

# Review of the NERMN Programme 2014



Bay of Plenty Regional Council  
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NEW ZEALAND

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Prepared by Rob Donald (Science Manager)

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Cover Photo: View of the Bay of Plenty region developed from a  
composite of satellite images.



# Acknowledgements

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## Executive summary

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The purpose of this review is to examine the current NERMN Programme and assess whether it meets the science needs of the Bay of Plenty Regional Council, and legislative requirements for environmental monitoring.

Development of the Bay of Plenty's Natural Environment Regional Monitoring Network (the NERMN) began in 1989. Since that time the NERMN has evolved to include monitoring of a wide range of natural resources at over 1,000 sites.

The following is the original goal of the NERMN:

*“to provide scientifically defensible information on the important physical, chemical and biological characteristics of the natural resources of the Bay of Plenty region as a basis for the preparation of Environment BOP [Bay of Plenty Regional Council] policies and plans, and the monitoring of their suitability and effectiveness.”*

This goal is still highly relevant and should be retained.

The review found that in general the parameters monitored under the NERMN are appropriate and are needed to adequately manage natural resources. However, for some resources there is a need to increase monitoring frequency and/or geographical coverage to meet future needs. These changes arise due to the anticipated future regional development of land and water, and due to legislative requirements that will likely impose additional monitoring on councils, for example:

- Monitoring which will follow the setting of water quality and quantity limits under the NPS for Freshwater.
- The need to monitor against proposed national 'bottom line' objectives for water (as a result of the proposed amendments to the National Policy Statement for Freshwater Management).
- The enactment of the Environmental Reporting Bill. This is expected to further the progression toward more consistency in environmental monitoring, including the development of national environmental monitoring standards.

While the review found that monitoring can be reduced in some areas (air quality and coastal dynamics monitoring), the overall effect of the recommendations would be an increase in the funding required to support the NERMN Programme as follows:

- An increase in annual operational expenditure of approximately 47% (\$1.27 million) by 2020. Note that this assumes a progressive five year implementation ('ramp up') period but has not been adjusted for inflation.
- An increase in annual capital expenditure of approximately 14% (\$45,000). This increase would also apply between now and 2020 and has not been adjusted for inflation.

If these recommendations are adopted further work would be required to refine the cost estimates and incorporate them into the planning process for the 2015-2025 Long Term Plan.

Finally a number of recommendations are made regarding reporting, Cultural Health Assessments and monitoring technology. These can be acted on progressively as part of the ongoing development of the NERMN Programme.



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# Part 1: Introduction

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Development of the Bay of Plenty's Natural Environment Regional Monitoring Network (the NERMN) began in 1989. Since that time the NERMN has evolved to include monitoring of a wide range of natural resources at over 1,000 sites (see Maps 1 and 2).

A number of formal reviews of the NERMN have been carried out<sup>1</sup> and each of these resulted in additions and enhancements to the programme. The latest review (2014) was identified as an Action in the Ten Year Plan (2012-2022) and is timely given expected changes to national legislation related to environmental monitoring, particularly for water.

## 1.1 Purpose of this review

The purpose of this review is to examine the current NERMN Programme and assess whether it meets the science needs of the Bay of Plenty Regional Council, and legislative requirements for environmental monitoring.

## 1.2 Structure of this report

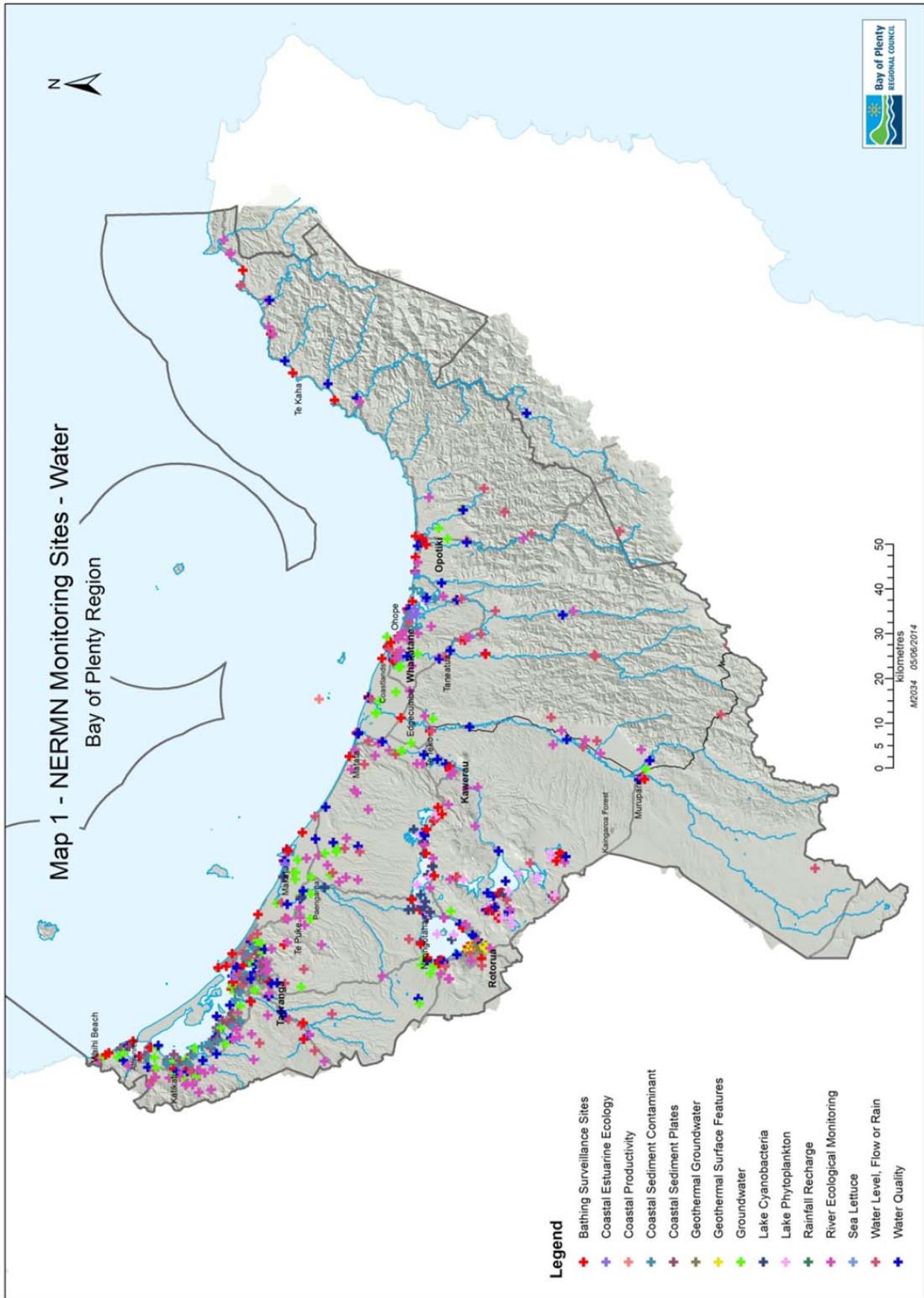
The report structure and rationale is described below.

- Part 1: Introduction.
- Part 2: Why monitor?  
Identifies the key legislative and policy drivers for the NERMN Programme.
- Part 3: Current state.  
Summarises the current state of the NERMN Programme including; goals and objectives, structure, expenditure and reporting.
- Part 4: Review of the NERMN modules.  
Provides more detailed descriptions of each of the NERMN modules and provides recommendations on the future state.
- Part 5: Summary and recommendations.  
Provides a synthesis of the key recommendations developed in Part 4.

