Report No.	18-197
Information Only - No Decision Required	

STATE AND TRENDS OF RIVER WATER QUALITY IN HORIZONS' REGION

1. PURPOSE

1.1. This paper provides Council with a summary of recent reporting on river water quality state and trend analysis for the region. The report was commissioned by Horizons and completed by Land Water People Ltd. (LWP).

1.2. The paper is accompanied by a presentation by Dr Ton Snelder, who is a lead author of the report.

2. EXECUTIVE SUMMARY

2.1. Monitoring and reporting of water quality is a core part of Horizons' science work programme. This analysis of river water quality state and trends was completed to inform the State of Environment report, due to be released in early 2019, as well as inform regulatory and non-regulatory decision making. In addition to a range of physico-chemical variables, this report also examines the state and trends of freshwater indicators of ecosystem health: periphyton and macroinvertebrates.

2.2. This paper presents a broad overview of the report findings, with further detail available within the report itself. To provide further context, we also outline the evolution of Horizons' water quality monitoring network since its inception in the late 1980's, including the introduction of quality assurance and data management processes over the past decade. The state of environment monitoring programme is one of continuous improvement, and staff actively work to ensure data is collected, processed, analysed and reported in line with best practice.

2.3. The current state of river health is assessed against both One Plan water quality targets and **National Objectives Framework** (NOF) attributes of the **National Policy Statement for Freshwater Management 2017** (NPS-FM). The trend analysis employed is an updated approach that builds on the methodology of Larned et al. (2015), utilised by the **Ministry for the Environment** (MfE) and is outlined in detail in a further report Aggregating Trend Data for Environmental Reporting, produced by LWP for MfE in August 2018.

2.4. The report presents the current state of water quality in the region, on a site by site basis, relative to targets set in the One Plan as well as the attributes specified in the NPS-FM. In addition, the study assessed water quality trends site by site, and across the region as a whole over 10 and 20 year periods ending in June 2017.

2.5. The report shows that the state of water quality for DRP, *E. coli* and clarity generally does not meet One Plan targets, while targets for ammoniacal nitrogen, cyanobacteria, periphyton (mats) and volatile matter are generally met. Most sites were above national bottom lines for NOF criteria for ammoniacal nitrogen and periphyton.

2.6. Individual site trend estimates were aggregated, to provide an overall picture of trends for the region. Variables showing predominately degrading trends include the chlorophyll-a periphyton measure, macroinvertebrate community index, dissolved reactive phosphorus, clarity and dissolved oxygen. Variables with a higher proportion of improving trends included *E.coli* (as G540), spot measures of dissolved oxygen (saturation), ammoniacal nitrogen, soluble inorganic nitrogen and particulate organic matter. It is noted that the dissolved oxygen measure analysed in this report is based on spot measures of dissolved oxygen, not the continuous monitoring of dissolved oxygen that has been analysed and reported to Council recently.

2.7. Trend magnitude was highly variable between sites however, in general, the largest degrading trends were associated with those sites that also had the poorest grades based on the One Plan or NOF state.

2.8. Much work has been undertaken in the region to improve water quality over the past two decades. This state and trend analysis provides us with sound information to inform decision-making around resource consenting, policy implementation, communication and the *Our Freshwater Future* policy process. This information will also inform non-regulatory work such as that undertaken under the Sustainable Land Use Initiative (SLUI), and the Freshwater and Partnerships programme.

2.9. A next step for this analysis is the presentation of this information in our State of Environment 2018 report. The March 2019, Environment Committee report will cover the current state and trends of lake water quality which was also completed as a supplementary analysis to the state and trends report. Further work is currently underway to assess drivers of water quality trends, as completed earlier in 2018 for sediment and *E.coli* as a part of the regional swimmability report completed for the Ministry for the Environment and Horizons Regional Council.

3. RECOMMENDATION

That the Committee recommends that Council:

a. receives the information contained in Report No. 18-197 and Annex.

b. receives the presentation by Dr Ton Snelder.

4. FINANCIAL IMPACT

4.1. There are no financial impacts associated with this item. This report reflects previously endorsed budgets approved as part of Council's annual planning and long term planning processes, and an identified work programme delivered as part of the Science Operational Plan.

5. COMMUNITY ENGAGEMENT

5.1. Presentation of water quality information will be made to the public as part of Horizons State of Environment reporting early in 2019.

6. SIGNIFICANT BUSINESS RISK IMPACT

6.1. No significant business risk has been identified.

7. BACKGROUND

History of the network

7.1. The SoE water quality programme has been delivered by Horizons over the past 20 years and is currently managed for Council by the Science and Innovation Team, with the Catchment Data team providing additional technical and field support.

7.2. Sampling and analysis has continued to improve with time. This has included changes to contracted laboratories to ensure the continued delivery of a high-quality, cost-effective service. Initial analysis was provided by an in-house laboratory based at Horizons Plamerston North office. Subsequent laboratories have included Central Environmental

Laboratories (CEL), Watercare, and more recently Environmental Laboratory Services (ELS). Laboratories have been fully accredited either by Telarc or IANZ, and sampling has been undertaken in line with best practice.

7.3. **Standard operating procedures** (SOPS), documenting all aspects of the sampling programme (from field meter calibration, sample collection, sample packaging and dispatch for analysis, to data management) have been introduced. In 2011 a quality coding process was added to the programme. With the recent introduction of a **National Environmental Standard** (NEMS) for Discrete Water Quality, we are currently looking at opportunities to further refine our current processes.

7.4. Physico-chemical water quality monitoring has been carried out as part of Horizons' **State of Environment** (SoE) programme since around 1978. Initial monitoring was largely exploratory, for the purposes of resource assessment. Regular monitoring was introduced in 1989 at five sites across the region. This included five sites currently incorporated in the network today (Manawatū at Hopelands, Mangahao at Ballance, Rangitikei at Mangaweka, Whanganui at Cherry Grove, and Mangatainoka at Pahiatua Town Bridge).

7.5. The **National Institute for Water and Atmosphere** (NIWA) also commenced monitoring in 1989 via the National Rivers Water Quality Network monitoring programme. This programme included seven sites across the region (Manawatū at Weber Road, Manawatū at Teachers College, Manawatū at Opiki Bridge, Rangitikei at Mangaweka, Rangitikei at Kakariki, Whanganui at Te Maire and Whanganui at Paetawa).

7.6. Further sites were added in 1994, following a review of the programme, and by 2006 there were 35 sites monitored every month, with a further 46 sites included on a rotational roster (sampled monthly for a year, every three years). This water quality information was analysed and reported in the 2005 State of Environment report and to inform the One Plan policy development process.

Monitoring upgrade 2007 to 2009

7.7. Following a review of the programme by the Science team in 2007-08, Council invested in an upgraded monitoring programme that doubled the size of the network and included sites upstream and downstream of point source discharges. These changes sought to align monitoring with the new water management zone framework and enable monitoring of the effectiveness of policies in the (then Proposed) One Plan. This review also lead to the removal of the rolling programme and replacement with monthly monitoring at 66 State of Environment sites.

7.8. The discharge monitoring programme (monitoring in and around major point source discharges) was rolled out between 2007 and 2009 as a part of the network upgrade. The aim being to improve the understanding of the effects of point source discharges from major industry sites and wastewater treatment plants in the region and to be able to separate out the contribution of these to water quality outcomes from the contributions from non-point source (or diffuse) discharges.

7.9. The upgrade also included additional parameters such as total nitrogen and total phosphorus, as well as biochemical oxygen demand. Biological oxygen demand was historically a major focus of water quality improvement for discharges to water and the impacts on sewage fungus in rivers. The upgraded programme included monitoring upstream and downstream of the major discharges as well as the effluent being discharged. Analysis of the results showed the majority of data upstream and downstream, of discharges were at very low levels or below detection and the upstream and downstream monitoring of biological oxygen demand was removed. The monitoring of the effluent for biological oxygen remains providing an ongoing check for this parameter.

