Waiporohita is monitored by Northland Regional Council monthly, and over the monitoring period from 2021 – 2023 inclusive, averaged a median total phosphorus of 0.115 mg/L. This may suggest that at times, the discharge from the W-WWTP is leaving the property at up to forty times higher concentrations than the surrounding landscape.

At Site 2, DRP is at 3.62 and 5.04 mg/L on the two sample dates. This is beyond the 0.05 mg/L upper range identified in the RPN.

2.6 VEGETATION SURVEYS

Since the granting of the consent, vegetation surveys have been undertaken by Wildland Consultants in 2013, 2016 and 2019. The baseline vegetation surveys undertaken by Opus and Wildlands Consultants prior to consent being granted were repeated in 2013, however it was identified the methodology was not sufficient to monitor change in vegetation due to eutrophication under that methodology, and so a new methodology was established in 2016 (Wildlands Consultants, 2016).

Monitoring in 2016 and 2019 involved the measurement of a range of vegetation composition, nutrient content, water depth and other measures in ten control vegetation plots, and ten impact vegetation plots, to allow comparison following a Before After Control Impact (BACI) methodology, allowing both spatial and temporal changes to be measured.

In both the 2016 and 2019 reports, Wildland Consultants conclude that:

"No changes were observed that can be reliably attributed to an increase in eutrophication. Therefore the effects of the discharge are likely to be in compliance with Condition 15 of NRC CON20050720301.

Future vegetation change should continue to be assessed quantitatively through the measurement of water depths, nutrient concentrations of shoot tips, percentage cover of wetland species, and frequency of occurrence of wetland species within permanently marked plots. Careful attention should be paid to any changes in nutrient status, particularly whether plant growth becomes not limited by nitrogen (N is >2% dry weight and P is >0.1% dry weight). If any trend is shown towards plant growth being not limited by nitrogen, this could result in further changes in vegetation composition, including increased abundance of Isolepis prolifer, and decreased abundance and or frequency of species characteristic of lower fertility habitats, such as Machaerina teretifolia and Machaerina juncea. Continuing the measurement and analysis of water depth will help to track the potential influence of water levels on vegetation composition."

2.7 CONTACT RECREATION

The post UV discharge monitoring provided by FNDC and NRC had a median *E. coli* of 5 MPN/100 mL, and a 95th percentile of 102.8 MPN/100mL. Compared to the contact recreation thresholds available, this is representative of very low faecal contamination, as Table 9 of the NPSFM for example requires a median concentration of less than 130 *E. coli* / 100mL and 95th percentile of less than 540 *E. coli* / 100mL. It is also significantly lower than the contact recreation upper limits for infrequent use identified in the RPN, of 576 *E.* coli / 100mL. As outlined in section 1.6.3, contact recreation immediately downstream of a discharge is not recommended, and is not likely to occur at this site due to the difficulty of access, however these results are indicative of a well-functioning and effective sterilisation treatment.

Results from receiving environment monitoring on 19th November 2024 were compromised as results were unable to be processed within acceptable timeframes to be reliable for these purposes (NEMS, 2019). Receiving environment monitoring on 29th of January 2025 report an *E. coli* concentration of 1000 *E. coli* / 100 mL, which is significantly higher than the median discharge monitoring results. It is unclear whether the UV was working properly at this time or why these elevated results. Of interest, by Site 2 *E. coli* concentrations have reached 12,000 *E. coli* / 100 mL and were 5,000 *E. coli* / 100 mL by the property boundary. The monitoring staff on site identified a significant presence of wildfowl (pers. comm Wayne Teal) and this is typical of both an oxidation pond and wetlands. As such it is likely that there is a significant faecal contamination load entering the waterway from wildfowl.

This is supported by results from FNDC and NRC monitoring comparing discharge concentrations of faecal coliforms with those in the receiving environment. This shows that faecal coliform concentrations are low, regularly less than 100 cfu / 100mL at point of discharge, but regularly exceeding 1000 cfu / 100mL in the receiving environment.