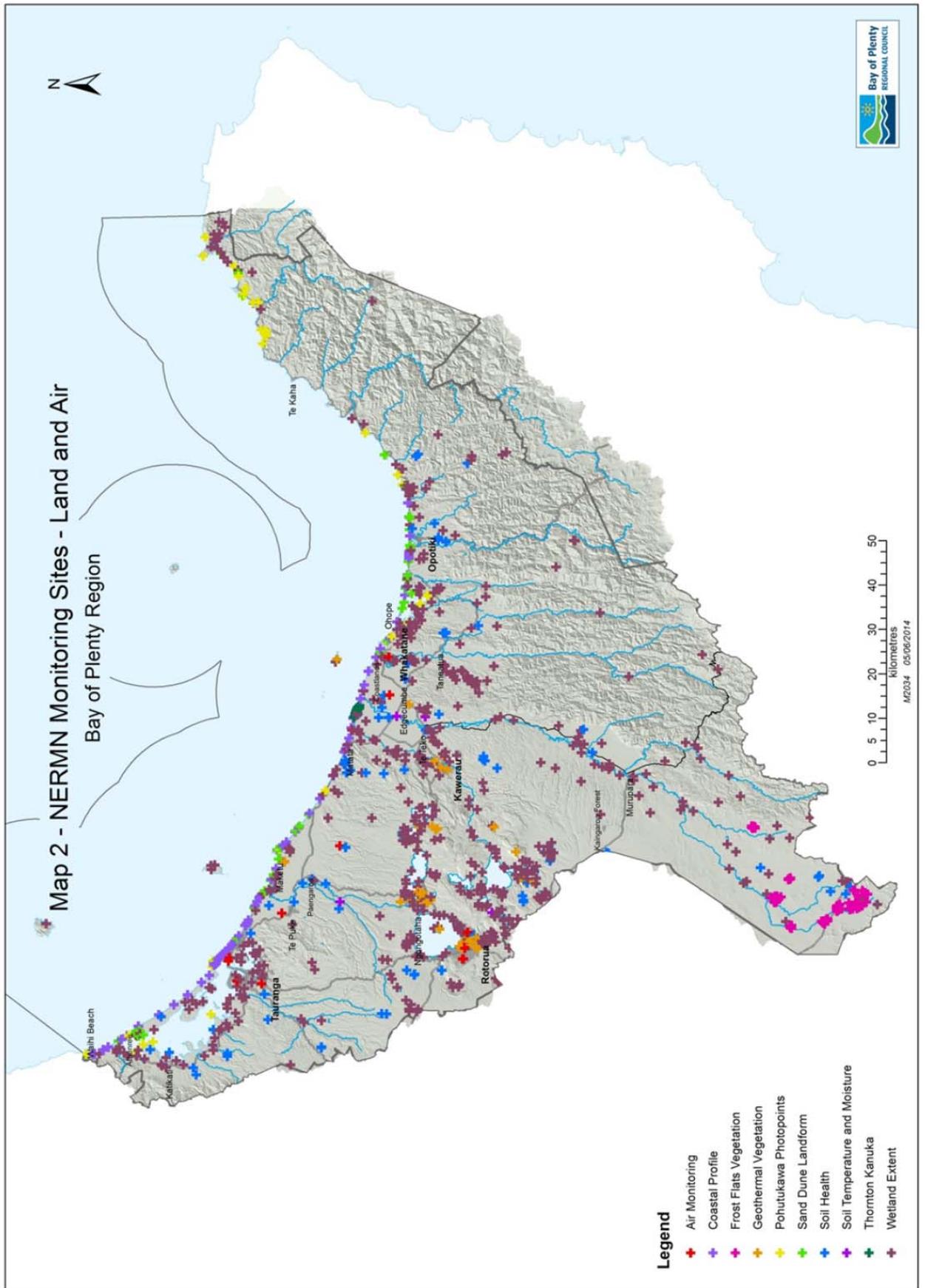
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<sup>1</sup> NERMN reviews include;

- Environment Bay of Plenty (1995). Natural Environment Regional Monitoring Network 1995. Environmental Report 95/21.
- Environment Bay of Plenty (2001). NERMN Review. Environmental Report 2001/07.
- Environment Bay of Plenty (2004). NERMN Air Monitoring Review. Environmental Publication 2004/03.
- Environment Bay of Plenty (2005). Review of the NERMN Modules: Freshwater Wetlands and Terrestrial Indigenous Biodiversity. Environmental Publication 2005/10.



Map 1 NERMN monitoring sites: Water.



Map 2 NERMN monitoring sites: Land and air.



## Part 2: Why monitor?

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Councils are required to use planning, monitoring and review to assist them in ensuring the sustainable management of natural resources. Monitoring for these purposes has four components:

- State of the Environment (SOE) monitoring of the state and trends associated with the quality and quantity of natural resources and the environment. Council undertakes this through the NERMN Programme.
- Impact monitoring measures the effects of specific activities on the environment. This is the responsibility of councils, although major consent holders also have a role in monitoring the effects of their activities on the environment.
- Compliance monitoring of resource consents is carried out to ensure that conditions attached to consents are being met. Self-monitoring by consent holders is also normally required with compliance monitoring by councils largely being an audit role.
- Performance monitoring measures whether councils are achieving the desired outcomes of objectives and policies in a cost-effective way.

While the NERMN programme is largely focussed on SOE monitoring, the data generated is often complementary and/or provides support to the other monitoring components listed above.

### 2.1 Legislation

#### 2.1.1 Resource Management Act

Section 35 of the RMA outlines the duties of regional and district councils to gather information, monitor, and keep records:

*“35 Duty to gather information, monitor, and keep records*

- (1) *Every local authority shall gather such information, and undertake or commission such research, as is necessary to carry out effectively its functions under this Act or regulations under this Act.*
- (2) *Every local authority shall monitor—*
  - (a) *the state of the whole or any part of the environment of its region or district to the extent that is appropriate to enable the local authority to effectively carry out its functions under this Act; and*
  - (b) *the efficiency and effectiveness of policies, rules, or other methods in its policy statement or its plan; and”...*

It is important to note that the current legislation is generally non-prescriptive in terms of the details of an SOE monitoring programme, this being left to each individual local authority depending on what it considers to be “appropriate” to carry out its functions. A notable exception to this are the Resource Management (National Environmental Standards for Air Quality) Regulations (2004) which prescribe monitoring for certain contaminants in designated airsheds (for example, PM<sub>10</sub> particulate monitoring at Rotorua).

## 2.1.2 NPS for freshwater management

The NPS (National Policy Statement) for Freshwater Management 2011 requires regional councils to:

- Maintain or improve overall water quality within a region.
- Avoid further over allocation of water, phase out existing over allocation and improve efficiency of water use.
- Safeguard the life-supporting capacity, ecosystem processes and indigenous species (including their associated ecosystems) of fresh water.
- Set freshwater objectives and limits for all water bodies.

In 2012, Bay of Plenty Regional Council notified its NPS Implementation Programme. The Programme identified a stepped approach to delivering the NPS in the region by 2030.

Nine Water Management Areas (WMA's) have been identified within the Bay of Plenty region and Council has agreed to begin implementation of the NPS on two of those initially, the Rangitāiki and the Kaituna. Information gap analysis will be conducted for each WMA as part of the NPS process and these two WMA's would have the highest priority for additional monitoring if this is found to be necessary. Additional monitoring may also be needed once limits are set to assess compliance.

## 2.2 Legislative changes

The following new legislation is being developed which is likely to more clearly define the environmental monitoring and reporting required to be undertaken by regional councils.

### 2.2.1 Environmental Reporting Bill

An Environmental Reporting Bill (the Bill) has been introduced to create a national-level environmental reporting system which ensures that reporting on the environment occurs on a regular basis and can be trusted by the public as independent, fair, and accurate. The Bill provides for comprehensive information on five key environmental 'domains' - air, climate and atmosphere, freshwater, marine and land, with biodiversity as a theme across all the domains. One environmental domain report would be released every six months and a comprehensive synthesis report covering all environmental domains would be released every three years.

The chief executive of the Ministry for the Environment (the 'Secretary') and the government statistician would be responsible for producing and publishing reports. While the Bill places no direct obligation on regional councils it is anticipated that much of the data required for reporting will be sourced from existing monitoring networks. The nature and breadth of the reporting chosen may therefore place additional monitoring requirements on councils.

The Bill had its first reading in Parliament in March 2014.

## 2.2.2 Amendments to the NPS for Freshwater Management

The government has proposed amendments<sup>2</sup> to the NPS for Freshwater Management to:

- Require regional councils to account for all water takes and contaminant discharges.
- Include a national framework to support communities setting freshwater objective.
- Establish ecosystem and human health as compulsory values in regional plans.
- Introduce national 'bottom lines' for ecosystem and human health that apply everywhere, and include restricted grounds for exceptions to these national 'bottom lines'.
- Provide explicit recognition of tangata whenua values for fresh water.
- Make it clear that regional councils need to identify a range of representative sites in waterways at which to monitor progress towards, or achievement of, freshwater objectives.