7.10. The existing programme was not designed to be spatially or regionally representative. Rather, the programme was designed to provide a mixture of spatial representativeness with additional monitoring in locations to inform regulatory and non-regulatory programmes.

This included identifying sources of contaminants and measuring the effectiveness of interventions, for example monitoring upstream and downstream of effluent discharges (as well as the discharge itself) which has enabled measurement of point-source management over time, as well as providing a measure of the management of the catchment upstream of the discharge. Presently, spatial representativeness of the network is skewed toward areas where there are known water quality issues, with fewer sites in the more pristine locations than a more spatially representative network would be expected to have.

7.11. The network upgrade in 2007 was also accompanied by automated reporting to Horizons website in a section referred to as "Water Quality Matters" which lead to the development of the LAWA website.

Macroinvertebrates

7.12. Monitoring of macroinvertebrates commenced in 1999 and was initially contracted to Massey University. Horizons moved this programme in-house in 2008 and monitoring is now overseen and delivered by the Science and Innovation team.

7.13. A review of the programme was undertaken in 2008 to expand the network and align the monitoring sites with the physico-chemical and flow monitoring network to allow for the assessment of potential drivers of invertebrate community health. Monitoring sites upstream and downstream of specific point source discharges was added to the programme in 2012 to further understand the impact of these discharges on ecosystem health.

7.14. Macroinvertebrate state and trends have been analysed and reported annually for many years to the Environment Committee of Council. This information is used to inform regulatory and non-regulatory programmes. From 2018, annual state and trends will be analysed and reported via LAWA. Presently, we are investigating drivers of macroinvertebrate community health through a collaborative research project with DairyNZ and NIWA.

Periphyton

7.15. Historically, the periphyton monitoring project involved annual sampling as a part of macroinvertebrate monitoring undertaken by Massey University. In 2007 Horizons reviewed the programme with assistance from Massey University and NIWA. The programme was subsequently moved to delivery by Horizons Science Team. The first year of an upgraded monitoring programme was 2009-10 and samples were collected and analysed monthly using a different laboratory method to the Massey programme. Again this upgraded programme was not designed to be spatially representative rather to enable determination of the relationships between periphyton, flow and nutrients to better inform future planning processes.

7.16. Horizons recent assessment of periphyton drivers in the Region was presented to Environment Committee in August 2018. The regional programme was also utilised as a case study for a recent publication by MfE providing policy guidance around how to derive nutrient thresholds to meet the requirements of the NPS-FM about managing waterways for periphyton outcomes (noting the nutrient concentrations for this requirement of the NPS-FM differ from the attribute that relates to nitrate toxicity).

Current monitoring programme

7.17. Changes to the programme since the 2007-08 review have been a result of:

- closures of point source discharges e.g. PPCS Shannon, DB Breweries, New Zealand Pharmaceuticals, Longburn wastewater and Ashhurst wastewater;
- additional sites for monitoring around Lake Horowhenua (all inflowing tributaries and the outflows);
- changes to the periphyton programme following analysis of the data (including additional sites to have a range of flow and nutrient concentrations);

- additions to the network to measure outcomes from the work of the Manawatū River Leaders Accord (five new sites in parts of tributaries that were previously not monitored e.g. the Kiwitea, Lower Oroua and one reference site in the Mangatainoka Catchment); and
- monitoring into the Manganui o te Ao in the Whanganui Catchment to improve spatial coverage and provide a measure of potential impacts on that stream, which receives water from another catchment via a hydroelectricity scheme.

7.18. In total the network samples up to 16 variables at 174 sites monthly (Figure 1), including 90 SoE sites, 26 sites upstream, 26 downstream and 32 effluent sites from major discharges (discharges of treated urban or industrial wastewater) across the region.

7.19. Many of the major upgrades to the various aspects of water quality monitoring have reached a 10 year maturity and we are now able to undertake a trend analysis on a larger number of sites. As such Land, Water People Ltd. were engaged by Horizons to undertake an assessment of state and trends of water quality in the Horizons Region. The following sections discuss the key findings of the report and the next steps for the analysis.

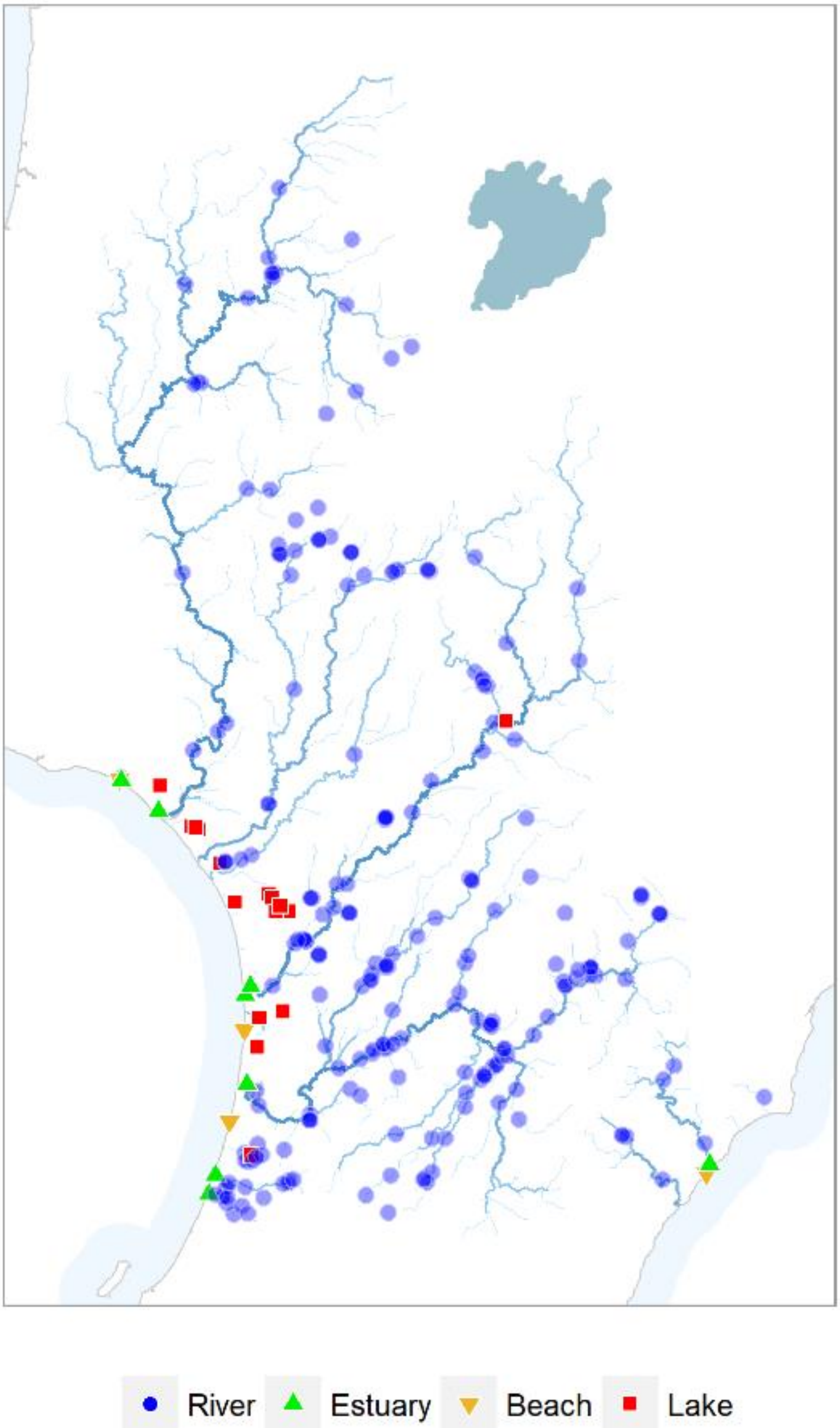


Figure 1 Current distribution of river water quality State of Environment and Discharge monitoring sites, along with current locations for estuary, beach and lake monitoring.