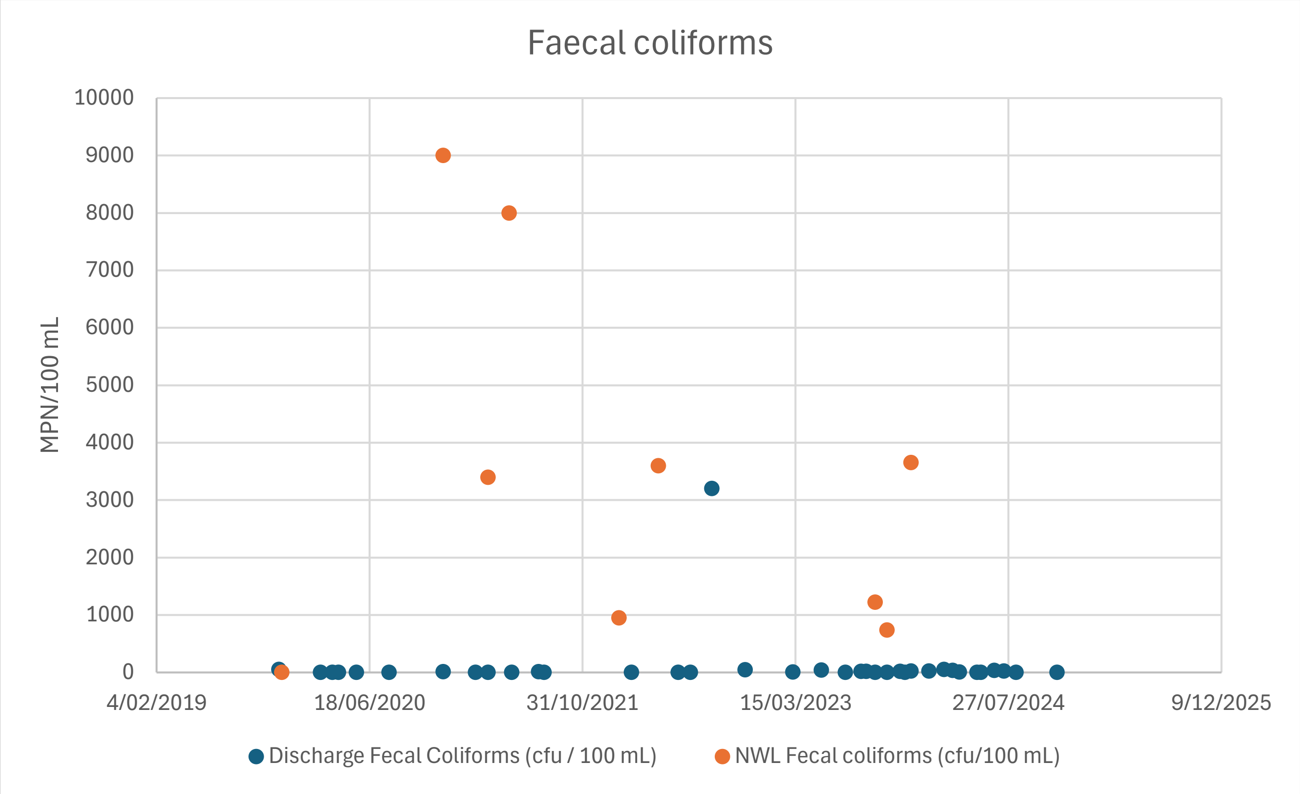

Figure 2-6: Faecal coliform results at the W-WWTP discharge and in the Natural Wetland (NWL) receiving environment between November 2019 and November 2024.

In summary, when the UV treatment is working effectively, it appears it is able to significantly lower faecal coliform and *E. coli* concentrations to broadly acceptable levels, however presence of wildfowl may result in elevated faecal contamination beyond guideline values.

2.8 SUSPENDED SOLIDS AND BIOLOGICAL OXYGEN DEMAND

Monitoring undertaken in the W-WWTP discharge indicates that the discharge is regularly non-compliant with the consented concentration of 30 mg/L. Over the approximate five-year period the median was 46 and a maximum of 122 mg/L was recorded. It is suspected that the cause of this is suspended algae in the discharge, but this has not been confirmed (pers. comm P. Shoebridge). Monitoring undertaken on the 19th of November 2024 and 29th January 2025 indicate the majority of TSS discharged was volatile (VSS) (i.e. able to be burned off under high temperature) and so could potentially have been organic, consistent with it being algal in nature.

Monitoring undertaken by WSP in November 2024 and January 2025 indicated a considerable increase in both TSS and VSS by Site 2. This may indicate a significant increase in algal growth in the discharge, consistent with an excess of nutrients being available in the water column.

Receiving environment monitoring paired with discharge monitoring undertaken by NRC indicates a closer relationship between the discharge and receiving environment as seen in Figure 2-7.