These amendments would have implications for regional council monitoring programmes. For example, bottom line limits for periphyton (algal growths) in rivers and streams are proposed that would likely require additional monitoring in areas where these growths are recognised as a potential issue.

Consultation on these amendments closed in February 2014 and officials are expected to provide further advice to Cabinet by the middle of 2014. Once requirements are finalised the monitoring needs for the Bay of Plenty can be better determined.

## 2.3 Regional Policies and Plans

### 2.3.1 Ten Year Plan

The NERMN Programme sits under the Regional Monitoring Activity in the current Ten Year Plan (2012-2022). The purpose of the Activity is summarised in the plan as follows:

*We do this activity to collect and analyse a range of data on natural resources in the Bay of Plenty. This enables us to:*

- *Monitor key natural and physical resources across the region.*
- *Monitor the impact of development on natural and physical resources.*
- *Identify trends in the state of natural and physical resources.*
- *Regularly report on monitoring results.*
- *Assess the efficiency and effectiveness of our Regional Policy Statement and regional plans.*
- *Investigate current issues relating to the environment.*

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<sup>2</sup> New Zealand Government 2013. Improving our freshwater management: Proposed amendments to the National Policy Statement for Freshwater Management 2011.

- *Assess the region's performance against national guidelines, indicators and standards.*
- *Make sound resource management decisions.*
- *Provide information and data on the current state that is easily accessed by the community.*

### 2.3.2 Regional Policy Statement and Regional Plans

The Regional Policy Statement (RPS) and regional plans contain objectives, policies and methods that more clearly define the monitoring that is considered appropriate for the Bay of Plenty region.

The Operative RPS is the 'umbrella' document that provides much of the scope of the current NERMN Programme. The relevant policy is given under Section 5.3.11 (Monitoring) where it states that the Council will:

*"5.3.11(c)(x) Maintain and where appropriate, develop and expand its Natural Environment Regional Monitoring Network to monitor indicators of the state of the region's:*

- (a) Surface (fresh) water resources and associated ecosystems;*
- (b) Groundwater resources;*
- (c) Geothermal resources;*
- (d) Coastal land and water resources and associated ecosystems (in conjunction with the Department of Conservation);*
- (e) Land resources;*
- (f) Air resources; and*
- (g) Natural hazards.*

*5.3.11(c)(xi) Document and report on the state of the region's natural and physical resources and associated ecosystems, and the effects of the use, development and protection of these resources."*

These and the other key regional policies relevant to the NERMN Programme are summarised in Appendix 1.

## Part 3: Current state

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### 3.1 Goal of the NERMN

The following is the original goal of the NERMN:

*“to provide scientifically defensible information on the important physical, chemical and biological characteristics of the natural resources of the Bay of Plenty region as a basis for the preparation of Environment BOP [Bay of Plenty Regional Council] policies and plans, and the monitoring of their suitability and effectiveness.”*

This goal is still highly relevant and should be retained.

### 3.2 Programme structure

The NERMN Programme is organised into modules which relate to specific scientific disciplines and natural resources (Figure 1).

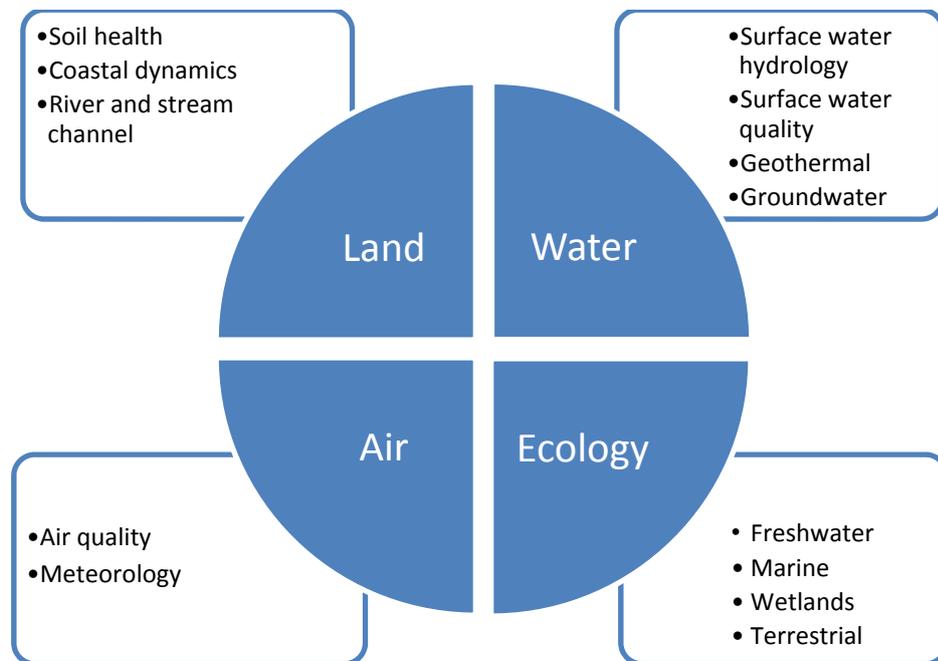


Figure 1 Overview of the current NERMN modules.

### 3.3 Expenditure

The budgeted total operating and capital expenditure for the NERMN Programme in 2013/2014 is \$2.7 million and \$324,000 respectively. The approximate proportion of this expenditure (including capital) on each module of the NERMN is shown below.

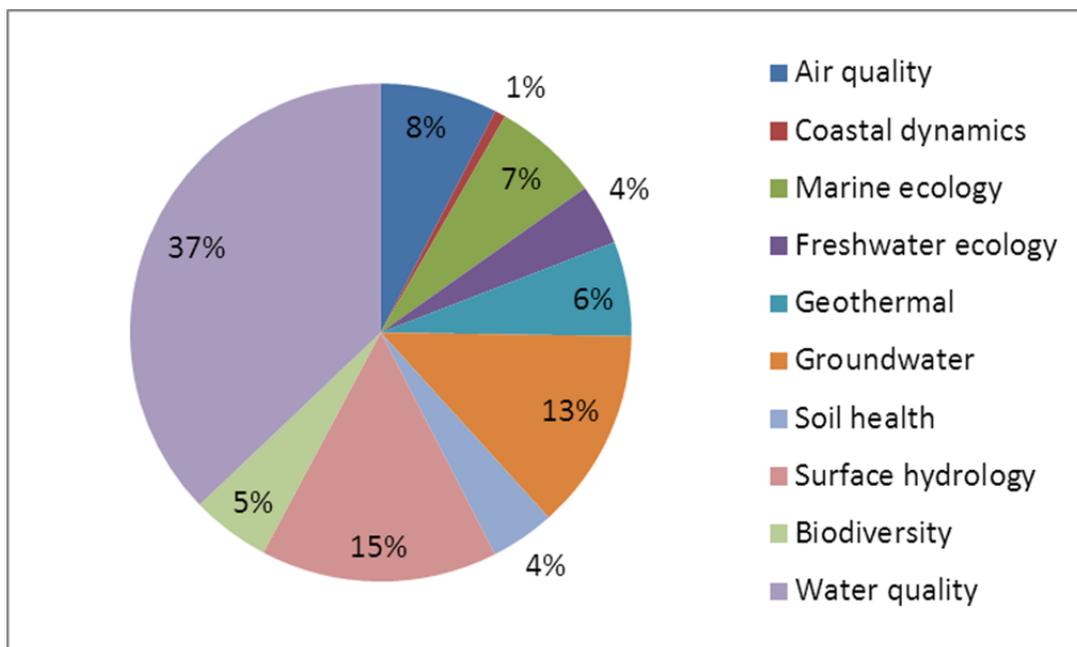


Figure 2 Proportion of expenditure on each module of the NERMN.

Operating expenditure covers employee expenses (51%), consultants, contractors and grants (12%), depreciation (15%), and general expenses (repairs, consumables, maintenance - 22%).

Funding for the programme is derived from a combination of general funds (regional rates and investment income) and Section 36 (RMA) charges levied on consent holders. The total contribution from consent holders in 2013/2014 is forecast to be approximately 25% of expenditure.

