Northland Regional Council Freshwater Plan Change - Freshwater Baseline State Evaluation

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Contents

1. Background

The National Policy Statement for Freshwater Management 2020 (NPS-FM 2020) requires Councils to set baseline attribute state for 22 compulsory attributes for rivers and lakes and any other attributes identified by Councils for inclusion in their freshwater plan change.

NPS-FM 2020 definition

Baseline state, in relation to an attribute, means the best state out of the following:

(a) the state on the date it is first identified by a regional council

(b) the state on the date on which a regional council sets a freshwater objective for the attribute under the National Policy Statement for Freshwater Management 2014 (as amended in 2017)

(c) the state on 7 September 2017

Northland Regional Council (Council) has used (a) above to determine the baseline state of our freshwater.

The information on the baseline state of our freshwater resources is fundamental to the freshwater plan change process. Its purpose is to describe the state of freshwater in Northland, and provide the basis for consultation with communities and tāngata whenua in determining:

- long-term visions,
- freshwater objectives,
- setting target attribute states for our freshwater resources, and
- the time frames to achieve them.

It will be used along with other information to identify priority areas for potential rule changes and targeted action plans.

2. Purpose

The purpose of this report is to:

1. Document the processes used to identify the baseline state for each attribute, outlining the justifications for the time period used,
2. Describe the quality and integrity of the data used, and
3. Provide a timeline for any attributes with insufficient data and indicate when there will be sufficient information to determine baseline state.

3. River water quality attributes

The NPSFM sets out nine compulsory water quality attributes (ammonia toxicity, nitrate toxicity, visual clarity (as an indicator of suspended fine sediment), deposited fine sediment, dissolved oxygen, *Escherichia coli (E. coli)* (as an indicator microbial contamination), cyanobacteria, dissolved reactive phosphorus, and ecosystem metabolism for rivers. In addition, Council has identified one additional water quality attribute – water temperature.

3.1 Baseline state time period 2015-2019

Selection of the five-year period between 2015-2019 for determining Northland Regional Council (Council) baseline state allowed the inclusion of best dataset identified which:

i) Covers most (5 out of 9) of the NPS-FM 2020 water quality attributes collected at 67 river water quality monitoring sites,
ii) Best represents the geographical extent and variation of land-use and landscape characteristics throughout Northland, and
iii) Five years data (60 data points) is recommended by the NPS-FM for most of the water quality attributes.

Between July 2014 and December 2020, additional monitoring sites were sampled in priority catchments including Waitangi, Whangārei, Doubtless Bay, and Mangere to supplement the long-term State of Environment (SOE) monitoring network as part of the five-year water quality investigations conducted at catchment scale. Therefore, the 2015-2019 period gave us the advantage of using a larger (with better spatial coverage) and optimal dataset (from the point of national consistency in sample collection and analysis procedure) which covered the majority of the NPS-FM attributes.

Furthermore, in 2020 Council initiated a review of the existing river monitoring network in a view of implementing the full set of NPS-FM attributes, greater national consistency (i.e., following NEMS protocol), extending the spatial coverage of the network including underrepresented Freshwater Management Units (FMUs) (e.g., Aupōuri, Herekino-Whangape, Bream Bay) and for enhanced integration with other environmental monitoring networks including hydrology, groundwater and coastal monitoring networks. The river and stream monitoring plan was completed in June 2022, while the network implementation work together with community and iwi engagement is still underway.

As a result of the review, new monitoring sites have been established while other monitoring sites have been discontinued. To allow this transition period of implementing the revised monitoring network, and at the same time not to jeopardise the requirements for freshwater plan change process, the water quality dataset collected between 2015-2019 was considered most suitable and comprehensive.

3.2 List of NPS-FM 2020 attributes assessed for baseline state

The baseline state for the river water quality attributes at monitoring site level (Appendix 1) is based on monthly discrete water quality sampling undertaken at 67 river monitoring sites between 2015 and 2019, (Rissmann and Pearson, 2020). Water quality samples were collected and processed following the nationally consistent NEMS protocol for river water quality.

The modelled water quality baseline state for all river segments including unmonitored rivers and streams is based on NIWA water quality modelling report (Semadeni-Davies et.al., 2021).

Ammonia (toxicity)

The baseline state for ammoniacal nitrogen (NH_4-N mg/L) toxicity was calculated as median and a maximum over a 5-year period based on monthly discrete water quality sampling. This attribute is strongly influenced by censored values (i.e., results with "<" or ">" signs) and rounding error. Censored values were replaced with synthetic values by undertaking probability plots (Rissmann and Pearson, 2020).

Nitrate (toxicity)

The baseline state for nitrate nitrogen (NO_3-N mg/L) toxicity was calculated as a median and a 95th percentile over 5-year period based on monthly discrete water quality sampling.

Suspended fine sediment (visual clarity)

The baseline state for suspended fine sediment is calculated as a 5-year median based on horizontal visual clarity or water clarity (black disc distance in metre) measurements undertaken during monthly discrete water quality sampling. Baseline state was estimated by assigning the relevant suspended sediment class to the relevant monitoring sites (using the river environment classification of the associated sampling reaches) in accordance with Table 23 of the NPS-FM 2020 (pg.65).

Escherichia coli (E. coli)

The baseline state for *E. coli* (MPN/100mL) is based on four metrics calculated from monthly discrete water quality sampling. These four metrics are: % exceedances over 540 MPN/100 mL, % exceedances over 260 MPN/100 mL, 5-year median *E. coli*/100 mL, and 95th percentile *E. coli*/100 mL. An overall baseline state for *E. coli* is determined by the worst state of the four *E. coli* metrics.

Dissolved reactive phosphorus

The baseline state for Dissolved reactive phosphorous (DRP mg/L) is calculated as a median and a 95th percentile over a 5-year period based on monthly discrete water quality sampling.

3.3 Quality of data

Ammonia (toxicity)

The data used for ammonia toxicity (NH_4-N) baseline state was the raw results from laboratory analysis rather than pH adjusted values. This made the baseline state assessment more conservative as pH adjusted NH_4-N concentrations are generally much lower than the lab reported raw NH_4-N measurements. The reason behind not using the pH adjusted NH_4-N data was the low confidence in the existing pH adjustment calculation used in Council's time series database at the time of assessing baseline state.

Suspended fine sediment (visual clarity)

The data collection was undertaken using a slightly different methodology than the NEMS standard, where a telescopic sampling pole of 2.8m fixed length was used to accommodate the inaccessible deep rivers from riverbanks. Therefore, visual clarity measurements beyond 2.8m were often recorded as ">3m". These data points were subsequently excluded from the baseline state calculation. As a result, the attribute state for suspended fine sediment is likely to be conservative, but the impact on the accuracy of which sites are below the bottom lines is likely to be minimal as the sites with water clarity values > 3m were already above the bottom line. The other difference in Council's visual clarity methodology was in relation to NEMS recommended black disc sizes, which depends on the visual clarity ranges. The data used for baseline state calculation was initially collected using a single size black disk equipment (20cm diameter) as opposed to NEMS standard (i.e., choosing appropriate diameter disk size of either 200mm, 60mm or 20mm depending on the

visibility ranges). Having recognised the NPS-FM 2020 requirement to use 'best available information', we felt that the data was robust enough for the purpose of calculating baseline state.

Overall, we have high confidence in the water quality data that has been used to determine the baseline state.

3.4 Attributes with Insufficient data

Dissolved oxygen (below point sources only)

This attribute requires monitoring of continuous dissolved oxygen (DO) downstream of consented point source discharges. Currently some resource consents have conditions that require discrete sampling of dissolved oxygen and a small number have continuous DO monitoring requirements at the point of discharge but there are no consents that require continuous monitoring of dissolved oxygen downstream of the discharge. This attribute is therefore currently data deficient. Council is in the process of identifying 'high risk' point sources discharges where downstream continuous monitoring of DO would be appropriate. Consents for several large point sources discharges are due for renewal in the next ten years. As part of the consent renewal process, Council will determine whether continuous DO monitoring is appropriate. As five years data is required to establish the baseline state, Council anticipates that sufficient data will be available by 2030.

Dissolved oxygen (SOE river monitoring sites)

This attribute requires monitoring of continuous dissolved oxygen (DO) with either using a telemetered or non-telemetered data logger installed at water quality monitoring locations covering the summer period i.e., 1st November to 30th April, which was not previously undertaken by Council. This attribute is therefore currently data deficient. This attribute is assessed by measuring DO minima (i.e., rolling average of 7 consecutive daily minimum values throughout the monitoring period and lowest daily minimum over the summer period). Data collection has started at a subset of SOE river monitoring sites following Envirolink advice from Cawthron Institute (Goodwin and Young, 2022). Goodwin and Young (2022) recommended collection of continuous DO data throughout the year rather than focussing on summer only, to gather better information on the year-round seasonal pattern in DO regime including any non-compliance issues at the site or immediate upstream environment. In January 2023, DO loggers were installed at 20 river sites. It is expected that a years' worth of data will be available at 20 river monitoring sites (depending on site access and health and safety) by the end of the 2023-2024 summer period, which will require post processing (for cleaning machine errors and other anomalies) before making the data available for analysis and reporting.