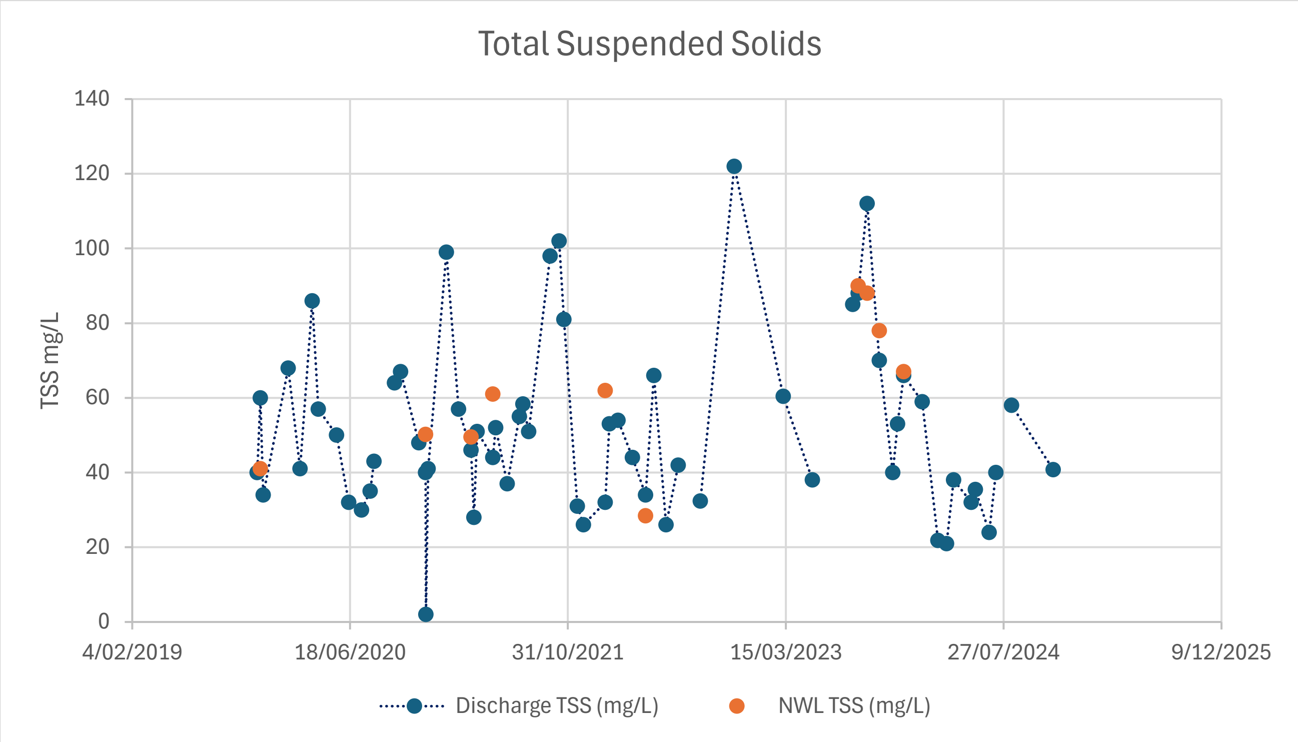

Figure 2-7: Total Suspended Solids results at the W-WWTP discharge and in the Natural Wetland (NWL) receiving environment between November 2019 and November 2024.

Biological oxygen demand is generally well below the consented median of 30 mg/L at the discharge, with discharge monitoring results indicating a median of 9.9 mg/L and a maximum of 23 mg/L. Monitoring in the receiving environment undertaken by NRC suggest and elevated BOD with a median of 15 mg/L, but of interest DO concentrations also appear to remain high with a median of 9.9 mg/L.

2.9 HEAVY METALS

Heavy metal thresholds at the 99% and 95% species protection levels as taken from the ANZG (2018) are displayed in Table 2-3.

Table 2-3: Species protection thresholds for lead, zinc and copper, at the 99%, 95% and 90% species protection levels.

species protection (%)	Lead (Pb) (µg/L)	Zinc (Zn)(µg/L)	Copper (Cu)(µg/L)
99%	1	2.4	1
95%	3.4	8	1.4
90%	6.5	15	1.8

As identified in 1.6.5, these heavy metals are subject to adjustments based on either hardness or dissolved organic carbon. The original measures are displayed in Appendix , however the adjusted concentrations are displayed in Table 2-4 with colour coded cells based on compliance with various species protection levels.

Table 2-4: results of water sampling for several heavy metals with the measured result, and the result following sample specific hardness or dissolved organic carbon correction in adjacent columns. Colour coded: blue = 99% species protection compliant; green = 95%; yellow = 90%; and red = not compliant with 90%.

Site Name	Date	Carbon (DOC)	Hardness (CaCO3)	Lead (Pb) (µg/L)	Lead (Pb) (µg/L) adjusted	Zinc (Zn)(µg/L)	Zinc (Zn)(µg/L) adjusted	Copper (Cu)(µg/L)	Copper (Cu)(µg/L) adjusted
Outlet	19/11/2024	19.1	81	0.5	0.14	28	12.04	6	0.17
Site 2 - First accessible	19/11/2024	36.4	37	0.5	0.38	9	7.53	1	0.02
Site 3 - Property Boundary	19/11/2024	37	36	3	2.38	9	7.71	13	0.19
Outlet	29/01/2025	12.3	74	1	0.32	13	6.03	4	0.18
Site 2 - First accessible	29/01/2025	29.2	50	2	1.05	27	17.49	2	0.04
Site 3 - Property Boundary	29/01/2025	26.2	54	2	0.95	26	15.78	4	0.08

From these results we can see that copper is always compliant with the 99% species protection level (likely due to the high level of dissolved organic carbon present); lead is compliant with 99% and 95% species protection levels; and zinc varies including at times exceeding 90% species protection thresholds.