### 3.4 Reporting

Reporting for each module of the NERMN has historically been in the form of published technical or environmental reports, or by information feeds to the Regional Council website. The frequency of reporting, and the nature of the information provided, varies depending on a number of factors as described below.

- Live reporting - telemetered monitoring sites provide continuous data to the Regional Council website. This includes data on river flow and lake level, tidal levels, coastal temperature and wave heights, meteorology (e.g. wind direction and speed, temperature) and air quality. The data is available for viewing in its raw form (typically at 15 minute intervals) and is also summarised in the form of graphs.
- Status reporting - a number of recreational water quality indicators are reported via the Regional Council website as results come to hand. These are based on faecal bacteria (*E.coli* and *Enterococci*) and blue green algae and are reported alongside information provided by health authorities on current health warnings.

- Annual reporting – some NERMN modules are reported annually to satisfy internal or external reporting needs, or where there is high public interest in the information. For example, the Trophic Level Index (TLI) is reported on annually to give feedback on achievement of water quality targets set for the Rotorua Lakes in the Regional Water and Land Plan. Another relevant example is the annual reporting of air quality which is driven in part by the requirements of the National Environmental Standards for Air Quality (the NES-AQ).
- Longer term reporting - in many cases monitoring data is reported through technical reports at intervals of 2-5 years, or longer. This can be driven by the frequency of data collection, or by statistical parameters that determine the number of data points needed to reliably detect trends. For example, monitoring of contaminants in estuarine sediments is conducted every three years meaning that reporting can be no more frequent than three-yearly. In other cases, such as river water quality, long term data sets (3-7 years) are needed to identify trends and this can influence reporting frequency.
- SOE reporting - State of the Environment (SOE) reporting includes information on a wide range of environmental, social, cultural and economic indicators. The last SOE report for the Bay of Plenty region was produced in 2008<sup>3</sup> and this covered several environmental indicators including air quality, ecological health of stream-water, and coastal habitat health. Some NERMN modules are also reported periodically in the form of scorecards, for example Rotorua Air Quality, or through other council SOE reporting (a notable example being the SOE reports produced by Rotorua District Council).

Recommendations on the nature and frequency of future environmental reporting under the NERMN Programme are given in Part 5 of this report.

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<sup>3</sup> Environment Bay of Plenty 2008: Bay of Plenty Community Outcomes Report 2008. Published by the Bay of Plenty Regional Council. December 2008.



## Part 4: Review of the NERMN modules

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Each of the NERMN modules is described and reviewed in turn in this part of the report.

### 4.1 Air quality

NERMN air quality monitoring was first established in 1997<sup>4</sup> and this module was reviewed and extended in 2005. The results of air quality monitoring across the Bay of Plenty were last comprehensively reported on in 2012<sup>5</sup>.

#### 4.1.1 Current state

In October 2004, the Government introduced the National Environmental Standards for Air Quality. These air quality standards were issued as Regulations in accordance with Sections 43 and 44 of the RMA.

The standards include five ambient air quality standards for carbon monoxide (CO), particulate matter less than 10 micrometres in diameter (PM<sub>10</sub>), nitrogen dioxide (NO<sub>2</sub>), sulphur dioxide (SO<sub>2</sub>) and ozone (O<sub>3</sub>).

The ambient standards are a subset of the ambient air quality guidelines which set the minimum requirements that outdoor air quality should meet for a range of air pollutants in order to protect human health and the environment<sup>6</sup>.

#### ***Rotorua Airshed***

In response to the Ministry for the Environment's request to nominate airsheds, the Bay of Plenty Regional Council has designated one airshed for the Bay of Plenty region, this is the Rotorua Airshed<sup>7</sup>.

The location and extent of this area was based on local air quality monitoring data, air emission inventories, air discharge consents, council staff knowledge, geophysical, population and meteorological information. The extent of the airshed was further qualified by a detailed airshed modelling exercise<sup>8</sup>.

To monitor the levels of PM<sub>10</sub> in the airshed two monitoring sites<sup>9</sup> are currently in operation.

An Action Plan<sup>10</sup> has been implemented for the airshed in order to meet the interim deadline in 2016 and the final deadline in 2020. Regular reports on Action Plan progress are presented to the Council.

#### ***Other monitoring***

A range of contaminants (PM<sub>10</sub>, CO, NO<sub>x</sub>, SO<sub>2</sub>, H<sub>2</sub>S and BTEX) have been monitored at locations throughout the region. Currently there are 10 sites operating, seven measuring PM<sub>10</sub>, one measuring SO<sub>2</sub> at Mount Maunganui and two sites in Rotorua measuring H<sub>2</sub>S (see Table 1).

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<sup>4</sup> Graham, B.W., 1997. Proposals for a Regional Air Monitoring Programme: Environment B.O.P., Works Consultancy Services, Auckland.

<sup>5</sup> Iremonger, S.D. 2012. NERMN Air Monitoring 2012. Bay of Regional Council Environmental Publication 2012/02.

<sup>6</sup> Ministry for the Environment. 2002. Ambient Air Quality Guidelines, Report ME437 prepared by the Ministry for the Environment and the Ministry of Health. Wellington: Ministry for the Environment. Available from [www.mfe.govt.nz](http://www.mfe.govt.nz)

<sup>7</sup> New Zealand Gazette, 2005, Bay of Plenty Regional Airshed Notice, New Zealand Gazette, No. 141, 25 August 2005.

<sup>8</sup> Fisher, G. et. al., 2007, Rotorua Airshed Modelling Investigation, Client report, Endpoint Ltd., Auckland.

<sup>9</sup> Edmund Road and Ngāpuna.

<sup>10</sup> Bay of Plenty Regional Council, Rotorua Air Quality Action Plan, 21p.

#### 4.1.2 Recommended future state

Table 1 highlights the proposed changes to air monitoring with additional detail following.

Table 1 Recommended ambient air monitoring sites.

<b>PM<sub>10</sub> instrument</b>	<b>Recommendations</b>
Edmund Road, Rotorua	Continue
Ngāpuna, Rotorua	Continue
Otumoetai, Tauranga	Continue
Morland Fox Park, Tauranga	Decommission
King Street, Whakatāne	Continue
Pongakawa	Decommission
Te Puke	Decommission
<b>PM<sub>2.5</sub> instrument</b>	
Edmund Road, Rotorua	Begin monitoring 2014
<b>SO<sub>2</sub> instrument</b>	
Totara Street, Mt Maunganui	Continue
<b>H<sub>2</sub>S instrument</b>	
Te Ngae Road, Rotorua	Decommission
Arawa Bowling Club, Rotorua	Decommission

The removal of a number of sites from the network will reduce staff requirements and on-going expenditure for this module of the NERMN Programme. The decommissioned equipment (meteorological and air quality instrumentation) should be carefully removed and stored as a source of spares.

#### **Particulate monitoring**

The changes recommended for PM<sub>10</sub> monitoring are significant. The Rotorua monitoring will continue in order to meet the requirements of the NES-AQ. Whakatāne should also continue until a suitable wintertime profile is determined.

The PM<sub>2.5</sub> monitoring will start this year (2014) at the Edmund Road site. It is envisaged that data from this site can be extrapolated on a ratio basis to other monitoring records within the Bay.

Monitoring at Pongakawa commenced in 1997, the 16 years of data now provides a good picture of background levels within the Bay of Plenty. The source profile is unlikely to change dramatically and hence the data collected to date will provide robust dataset for any future investigations. This site can now be decommissioned.

The Otumoetai air quality site was one of the first installed in the Bay of Plenty in 1997. Collected data to date shows PM<sub>10</sub> air quality to be well below the NES-AQ health effect value and this data pattern has been consistent. While land use and population indicators in this area are unlikely to change significantly it is recommended that this site be retained as the long term PM<sub>10</sub> indicator site in Tauranga.

The Morland Fox park site was set up to investigate air quality at a worst case location for PM<sub>10</sub> concentrations based on emission inventory and topographic data analysis. The collected data like that at Otumoetai has shown that levels of PM<sub>10</sub> in this area are well below the NES-AQ value. This site can now be decommissioned.

The site at Te Puke was part of the investigative programme and is not required to continue based on recorded data to date.