Deposited fine sediment

Deposited fine sediment cover (FSC) applies to only wadeable, and naturally hard-bottomed rivers and streams. NPS-FM requires measurements to be made using Stream Assessment Method 2 (SAM2), in accordance with guidance in Clapcott et al. (2011). This is an in-stream visual assessment of the surface area of the streambed covered with fine sediment and involves taking a minimum of 20 visual cover measurements during each sampling event. Under the NPS-FM, baseline state is determined from the median of 60 measurements made over five years of monthly monitoring (or over a longer period where flow conditions only permit seasonal monitoring). The FSC monitoring has not previously been collected by Council but has now been integrated with the periphyton visual assessment protocol. Data collection started in 2022 so adequate data will be available by the end of 2027.

Cyanobacteria (planktonic)

There are very few lake-fed rivers in Northland, and they have not previously been sampled by Council. The planktonic cyanobacteria sampling has been planned in two rivers from 2022-2023 summer. NPS-FM recommends the baseline state to be based on an 80th percentile value from 30 samples collected over 3 years. Adequate data will be available by the end of 2026.

Ecosystem metabolism (both gross primary production and ecosystem respiration)

This attribute requires the use of continuous dissolved oxygen (DO) data collected over the summer period - i.e., 1st November to 30th April, which was not previously collected by Council. Furthermore, Table 21 of the NPS-FM 2020 (pg.65) for this attribute does not provide any guidance on water quality bands. Council has recently received an Envirolink advice from Cawthron Institute (Goodwin and Young, 2022) regarding the estimation of river ecosystem metabolism parameters from continuous DO data and reporting of the attribute using an interim quality banding system (as per advice from the Freshwater Science and Technical Advisory Group or STAG to MfE in 2019).

Water temperature

Although water temperature is not one of the compulsory attributes listed in NPS-FM, it is an important characteristic of aquatic system affecting rate of chemical and biological processes (e.g., growth rate, reproduction), and the levels of dissolved oxygen (e.g., warm water contains less oxygen than cold water). Many fish and invertebrates (e.g., most stonefly and some mayfly species) are sensitive to high water temperature. Water temperature varies between day and night and seasonally. Water temperature can also vary locally reflecting local conditions (e.g., riparian shade) or upstream catchment characteristics (e.g., cold water flowing from forested catchments). The temperature regime is particularly significant for Northland rivers because of the region's sub-tropical warm climate and prolonged summer compared to other parts of New Zealand.

A strong correlation was found between water temperature and periphyton biomass for Northland rivers by Kilroy and Stoffels (2019), which triggered collection of continuous water temperature data from 2021. Continuous water temperature monitoring gathers more accurate data and avoids any bias from monthly spot measurements of temperature during discrete SOE monitoring. The report concluded that the medians of daily mean temperature observed in Northland is 3–4 degree centigrade (°C) higher than the medians of daily mean in Horizons and Canterbury rivers. Though the medians of mean temperature differences seem low (3–4°C), such differences are large in terms of effects on periphyton growth.

It is expected that a year's worth of continuous water temperature data, together with dissolved oxygen (DO) will be available by the end of 2023-2024 summer period from 20 river monitoring sites, where DO loggers have been recently installed. Cox-Rutherford temperature index (CRI) will be measured from continuous temperature data recorded at 15-minute intervals over five consecutive hottest days occurring during summer period (e.g., 1st November to 30th April). CRI is the average of daily mean and daily maximum temperatures recorded for each of those five hottest days. In the absence of NPS-FM guidance and bands for temperature attribute, Council will use a temperature threshold value of 20°C for "outstanding rivers" and 24°C for other rivers (to be assessed by CRI) to protect the ecosystem health as per expert opinion based on the recommended temperature attribute table for New Zealand maritime climates (Davies-Colley et al., 2013). These temperature thresholds are currently used in Council's water quality standards for ecosystem health, for point source discharges, after allowing for reasonable mixing. (Proposed Regional Plan for Northland – Section H3 Water quality standards and guidelines)

4. River ecological attributes

The NPSFM sets out three compulsory ecological attributes (Fish Index of Biotic Integrity, macroinvertebrates, and periphyton biomass) for rivers and streams. In addition, Council has identified one additional ecological attribute – Rapid Habitat Assessment.

4.1 Baseline state time period

For consistency, the baseline state time period was selected to coincide with the rivers and streams water quality baseline state period, i.e., 2015-2019.

4.2 List of NPS-FM 2020 attributes assessed for baseline state

Macroinvertebrate Community Index (MCI), Qualitative Macroinvertebrate Community Index (QMCI), and Average Score Per Metric (ASPM)

Baseline state assessment of macroinvertebrate community indices (i.e., MCI, QMCI, and ASPM) is based on 5-year site-medians calculated from annual macroinvertebrate monitoring datasets collected at 66 river monitoring sites between 2015 and 2019 (Death et.al., 2020).

Macroinvertebrate samples were collected in both hard-bottomed and soft-bottomed rivers in Northland using the Stark sampling protocols (Stark et.al., 2001). Hard-bottomed rivers were sampled using Stark protocol C1 (Hard-bottomed semi-quantitative) and soft-bottomed rivers were sampled using Stark protocol C2 (Soft-bottomed semi-quantitative). Samples were processed used Stark protocol P2 (full count quantitative method with sub-sampling option for samples with high numbers of dominant taxa).

MCI is calculated based on the presence of macroinvertebrate taxa which are assigned scores reflecting their tolerance to organic pollution and environmental extremes. The tolerance scores for individual taxa range between 1 and 10 (1 being highly tolerant and 10 being highly sensitive to pollution). The final MCI score for each stream is based on the sum of tolerance scores for all taxa found in a sample in each year. QMCI is based on the sum of tolerance scores for each taxon weighted by the number of individuals. ASPM is the average of three standardised macroinvertebrate metrics – percent EPT abundance, EPT richness, and MCI. EPT includes the sensitive taxa that belong to Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddis fly) groups. All of these three attributes (i.e., MCI, QMCI, and ASPM) were used for baseline state assessment (Appendix 2A).

Notably, there are a few taxa often encountered in Northland rivers, which do not have a hard-bottomed/soft-bottomed tolerance score according to the current NEMS protocol for Macroinvertebrates. As Death et.al (2020) did not want these taxa to be excluded from their calculations, they have assigned tolerance scores to these taxa based on their expert opinion and following Stark and Maxted (2007).

Periphyton Biomass (trophic state)

Assessment of baseline state for benthic periphyton biomass (chlorophyll-*a* in mg/m^2 river bed area) is based on monthly periphyton monitoring data collected at 39 river monitoring sites between January 2015 and May 2018 (Kilroy and Stoffels, 2019). Periphyton samples were collected by following Biggs and Kilroy (2000) periphyton monitoring manual. According to the River Environment Classification (REC) climate and geology categories in Northland, all periphyton monitoring sites used in this assessment fell under the default class for NPS-FM numeric attribute state (i.e., they did not fall into the productive category as defined in Attribute Table 2 of the NPS-FM). Monthly chlorophyll-*a* data collected during the entire analysis period was used to calculate the NPS-FM numeric attribute state based on the 92nd

percentile (i.e., exceedance of NPS-FM criteria by no more than 8% of samples) at each site (Appendix 2B).

Fish Index of Biotic Integrity (IBI)

- December 2021 – April 2022: the most recent sampling season was used for establishing baseline state because it was the first year that at least 20 monitoring sites were sampled with a consistent applied methodology.
- Fish Index of Biotic of Integrity (IBI): fish sampling was undertaken following Joy et al. (2013) protocols as required by the NPS-FM 2020. IBI scores were calculated using a purpose-built Microsoft Excel macro developed for Northland Regional Council following the methods in Joy and Death (2004), providing a score between 0-60. This calculation reflects a regional IBI specific to Northland only, as a national IBI calculation methodology and platform are still in development (Appendix 2C).

Rapid Habitat Assessment (RHA)

Habitat assessments were undertaken annually following the protocols described in Clapcott (2015). Assessments generate qualitative scores from 0-100 such that higher scores indicate higher habitat quality. The only compulsory attribute in the NPS-FM 2020 addressing habitat is the deposited fine sediment attribute, which cannot be reported on yet as data is still being collected and it is only one component of habitat. Therefore, RHA is being proposed as an additional attribute as it provide a more comprehensive assessment of habitat quality. Quality bands were determined following the advice from national expert Dr Joanna Clapcott from Cawthron Institute. Baseline state was set using the five year (2015-2019) median value for each site (Appendix 2D).