8. DISCUSSION

8.1. The latest state and trends report presents state of water quality in the region on a site by site basis, relative to targets set in the One Plan, as well as those specified in the **National Objectives Framework** (NOF) of the **National Policy Statement – Freshwater Management** (NPS-FM) (Ministry for Environment, 2017a) recognising that although there are similarities differences do apply. In addition, the study assessed water quality trends site by site, and across the region as a whole.

8.2. This study considered flow adjusting the river water quality data as part of trend assessment. Adjusting data to account for flow can improve trend detection however, based on the examination of a subset of sites with adequate flow data and comparing trends evaluated with and without flow adjustment, it was concluded that the regional-scale findings of this study do not differ between analyses based on raw or flow adjusted trends. Therefore, the trends presented in this report are not flow adjusted but flow adjusted results for sites with flow data are provided as supplementary data.

State of Water Quality

8.3. A key finding was that many parameters at State of the Environment (SoE) sites almost uniformly pass or fail One Plan targets (Figure 2). Site grades based on the Horizons One Plan criteria were dominated by failing sites for **dissolved reactive phosphorus** (DRP), ***Escherichia coli*** (*E. coli*) and clarity. Conversely, almost all sites passed the One Plan criteria for **ammoniacal-nitrogen** (NH_4-N), cyanobacteria, periphyton (mats) and **volatile matter** (POM). Grades varied across the region for **dissolved oxygen saturation** (DO), the periphyton measure chlorophyll-*a*, **Macroinvertebrate Community Index** (MCI), periphyton (filaments) and **soluble inorganic nitrogen** (SIN).

8.4. In terms of comparison of water quality state against the NOF (Figure 3), most sites were in the A band for both **nitrate (NO_3-N)** and ammoniacal-N (median) criteria. It is noted that these gradings relate to nitrate toxicity and not the NOF requirement for periphyton which is more stringent but not provided as a numerical measure. Horizons are currently working with NIWA to derive the numbers that relate to the periphyton measure of the NOF. While the updated nutrient criteria for the periphyton requirements of the NOF are not available for analysis, the values used for this in the One Plan are available and the data is compared to these targets in Figure 2. These analyses show the majority of the Soluble Inorganic Nitrogen (SIN) and Dissolved Reactive Phosphorus (DRP) measures do not meet the targets of the One Plan. These nutrient targets were set to manage impacts of nutrient on periphyton growth in rivers.

8.5. The new periphyton monitoring programme enables a direct measure of whether periphyton targets are being met without the requirement for any assumptions between the linkages between nutrients and periphyton i.e. the periphyton measures provide a direct measure of the outcome being sought to be managed through a nutrient management regime.

8.6. When considering if the periphyton outcomes are being met, it is important to note that the One Plan framework for nutrient management set up a process to move toward achievement of the periphyton outcome and not to necessarily achieve it over the life of the One Plan. For example, the Manawatū at Hopelands site was modelled to change from a current load in 2012 of 762 tonnes SIN/year to a load of 670 tonnes SIN/year by year 20 i.e. a reduction of approximately 12% (Roygard and Clark, 2012). The target load for this site was calculated to be 364 tonnes SIN/year, requiring a reduction of 52% from the estimated current load of 762 tonnes. Note, the target load is the translation of the target concentration for SIN that is expressed as a concentration of SIN into an annual load.

8.7. Horizons monthly periphyton data includes a range of measures including chlorophyll-a, percentage cover of mats and percentage cover of filaments (fils). These measures enable comparison to the periphyton targets of the One Plan (chlorophyll-a, mats and fils) and the NOF bands for the periphyton attribute component of Ecological Health, which is a measure of chlorophyll-a. Horizons periphyton data is the largest regional data set collected monthly and the longest data set of this type in New Zealand. It is noted that NIWA's national network that includes monthly periphyton data does not include chlorophyll-a monitoring.

8.8. A key difference exists between the One Plan and NPS-FM targets for periphyton criteria. The One Plan does not allow for any exceedances of the maximum periphyton measurements. The NPS-FM allows one exceedance per year for the majority of rivers in the country and two exceedances for some rivers that are naturally productive. Productive is not related to agricultural production, rather is about the stream being classified in the National River Environment Classification as being "dry" (therefore expected to have less frequent flushing flows) and having specific geologies (which lead to naturally higher nutrient amounts in the waterways). The areas which are considered productive are defined in the NPS-FM based on a river classification system.

8.9. The regional periphyton data shows a mix of sites complying with the One Plan periphyton targets and sites that do not comply (Figure 2). Compared to the NOF (Figure 3) most sites were generally in Band 'A' or Band 'B' for periphyton criteria, with some being Band D (see below). Please note, Figure 3 refers to the periphyton criteria as periphyton cover, however is presenting the results for the measure of Chlorophyll a in the NOF. A small number of sites were below the nation bottom line of the NOF, i.e. Band D, and are required by the NPS-FM to be restored to levels above the national bottom line. None of these 5 sites are in priority catchments for the nutrient management rules of the One Plan. The Band D for periphyton sites are:

- Three sites in the Manawatū Catchment
    - the <u>Makuri at Tuscan Hills</u> and <u>Tiraumea at Ngaturi</u> sites in the Tiraumea sub catchment. This is not a priority zone for nutrient management but a priority sub-catchment for SLUI due to the predominance of hill country sheep and beef farms and highly erodible land. The Tiraumea has 54,677 ha of SLUI farm plans, approximately 60% of the approximately 91,500 ha catchment. Further, environmental farm plans have been completed for all 10 dairy farms in the Tiraumea through the Manawatū Clean-Up Fund project of the Manawatū River Leaders Accord with support from Horizons, MfE, DairyNZ, and fertilizer companies.
    - The site in the <u>Manawatū downstream of the Palmerston North City treated wastewater discharge</u>. Noting the site upstream of this is Band B.
- One site in the Rangitīkei Catchment, <u>Mowhango at Waiouru</u> is located downstream of the outlet of the Mowhango Dam that diverts water from the upper Mowhango into the Tongariro Power Scheme. The Mowhango at Waiouru site monitors the Mowhango Stream downstream of the diversion.
- One site in the Whangaheu Catchment, <u>Makotuku at downstream Raetihi</u>. This site is influenced by both the discharge of treated sewage and the hydroelectricity scheme that diverts water to the Manganui o te Ao. Noting the site upstream of the Raetihi sewage discharge is Band C and the site upstream of the hydroelectricity diversion by New Zealand Energy is Band A.

8.10. A summary of the periphyton results for state and trends in relation to the priority catchments for the nutrient management rules of the One Plan is provided in Annex A.

8.11. National Objectives Framework (NOF) bands were variable across the region for the *E. coli* criteria (Figure 3). The NOF human health for recreation attribute table defines the swimming grade at a site based on four statistics derived from *E. coli* measurements: median, percentage of exceedances over 540 *E. coli* per 100mL, percentage of exceedances over 260 *E. coli per* 100mL, and the 95th percentile. Thresholds for each statistic are associated with a category from A (Excellent) to E (Poor) which are associated with the level of risk of Campylobacter infection. The swimming grade for a site is the lowest grade indicated by the individual statistics. A separate item in this agenda discusses in more detail the swimmability targets of the NPS-FM.

8.12. Patterns were similar for impact (downstream of point source discharge) sites, although a greater proportion of failing sites tend to occur below discharges. Maps of the comparison of state at sites downstream of the major point source discharges compared to the One Plan and NOF criteria are available in the report. More information on the water quality trends downstream of point source discharges is provided below.