Adverse health effects from particulate exposure (PM<sub>10</sub> and PM<sub>2.5</sub>) are now better understood and thus this contaminant should continue to be the main focus of monitoring. Improvements in air quality and meteorological (wind speed and direction) monitoring equipment should also be investigated to ensure high capture rates are maintained.

### ***Sulphur dioxide***

Monitoring of sulphur dioxide should continue at the Totara Street (Mount Maunganui) site as there have been several periods where the NES-AQ standard has been exceeded in the industrial/port area. Continuation of this monitoring will also improve the understanding of the ambient levels of this contaminant, and will add value to any further investigative work required in this area.

### ***Hydrogen sulphide***

The H<sub>2</sub>S programme had been postponed in the recent past due to the SO<sub>2</sub> monitoring requirements in Mount Maunganui. The Te Ngae Road site was maintained during this period to provide continuity.

Within the recent local H<sub>2</sub>S odour threshold investigation report<sup>11</sup> a chapter summarised the H<sub>2</sub>S datasets within the region and particularly in Rotorua. This summary showed that there is now a reasonable understanding of the spatial and temporal distribution of this contaminant within the city.

A recent study<sup>12</sup> investigating possible health effects of hydrogen sulphide in Rotorua involving 1637 local participants has now finished its field programme and no longer requires ambient monitoring support. The first research paper<sup>13</sup> from the study is focussed on the relationship with asthma. The study provided no evidence that asthma risk increases with H<sub>2</sub>S exposure. Suggestions of a reduced risk in the higher exposure areas are consistent with recent evidence that H<sub>2</sub>S has signalling functions in the body, including induction of smooth muscle relaxation and reduction of inflammation.

To date the historical H<sub>2</sub>S recorded data shows no long-term trends which are discernible, this reflects the nature (episodic in many cases) of the geothermal source and the effects of meteorology within the Rotorua urban area. Concerns about possible chronic health effects are resolved through long term health studies which will be supported on an as required basis.

For the reasons stated above it is recommended that monitoring of H<sub>2</sub>S in Rotorua can be discontinued.

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<sup>11</sup> Iremonger, S.D. 2012. A review of odour properties of H<sub>2</sub>S – Odour Threshold Investigation 2012, Environmental Publication 2012/06, June 2012, 69p. Obj. ref. A1510172.

<sup>12</sup> Bates, M. N., 2006, Effects of Long Term Low Level Hydrogen Sulphide Exposure, National Institute of Environmental Health Sciences, Research Summary Document Grant Number R01ES014038. Obj. ref. fA218005.

<sup>13</sup> Bates, M. N et. al, 2013, Associations of ambient hydrogen sulphide exposure with self reported asthma and asthma symptoms, Environmental Research, 122, 81-87. Obj. ref. A1574361.

## ***Meteorological monitoring***

It is important that basic meteorological parameters (wind speed, direction and air temperature) are recorded at all of the air quality monitoring sites. The minimum requirements are outlined in the Good Practice Guide for Air Quality Monitoring<sup>14</sup>. This additional information provides added value to the primary dataset in determining causes of elevated concentrations and long term source contributions. The datasets are also critical for future modelling investigations in relation to airshed compliance or the consenting of significant activities.

In summary meteorological instruments should be operational at all times at the following sites; Edmund Road and Ngāpuna (Rotorua), Totara Street (Mount Maunganui) and King Street (Whakatāne).

In addition to monitoring at the air quality sites the Edgecumbe Meteorological Station should continue to be maintained within the NERMN Programme. It has been operational since 1992 and provides important data which compliments the MetService network which is centred on sites at each of the regions airports. This site also provides information that is useful when investigating complaints.

## **4.2 Surface water hydrology**

The NERMN Programme includes a network of automated and manual hydrology monitoring sites, a number of which have been in place for several decades. While many of the rainfall, river level and river flow sites were originally installed to provide flood warning these also provide valuable information on surface water quantity on the larger river systems. The monitoring also complements other modules of the NERMN Programme, particularly groundwater, water quality and ecology.

The hydrology monitoring network includes the following sites:

- 55 rainfall stations (38 are continuously monitored, 17 are manually read).
- 43 river level monitoring stations (all continuously monitored).
- 25 river flow monitoring stations (all continuously monitored) and 22 monitored monthly by gauging which coincides with water quality sampling.
- 12 lake level and five tidal level monitoring stations (all continuously monitored).
- One open coastal wave and temperature monitoring site, this is the 'Wave Buoy' located 13 km off Pukehina Beach (continuously monitored).

In addition to these sites there is also access to the data gathered by NIWA across an additional 14 sites (mostly river level and flow).

### **4.2.1 Recommended future state**

Additional hydrology monitoring is likely to be required in the future due to:

- Increased legislated requirements related to water management. For example, the NPS for Freshwater Management, along with pending legislation on environmental reporting and the National Objectives Framework for freshwater.

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<sup>14</sup> Ministry for the Environment. 2009. Good Practice Guide for Air Quality Monitoring and Data Management 2009. Wellington: Ministry for the Environment.

- Developing pressure on water resources leading to the need for more information on hydrology to inform water allocation and plan change decisions.
- The need for better information on low flow hydrology, particularly for smaller rivers and streams, to ensure future minimum flow requirements are being given effect to.
- Ongoing review by NIWA of their monitoring sites which could result in critical sites being handed over to BOPRC.

To meet these requirements it is estimated that there will be a need for at least an additional one to two sites per annum for the next five years.

### 4.3 Geothermal

Currently there are three geothermal systems that have some form of regional monitoring; Rotorua, Tauranga, and Waimangu. Two monitoring programs are in place for the Rotorua geothermal field (bore monitoring and surface feature monitoring), bore monitoring is in place for the Tauranga geothermal field, and surface feature monitoring is in place for the Waimangu geothermal system.

Comprehensive reporting on the geothermal fields has been limited to Rotorua, the last summary report was produced in 2001<sup>15</sup>.

*Table 2 Current geothermal monitoring regime.*

System	Monitoring	Parameters	Frequency	Duration
Rotorua	10 bores.	Water level, temperature, barometric pressure.	5 bores recorded automatically every hour (loggers & telemetry), depth range 150 m to 300 m for temperatures >70°C. 5 bores recorded manually fortnightly, depth range 3 m to 10 m for temperatures <70°C. Barometric pressure recorded 15 minute intervals (logger & telemetry).	Since 1982 to present.
Rotorua	39 surface features.	Description, flow, temperature.	Monthly site visit to each feature.	Since 2008 to present.
Tauranga	14 bores.	Water level.	1 bore recorded automatically. 13 bores recorded manually every quarter.	Since 1986 to present.
Tauranga	10 bores.	Water quality.	Annual water sample analysed for 20 parameters.	Since 1992 to present.
Waimangu	1 surface feature.	Lake flow and temperature, climate.	Continuous.	Since 2011.

<sup>15</sup> Gordon, D.A. et al. 2001. Rotorua Geothermal Field Management Monitoring. Environment BOP Environmental Report 2001/22.

### 4.3.1 Recommended future state

#### Rotorua

Geothermal fluid corrodes the casing work of monitoring bores over time meaning there needs to be a regular programme of replacement. Just five bores remain of the 12 original deep geothermal monitoring bores established in the 1980's to assess the recovery of the Rotorua geothermal field. These five are replacement bores to the same depth as the original bores and provide for continuity of monitoring and correlation of data. An additional five bore sites were established to monitor the level of shallow geothermal groundwater and these are still operational.

A number of research projects are currently underway to better understand the nature and state of the Rotorua geothermal field. These include conceptual geological modelling, thermal infrared surveys, and detailed analysis of the historical monitoring data. It is predicted that as a result of this work, and due to the deterioration of monitoring sites over time, there will be the need for at least four new geothermal bores between now and 2020.

#### Tauranga

The Tauranga system is a low temperature field (<70°C) which is hydraulically linked to groundwater. Automated monitoring of water levels and more frequent water quality monitoring on the existing bores is recommended to improve the ability to detect trends.

#### Waimangu

The Waimangu geothermal system is a protected field under the Regional Water and Land Plan. However this system is hydraulically connected to three other geothermal systems in the Waikato region; the Waiotapu and Waikite (both protected under Waikato Regional Council (WRC) rules), and Reporoa (which has policy provisions for development).

The present surface feature monitoring regime at Frying Pan Lake (managed by BOPRC and WRC) and Lake Inferno (managed by GNS Science) should be retained.