4.3 Quality of data

The data used is the best available information on which to establish baseline states for NPS-FM 2020 freshwater ecological attributes. The samples were collected in accordance with national sampling protocols and analysed in an accredited laboratory (EOS Ecology for macroinvertebrates and NIWA for periphyton biomass).

5. Lakes water quality attributes

The NPSFM sets out 10 compulsory water quality attributes (phytoplankton, total nitrogen, total phosphorus, ammonia toxicity, *E. coli* as indicator microbial contamination, cyanobacteria, native and invasive submerged plants, lake bottom and mid-hypolimnetic dissolved oxygen) for lakes. In addition, Council has identified one additional water quality attribute – Lake Trophic Level Index or TLI (Appendix 3).

5.1 Baseline state time period 2016-2020

Selection of the date range between January 2016 and December 2020 for determining Northland's baseline state for lake water quality allowed the inclusion of optimal datasets covering a large number of monitored lakes (27 lakes). This was necessary to include as many NPS-FM attributes as possible as the majority of the lakes were monitored on a quarterly basis. Baseline state for each attribute was based on average of the annual median values calculated for each year starting from 2016 to 2020.

5.2 List of NPS-FM 2020 attributes assessed for baseline state

Baseline state for lakes water quality attributes at monitoring site level (Appendix 3) is based on discrete water quality samples collected on a quarterly basis at 27 SOE lakes between 2016 and 2020. Water quality samples were collected by following the nationally consistent NEMS protocol for lake water quality and samples were analysed in an accredited laboratory.

Phytoplankton (trophic state)

The baseline state of annual median and annual maximum phytoplankton was estimated by averaging the values calculated for each of the five monitoring years using discrete chlorophyll-*a* samples (chlorophyll-*a* mg/m^3) collected during quarterly SOE monitoring.

Total nitrogen (trophic state), Total phosphorous (trophic state)

The baseline state of annual median total nitrogen (TN mg/m^3) and total phosphorous (TP mg/m^3) were calculated by averaging the medians calculated for each of the five monitoring years using discrete water quality samples.

The baseline states for total nitrogen were assessed separately using different threshold values based on two types of lakes – *viz.* seasonally stratified deep lakes (e.g., Lake Kai Iwi, Lake Taharoa) and polymictic or shallow lakes (e.g., Lake Ngātu, Lake Waiporohita).

Ammonia (toxicity)

The baseline state of annual median and annual maximum ammonia toxicity (NH_4-N mg/L) was determined by averaging the values calculated for each of the five monitoring years using discrete water quality samples.

Submerged plants (natives)

The baseline state for submerged plants (natives) was based on the most recent Lake SPI survey[1] (lake submerged plant index) undertaken at 27 SOE lakes between 2016-2020. Lake SPI surveys are undertaken on a 5-year rotation by NIWA experts, and therefore, not all lakes were surveyed in the same year.

[1] https://lakespi.niwa.co.nz/

Submerged plants (invasive species)

Same process as submerged plants (natives), but used the Lake SPI index for invasive species based on Lake SPI survey results.

5.3 NRC proposed non NPS-FM attributes

Trophic Level Index (TLI)

The Trophic Level Index or TLI is a non NPS-FM attribute. However, this attribute is reported in LAWA[2] (Land and Water Aotearoa) website on an annual basis to indicate overall lake water quality in terms of trophic state. The TLI integrates four key measures of trophic state – total nitrogen (nutrient), total phosphorous (nutrient), chlorophyll-*a* (productivity), and secchi depth (water clarity). Initially, the TLI score was calculated for each of the four variables and then averaged to derive an overall TLI score for each sampling event (using the equations in Burns et.al., 2000). The baseline state of this overall TLI score for each site was calculated by averaging the scores across the 5-year monitoring period. In order to define the baseline state the 5-year mean TLI scores for all lakes were assessed against the trophic state categories, consistent with the Burns et.al., 2000 as well as LAWA annual reporting (Table 1).

Table 1. Lake trophic state categories based on trophic level index (TLI)

Baseline state	Trophic state (nutrient enrichment)	TLI score
Very good	Ultra-microtrophic	<1
Very good	Microtrophic	1-2
Good	Oligotrophic	2-3
Fair	Mesotrophic	3-4
Poor	Eutrophic	4-5
Poor	Supertrophic	5-6
Poor	Hypertrophic	>6

Exotic fish

This is an NRC proposed non NPS-FM attribute, as exotic pest fish have the potential to impact on lake ecosystem health and water quality process, which in turn can significantly alter native freshwater communities. Once established, they can be very difficult to eradicate. Northland lakes are particularly at risk as the warmer temperatures provide favourable conditions for many exotic fish species.

The baseline state for this attribute has been calculated by aggregating scores for individual contributing factors which include i) number of pest fish species recorded (presence/absence data from 20 years' record), ii) their current impact on lake water quality and ecosystem; iii) risk of introducing pest fish, and iv) potential future impacts from pest fish on lake ecosystem. The aggregated pest fish scores also incorporate pest fish ranks based on their predicted impact/risk for Northland lakes by following the Fish Risk Assessment Model or FRAM scores (Rowe and Wilding, 2012). To define the baseline state for Exotic fish attribute each lake was classified into four quality categories based on total pest fish scores (Table 2).

[2] https://www.lawa.org.nz/explore-data/northland-region/lakes/

Table 2: Baseline state categories for Exotic fish attribute based on aggregated pest fish scores

Baseline state	Attribute band description	Total pest fish score
Unimpacted	No pest fish detected, no impact	<=3
Slightly impacted	Pest fish of low to serious type (based on FRAM score) detected, limited current impact	>3 and <=10
Moderately impacted	Pest fish of low to serious type (based on FRAM score) detected, moderate impact and possible risk of future impact	>10 and <=12
Severely impacted	Pest fish of serious type (based on FRAM score) detected, severe impact	>12

5.4 Quality of data

The data used is the best available information (see Section 1.6 in the NPS-FM for further details) on which to establish baseline states for lake water quality attributes. The samples were collected in accordance with nationally consistent sampling protocols and analysed in an accredited laboratory.

Overall, we have high confidence in the water quality data used to determine the baseline state.

5.5 Insufficient data

Escherichia coli (E. coli)

Under NPS-FM the baseline state for this attribute is determined using a minimum of 60 samples collected on a regular basis regardless of weather and flow conditions over 5 years (i.e., at least a sampling frequency on a monthly basis). If sampling has been missed due to adverse weather conditions a timeframe longer than 5 years can be used to determine the baseline state. The quarterly sampling of SOE lakes did not satisfy the data requirements to determine the baseline state. Data collection on a monthly basis commenced in 2022. Adequate data will be available by the end of 2027.

Cyanobacteria (planktonic)

Under NPS-FM, the baseline state for this attribute is determined using a minimum of 12 cyanobacteria samples (biovolume mm^3/L) collected over 3 years. The NPS-FM recommends using 30 samples collected over 3 years. The numeric attribute state for each monitoring site is measured using the 80^{th} percentile (i.e., triggered by at least 20% of the samples) of total biovolume measurements (i.e., combined total of individual cyanobacteria species in each sample) across the monitoring period. Biovolume is calculated by multiplying the number of cyanobacteria cells (cells/mL) with the respective cell volume (μm^3) for each species (Ministry for the Environment and Ministry of Health 2009). Data collection started in 2022 so adequate data will be available by the end of 2025.

Lake-bottom and Mid-hypolimnetic dissolved oxygen

Under NPS-FM the baseline state for this attribute is determined using either continuous data logger or discrete lake profiles undertaken during SOE sampling. It is anticipated that an adequate discrete lake profile dataset will be available at 12 SOE lakes by the end of 2024, which will require post processing (for cleaning machine errors and other anomalies) before making the data available for analysis and reporting.

6. Swimming water quality attribute

NPS-FM 2020 attribute

E. coli (95th percentile) (see Table22 primary contact sites in the NPS-FM 2020)

6.1 Baseline state time period

The five-year swimming season period used to calculate the baseline state for primary contact sites was the 2016/17 to 2020/21 swimming seasons. This five-year period was chosen to align as closely as possible to the same five-year period used to calculate baseline state for rivers, streams, and lakes water quality. However, the number and location of swimming sites monitored each season can vary and selecting a five-year period to capture the most comprehensive dataset was also a considering factor.