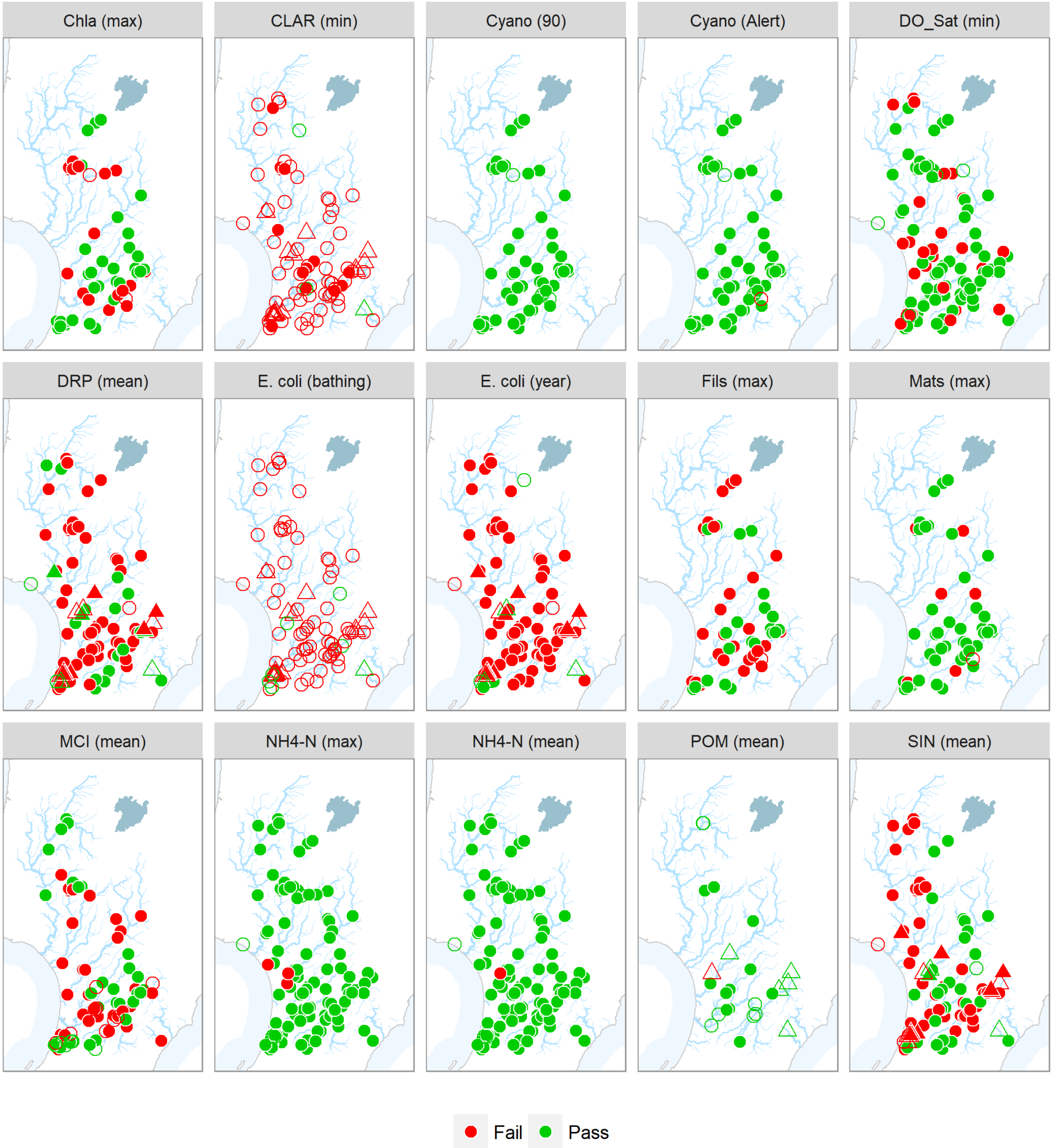


Figure 2 Maps showing SoE site state grades based on the Horizons One Plan criteria. Sites that required flow data for evaluating the state statistic, but for which flow percentiles were estimated only from gaugings are shown as triangles. Grades for sites that did not meet the sample number requirements specified are shown with open shapes.

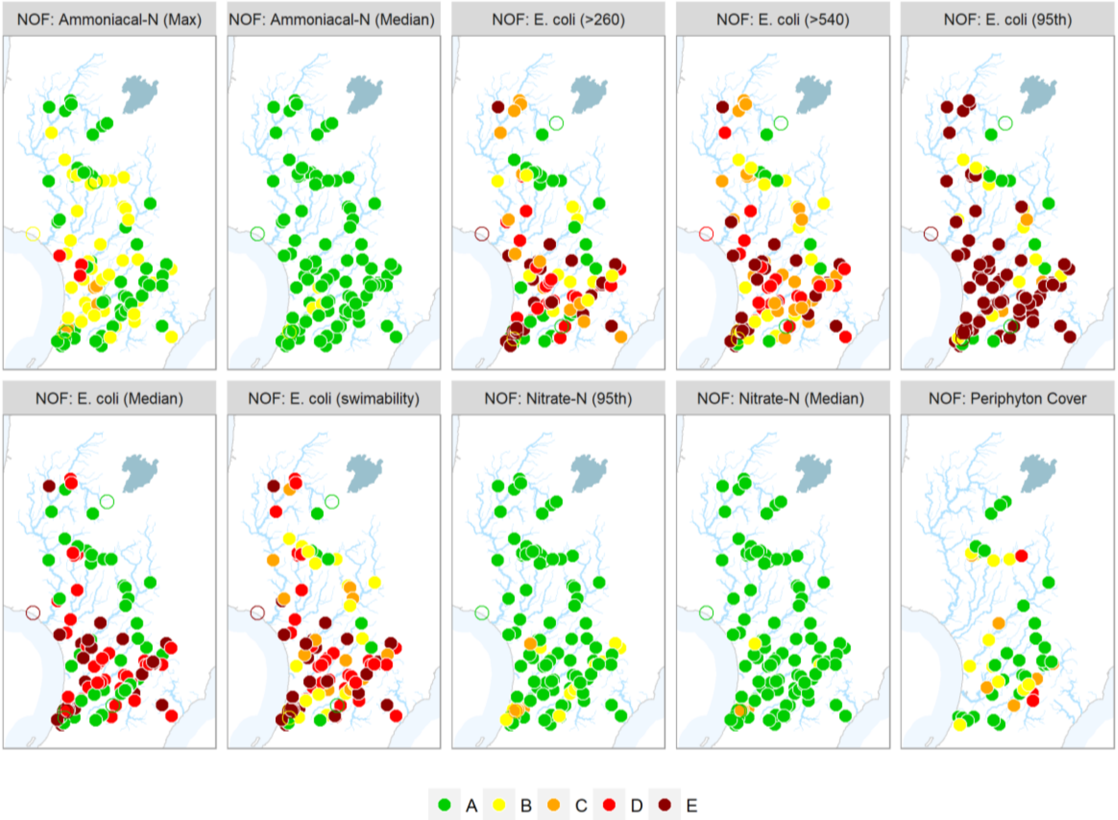


Figure 3 Maps showing SoE site state bands categorised by the NOF attribute bands. Bands for sites that did not meet the sample number requirements are shown with open circles. Note the measure referred to as NOF:Periphyton Cover is a comparison of the NOF attribute for periphyton that is a measure of Chlorophyll a.