In all cases it is important to note that this is based on two rounds of sampling only, and so results such as the increase in zinc from the outlet to the subsequent two sites on the 29th January 2025 result cannot be put in the context of what usually occurs.

Additionally, there is no available site unaffected by the discharge (i.e. control site) present, therefore it is not clearly evident whether it is the discharge driving these concentrations measured. Further monitoring, including at a suitable control site would provide more clarity on this situation.

3 DISCUSSION OF RESULTS

3.1 FINDINGS OF WATER SAMPLING

Water quality sampling was based on discharge monitoring undertaken by both FNDC and NRC for a limited set of parameters (as required by consent) over an approximate five-year period, and only two rounds of sampling in the receiving environment. As such they are considered to be indicative only. It is recommended that additional monitoring in the receiving environment is undertaken to provide certainty regarding the likely effects. However, from this monitoring it appears that:

- Nitrate nitrogen toxicity and ammoniacal nitrogen toxicity once adjusted for pH, do not appear likely to breach median national bottom lines for toxicity at Site 2, and were meeting the NPSFM A band on both monitoring rounds undertaken by WSP in the receiving environment. It is noteworthy that at times maximum ammoniacal nitrogen concentrations can be significantly elevated in the discharge and receiving environment, though there is insufficient data to compare with National Bottom Line 95th percentile concentrations. Given target concentrations expressed in the PRPN, these ammoniacal nitrogen concentrations may constitute an effect that is more than minor;
- Eutrophication
  - The concentration of total nitrogen leaving the site appears to be up to three times higher than concentrations in a nearby lake with a similar landuse and in excess of standards in the RPN and PRPN;
  - Concentrations of total phosphorus leaving the site appear to be up to 40 times higher than concentrations in a nearby lake with a similar landuse and in excess of standards in the RPN and PRPN;
  - The vegetation surveys observed no changes that can reliably be attributed to an in increase in eutrophication. Of particular note, in both 2016 and 2019 the nutrient content of the plant material indicated nitrogen limitation, but not phosphorus limitation at both the control and impact sites. There was deemed to be no statistically significant different between these sites and between the years. It is anticipated that the significant degree of dilution afforded to the wastewater is such that any impact of this additional nutrients is sufficiently limited that it is unable to be measured, and the large amount of vegetation present rapidly assimilates large amounts of the nutrients;
  - As such, though the site is discharging elevated concentrations of nutrients, it is not clear that there is an actual measurable effect in the receiving environment and the activity may be characterised as having a less than minor effect based on this assessment. It is noted that this assessment has been unable to consider cumulative effects, given a lack of information in the Waimango Swamp;
- Faecal coliforms such as *E. coli* appear to be sufficiently treated via UV treatment, and as such low *E. coli* concentrations are anticipated from the discharge. The noted presence of wildfowl typical of a wastewater treatment oxidation pond and of wetlands are likely to significantly add to the *E. coli* load in the receiving environment, therefore the discharge is likely having a less than minor effect;
- Total suspended solids and BOD can at times be elevated in the discharge and it is unclear (when comparing WSP sampling and sampling provided in the Natural Wetland by NRC) whether this drives an increase in these parameters in the receiving environment. Of note, median BOD in the receiving environment appears to exceed that in the discharge, and it is considered that the significant algal growth in the receiving environment may be driving this. Additional monitoring may be necessary to

confirm the effect of the discharge in the receiving environment and future treatment upgrades should seek to reduce TSS and BOD discharge;

- In two rounds of sampling copper is always compliant with the 99% species protection level at all sites; lead is compliant with 99% and 95% species protection levels; and zinc varies including at times exceeding 90% species protection thresholds. Further monitoring, including of control sites is necessary to provide certainty regarding heavy metals.

3.2 CONSIDERATION OF UPGRADE OPTIONS

The BPO process identifies a short list of three options that were designed based on future flows and loads to the plant were considered based on population growth as well as the holiday seasonal fluctuations. Ultimately three short list options were identified.

The expected discharge qualities are displayed in Table 1-1 and it is broadly anticipated these will result in a modest improvement to all the measured parameters, in particular TSS, which currently regularly breaches its consent conditions. In addition, the sequencing batch reactor (SBR) would be anticipated to have considerable improvements to ammoniacal nitrogen, BOD and TN; and the Intermittent Decanting Extended Aeration Lagoon (IDEAL) would be anticipated to have significant improvements to ammoniacal nitrogen, and reasonable improvements to BOD and TN.

Ammoniacal nitrogen improvements, particularly peak concentrations, may cause receiving environment conditions to breach national bottom-line standards identified in the NPSFM, therefore a treatment option that better targets ammoniacal nitrogen may be preferable (e.g. SBR or IDEAL).