6.2 Quality of data

The NPS-FM 2020 does not provide a methodology, length of time or minimum number of samples needed to determine the baseline state for primary contact sites. In the absence of national guidance, and to maintain national consistency, Council used Land Air Water Aotearoa (https://www.lawa.org.nz/explore-data/swimming/) criteria for determining the 'long-term' grade which is based on five years of data and a minimum of 50 data points.

The time period and number of samples used to calculate the baseline state for each primary contact site is summarised in Appendix 4.

From the 2022/23 season, freshwater sites will continue to be monitored weekly, however water quality information presented to the public will be 'real-time' modelled predictions, rather than weekly sampling results. Estuarine and coastal sites will be monitored less frequently to maintain model validation/calibrations.

7. Groundwater

7.1 Baseline time period

For consistency the baseline state time period was selected to coincide with the rivers and streams water quality baseline period, i.e., 2015-2019.

The attributes selected for reporting groundwater quality state are the attributes which most likely reflect impacts associated with human activities. The attributes include *E. coli* an indication of faecal contamination, nitrate-nitrogen and dissolved reactive phosphorus (DRP), an indication of effluent and fertiliser application to land, and chloride which can indicate changes in groundwater mixing and recharge and shifts in the freshwater / saltwater interface in coastal areas. These attributes are consistent with the NPS-FM 2020 National Objective Framework (NOF) attributes for surface water receiving environments and are also consistent with the national LAWA reporting system.

There is currently no specific biological or ecosystem health monitoring undertaken within aquifers in the Northland region. This is a national gap which requires research and advice on what to monitor, and how to monitor.

The baseline state was calculated based on the statistical median of five years of data (Appendix 5).

7.2 Quality of data

The data used is the best available information on which to establish baseline state. The samples were collected in accordance with national sampling protocols and analysed in an ISO accredited laboratory.

8. Wetlands

8.1 Insufficient Baseline data

Wetlands used to cover around 20% of Northland. Today, the remaining wetlands that cover less than 5% of Northland's land area, are many (more than 1,000) and fragmented.

Although the NPS-FM 2020 hasn't provided attributes for wetlands, council has identified a set of attributes based on the wetland condition indicators used in the National Wetland Monitoring System's (NWMS) Wetland Condition Index (WCI) methodology (Peters and Clarkson, 2010). Council has used the WCI methodology for outcome monitoring for a set of c. 30 wetlands.

The data available from the outcome monitoring programme, as well as the top wetland project, which ranked 246 of the top wetlands (Wildlands Consultants, 2011) to enable prioritising wetlands for protection, provide valuable wetland information. However, these data sets don't provide enough information to set the baseline state for a representative set of wetlands across Northland.

Council is in the process of developing a comprehensive wetland environmental monitoring programme to provide us with an assessment of the wetland baseline state across the region. The first step has been a framework developed by Manaaki Whenua – Landcare Research (MWLR) (Clarkson and Price, 2022) for monitoring the ecological state and trend of freshwater wetlands, and provision of a set of priority monitoring sites that is representative of Northland wetlands. This is concurrent with a project to accurately map all wetlands within the region.

A timeframe has yet to be set to implement a wetland SOE monitoring programme for Northland as it will depend on available resources and budget.

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10. Appendices

Appendix 1. Rivers and streams water quality baseline state

Baseline state for river water quality based on data collected from 2015-2019 sampling season. Cells highlighted in Blue = Excellent, Green = Good, Orange = Fair, and Red = Poor.

Site Name	Site ID	FMU	Ammonia toxicity mg/L (median)	Ammonia toxicity mg/L (max.)	Nitrate toxicity mg/L (median)	Nitrate toxicity mg/L (95th percentile)	Suspended fine sediment (median visual clarity m)	*E. coli* % exceedances over 540/100mL	*E. coli* % exceedances over 260/100mL	*E. coli* concentration MPN/100mL (median)	*E. coli* concentration MPN/100mL (95th percentile)	Overall *E. coli*	Dissolved reactive phosphorus mg/L (median)	Dissolved reactive phosphorus mg/L (95th percentile)
Aurere at Pekerau Road	312590	Doubtless Bay	0.024	1.62	0.048	0.62	1.13	30.2	74.6	437	1970	E	0.104	0.201
Awanui at FNDC	100363	Awanui	0.007	0.058	0.016	0.151	1	31.7	53.3	282.5	5620.2	E	0.018	0.027
Awanui at Waihue Channel	100370	Awanui	0.044	1.3	0.038	0.243	0.79	29.3	53.3	288	4885.7	E	0.044	0.11
Hakaru at Topuni	109021	Northern Wairoa	0.015	0.16	0.2	0.431	1.43	20	25	134	17359.8	E	0.059	0.093
Hatea at Mair Park	100194	Whangārei	0.009	0.055	0.47	0.695	1.41	33.7	62	350	14798.4	E	0.011	0.015
Hatea at Whangarei Falls	105972	Whangārei	0.01	0.084	0.36	0.55	1.22	38.6	81.8	447.5	4865.6	E	0.012	0.015
Kaeo at Dip Road	102674	Whangaroa	0.008	0.051	0.018	0.15	1.38	36.7	63.3	403.5	6571.8	E	0.008	0.017
Kaihu at Gorge	102256	Northern Wairoa	0.005	0.035	0.18	0.391	1.66	15	31.7	181.5	3897	E	0.008	0.011

Site Name	Site ID	FMU	Ammonia toxicity mg/L (median)	Ammonia toxicity mg/L (max.)	Nitrate toxicity mg/L (median)	Nitrate toxicity mg/L (95th percentile)	Suspended fine sediment (median visual clarity m)	*E. coli* % exceedances over 540/100mL	*E. coli* % exceedances over 260/100mL	*E. coli* concentration MPN/100mL (median)	*E. coli* concentration MPN/100mL (95th percentile)	Overall *E. coli*	Dissolved reactive phosphorus mg/L (median)	Dissolved reactive phosphorus mg/L (95th percentile)
Kenana at Kenana Road	306635	Doubtless Bay	0.006	0.025	0.024	0.101	1.7	28.3	63.3	333.5	1038.3	E	0.022	0.033
Kerikeri at Stone Store	101530	Bay of Islands	0.013	0.15	0.415	0.635	2.19	25.8	44.9	228	12611.4	E	0.01	0.047
Manaia at SH10	306639	Bay of Islands	0.016	0.33	0.135	0.36	1	20	41.7	235	1609.6	E	0.02	0.028
Mangahahuru at Apotu Road	100281	Northern Wairoa	0.016	0.17	0.305	0.49	1.25	18.3	60	310	7584.9	E	0.033	0.068
Mangahahuru at Main Road	100237	Northern Wairoa	0.01	0.066	0.14	0.38	1.36	36.7	66.7	452.5	3488.6	E	0.013	0.018
Mangakahia at Titoki	101038	Northern Wairoa	0.009	0.139	0.094	0.386	0.82	24.4	39.5	179.7	11690	E	0.01	0.02
Mangakahia at Twin Bridges	109096	Northern Wairoa	0.005	0.045	0.029	0.201	1.55	18.3	36.7	121	4489.4	E	0.009	0.013
Mangakino at Mangakino Lane	109795	Whangārei	0.006	0.023	0.165	0.394	0.7	8.3	20	149	986	E	0.012	0.016
Mangakino U/S Waitaua Confluence	109982	Whangārei	0.015	0.033	0.22	0.432	0.95	53.3	91.7	559.5	1720.3	E	0.014	0.019
Mangamuka at Iwitaua Road	108978	Hokianga	0.005	0.037	0.005	0.061	1.5	38.3	66.7	345	2938.6	E	0.034	0.042