8.13. Trends were assessed over a range of periods (ranging from five through to 28 years), and analysed for 20 year (1997 – 2017) and 10 year (2007 – 2017) periods. Two methods were used to present the trend results. The methods will be explained further by Dr Snelder during the presentation however, in short the first method is the more traditional method that classifies sites as improving, degrading or as having insufficient data based on the 95th percentile confidence in the trend. A more nuanced approach is used in method two whereby different confidence categories can be used to express probability that the trend direction is improving (or its complement; degrading).

8.14. Using the traditional approach (shown in Figure 4 and Figure 5, for the 10 and 20 year periods respectively):

- For the 10-year time period a large proportion of the trends (78%) analysed were classified as having "insufficient data" to determine a confident trend. For the 10-year trends defined with confidence, there were a mix of both improving (16%) and degrading (14%) trends. However, this distribution differed between variables, with some variables dominated by degrading trends (e.g., Chlorophyll a, MCI) or by improving trends (Ammoniacal-N and Particulate Organic Matter, POM).
- For the 20-year time period, across all variables, 46% of site trends were classified as having "insufficient data", 35% as improving and 19% degrading.
- There was not a strong geographical pattern associated with the distribution of improving or degrading trends for any variables, although there may be some patterns associated with river size or catchment characteristics that are not immediately evident from the maps. There appeared to be a cluster of improving DRP trends within the Manawatū River Catchment for the 10-year trends (Figure 3) and most of the

improving trends for the 20-year period (across all variables) were located within the Manawatū River Catchment (Figure 4).

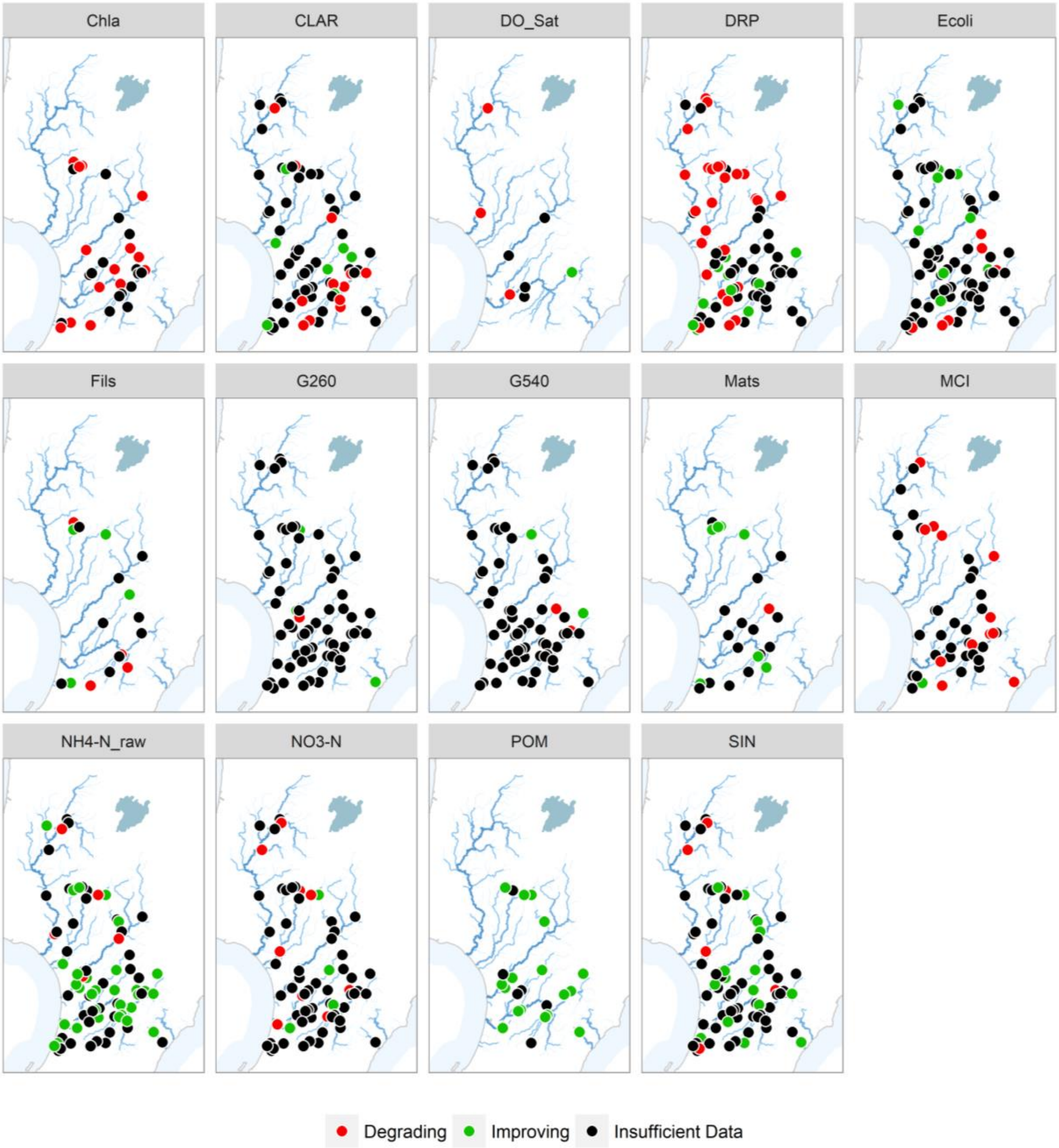


Figure 4 Map of sites classified by their 10-year water quality variable trend descriptions. Site and variable combinations for which there were many missing or censored values are not shown in the plots. Note that trend descriptions indicate degrading and improving (rather than trend direction of the water quality variable). Trends are all based on analyses performed using raw (i.e., not flow adjusted) data.