Table 3 Recommended additional geothermal monitoring.

System	Monitoring	Parameters	Frequency
Rotorua (>70°C).	4 bores (new installations).	Water level, temperature profiles, water quality.	Bore water level recorded automatically every hour (loggers and telemetry). Temperature profile and water quality samples annually.
Tauranga (>30°C <70°C).	14 bores (existing). 10 bores (existing).	Water level monitoring upgrade. Water quality monitoring upgrade.	Bore water level recorded automatically every hour (loggers and telemetry). Water sample each quarter analysed for 20 parameters.

## 4.4 Groundwater

Groundwater monitoring began under the NERMN Programme in 1990 but monitoring has occurred at some sites since 1983. The monitoring includes groundwater level and quality, and groundwater recharge (at lysimeter sites).

The purpose of the groundwater monitoring is:

- To provide data on the properties of the groundwater systems.
- To identify trends in groundwater level and quality that may affect groundwater availability and potential use.
- To provide data on recharge rates to groundwater.

The current groundwater monitoring regime is summarised below.

*Table 4 Groundwater monitoring regime.*

<b>Number of sites</b>	<ul style="list-style-type: none"> <li>• Water level - 54, water quality - 22, recharge - 5.</li> </ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"> <li>• 8 bore water level recorded automatically every hour (loggers &amp; telemetry).</li> <li>• 46 bore water level recorded manually quarterly.</li> <li>• Annual water quality sampling and analysis of 20 parameters.</li> <li>• 5 monitoring bores have both water level and water quality monitoring.</li> <li>• Rainfall recharge sites (lysimeters) are monitored automatically.</li> </ul>
<b>Water quality parameters</b>	<ul style="list-style-type: none"> <li>• Historically over 50 parameters including heavy and rare metals indicative of geothermal systems.</li> </ul>
<b>Length of data record</b>	<ul style="list-style-type: none"> <li>• Water level - 1987 to present.</li> <li>• Water quality - 1991 to present.</li> <li>• Recharge - 2005 to present for some sites.</li> </ul>

The results of the groundwater monitoring were last comprehensively reported in 2013<sup>16</sup>.

### 4.4.1 Recommended future state

The existing monitoring has been reviewed and some bores with poor data record removed from the programme. Alternative bores are being investigated for on-going monitoring with priority given to the first NPS for Freshwater Management catchments (Kaituna and Rangitāiki), and for catchments where allocation pressure has been identified.

The recommended programme is set out in sub-regional areas to ensure adequate coverage and to address a number of resource issues (e.g. coastal salt water intrusion, low heat geothermal, lake-catchment nutrients, abstraction pressure leading to groundwater level decline). Within each of these sub-regional areas a network of ground water bores is recommended (water quality and level monitoring) along with rainfall recharge monitoring (lysimeter stations).

<sup>16</sup> Barber, J. and Harvey, D. 2013. NERMN Groundwater Monitoring Report. Environmental Publication 2013/02. Bay of Plenty Regional Council, Whakatāne.

To understand groundwater flows and the impacts of land use and other activities there is a need for rainfall and surface water hydrology data (e.g. stream level and base flows). Most of the surface water hydrology sites required are already established and data from these stations will be used with additional monitoring of springs and isotopes (for water aging).

The proposed monitoring sub-regions are:

- Tauranga Harbour.
- Te Puke – Waitahanui.
- Rangitāiki Plains.
- Galatea Plains.
- Upper Rangitāiki.
- Ōpōtiki Plains.
- Rotorua Lakes (includes the Tarawera Catchment lakes).

All of this information combined can provide a better understanding of how groundwater systems are replenished, how groundwater and surface water interact, the flow available for allocation, and the impact of water abstraction.

Regular data assessment (quarterly and annual) is required, with five yearly reporting to identify trends. Some automatic monitoring sites will require ‘alarms’ to be set to indicate potential issues such as salt water intrusion.

A summary of the recommended monitoring for each groundwater sub-region is given below.

*Table 5 Recommended groundwater monitoring regime.*

Sub-region	Bore water level		Bore water quality		Recharge		Spring flow and water quality		Isotope	
	P	E	P	E	P	E	P	E	P	E
Tauranga Harbour	1	10	1	5	1	1	4	-	4	-
Te Puke Waitahanui	4	11	5	8	1	2	5	-	5	-
Rangitāiki Plains	6	4	6	1	1	-	4	1	5	-
Galatea Plains	3	1	4	-	1	-	4	-	4	-
Upper Rangitāiki	4	-	4	-	-	1	4	-	4	-
Ōpōtiki Plains	4	1	4	1	1	-	3	-	3	-
Rotorua Lakes	-	18	-	17	-	1	-	-	-	-
<b>Sub-total</b>	<b>22</b>	<b>45</b>	<b>24</b>	<b>32</b>	<b>5</b>	<b>5</b>	<b>24</b>	<b>1</b>	<b>25</b>	<b>0</b>
<b>Total</b>	<b>67</b>		<b>56</b>		<b>10</b>		<b>25</b>		<b>25</b>	

P = number of proposed new sites; E = number of existing sites.

Trend analysis is made difficult by infrequent monitoring (quarterly for manual water level and annual for water quality), and measurements are taken at various times of the year. It is recommended that groundwater level bores are progressively converted to automatic monitoring (continuous) and groundwater quality monitoring increased from annually to quarterly.

There is also the need for better understanding of the linkages between groundwater and surface water. To this end monitoring of springs is recommended as is the retention of existing surface water flow monitoring. Springs represent groundwater that has reached the surface and this supports stream flows and wetlands. Monitoring of signature isotopes at five yearly intervals is also recommended to better understand groundwater source, age and flow direction.

## 4.5 Surface water quality

### 4.5.1 Rivers and streams

The river and stream water quality monitoring network has been operating since 1989 and the results are used to:

- Report on the state of the environment in terms of the water quality of rivers and streams.
- Compare measured water quality parameters against water quality classifications, guidelines and standards.
- Detect water quality trends in the interests of maintaining and/or enhancing water quality.
- Identify specific water quality issues.

Fifty river and stream sites are monitored by the Regional Council, with a further six sites monitored by NIWA (see table below). The sites cover a range of land uses and catchment land cover and include most of the major rivers and streams in the Bay of Plenty.

*Table 6 River and stream water quality monitoring regime.*

<b>Number of sites</b>	<ul style="list-style-type: none"> <li>• 50 (plus 6 sites are monitored by NIWA).</li> </ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"> <li>• Monthly at 35-40 sites (26 on a 3-year on 3-year off rotation).</li> <li>• Quarterly 4 sites.</li> </ul>
<b>Water quality parameters</b>	<ul style="list-style-type: none"> <li>• Temperature, dissolved oxygen, pH, water clarity, conductivity, NH<sub>4</sub>-H, NO<sub>x</sub>-N, TN, DRP, TP, turbidity, TSS, colour coefficient, <i>E.coli</i>, Faecal Coliforms, Enterococci, flow or stage height.</li> </ul>
<b>Length of data record</b>	<ul style="list-style-type: none"> <li>• 1990 to present - 33 sites (NIWA sites from 1989).</li> <li>• 1993 to present - 4 sites.</li> <li>• 1995 to present - 3 sites.</li> <li>• 1999 to present - 2 sites.</li> <li>• 2001 to present - 6 sites.</li> <li>• 2003 to present - 2 sites.</li> </ul>

Monitoring information for rivers and streams was last reported in detail in 2009<sup>17</sup> and 2011<sup>18</sup>.

### Recommended future state

The freshwater monitoring network was independently reviewed in 2012<sup>19</sup>. The review found that the network was operating well and made a number of recommendations for improvement including:

- Increase the number of water quality sites in rivers classed 'hill-country/non-volcanic' and 'lowland/non-volcanic'.
- Change some of the sites currently monitored on a three year rotation to long term sites monitored on a continual basis. If this is done priority should be given to sites classed 'hill-country/non-volcanic', 'lowland/non-volcanic' and 'indigenous forest'.
- Identify possible reference (or un-impacted) sites.
- Increase the number of sites with permanent dissolved oxygen and temperature loggers, particularly in large 'U' shaped rivers (e.g. the Kaituna, Rangitāiki).