Site Name	Site ID	FMU	Ammonia toxicity mg/L (median)	Ammonia toxicity mg/L (max.)	Nitrate toxicity mg/L (median)	Nitrate toxicity mg/L (95th percentile)	Suspended fine sediment (median visual clarity m)	*E. coli* % exceedances over 540/100mL	*E. coli* % exceedances over 260/100mL	*E. coli* concentration MPN/100mL (median)	*E. coli* concentration MPN/100mL (95th percentile)	Overall *E. coli*	Dissolved reactive phosphorus mg/L (median)	Dissolved reactive phosphorus mg/L (95th percentile)
Manganui at Mititai Road	102257	Northern Wairoa	0.028	0.29	0.097	0.441	0.8	21.7	28.3	120	3638.2	E	0.036	0.073
Mangere at Kara Road	102106	Northern Wairoa	0.01	0.053	0.42	0.7	1.51	55	88.3	615	2433.8	E	0.19	0.021
Mangere at Knights Road	101625	Northern Wairoa	0.031	1.6	0.48	1	0.98	68.2	91.8	656.5	11288.4	E	0.015	0.141
Mangere at Kokopu Road	102109	Northern Wairoa	0.016	0.093	0.41	0.731	1.3	63.3	90	599	2206.6	E	0.047	0.045
Mangere at Wood Road	109166	Northern Wairoa	0.014	0.06	0.415	0.731	1.4	48.3	83.3	524.5	1436.4	E	0.015	0.02
Ngunguru at Coalhill Lane	110603	Whananaki Coast	0.008	0.034	0.115	0.29	2.15	28.3	53.3	310.5	7346.7	E	0.016	0.024
Opouteke at Suspension Bridge	102258	Northern Wairoa	0.005	0.039	0.07	0.395	1.42	15	30	145	1220.8	E	0.009	0.015
Oruaiti at Sawyer Road	306673	Doubtless Bay	0.007	0.028	0.008	0.074	1.4	20	38.3	194	2053.8	E	0.012	0.016
Oruaiti at Windust Road	304641	Doubtless Bay	0.008	0.024	0.033	0.145	1.4	18.3	56.7	275	2530	E	0.012	0.016
Oruru at Oruru Road	108979	Doubtless Bay	0.008	0.056	0.022	0.13	1.28	22.5	59.5	305	2778.5	E	0.027	0.039
Otaika at Cemetery Road	306865	Whangārei	0.017	0.062	1.35	1.8	0.93	58.3	76.7	795	3873	E	0.018	0.028

Site Name	Site ID	FMU	Ammonia toxicity mg/L (median)	Ammonia toxicity mg/L (max.)	Nitrate toxicity mg/L (median)	Nitrate toxicity mg/L (95th percentile)	Suspended fine sediment (median visual clarity m)	*E. coli* % exceedances over 540/100mL	*E. coli* % exceedances over 260/100mL	*E. coli* concentration MPN/100mL (median)	*E. coli* concentration MPN/100mL (95th percentile)	Overall *E. coli*	Dissolved reactive phosphorus mg/L (median)	Dissolved reactive phosphorus mg/L (95th percentile)
Otaika at Otaika Valley Road	110431	Whangārei	0.014	0.15	1.1	1.6	1.23	51.4	85.3	550	4507.4	E	0.021	0.033
Otakaranga at Otaika Valley Road	306863	Whangārei	0.017	0.12	0.044	0.349	1	46.7	73.3	450	2417.8	E	0.01	0.018
Paranui at Paranui Road	306665	Doubtless Bay	0.01	0.031	0.028	0.151	1.4	8.3	33.3	191	700.7	E	0.008	0.012
Parapara at Parapara Toatoa Road	304599	Doubtless Bay	0.012	0.058	0.022	0.049	1.4	16.7	61.7	301.5	1148.9	E	0.011	0.014
Parapara at Taumata Road	304597	Doubtless Bay	0.02	0.081	0.028	0.081	0.81	23.3	70	343	1107.3	E	0.014	0.023
Pekepeka at Ohaeawai	306643	Bay of Islands	0.006	0.073	0.28	0.49	1.82	6.7	35	212	628.6	E	0.01	0.013
Peria at Honeymoon Valley Road	306641	Doubtless Bay	0.005	0.019	0.024	0.049	2.1	5	21.7	132	500.7	E	0.051	0.061
Pukenui at Kanehiana Drive	312177	Whangārei	0.008	0.042	0.1	0.255	1.82	34.8	63	394.5	6394.8	E	0.017	0.024
Punakitere at Taheke	105231	Hokianga	0.012	0.18	0.375	0.583	0.91	40	60	327	5863.4	E	0.023	0.057
Punaruku at Russell Road	313171	Whananaki Coast	0.005	0.026	0.017	0.058	3	9.5	21.4	121	1057.6	E	0.01	0.013

Site Name	Site ID	FMU	Ammonia toxicity mg/L (median)	Ammonia toxicity mg/L (max.)	Nitrate toxicity mg/L (median)	Nitrate toxicity mg/L (95th percentile)	Suspended fine sediment (median visual clarity m)	*E. coli* % exceedances over 540/100mL	*E. coli* % exceedances over 260/100mL	*E. coli* concentration MPN/100mL (median)	*E. coli* concentration MPN/100mL (95th percentile)	Overall *E. coli*	Dissolved reactive phosphorus mg/L (median)	Dissolved reactive phosphorus mg/L (95th percentile)
Puwera at SH1	315381	Whangārei	0.035	5	0.25	0.688	0.89	53.5	83.7	594	2253.8	E	0.017	0.036
Raumanga at Bernard Street	304709	Whangārei	0.015	0.053	1.1	1.3	1.55	61.8	92.7	670	3873	E	0.016	0.022
Ruakaka at Flyger Road	105008	Bream Bay	0.035	0.41	0.39	0.834	0.93	41.7	80	464.5	8965.6	E	0.089	0.161
Stony Creek at Sawyer Road	306675	Doubtless Bay	0.01	0.08	0.042	0.16	1.6	13.3	28.3	150	1520.9	E	0.013	0.022
Tapapa at SH1	313165	Hokianga	0.005	0.018	0.026	0.066	1.9	7.1	16.7	103.5	581.4	E	0.036	0.06
Utakura at Horeke Road	109020	Hokianga	0.014	0.059	0.11	0.242	0.94	11.1	38.9	206	1509.9	E	0.01	0.025
Utakura at Okaka Road	107284	Hokianga	0.015	0.43	0.155	0.313	1.1	25.5	44.7	250	4953.3	E	0.013	0.031
Victoria at Victoria Valley Road	105532	Awanui	0.005	0.022	0.004	0.073	1.8	10	18.3	158	880	E	0.02	0.028
Waiarohia at Second Avenue	108359	Whangārei	0.011	0.44	0.35	0.615	2.07	34.2	66.7	417	9232	E	0.014	0.02
Waiarohia at Whau Valley	107773	Whangārei	0.009	0.078	0.4	0.741	1.82	31.7	75	380	2038.2	E	0.016	0.023
Waiaruhe at Puketona	304589	Bay of Islands	0.018	0.095	0.24	0.452	1.4	18.3	45	243.5	790.4	E	0.012	0.019
Waiaruhe D/S Mangamutu Confluence	306661	Bay of Islands	0.125	0.86	0.405	0.684	1.42	21.7	55	280	1086	E	0.009	0.016

Site Name	Site ID	FMU	Ammonia toxicity mg/L (median)	Ammonia toxicity mg/L (max.)	Nitrate toxicity mg/L (median)	Nitrate toxicity mg/L (95th percentile)	Suspended fine sediment (median visual clarity m)	*E. coli* % exceedances over 540/100mL	*E. coli* % exceedances over 260/100mL	*E. coli* concentration MPN/100mL (median)	*E. coli* concentration MPN/100mL (95th percentile)	Overall *E. coli*	Dissolved reactive phosphorus mg/L (median)	Dissolved reactive phosphorus mg/L (95th percentile)
Waiharakeke at Stringers Road	100007	Bay of Islands	0.016	0.62	0.12	0.358	1.09	26.7	50	259	13123.7	E	0.016	0.032
Waimamaku at SH12	109098	Waipoua	0.005	0.017	0.004	0.033	1.4	26.7	53.3	286.5	2890.6	E	0.006	0.009
Waiotu at SH1	102248	Northern Wairoa	0.018	0.32	0.25	0.754	1.25	23.3	65	350	14620.2	E	0.021	0.051
Waipao at Draffin Road	108941	Northern Wairoa	0.009	0.32	2.3	3.32	2	58.3	86.7	676.5	9957.4	E	0.033	0.053
Waipapa at Forest Ranger	101751	Hokianga	0.004	0.008	0.03	0.066	3.23	10	18.3	81.1	1124.1	E	0.005	0.007
Waipapa at Waimate North Road	306915	Bay of Islands	0.008	0.29	0.11	0.372	1.3	18.3	43.3	242	3676.6	E	0.017	0.039
Waipapa at Waipapa Landing	101524	Bay of Islands	0.015	0.086	0.265	0.441	2.48	15	28.3	189.5	3350.9	E	0.006	0.011
Waipoua at SH12	103304	Waipoua	0.005	0.053	0.016	0.067	1.75	10	16.7	64	2145.9	E	0.007	0.01
Wairau at SH12	313168	Waipoua	0.005	0.021	0.004	0.006	1.51	7.3	19.5	86	670	B	0.005	0.008
Wairua at Purua	101753	Northern Wairoa	0.023	0.18	0.39	1.06	0.9	22.4	30.6	121.1	23326	E	0.025	0.055
Waitangi at SH10	304595	Bay of Islands	0.01	0.065	0.23	0.4	1.28	20	48.3	259.5	4898.4	E	0.009	0.015
Waitangi at Waimate North Road	103178	Bay of Islands	0.011	0.063	0.31	0.49	1.51	27	56.8	305	9635	E	0.006	0.012