At this stage there is not clear information that nitrate nitrogen is driving toxicity concerns, and any of the proposed upgrades would be expected to make modes improvements in the TN being discharged. It is noteworthy that a reduction in ammoniacal-N may drive an increase in nitrate concentration.

Currently eutrophication does not appear to be a risk, though the discharge is likely discharging nutrient concentrations elevated to the surrounding environment. All options proposed are expected to make modest improvements to the TN and TP concentrations discharged from site.

All proposed options will continue to include treatment of faecal coliforms, and therefore it would be anticipated that the existing high-quality discharge would continue.

All three proposed options would result in a significant reduction in TSS as compared to what is currently consented and what is currently occurring, and a modest improvement in BOD concentrations. It is unclear whether discharge concentrations are driving elevated concentrations in the receiving environment, however dissolved oxygen concentrations in the receiving environment appear to still sit at desirable levels, so it is considered likely that any of the proposed options would maintain this situation.

3.3 SUMMARY OF FINDINGS

The findings of the water quality sampling indicated that the discharge is likely not driving a long-term chronic toxicity effect but may at times breach acceptable standards for peak ammoniacal nitrogen levels. Additionally, the high loads of TSS at times being discharged may be resulting in elevated concentrations in the receiving environment.

Proposed upgrades considered under the BPO process will result in modest improvements to a number of parameters including TSS, and in some instances BOD, ammoniacal nitrogen, and TN. Improvements in TSS, and ammoniacal nitrogen compared to current are likely particularly desirable.

There is potentially an excess of both nitrogen and phosphorus being discharged into the receiving environment at a level beyond background concentrations and beyond guideline values.

The findings of the vegetation surveys suggest this does not appear to be manifesting in a change to vegetation composition, or nutrient concentrations in the plant material, potentially as a result of the significant dilution and uptake capacity provided by the Waimango Swamp. As such the expectation is that there will continue to be no measurable change in the receiving environment due to eutrophication, however vegetation surveys would need to continue to occur to ensure this is correct.

Faecal contamination treatment at the plant appears to be effective, and increased concentrations further along the discharge drain may reasonably be able to be explained by the presence of wildfowl. Proposed upgrades to the W-WWTP will continue to maintain this high quality.

In this assessment it was not possible to directly address issues of cumulative effects. As there is no monitoring currently undertaken in the Waimango Swamp, it is not clear what its current state is. Given the surrounding landscape and water quality monitoring from a nearby lake, it is considered likely that the Waimango Swamp already contains elevated nutrient concentrations, and the discharge of the W-WWTP adds to this nutrient loading. It is recommended that an appropriate control monitoring site is identified in, or immediately adjacent to the Waimango Swamp, to better address this issue.

4 RECOMMENDATIONS

As a result of the above assessment, the following recommendations are made, with the intention they are incorporated into, or inform, proposed conditions of consent. These conditions are only part of the expected condition set, to monitoring and propose discharge standards for the W-WWTP, with reporting requirements and other standard consent conditions not addressed. It is noted that crafting of consent conditions is a technical skill within the remit of a resource consent planner, and therefore wording may change between the below recommendations and proposed conditions:

- Discharge monitoring:
  - Following commissioning of the fully upgraded W-WWTP, monthly water sampling should be undertaken at the point of discharge, and at a point representing reasonable mixing in the receiving environment;
  - Water sampling should be undertaken by a suitably trained person, and in compliance with National Environmental Monitoring Standards (NEMS, 2019). Samples should be sent to a suitably accredited laboratory for sample processing in lines with the requirements of the NEMS (2019);
  - The reasonable mixing location should be identified in consultation with the Northland Regional Council, however as a starting point, this could be considered as 50m from the point of discharge, given the discharge appears to be flowing water at this point;
  - Once an agreed reasonable mixing locations is determined, an accessway and associated infrastructure should be constructed such that safe monitoring can be undertaken at all times of year;
  - Monitoring should be for the following parameters:

Parameter	Discharge Monitoring	Receiving Environment
Total Nitrogen	x	x
Nitrate	x	x
Nitrite	x	x
Ammoniacal Nitrogen	x	x
Dissolved Inorganic Nitrogen (by calculation)	x	x
Total Phosphorus	x	x
Dissolved Reactive Phosphorus	x	x
E. coli	x	x
Total suspended solids	x	x
5-day Biological Oxygen Demand	x	x
Dissolved Oxygen (mg/L and % saturation)	x	x
Temperature		x
pH	x	x
Zinc	x	x
Dissolved Copper	x	x
Total Hardness (as $CaCO_3$)		x
Dissolved Organic Carbon (DOC)		x

  - Monitoring for Copper and Zinc (and their associated parameters DOC and Hardness respectively) to occur monthly for one year only.