NIWA acting for Ministry for the Environment have reviewed river water quality monitoring nationally<sup>20</sup> and have made several recommendations. Two of these have potentially significant resourcing implications for regional councils:

- All sites should be monitored monthly.
- Individual sites should be sampled at a consistent time (+/- 1hour) on every visit.

The review also recommended a number of quality assurance (QA) measures and suggested that at least 10% of the monitoring budget should be spent on this activity.

A robust monitoring programme is needed that can more reliably detect water quality trends. The recommended change therefore is to monitor all sites on a monthly basis, and to add one or two reference sites.

*Table 7 Recommended water quality monitoring for rivers and streams.*

<b>Number of sites</b>	<ul style="list-style-type: none"> <li>• Increase from 50 sites currently to up to 60 sites (plus 6 sites are monitored by NIWA).</li> </ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"> <li>• Increase to monthly for all sites (ongoing with no site rotation).</li> </ul>
<b>Water quality parameters</b>	<ul style="list-style-type: none"> <li>• Temperature, dissolved oxygen, pH, water clarity, conductivity, NH4-H, NOx-N, TN, DRP, TP, turbidity, SS, colour coefficient, <i>E.coli</i>, Faecal coliforms, Enterococci, flow or stage height.</li> </ul>

<sup>17</sup> Scholes, P. Water Quality of the Bay of Plenty Rivers 1989-2008. Environment Bay of Plenty, Environmental Publication 2009/11.

<sup>18</sup> Scholes, P., Donald, R. and McIntosh, J. Water Quality Classification Assessments, Rivers and Stream in the Bay of Plenty. Environment Bay of Plenty, Environmental Publication 2011/07.

<sup>19</sup> Hamill K. and O. Ausseil (2012): Review of BOPRC Natural Environmental Regional Monitoring Network – freshwater quality. Opus International Consultants.

<sup>20</sup> NIWA 2012. Freshwater Monitoring Protocols and Quality Assurance (QA), National Environmental Monitoring and Reporting (NEMaR) Variables step 2. NIWA Client Report HAM2012-092.

#### 4.5.2 Lake water quality

The water quality of the Rotorua Lakes has been monitored by the Bay of Plenty Regional Council since 1990. One of the key purposes of the monitoring is to provide feedback on progress against the TLI (Trophic Level Index) targets for each of the lakes. The TLI is an indicator of the environmental quality of a lake and is composed of two biological and two chemical components. Each lake has a TLI standard (Objective TLI) which is set in the Regional Water and Land Plan.

Water quality sampling of the Rotorua Lakes is carried out monthly. Each lake is sampled at single or multiple deep water sites. Vertical profiles of temperature, dissolved oxygen, conductivity and fluorescence are recorded by a data logger with appropriate sensor arrays. Depth sampling varies depending on the stratification status of each lake with samples taken to represent the epilimnion (top layer) and the hypolimnion (bottom layer).

Monitoring buoys are located in five lakes and these collect continuous data on a number of parameters including dissolved oxygen, temperature and chlorophyll-a (fluorescence). These buoys are operated by the University of Waikato and provide valuable data.

*Table 8 Lake water quality monitoring regime.*

<b>Number of sites</b>	<ul style="list-style-type: none"><li>• 14 sites (12 lakes).</li></ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"><li>• Monthly. Five lakes monitored continuously (lake buoys).</li></ul>
<b>Water quality parameters</b>	<ul style="list-style-type: none"><li>• pH, water clarity, conductivity, NH<sub>4</sub>-H, NO<sub>x</sub>-N, TN, DRP, TP, chlorophyll-a.</li><li>• By sensor array: Dissolved oxygen, temperature, turbidity, fluorescence, PAR, conductivity.</li></ul>
<b>Length of data record</b>	<ul style="list-style-type: none"><li>• 1990 to present.</li></ul>

The TLI is reported annually for the July to June period. Comprehensive reports examining the various water quality parameters in more detail were last undertaken in 2009<sup>21</sup> and 2011<sup>22</sup>.

#### **Recommended future state**

No significant changes are recommended. The lake monitoring programme is working well and meets most of the recent recommendations being considered by the Ministry for the Environment for the National Environmental Monitoring and Reporting framework (NEMaR).

While not currently part of the NERMN Programme it is likely that additional resourcing will be necessary in the future to maintain the operation of the University of Waikato lake buoys at several sites.

<sup>21</sup> Scholes, P. 2009. Rotorua Lakes Water Quality Report 2009. Environment Bay of Plenty, Environmental Publication 2009/12, November 2009.

<sup>22</sup> Scholes, P. 2011. 2010/2011 Rotorua Lakes Trophic Level Index Update. Bay of Plenty Regional Council Environmental Publication 2011/17, December 2011.

### 4.5.3 Harbour and estuary water quality

Monitoring of the water quality of harbours and estuaries began in 1990. The objectives of the monitoring programme are to determine:

- The state and trends of water quality.
- Progress against the water quality classifications (standards) for riverine and coastal estuaries.
- Potential adverse effects on water quality from various activities.

Nine estuarine systems are currently monitored, with 21 sites sampled every two months over the high tide period and three sites over the low tide period.

Table 9 Harbour and estuary water quality monitoring regime.

<b>Number of sites</b>	<ul style="list-style-type: none"><li>• 21 (nine estuaries).</li></ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"><li>• Every two months at all sites.</li></ul>
<b>Water quality parameters</b>	<ul style="list-style-type: none"><li>• Dissolved oxygen, Temperature, pH, water clarity, conductivity, salinity, NH<sub>4</sub>-H, NO<sub>x</sub>-N, TN, DRP, TP, turbidity, SS, <i>E.coli</i>, Faecal Coliforms, Enterococci, chlorophyll-a.</li></ul>
<b>Length of data record</b>	<ul style="list-style-type: none"><li>• 1990 to present for 10 sites.</li><li>• 1995 to present for 4 sites.</li><li>• 1998 to present for 6 sites.</li><li>• 2004 to present for 1 site.</li></ul>

Monitoring information for harbours and estuaries was last fully reported on in 2005<sup>23</sup>. An updated report is due to be completed in 2014.

#### **Tauranga Harbour**

In addition to the above, the following targeted monitoring has recently been initiated in Tauranga Harbour and the catchment to better understand nutrient dynamics and sedimentation:

- Nutrient levels in water at the southern harbour entrance (adjacent to Port of Tauranga) and at the entrance to the Waikaraeo sub-estuary. Sampling is undertaken once every two weeks at low and high tide.
- Continuous sediment load monitoring (using flow rate and turbidity sensors) on the Kopurererua Stream at State Highway 29.
- Sediment plate monitoring at approximately 60 sites in the harbour. These were installed in the summer of 2013/2014 and consist of large floor tiles buried at shallow depth in the sediment. They are used to give an accurate assessment of sedimentation rates over longer periods of time.

This monitoring represents the minimum required to inform the management of the harbour. It may need to be increased in the future to provide more detailed information in support of the Tauranga Harbour Programme.

<sup>23</sup> Scholes, P. 2005. NERMN Estuarine Water Quality 2005. Environmental Publication 2005/19. Environment Bay of Plenty, Whakatāne.

## Recommended future state

There are some problems with the reliability of trend detection in coastal estuarine environments due to tidal patterns and the shallow nature of some sites. Previous analysis has shown that wave action, which disturbs sediment, can bias the results for some water quality parameters (e.g. TSS, faecal indicator bacteria). Because of this interpreting data is problematic and it can be difficult to determine if trends are due to external impacts or natural factors.

Monthly monitoring is recommended to improve trend detection and improve the ability to assess performance against water quality classifications across the tidal range. The use of continuous water quality monitoring at some key sites, as is now occurring in the Rotorua Lakes, may be a sound substitute for manual monthly monitoring and should be investigated further. Monitoring buoys are available to monitor several parameters including dissolved oxygen, turbidity, salinity and chlorophyll-a (fluorescence).

The targeted monitoring of nutrients and sedimentation in Tauranga Harbour should continue with appropriate review and consideration of additional sites and parameters within two years (by 2016).