Site Name	Site ID	FMU	Ammonia toxicity mg/L (median)	Ammonia toxicity mg/L (max.)	Nitrate toxicity mg/L (median)	Nitrate toxicity mg/L (95th percentile)	Suspended fine sediment (median visual clarity m)	*E. coli* % exceedances over 540/100mL	*E. coli* % exceedances over 260/100mL	*E. coli* concentration MPN/100mL (median)	*E. coli* concentration MPN/100mL (95th percentile)	Overall *E. coli*	Dissolved reactive phosphorus mg/L (median)	Dissolved reactive phosphorus mg/L (95th percentile)
Waitangi at Wakelins	101752	Bay of Islands	0.01	0.067	0.21	0.446	1.3	17.6	32.4	170	2419.2	E	0.01	0.022
Waitaua at Vinegar Hill Road	108738	Whangārei	0.014	0.061	0.51	0.701	1.52	56.7	90	605	2082.7	E	0.011	0.014
Watercress at SH1	306655	Bay of Islands	0.01	0.08	0.715	1.1	1.7	33.3	70	328.5	2018.9	E	0.033	0.046
Whakapara at Cableway	102249	Northern Wairoa	0.011	0.15	0.24	0.595	1.48	21.7	53.3	275.5	17455.7	E	0.027	0.041

Appendix 2. Rivers and streams ecology baseline state

A. Baseline state for macroinvertebrate community indices based on annual sampling between 2015 and 2019. Cells highlighted in Blue = Excellent, Green = Good, Orange = Fair, and Red = Poor.

Site Name	Site ID	FMU	Macroinvertebrate community index (MCI)	Qualitative macroinvertebrate community index (QMCI)	Average score per metric (ASPM)
Aurere at Pekerau Road	312590	Doubtless Bay	64	2.2	0.1
Awanui at FNDC	100363	Awanui	92	4.2	0.3
Awanui at Waihue Channel	100370	Awanui	74	2.3	0.2
Hakaru at Topuni	109021	Northern Wairoa	76	3.6	0.2
Hatea at Mair Park	100194	Whangārei	79	3.9	0.2
Hatea at Whangarei Falls	105972	Whangārei	81	3.8	0.2
Kaeo at Dip Road	102674	Whangaroa	93	5	0.2
Kaihu at Gorge	102256	Northern Wairoa	86	3.8	0.3
Kenana at Kenana Road	306635	Doubtless Bay	91	4	0.3
Kerikeri at Stone Store	101530	Bay of Islands	80	3.8	0.2
Manaia at SH10	306639	Bay of Islands	60	2.8	0.2
Mangahahuru at Apotu Road	100281	Northern Wairoa	79	3.2	0.2
Mangahahuru at Main Road	100237	Northern Wairoa	117	5.4	0.4
Mangakahia at Titoki	101038	Northern Wairoa	95	2.2	0.2
Mangakahia at Twin Bridges	109096	Northern Wairoa	88	3.4	0.2
Mangakino at Mangakino Lane	109795	Whangārei	105	6	0.5
Mangakino U/S Waitaua Confluence	109982	Whangārei	93	2.6	0.2
Mangamuka at Iwitaua Road	108978	Hokianga	106	5.5	0.4
Manganui at Mititai Road	102257	Northern Wairoa	53	2.1	0.1
Mangere at Kara Road	102106	Northern Wairoa	109	5.2	0.4
Mangere at Knights Road	101625	Northern Wairoa	86	2.2	0.2
Mangere at Kokopu Road	102109	Northern Wairoa	99	2.3	0.2
Mangere at Wood Road	109166	Northern Wairoa	79	3.9	0.2
Ngunguru at Coalhill Lane	110603	Whananaki Coast	92	4.6	0.3
Opouteke at Suspension Bridge	102258	Northern Wairoa	82	3	0.2
Oruaiti at Sawyer Road	306673	Doubtless Bay	86	3.7	0.3
Oruaiti at Windust Road	304641	Doubtless Bay	88	3.9	0.2
Oruru at Oruru Road	108979	Doubtless Bay	91	2.4	0.2
Otaika at Cemetery Road	306865	Whangārei	88	3.2	0.3
Otaika at Otaika Valley Road	110431	Whangārei	106	4.6	0.3

Site Name	Site ID	FMU	Macroinvertebrate community index (MCI)	Qualitative macroinvertebrate community index (QMCI)	Average score per metric (ASPM)
Otakaranga at Otaika Valley Road	306863	Whangārei	58	2	0.1
Paranui at Paranui Road	306665	Doubtless Bay	64	3.7	0.2
Parapara at Parapara Toatoa Road	304599	Doubtless Bay	89	4.6	0.4
Parapara at Taumata Road	304597	Doubtless Bay	87	2.1	0.2
Pekepeka at Ohaeawai	306643	Bay of Islands	86	3.1	0.2
Peria at Honeymoon Valley Road	306641	Doubtless Bay	118	6.6	0.5
Pukenui at Kanehiana Drive	312177	Whangārei	127	5.8	0.6
Punakitere at Taheke	105231	Hokianga	88	4.2	0.4
Punaruku at Russell Road	313171	Whananaki Coast	113	5	0.4
Puwera at SH1	315381	Whangārei	60	2	0.1
Raumanga at Bernard Street	304709	Whangārei	85	4.1	0.2
Ruakaka at Flyger Road	105008	Bream Bay	86	3.6	0.2
Stony Creek at Sawyer Road	306675	Doubtless Bay	90	4.1	0.3
Tapapa at SH1	313165	Hokianga	121	7	0.6
Utakura at Horeke Road	109020	Hokianga	ND	ND	ND
Utakura at Okaka Road	107284	Hokianga	66	2.1	0.1
Victoria at Victoria Valley Road	105532	Awanui	106	4.8	0.4
Waiarohia at Second Avenue	108359	Whangārei	77	3.6	0.2
Waiarohia at Whau Valley	107773	Whangārei	78	3.5	0.2
Waiaruhe at Puketona	304589	Bay of Islands	91	3.1	0.3
Waiaruhe D/S Mangamutu Confluence	306661	Bay of Islands	97	5.9	0.5
Waiharakeke at Stringers Road	100007	Bay of Islands	92	4.5	0.4
Waimamaku at SH12	109098	Waipoua	94	4	0.3
Waiotu at SH1	102248	Northern Wairoa	78	2.2	0.2
Waipao at Draffin Road	108941	Northern Wairoa	109	3.1	0.3
Waipapa at Forest Ranger	101751	Hokianga	108	5.1	0.4
Waipapa at Waimate North Road	306915	Bay of Islands	90	4.2	0.3
Waipapa at Waipapa Landing	101524	Bay of Islands	66	3	0.1
Waipoua at SH12	103304	Waipoua	133	7.6	0.7
Wairau at SH12	313168	Waipoua	122	6.3	0.5
Wairua at Purua	101753	Northern Wairoa	77	2.2	0.2
Waitangi at SH10	304595	Bay of Islands	94	4.4	0.3
Waitangi at Waimate North Road	103178	Bay of Islands	114	6.1	0.4
Waitangi at Wakelins	101752	Bay of Islands	71	1.8	0.1
Waitaua at Vinegar Hill Road	108738	Whangārei	80	2.4	0.2
Watercress at SH1	306655	Bay of Islands	89	4.5	0.4
Whakapara at Cableway	102249	Northern Wairoa	78	2.3	0.2

B. Baseline state for periphyton biomass (92nd percentile Chlorophyll a mg/m2) based on monthly sampling between January 2015 and May 2019. Cells highlighted in Blue = Excellent, Green = Good, Orange = Fair, and Red = Poor. ND (i.e., no data) indicates sites unsuitable for periphyton monitoring.