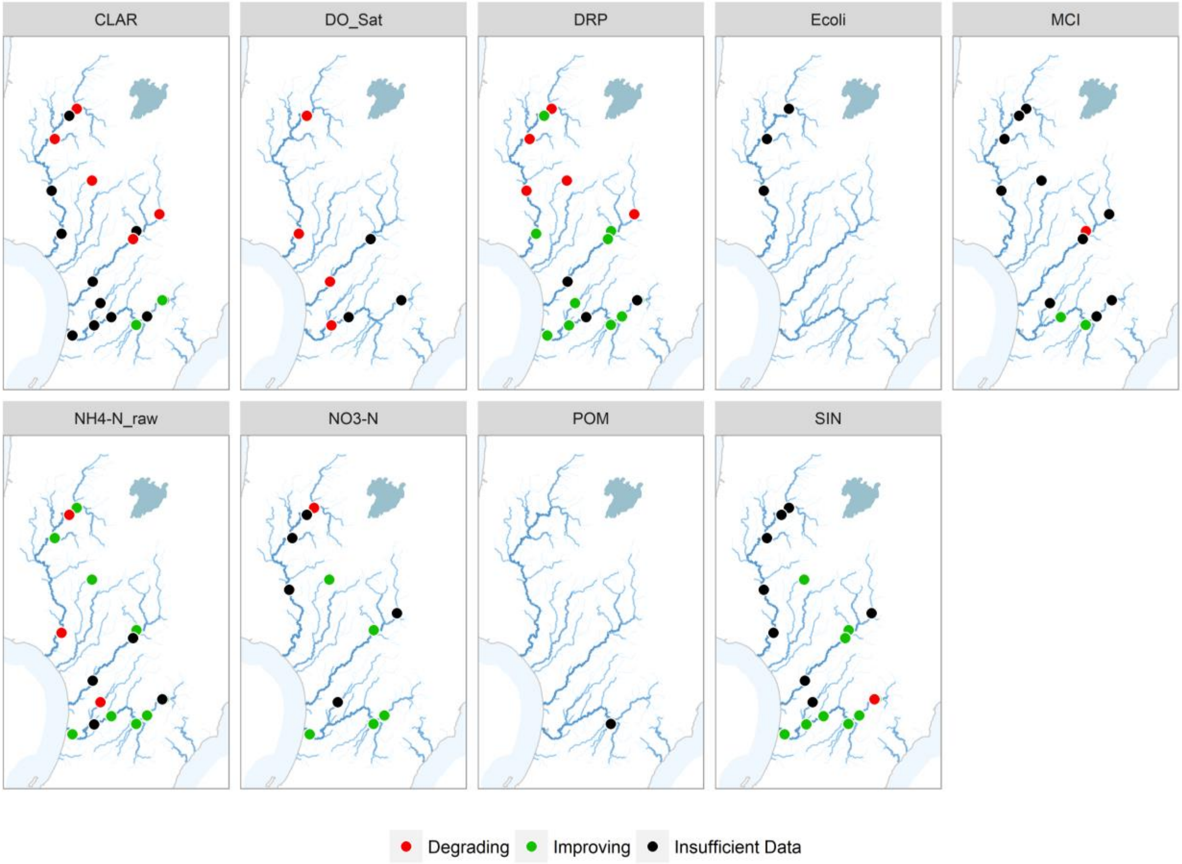


Figure 5 Map of SoE sites classified by their 20-year raw water quality variable trend descriptions. Site and variable combinations for which there were many missing or censored values are not shown in the plots. Note that trend descriptions indicate degrading and improving (rather than trend direction of the water quality variable). Trends are all based on analyses performed using raw (i.e., not flow adjusted) data.

8.15. The new method utilised by MfE, Horizons and LAWA presents a more nuanced approach to reporting aggregated trends. This enables further exploration of the sites traditionally identified as having insufficient data. In this case, those sites that are classed as “improving” in the previous figures are shown in green and those as “degrading” (i.e., exceptionally unlikely to be improving) in red, but the “insufficient data” sites are placed on a continuous colour spectrum between green and red, based on their evaluated probability of trend improvement (Figures 6 and 7).

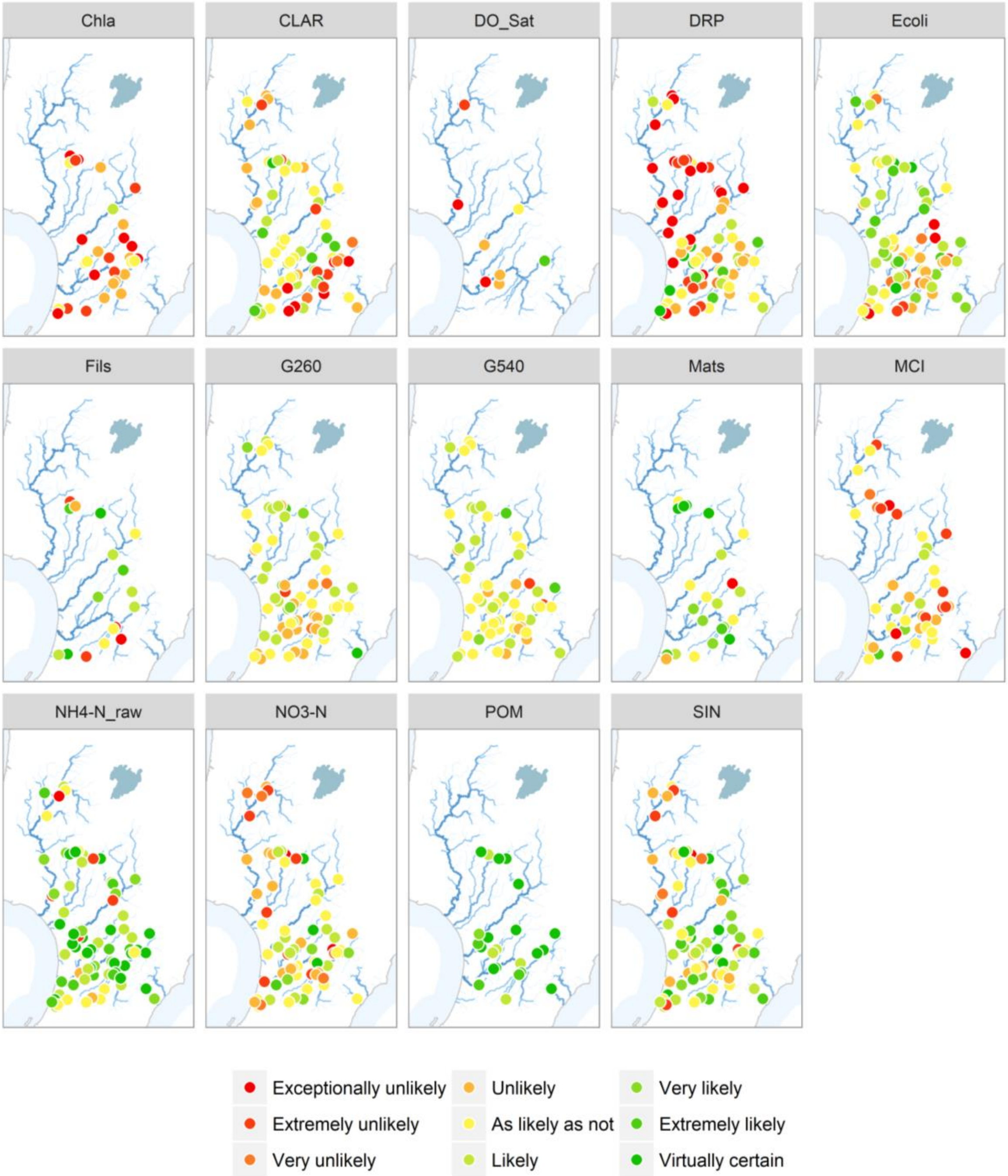


Figure 6 Map of SoE sites categorised by their 10-year raw water quality trend probability of improvement.Probability of improvement is expressed using the categorical levels of confidence defined by the IPCC. Sites that are classed as "improving" are shown in green and those as "degrading" (i.e., exceptionally unlikely to be improving) in red, with the colour spectrum between green and red showing the probability of trend improvement.