- Discharge standards -at the point of discharge, following commissioning of the fully upgraded W-WWTP should include:
    - Annual median *E. coli* concentrations not to exceed 130 MPN/100 mL and annual 95th percentile not to exceed 1200 MPN/100 mL;
    - Total Suspended Solids not to exceed an annual average 10 mg/L, and annual 90th percentile of 15 mg/L;
    - 5-day Biological Oxygen Demand not to exceed an annual average 15 mg/L, and annual 90th percentile 25 mg/L;
- Discharge standards -at the point of reasonable mixing, following commissioning of the fully upgraded W-WWTP should include:
    - annual median concentration of ammoniacal nitrogen not to exceed 0.24 mg/L and annual 95th percentile not to exceed 0.4 mg/L following pH adjustment;
    - annual median concentration of nitrate not to exceed 2.4 mg/L and annual 95th percentile not to exceed 3.5 mg/L;
    - Copper and Zinc to be assessed against appropriate guideline values in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Annual median concentrations not to exceed the 95% species protection thresholds therein following adjustment.
- Vegetation surveys undertaken by Wildlands Consultants in 2016 and 2019 should be repeated, to confirm the current understanding that elevated concentrations of nutrients being discharged from the W-WWTP are having no eutrophication effect in the receiving environment;
    - These should be undertaken by a suitably qualified expert;
    - Surveys should be undertaken at the locations and following the protocols identified in the Wildlands Consultants 2016 report;
    - This should occur following upgrade and commissioning of the W-WWTP upgrades and every five years thereafter;
    - There should be no more than minor increase in the extent of eutrophic wetland vegetation assessed against the results provided in the Wildlands Consultants 2016 report;
    - There shall be no statistically significant increase in nutrient concentration in leaf material between impact and control plots, as identified in the Wildlands Consultants 2016 report.

5 LIMITATIONS

This report (‘Report’) has been prepared by WSP New Zealand Limited (‘WSP’) exclusively for Far North District Council (‘Client’) in relation to a water quality technical assessment (‘Purpose’) and in accordance with the Short Form Agreement dated 14/08/2024 (‘Agreement’). The findings in this Report are based on and are subject to the assumptions specified in the Report and in the pricing schedule dated 07 August 2024. WSP accepts no liability whatsoever for any use or reliance on this Report, in whole or in part, for any purpose other than the Purpose or for any use or reliance on this Report by any third party.

In preparing this Report, WSP has relied upon data, surveys, analyses, designs, plans and other information (‘Client Data’) provided by or on behalf of the Client. Except as otherwise stated in this Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable for any incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

APPENDIX A

POST UV DISCHARGE AND REVIEVING ENVIRONMENT WATER QUALITY – COMBINATION FNDC AND NRC

Results are for the period approximately November 2019 until November 2024. Results from both FNDC and NRC are combined.

Note: results that are below or above detection limit are often reported with < or > symbols. In order to derive useable numbers for calculation of medians or statistics, less than symbols (<) have been removed with the reported detection limit being halved (i.e. <10 converted to 5). No greater than symbols (>) were present.

Date	pH	Temperature (deg C)	Discharge DO (mg/L)	Discharge BOD (mg/L)	Discharge TSS (mg/L)	Discharge Faecal Coliforms (cfu / 100 mL)	E.coli (cfu / 100 mL)	Discharge Ammoniacal-N (mg/L)	NWL pH	NWL DO (mg/L)	NWL BOD (mg/L)	NWL TSS (mg/L)	NWL Faecal coliforms (cfu/100 mL)	NWL Ammoniacal N (mg/L)
18/11/2019	6.83	24.0	5.33	7.4	40	50.0	5.0	0.33						
25/11/2019	7.10	22.6	9.80	18.0	60			0.40	6.8	4.1	10	41	0.8	0.5
2/12/2019	6.92	24.5	5.06	8.2	34		5.0	0.35						
28/01/2020	7.21	27.5	5.10		68		5.0	0.43						
24/02/2020	7.38	22.5	4.26	7.2	41	5.0	5.0	0.36						
23/03/2020	7.46	23.2	7.24	15.0	86	5.0	86.0	0.21						
6/04/2020	7.96	21.3	6.94	7.5	57	0.9	5.0	0.20						
18/05/2020	6.58	15.9	8.33	8.9	50	0.8	5.0	0.20						
15/06/2020	7.19	15.8	9.00		32		110.0	0.34						
14/07/2020	6.85	13.9	9.09	7.3	30		10.0	8.90						
3/08/2020	6.92	14.6	8.44	9.2	35	5.0	10.0	0.49						
12/08/2020	6.27	14.8	9.49	18.0	43			1.10						
22/09/2020				9.9										
28/09/2020	6.13	18.1	7.30	9.6	64		10.0	1.50						
12/10/2020	6.34	19.2	7.64		67		5.0	4.60						
23/11/2020	6.24	21.7	7.09	11.0	48		5.0	1.50						
7/12/2020				7.3										
8/12/2020	6.67	23.5	5.27	5.3	40	13.0		0.57	6.74	8.9	17	50.2	9000	0.214
9/12/2020	6.59	23.8	5.01		2		5.0	0.42						
14/12/2020	7.18	23.8	5.80		41		5.0	0.62						
25/01/2021	6.76	24.6	5.23	14.0	99		5.0	0.38						
22/02/2021	7.19	23.7	5.57	19.0	57	0.8	5.0	2.30						
23/03/2021	7.32	21.4	5.40	7.6	46	1.7		0.44		9.1	15	49.5	3400	0.165
29/03/2021	7.40	20.7	6.25		28		10.0	0.16						
6/04/2021	6.74	22.6	6.66	16.0	51		73.0	0.13						
12/05/2021	7.03	19.6	6.30	8.1	44			0.23	7.11	8.5	13	61	8000	0.2
18/05/2021	7.30	18.5	0.33	7.1	52	0.8	5.0	0.39						
14/06/2021	7.84	18.3	8.74		37		5.0	9.00						
12/07/2021	6.47	13.0	9.96	11.0	55		5.0	27.00						
20/07/2021	6.48	14.5	9.65	12.0	58.4	15.0		5.25						
2/08/2021	5.55	15.1	9.32	9.0	51	0.8	5.0	5.50						
20/09/2021	6.08	17.8	9.28	11.0	98		5.0	21.00						
11/10/2021	7.19	18.3	9.46	7.1	102		5.0	4.20						
22/10/2021	5.56	19.6	8.32	13.0	81			3.60						
22/11/2021	6.25	24.3	7.42	6.9	31		5.0	0.05						
6/12/2021	7.88	24.7	6.80	8.3	26		1515.0	0.20						