Site Name	Site ID	FMU	Periphyton biomass (92nd percentile Chlorophyll *a* mg/m^2)
Aurere at Pekerau Road	312590	Doubtless Bay	ND
Awanui at FNDC	100363	Awanui	173.5
Awanui at Waihue Channel	100370	Awanui	ND
Hakaru at Topuni	109021	Northern Wairoa	717
Hatea at Mair Park	100194	Whangārei	14.7
Hatea at Whangarei Falls	105972	Whangārei	ND
Kaeo at Dip Road	102674	Whangaroa	26.8
Kaihu at Gorge	102256	Northern Wairoa	66.9
Kenana at Kenana Road	306635	Doubtless Bay	ND
Kerikeri at Stone Store	101530	Bay of Islands	63.5
Manaia at SH10	306639	Bay of Islands	ND
Mangahahuru at Apotu Road	100281	Northern Wairoa	ND
Mangahahuru at Main Road	100237	Northern Wairoa	22.6
Mangakahia at Titoki	101038	Northern Wairoa	ND
Mangakahia at Twin Bridges	109096	Northern Wairoa	96.9
Mangakino at Mangakino Lane	109795	Whangārei	38.1
Mangakino U/S Waitaua Confluence	109982	Whangārei	ND
Mangamuka at Iwitaua Road	108978	Hokianga	22.1
Manganui at Mititai Road	102257	Northern Wairoa	ND
Mangere at Kara Road	102106	Northern Wairoa	ND
Mangere at Knights Road	101625	Northern Wairoa	ND
Mangere at Kokopu Road	102109	Northern Wairoa	ND
Mangere at Wood Road	109166	Northern Wairoa	ND
Ngunguru at Coalhill Lane	110603	Whananaki Coast	77.4
Opouteke at Suspension Bridge	102258	Northern Wairoa	153.7
Oruaiti at Sawyer Road	306673	Doubtless Bay	106.7
Oruaiti at Windust Road	304641	Doubtless Bay	61.7
Oruru at Oruru Road	108979	Doubtless Bay	ND
Otaika at Cemetery Road	306865	Whangārei	ND
Otaika at Otaika Valley Road	110431	Whangārei	52.6
Otakaranga at Otaika Valley Road	306863	Whangārei	ND
Paranui at Paranui Road	306665	Doubtless Bay	ND
Parapara at Parapara Toatoa Road	304599	Doubtless Bay	ND
Parapara at Taumata Road	304597	Doubtless Bay	ND

Site Name	Site ID	FMU	Periphyton biomass (92nd percentile Chlorophyll *a* mg/m^2)
Pekepeka at Ohaeawai	306643	Bay of Islands	85.4
Peria at Honeymoon Valley Road	306641	Doubtless Bay	110.3
Pukenui at Kanehiana Drive	312177	Whangārei	Provisional A (< 3 years of data)
Punakitere at Taheke	105231	Hokianga	132.8
Punaruku at Russell Road	313171	Whananaki Coast	8.9
Puwera at SH1	315381	Whangārei	ND
Raumanga at Bernard Street	304709	Whangārei	46.7
Ruakaka at Flyger Road	105008	Bream Bay	63.1
Stony Creek at Sawyer Road	306675	Doubtless Bay	24.6
Tapapa at SH1	313165	Hokianga	5.1
Utakura at Horeke Road	109020	Hokianga	ND
Utakura at Okaka Road	107284	Hokianga	ND
Victoria at Victoria Valley Road	105532	Awanui	30.6
Waiarohia at Second Avenue	108359	Whangārei	112.7
Waiarohia at Whau Valley	107773	Whangārei	65.9
Waiaruhe at Puketona	304589	Bay of Islands	54.4
Waiaruhe D/S Mangamutu Confluence	306661	Bay of Islands	52.1
Waiharakeke at Stringers Road	100007	Bay of Islands	250.5
Waimamaku at SH12	109098	Waipoua	30.1
Waiotu at SH1	102248	Northern Wairoa	ND
Waipao at Draffin Road	108941	Northern Wairoa	54.2
Waipapa at Forest Ranger	101751	Hokianga	31.7
Waipapa at Waimate North Road	306915	Bay of Islands	34.4
Waipapa at Waipapa Landing	101524	Bay of Islands	160.3
Waipoua at SH12	103304	Waipoua	4.3
Wairau at SH12	313168	Waipoua	ND
Wairua at Purua	101753	Northern Wairoa	ND
Waitangi at SH10	304595	Bay of Islands	29.8
Waitangi at Waimate North Road	103178	Bay of Islands	31.9
Waitangi at Wakelins	101752	Bay of Islands	ND
Waitaua at Vinegar Hill Road	108738	Whangārei	ND
Watercress at SH1	306655	Bay of Islands	54.3
Whakapara at Cableway	102249	Northern Wairoa	ND

C. Baseline state for Fish Index of Biotic Integrity (Fish IBI) from 2021-2022 sampling season.

Site Name	Site ID	FMU	Fish IBI	Baseline State
Otaika at Otaika Valley Road	110431	Whangarei	44	A
Opouteke at Suspension Bridge	102258	Northern Wairoa	30	B
Opaopao Stream at Forest Road	331866	Hokianga	54	A
Waiarohia at Second Avenue	108359	Whangarei	54	A
Unnamed Tributary at Hakaru at Toponui	332199	Northern Wairoa	14	D
Kerikeri River at Rainbow Falls	308794	Bay of Islands	28	B
Mangahahuru at Main Rd	100237	Northern Wairoa	32	B
Ngunguru at Coal Hill	110603	Whananaki Coast	52	A
Pukenui at Kanehiana Drive	312177	Whangarei	32	B
Raumanga at Bernard Street	304709	Whangarei	46	A
Tangowahine at Tangowahine Valley Road	322490	Northern Wairoa	18	C
Toronui Stream at Waipoua Confluence	332198	Waipoua	44	A
Waikoromiko at Hatea Confluence	331834	Whangarei	54	A
Waimamaku at SH12	109098	Waipoua	44	A
Waitangi at Waimate North	103178	Bay of Islands	24	C
Tapapa at SH1	313165	Hokianga	40	A
Oruaiti at Windust Road	304641	Doubtless Bay	44	A
Oruru at Oruru Road	108979	Doubtless Bay	52	A
Punaruku at Russell Road	313171	Whananaki Coast	52	A
Ruakaka at Flyger Road	105008	Bream Bay	52	A
Kerikeri River at Rainbow Falls	308794	Bay of Islands	28	B
Mangahahuru at Main Rd	100237	Northern Wairoa	32	B

D. Baseline state for Rapid Habitat Assessments based on 5-year medians from 2015-2019.

Site Name	Site ID	5 Year Median (%?)	Total Number of Observations 2015-2019	Baseline State
Waiharakeke at Stringers Road	100007	55.5	3	Good
Hatea at Mair Park	100194	78.5	4	Excellent
Mangahahuru at Main Road	100237	66.25	4	Good
Awanui at FNDC	100363	43	5	Fair
Mangere at Knight Road	101625	42.5	3	Fair
Waipapa at Forest Ranger	101751	79	5	Excellent
Waitangi at Wakelins	101752	44	4	Fair
Wairua at Purua	101753	45.75	4	Fair
Waiotu at SH1	102248	36	3	Fair
Kaihu at Gorge	102256	74	4	Good
Manganui at Mititai Road	102257	30.5	4	Fair
Opouteke at Suspension	102258	52.75	4	Good
Kaeo at Dip Road	102674	50	5	Fair
Waitangi at Waimate North Road	103178	44	6	Fair
Waipoua at SH12	103304	88	3	Excellent
Ruakaka at Flyger Road	105008	57	5	Good
Punakitere at Taheke	105231	62.5	5	Good
Victoria at Victoria Valley Road	105532	71	5	Good
Hatea at Whangarei Falls	105972	56.75	4	Good
Utakura at Okaka Road	107284	38	2	Fair
Waiarohia at Second Avenue	108359	57	3	Good
Waipao at Draffin Road	108941	63	5	Good
Oruru at Oruru Road	108979	41	4	Fair
Hakaru at Topuni	109021	53.25	4	Good
Mangakahia at Twin Bridges	109096	62	4	Good
Waimamaku at SH12	109098	57.5	4	Good
Otaika at Otaika Valley Road	110431	70.5	4	Good
Ngunguru at Coalhill Lane	110603	52.75	4	Good
Waiaruhe at Puketona	304589	52.5	3	Good
Wairuhe at Puketona	304589	68	1	Good
Parapara at Taumata Road	304597	46	3	Fair
Oruaiti at Windust Road	304641	54.5	4	Good
Raumanga at Bernard Street	304709	74.5	2	Good
Pukenui at Kanehiana Drive	312177	87.5	4	Excellent
Tapapa at SH1	313165	95	5	Excellent
Wairau at SH12	313168	74	4	Good
Punaruku at Russell Road	313171	77	4	Excellent
Tangowahine at Tangowahine Valley Road	322490	60.25	2	Good
Kerikeri at Kerikeri Basin Reserve	324659	73.25	2	Good

Excellent = >75%; Good = 50-75%; Fair = 25-50%; Poor <25%

Appendix 3. Lakes baseline state

Baseline state for lakes water quality based on data collected from 2016-2020 sampling season. For *Lake TLI* attribute, cells in Blue = Very good, Green = Good, Orange = Fair, and Red = poor. For *Exotic fish* attribute cells in Blue = Unimpacted, Green = Slightly impacted, Orange = Moderately impacted, and Red = Severely impacted. For all other water quality attributes cells in Blue = Excellent, Green = Good, Orange = Fair, and Red = Poor. Lake names shaded indicates seasonally stratified, otherwise polymictic (i.e., too shallow to develop thermal stratification). **Lakes names in bold and blue** indicates "outstanding lakes".