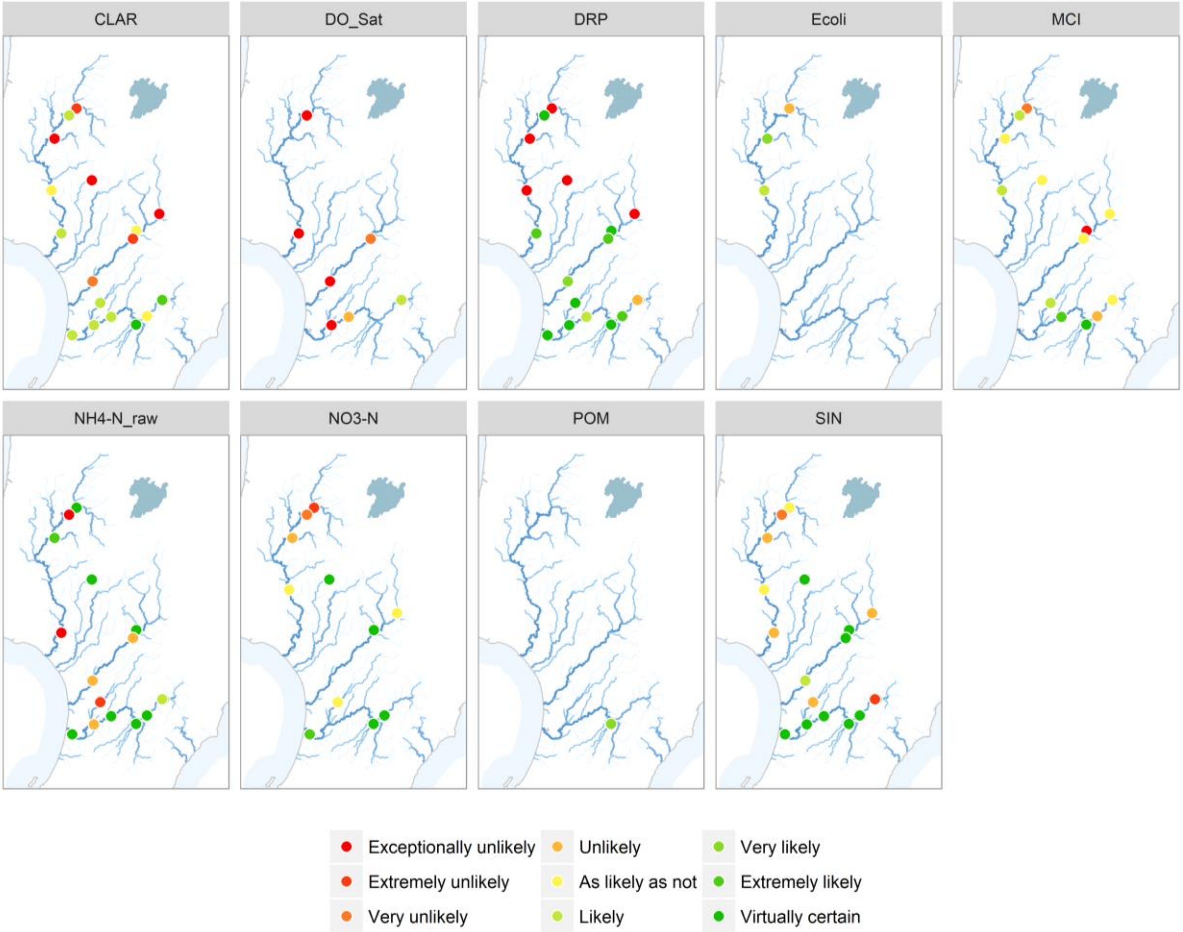


Figure 7 Map of sites categorised by their 20-year raw water quality trend probability of improvement. Probability of improvement is expressed using the categorical levels of confidence defined by the IPCC. Sites that are classed as "improving" are shown in green and those as "degrading" (i.e., exceptionally unlikely to be improving) in red, with the colour spectrum between green and red showing the probability of trend improvement.

8.16. Comparing the 10 and 20-year **probability of improving trend** (PIT) indicates variable differences between the two time periods. SIN, Ammoniacal-N and DO all show larger PIT values for the shorter time period. Clarity, DRP, *E. coli*, MCI and NO_3-N all show lower PIT values for the shorter time period. However, it is noted that the 20-year trend dataset is based on a much smaller number of sites, and once confidence intervals are considered, it was found that these differences were well within the uncertainty in the predicted proportions, with the exception of DRP, where the uncertainty bounds for the PIT values for the two time periods do not overlap, suggesting high confidence in the change from a majority of improving trends to a majority of degrading trends.

8.17. There were significant relationships between decreasing *E. coli* trends at discharge sites and decreasing *E. coli* trends at associated downstream impact sites. This is strong evidence of regional improvement in *E. coli* associated with improvements to point source discharge quality over the past decade. However, the relationships were much weaker (or non-existent) for other variables.

8.18. Trend magnitude was highly variable between sites. In general, the largest degrading trends were associated with those sites that also had the poorest state grades based on the One Plan and/or NOF criteria. It is these sites that are likely to warrant the greatest effort to reverse degrading water quality. Contrary to the pattern for most variables, the largest magnitude improving trends for *E. coli* were at sites that currently have *E. coli* in the NOF E band. This may reflect targeted efforts to improve practices in catchments upstream of these sites; this will be explored as part of the next phase of this work.

8.19. Much work has been undertaken in the region to improve water quality over the past two decades including development of several regional planning documents. Direct discharges of dairy shed effluent were removed from the regions' waterways by 2012. Other region-wide management interventions have included non-regulatory work such as that undertaken under the SLUI (Sustainable Land Use Initiative), and the freshwater and partnerships programme. Though resource consenting, and actions undertaken as part of the Manawatū River Leaders Accord, upgrades to wastewater treatment plants have addressed issues with point source discharges while nutrient management plans have assisted farmers with targeted actions to address nutrient loss from intensive land use.

Case study – Feilding Wastewater

8.20. An example of management interventions are the upgrades to the Feilding Wastewater Treatment Plant that began in 2008. The plant is the largest in the district, serving industry and a growing population of more than 15,000 and producing around 7,500 m^3/day of effluent (Figure 8).

8.21. In 2011, an upgraded programme was initiated to produce a product that was able to meet the requirements of the Proposed One Plan. This required a reduction in nutrients (nitrogen and phosphorus), and a significant reduction in suspended sediment and bacteria (*E. coli*).

Figure 8 Upgrades to Feilding Wastewater Treatment Plant have contributed to improving water quality in the Oroua River.

8.22. In addition to key process elements such as screening, anaerobic and aerated lagoons, sedimentation, clarification and UV disinfection, the existing sludge stream from the sedimentation basins is processed by digestion prior to thickening and stabilisation via storage in sludge lagoons. Works included reconstruction of existing ponds and the addition of clarification units, ongoing alum dosing to remove phosphorus and residual suspended solids (which began in 2008), enhancing the standard of disinfection achieved by the UV disinfection system. The plant introduced additional aeration to address occasional non-compliance issues with respect to ammonia, and enhanced performance of the WWTP by recirculation through biological trickling filters and removal of flow spikes. In addition the aerated lagoons have been lined to prevent seepage.

8.23. Analysis of ten year trends downstream of the Feilding WWTP shows a high probability of improving trends for the majority of water quality indicators including turbidity, nitrogen (as TN, SIN and Ammoniacal-N), phosphorus (as TP and DRP), dissolved oxygen, *E. coli*, and periphyton (chl a and mats). A significant shift improvement in water quality indicators is noted post-2011 and can be seen in data shown on the LAWA website (site name: Oroua at d/s Feilding STP) and in Figures 9 and 10 (below).