Date	pH	Temperature (deg C)	Discharge DO (mg/L)	Discharge BOD (mg/L)	Discharge TSS (mg/L)	Discharge Faecal Coliforms (cfu / 100 mL)	E.coli (cfu / 100 mL)	Discharge Ammoniacal-N (mg/L)	NWL pH	NWL DO (mg/L)	NWL BOD (mg/L)	NWL TSS (mg/L)	NWL Faecal coliforms (cfu/100 mL)	NWL Ammoniacal N (mg/L)
25/01/2022	7.40	23.5	5.42	8.8	32		10.0	0.25	7.24	6.7	30	62	950	0.096
3/02/2022	7.04	24.3	1.15	13.0	53			0.50						
23/02/2022	7.28	21.7	2.47	9.6	54	0.8	5.0	0.57						
28/03/2022	7.42	21.7	7.67	9.1	44		31.0	0.47						
27/04/2022	7.01	19.4	7.29	11.0	34		10.0	0.08	6.92	8.6	29	28.4	3600	0.068
16/05/2022	7.43	19.5	8.20	11.0	66		5.0	0.01						
13/06/2022	7.36	16.8	5.94	11.0	26	0.8	5.0	0.08						
11/07/2022	6.37	15.7	9.02	5.4	42	0.9	0.8	1.65						
2/08/2022	7.58	13.6	9.97					1.00						
31/08/2022	7.35	16.1	8.20	10.0	32.4	3200.0		12.70						
17/11/2022		24.1	6.15	14.0	122	47.0		0.17						
9/03/2023	6.95	24.0	4.11	23.0	60.4	8.2		1.55						
15/05/2023	5.77	16.1	9.40	5.7	38	43.0		0.26						
10/07/2023	6.93	14.3	9.62	4.9		0.8		0.34	6.92	9.38	6.5			0.32
16/08/2023	6.30	14.0	7.08	12.0	85	21.0		6.08						
28/08/2023	6.96	14.7	10.39	8.9	88	20.0		9.10	6.71	10.57	8.9	90		8.5
18/09/2023	5.84	14.5	9.81	7.7	112	1.6	5.0	11.00	5.9	10.56	8.6	88	1223	12
16/10/2023	5.23	20.3	10.17	9.3	70	1.6	5.0	6.80	5.5	8.66	29	78	738	7.4
16/11/2023	6.35	21.7	6.65	10.0	40	18.0		5.60						
27/11/2023	5.93	21.3	7.89	12.0	53	0.8	5.0	2.50						
11/12/2023	6.92	24.0	7.87	12.0	66	25.0	5.0	0.40	6.87	9.17	19	67	3654	0.2
22/01/2024	6.91	27.4	6.03	18.0	59	26.0	10.0	1.10						
27/02/2024	7.46	23.1	6.23	6.0	21.8	55.0	52.0	15.00						
18/03/2024	7.39	21.2	7.09	4.2	21	34.0	5.0	0.80						
3/04/2024	6.92	20.3	7.35	13.0	38	8.2	20.0	0.04						
14/05/2024	7.21	15.6	8.19	22.0	32	0.8	5.0	1.10						
23/05/2024	6.58	16.6	2.97	11.0	35.5	4.9		0.43						
24/06/2024	5.13	15.6	9.10	6.6	24	33.0	75.0	0.28						
9/07/2024	5.18	13.7	9.62	12.0	40		5.0	0.40						
16/07/2024						23.0								
14/08/2024	6.07	13.9	5.83	12.0	58	0.8		0.90						
18/11/2024	6.66	21.5	4.84	12.0	40.8	0.8		0.18						
Count	64	65	65	59	63	37	45	65	10	11	11	10	9	11
Average (mean)	6.78	19.7	7.12	10.6	51.5	99.3	48.4	2.83	6.67	8.57	16.91	61.51	3396.20	2.70
Median	6.92	20.3	7.29	9.9	46	5.0	5.0	0.49	6.84	8.90	15.00	61.50	3400.00	0.21
Max	7.96	27.5	10.39	23.0	122	3200.0	1515.0	27.00	7.24	10.57	30.00	90.00	9000.00	12.00