Lake Names	Site ID	FMU	Phytoplankton (annual median Chlorophyll *a* mg/m3)	Phytoplankton (annual max. Chlorophyll *a* mg/m3)	Ammonia toxicity (annual median NH_4-N mg/L)	Ammonia toxicity (annual max. NH_4-N mg/L)	Total nitrogen (annual median TN mg/m3)	Total phosphorus (annual median TP mg/m3)	Submerged plants (Lake SPI natives)	Submerged plants (Lake SPI invasive)	Lake trophic level index (TLI score)	Exotic fish
Lake Carrot	107776	Aupōuri	8	12	0.002	0.007	515	19	55	32	4.19	2
Lake Heather	101031	Aupōuri	15	33	0.010	0.023	652	30	0	0	4.71	7
Lake Kahuparere	101367	Northern Wairoa	5	14	0.010	0.045	367	13	70	27	3.83	1
Lake Karaka	108347	Poutō	19	105	0.008	0.022	393	34	62	0	4.62	2
Lake Mokeno	100593	Poutō	4	23	0.027	0.166	660	21	61	0	4.13	2
Lake Ngakapua North	108242	Aupōuri	4	7	0.003	0.009	414	10	63	34	3.73	9
Lake Ngakapua South	101913	Aupōuri	6	12	0.002	0.006	559	15	56	30	4.00	9
Lake Ngatu	101032	Awanui	5	12	0.047	0.080	796	9	53	0	3.83	12
Lake Omapere at outlet (Utakura River)	100501	Hokianga	7	22	0.013	0.107	486	36	0	0	4.74	15
Lake Rotokawau (Aupouri)	106734	Awanui	8	20	0.003	0.015	761	18	37	68	4.38	8
Lake Rotoroa (Aupouri)	100425	Aupōuri	6	13	0.006	0.015	638	11	47	70	3.95	8

Lake Names	Site ID	FMU	Phytoplankton (annual median Chlorophyll *a* mg/m3)	Phytoplankton (annual max. Chlorophyll *a* mg/m3)	Ammonia toxicity (annual median NH_4-N mg/L)	Ammonia toxicity (annual max. NH_4-N mg/L)	Total nitrogen (annual median TN mg/m3)	Total phosphorus (annual median TP mg/m3)	Submerged plants (Lake SPI natives)	Submerged plants (Lake SPI invasive)	Lake trophic level index (TLI score)	Exotic fish
Lake Rototuna	101375	Northern Wairoa	26	64	0.005	0.021	990	38	64	7	4.90	10
Lake Swan (Roto-otuauru)	101377	Northern Wairoa	21	73	0.007	0.063	1003	45	N/A	N/A	5.07	7
Lake Te Kahika	101909	Aupōuri	1	1	0.009	0.020	380	9	0	0	3.16	1
Lake Wahakari	101034	Aupōuri	1	2	0.002	0.003	292	6	51	46	3.16	9
Lake Waihopo	108232	Aupōuri	3	8	0.008	0.017	601	17	79	21	3.95	1
Lake Waipara	108240	Aupōuri	2	4	0.002	0.003	389	12	0	0	3.59	1
Lake Waiparera	101033	Awanui	14	37	0.005	0.086	926	25	47	81	4.65	14
Lake Waiporohita	101930	Doubtless Bay	13	30	0.008	0.021	1065	37	85	0	4.82	10
Lake Kai iwi	100438	Poutō	1	5	0.007	0.014	351	6	71	12	2.82	12
Lake Kanono	101369	Northern Wairoa	7	21	0.009	0.018	326	13	59	17	3.78	1
Lake Humuhumu	101379	Northern Wairoa	3	10	0.005	0.029	326	14	63	24	3.50	1
Lake Morehurehu	101908	Aupōuri	3	4	0.004	0.007	422	14	21	27	3.82	1
Lake Rotokawau (Pouto)	101373	Northern Wairoa	3	10	0.012	0.031	426	8	43	27	3.27	2
Lake Taharoa	100442	Poutō	1	2	0.001	0.002	109	2	79	0	1.98	10
Lake Waikare	100448	Poutō	1	2	0.001	0.001	177	3	79	19	2.51	10
Lake Wainui	108346	Poutō	3	17	0.014	0.051	448	22	73	0	3.88	1

Appendix 4. Northland Region Swimming Sites Baseline state.

Baseline state is based on the 2016/17-2020/21 swimming seasons and NPS-FM Table 22 *E. coli* attribute bands. Only sites with 50 samples or more are included.

Freshwater Swimming Site	Site No.	Baseline period	Number of Samples	E. coli 95th percentile	Baseline state
Ahuroa at Piroa Falls	317597	2016/17-2020/21	71	1566	Poor
Hatea River at Whangarei Falls	105972	2016/17-2019/20*	65	6198	Poor
Kerikeri at Rainbow Falls	308794	2016/17-2020/21	81	3076	Poor
Lake Ngatu	100402	2016/17-2020/21	73	115	Excellent
Lake Taharoa pump house	105434	2016/17-2020/21	73	25	Excellent
Lake Waro (Hikurangi)	107272	2016/17-2020/21	74	247	Good
Raumanga Stream	103246	2016/17-2020/21	90	1101	Poor
Tirohanga Stream	102252	2016/17-2020/21	84	1385	Poor
Victoria River	104908	2016/17-2020/21	86	1142	Poor
Waipapa River at forest pools/Waihou Valley	103248	2016/17-2020/21	74	1060	Poor
Waipoua River at DOC HQ	108613	2016/17-2020/21	78	833	Poor
Waitangi at Wakelins	101752	2016/17-2019/20*	65	1101	Poor

* Although these sites don't have a full 5-years of data, they have been included as they have more than 50 data points.

Appendix 5. Groundwater quality baseline state

Baseline state is based on SOE data collected during 2015-2019 sampling season

Site Name	Chloride Median	DRP Median	Nitrate Median	*E. coli* Median
101313	640	0.03	3.7	0.75
101759	27	0.022	2.655	0.5
102039	50	0.09	0.005	NA
102110	110	0.048	0.001	0.5
102332	32	NA	0.067	0.5
102368	130	NA	NA	0.5
103138	370	0.105	0.002	0.5
103192	43	0.16	0.002	0.5
104650	24	NA	1.8	8
104890	61	0.008	0.005	NA
105914	31	0.005	0.37	NA
105916	14.5	0.01	0.685	NA
106545	201	0.03	1.35	NA
106694	69	0.023	0.002	0.5
106695	84.5	0.365	0.121	0.5
106697	48.5	0.039	0.825	1
106698	31	0.068	0.006	0.5
106724	59	0.002	0.005	NA
106736	61	0.089	0.002	0.5
106737	64.5	0.215	0.002	0.5
106739	13	0.016	2.1	0.5
106740	19	0.063	6.7	0.5
106741	16	0.004	4.3	1
106742	15	0.037	3.65	0.5
107034	31	0.046	0.004	0.5
108260	120	0.064	0.005	0.5
108261	73.5	0.019	0.71	0.5
108262	99.85	0.019	1.9	0.5
108263	170	0.019	9.7	0.5
108333	32	0.041	3.8	0.5
108334	22	NA	3.9	179
108341	59	0.13	4.75	0.5
108360	62	0.022	0.049	1
108361	50	0.022	5.25	0.5
108590	19	0.012	6.4	0.5

Site Name	Chloride Median	DRP Median	Nitrate Median	*E. coli* Median
108686	34	0.012	1.5	0.5
108688	290	NA	NA	2
108954	13	0.055	1.6	0.5
108991	NA	NA	7.65	0.5
109005	NA	NA	0.64	0.5
109028	96	NA	NA	0.5
109049	11	0.073	0.054	0.5
109244	NA	0.015	7.9	0.5
109245	NA	0.071	4.7	0.5
109246	NA	0.074	5.75	0.5
109650	15.05	0.03	3	NA
109653	18.75	0.08	1.9	NA
109655	NA	0.01	5.6	0.75
109993	36	0.14	0.001	11
110313	NA	NA	2.3	NA
110317	NA	NA	1	NA
110361	NA	NA	NA	NA
110405	NA	NA	1.1	NA
309509	40	0.019	9.2	0.5
310783	43.5	0.021	0.045	NA
310785	45	0.03	0.004	NA
313685	99	NA	NA	1
316184	53.5	0.115	0.002	NA
316185	50.5	0.145	0.001	NA
317270	43	0.028	0.052	0.5
320108	27	0.21	0.005	NA
323844	40	0.12	0.006	0.5
323856	62.1	0.017	0.001	0.75
324578	80.1	0.1	0.012	0.5

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