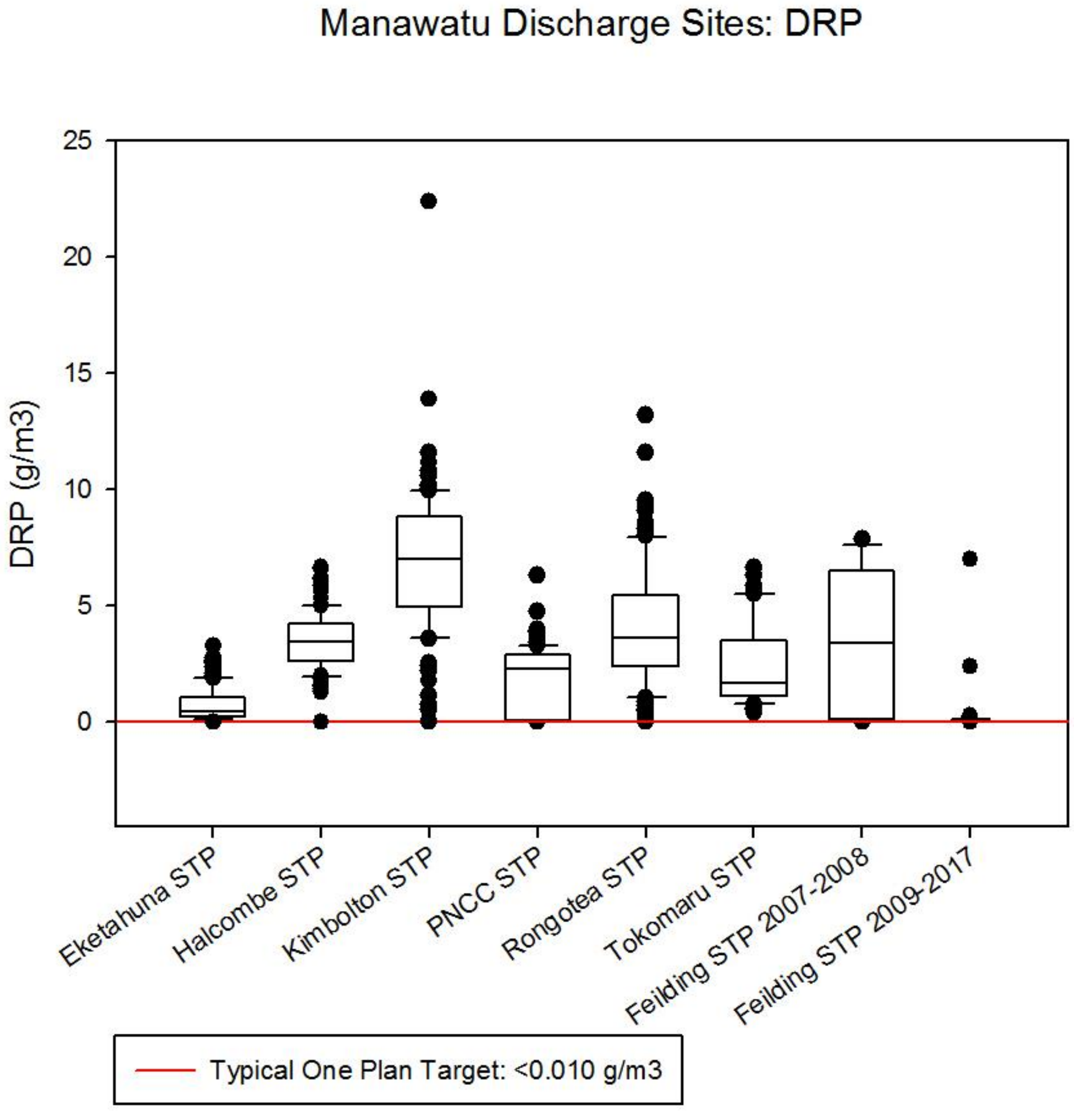
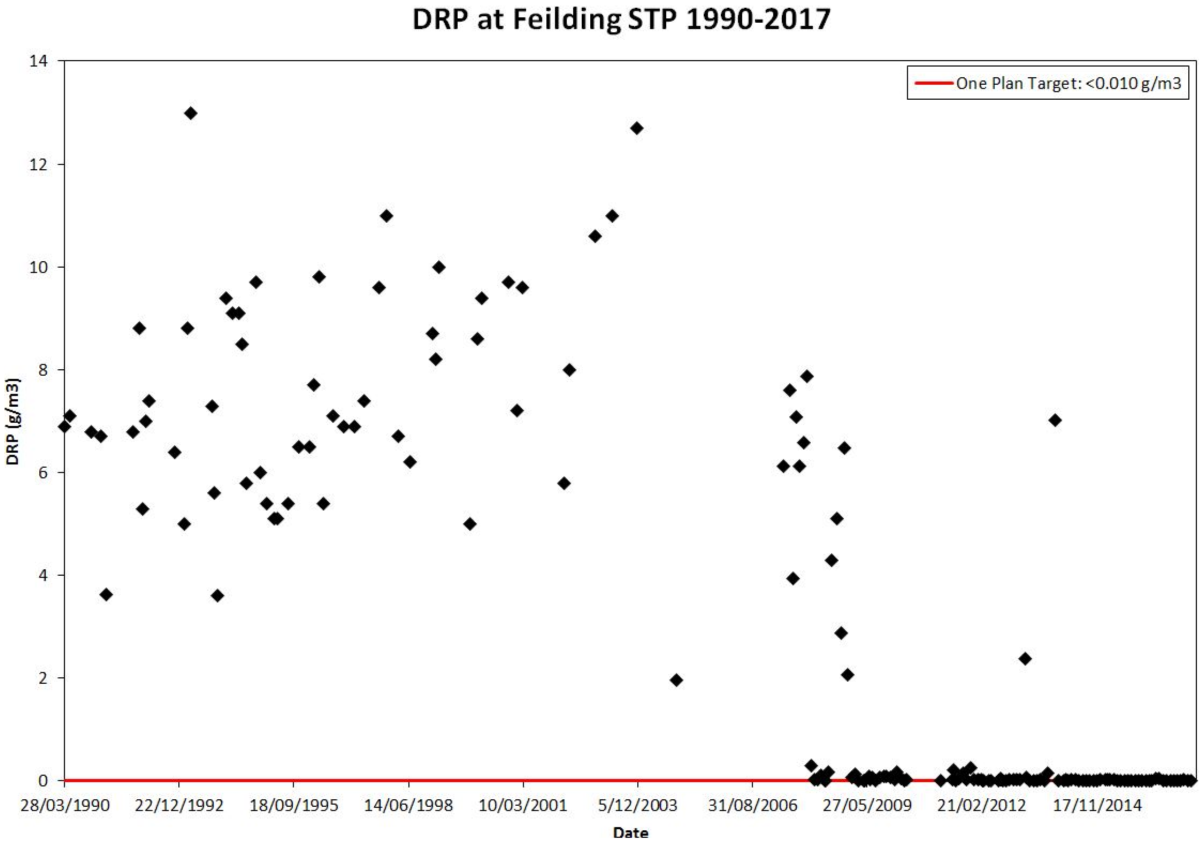


Figure 9 DRP concentrations (g/m^3) at the Feilding WWTP before and after plant upgrades took place, and a comparison to other WWTP discharges in the Manawatū catchment.



Dissolved Reactive Phosphorus (DRP) concentrations (g/m^3) of the discharge at the Feilding WWTP showing the improvements made via investment in water quality interventions.

8.24. New consents recently granted now enable Manawatū District Council to dispose of a significant proportion of treated effluent from the WWTP onto land. Increased storage capacity of two additional storage ponds with a total capacity of 25,000 m^3 provide the ability to discharge to the Oroua River at times when flows are higher to provide increased dilution, reducing the impact on in-stream water quality.

8.25. Further works to increase the treatment capacity and to create a more robust treatment system include a receiving facility to separate industrial streams from the main treatment processes, sludge dewatering equipment, irrigation system, composting or improved clarification and DRP removal.

9. CONSULTATION

9.1. No specific consultation was conducted in preparing this item.

10. TIMELINE / NEXT STEPS

10.1. This report, as well as additional analyses for Lakes and Coast, provides the backbone for the water quality section of the State of the Environment water quality chapter. Additionally the results will be used to support resource consent decision-making, and inform non-regulatory interventions to improve water quality in the region.

10.2. LWP have been contracted to undertake a follow up analysis to spatially model state and ten year trends in water quality and look at the interventions in each catchment to determine what is driving state and trends in water quality across the region, similar to that undertaken for sediment and *E. coli* earlier in the year. Staff have scoped potential drivers and will be workshopping this with Dr Snelder following this presentation to council. It is expected that a draft report of this analysis will be available by mid-2019.

10.3. In addition to this work, LWP have been contracted to undertake an assessment of contaminant loads across the region to fulfil requirements under the NPS-FM to complete a set of resource accounts. The information from this project will likely be used to help inform the next phase of the policy cycle and support '*Our Freshwater Future*'.

10.4. In collaboration with DairyNZ, NIWA has been engaged to further explore drivers of periphyton. This includes investigating the ability to derive look-up tables for nitrogen and phosphorus concentrations for the different NPS-FM periphyton bands. This work is expected to be delivered in 2019. Work is currently underway to scope the next phase of this work which will look at converting the derived concentrations to in-river nutrient loads for policy purposes.

11. SIGNIFICANCE

11.1. This is not a significant decision according to the Council's Policy on Significance and Engagement.

12. REFERENCES

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ANNEXES

A Periphyton State and Trends in Priority Catchments