APPENDIX B

RECEIVING ENVIRONMENT WATER QUALITY RESULTS – NOVEMBER 2024 – JANUARY 2025

Site Name	Date	Total Nitrogen	Ammoniacal nitrogen	Nitrate N	Nitrite N	Dissolved Inorganic Nitrogen	Total phosphorus	Dissolved Reactive Phosphorus	Total Suspended Solids	Volatile Suspended Solids	BOD 5	Escherichia coli	pH	Copper (Cu)	Hardness (as CaCo3)	Lead (Pb)	Magnesium (Mg)	Zinc (Zn)
Outlet	19/11/2024	25.8	0.61	18.3	1.85	20.76	8.52	7.88	28	28	3	0.5	6.3	0.006	81	0.0005	5.6	0.028
Site 2 – First accessible	19/11/2024	3.99	0.33	0.07	0.005	0.405	4.37	3.62	722	598	3	20	5.9	0.001	37	0.0005	3.4	0.009
Site 3 - Property Boundary	19/11/2024	1.53	0.08	0.005	0.005	0.09	1.96	1.64	1.5	1.5	3	16	5.9	0.013	36	0.003	3.4	0.009
Outlet	29/01/2025	15.5	8.87	1.58	0.41	10.86	10.3	9.4	34	31	3	1000	7.6	0.004	74	0.001	6.1	0.013
Site 2 - First accessible	29/01/2025	4.05	0.07	0.22	0.01	0.3	6.36	5.04	2400	1820	6	12000	6.6	0.002	50	0.002	4.5	0.027
Site 3 - Property Boundary	29/01/2025	5.44	0.03	0.31	0.01	0.35	5.27	4.98	2330	1840	6	5000	6.5	0.004	54	0.002	4.5	0.026

APPENDIX C

NPSFM TABLE 5 AND TABLE 6 TOXICITY THRESHOLDS

Table 5 – Ammonia (toxicity)

Value (and component)	Ecosystem health (Water quality)	
Freshwater body type	Rivers and lakes	
Attribute unit	mg NH_4-N/L (milligrams ammoniacal-nitrogen per litre)	
Attribute band and description	**Numeric attribute state**	
	Annual median	Annual 95th percentile
A 99% species protection level: No observed effect on any species tested.	≤0.03	≤0.05
B 95% species protection level: Starts impacting occasionally on the 5% most sensitive species.	>0.03 and ≤0.24	>0.05 and ≤0.40
National bottom line	**0.24**	**0.40**
C 80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species).	>0.24 and ≤1.30	>0.40 and ≤2.20
D Starts approaching acute impact level (that is, risk of death) for sensitive species.	>1.30	>2.20
Numeric attribute state is based on pH 8 and temperature of 20°C. Compliance with the numeric attribute states should be undertaken after pH adjustment.		

Table 6 – Nitrate (toxicity)

Value (and component)	Ecosystem health (Water quality)	
Freshwater body type	Rivers	
Attribute unit	mg NO_3 – N/L (milligrams nitrate-nitrogen per litre)	
Attribute band and description	**Numeric attribute state**	
	Annual median	Annual 95th percentile
A High conservation value system. Unlikely to be effects even on sensitive species.	≤1.0	≤1.5
B Some growth effect on up to 5% of species.	>1.0 and ≤2.4	>1.5 and ≤3.5
National bottom line	**2.4**	**3.5**
C Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.	>2.4 and ≤6.9	>3.5 and ≤9.8
D Impacts on growth of multiple species, and starts approaching acute impact level (that is, risk of death) for sensitive species at higher concentrations (>20 mg/L).	>6.9	>9.8
This attribute measures the toxic effects of nitrate, not the trophic state. Where other attributes measure trophic state, for example periphyton, freshwater objectives, limits and/or methods for those attributes may be more stringent.		

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