*Table 10 Recommended water quality monitoring regime for harbours and estuaries.*

<b>Number of sites</b>	<ul style="list-style-type: none"><li>• Water quality - 21 (9 estuaries).</li><li>• Tauranga Harbour – nutrients at 2-4 open water sites, sedimentation rates at up to 60 sites, continuous sediment load monitoring at a minimum of 2 stream sites.</li></ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"><li>• Increase to monthly at all water quality sites.</li><li>• As required at Tauranga Harbour sites.</li></ul>
<b>Water quality parameters</b>	<ul style="list-style-type: none"><li>• Dissolved oxygen, Temperature, pH, water clarity, conductivity, salinity, NH<sub>4</sub>-H, NO<sub>x</sub>-N, TN, DRP, TP, turbidity, TSS, <i>E.coli</i>, Faecal Coliforms, Enterococci, chlorophyll-a.</li></ul>

### 4.5.4 Bathing quality

Annual water quality surveys occur at popular recreational (bathing) sites and shellfish beds over the warmer months (October to March). The surveys are used to identify the risk to public health from faecal contamination at these sites. The information is then used by public health (Toi Te Ora) and local authorities to advise the community on the suitability of water for bathing or shellfish consumption.

A number of regional policies and plans have objectives based on a contact recreation standard:

- On-site Effluent Treatment (OSET) Regional Plan.
- Regional Water and Land Plan.
- Regional Coastal Environment Plan.
- Regional Policy Statement.

Approximately 80 sites are monitored with sites sampled for water quality weekly or fortnightly during the bathing season. Over 1,260 water quality samples are taken in a season for routine monitoring. When bacteria are detected above alert levels monitoring is increased to daily and further sampling in the catchment may also occur. Over 100 extra samples over the season may be required due to bathing alert levels being reached.

Shellfish monitoring is targeted at specific areas as required to support specific catchment investigations.

Table 11 Bathing surveillance monitoring regime.

<b>Number of sites</b>	<ul style="list-style-type: none"> <li>82 sites: 20 lake sites; 29 river sites; 33 Marine sites.</li> <li>Shellfish ~ 24 sites.</li> </ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"> <li>For water weekly or every second week (October to March).</li> <li>Shellfish: once or twice during summer (sampled as required, just a few sites are sampled every year).</li> </ul>
<b>Water quality parameters</b>	<ul style="list-style-type: none"> <li><i>E.coli</i>, Enterococci, Faecal coliforms (in shellfish).</li> </ul>
<b>Length of data record</b>	<ul style="list-style-type: none"> <li>1990 to present: variable depending on the site. Most sites have been consistently monitored since 2003.</li> </ul>

The results of the bathing surveillance monitoring were last reported for the 2011/2012 season<sup>24</sup>. Grading data for individual sites is also supplied to the Ministry for the Environment and this forms part of the national bathing surveillance reporting.

### Recommended future state

The current monitoring programme does not fully meet the monitoring guidelines provided by the Ministry for the Environment and Ministry of Health<sup>25</sup>. These state that ideally there should be 100 data points or greater collected over the previous five years (20 samples per site per season) in order to provide a 'Suitability for Recreation Beach Grade' (SFRG). For the current bathing sites this would result in a further 400 samples per monitoring season (an increase of approximately 32%).

An alternative would be to reduce monitoring of the high quality lake and open coastal sites to every three years as these have consistently shown low levels of faecal contamination. This would allow resources to be focused on the poorer quality river and estuarine sites (including source tracking) and allow the sampling frequency to be increased for other sites. This approach while practical is not recommended as focussing on poorer quality sites would unfairly portray the overall bathing water quality in the Bay of Plenty.

<sup>24</sup> Scholes, P. 2012. Bathing and shellfish surveillance report 2011/2012. Environmental Publication 2012/09, Bay of Plenty Regional Council, Whakatāne.

<sup>25</sup> Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas Published in June 2002 by the Ministry for the Environment Manatu Mo Te Taiiao PO Box 10-362, Wellington, New Zealand. Updated in June 2003.

Table 12 Recommended monitoring regime for bathing surveillance.

<b>Number of sites</b>	<ul style="list-style-type: none"> <li>82 sites: 20 lake sites; 29 river sites; 33 Marine sites.</li> <li>Shellfish ~ 24 sites.</li> </ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"> <li>For water weekly (October to March), at least 20 samples per site per summer monitoring season.</li> <li>Shellfish: once or twice during summer (sample as required, not all sites are sampled every year).</li> </ul>
<b>Water quality parameters</b>	<ul style="list-style-type: none"> <li><i>E.coli</i>, Enterococci, Faecal coliforms (in shellfish).</li> </ul>

## 4.6 Freshwater ecology

### 4.6.1 River and stream ecology

#### **Algae**

There is currently no routine monitoring of attached benthic algae (periphyton) in rivers and streams. However periphyton coverage is monitored in certain rivers and streams in response to complaints, when there are observations of nuisance growths, or following long periods of low flow. Some forms are potentially toxic, particularly the blue-green algae *Phormidium*, and health warnings can be issued when the coverage of these algae is extensive.

#### **Invertebrates**

River and stream invertebrate monitoring has been part of the NERMN programme since 1992. It is designed to assess the ecological condition of rivers and streams throughout the region and to detect any trends in ecosystem health. Invertebrates are easy to sample and are also a reasonably good 'surrogate' for other components of the ecosystem which are more difficult to monitor (for example fish communities).

Data collected by this program can be used to detect changes in stream health following catchment improvement works such as land retirement and riparian fencing. However, this analysis relies on sound data indicating the extent and nature of works carried out in each catchment (e.g. length and quality of riparian protection implemented).

Invertebrate samples are collected each summer (December through February) from 118 sites throughout the Bay of Plenty, especially in the mid and western parts of the region. Sampling consists of a mixture of quantitative invertebrate samples from 17 cobble-bottomed streams (13 in the east, and four in the west of the region), and semi-quantitative samples from the remaining 101 rivers and streams.

Despite the long duration that invertebrate sampling has been undertaken (up to 18 years), the last report summarising the monitoring findings was prepared in 2001<sup>26</sup>. Prior to this there were reports on the initial three years of the monitoring programme<sup>27,28</sup>. A report summarising all data and describing trends in ecological

<sup>26</sup> Wilding, T. K. (2001). River invertebrate monitoring 1991-2000. Environmental report 2001/13, Environment Bay of Plenty, Whakatāne.

<sup>27</sup> Donald, R. (1992). Bay of Plenty Regional Council natural environment regional monitoring network freshwater ecology program riverine component 1992. Technical report number 29, Bay of Plenty Regional Council, Whakatāne.

<sup>28</sup> Donald, R. (1995). Environment Bay of Plenty natural environment regional monitoring network River ecology program 1992-1995. Environmental report 95/16, Environment Bay of Plenty, Whakatāne.

condition over time is currently being prepared and data gleaned from the work has been used in preparation of a number of Council reports<sup>29</sup>.

*Table 13 River and stream invertebrate monitoring regime.*

<b>Number of sites</b>	<ul style="list-style-type: none"> <li>• 118 sites.</li> </ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"> <li>• Annually (December - February).</li> </ul>
<b>Measured parameters</b>	<ul style="list-style-type: none"> <li>• Habitat assessments (including streambed conditions, riparian vegetation, stock access etc. Note that assessment protocols have changed over time).</li> <li>• Invertebrates present.</li> </ul>
<b>Length of data record</b>	<ul style="list-style-type: none"> <li>• 5 or fewer years: 5 sites.</li> <li>• 6 year period: 2 sites.</li> <li>• 7 year period: 3 sites.</li> <li>• 8 year period: 41 sites.</li> <li>• 9 year period: 50 sites.</li> <li>• 16-18 year period: 17 sites.</li> </ul>

### **Recommended future state**

Monitoring of algae (periphyton) in susceptible rivers and streams should continue on a case by case basis to assist health authorities when blooms are identified. Susceptible sites are those that have stable beds composed of hard substrate (e.g. rocks and cobbles) and flow conditions that support extensive algae growth. This is not the case for many rivers and streams in the Bay of Plenty, particularly those with unstable pumice beds or where depth is sufficient to be light limiting to algal growth.

It is likely that new legislation (particularly amendments to the NPS for Freshwater Management) will impose a requirement on regional councils to monitor periphyton so as to assess whether national 'bottom-line' limits for human and ecological health are being met. Additional monitoring of water quality and quantity would also be needed to inform limit setting in relationship to periphyton.

It is recommended that no additional long-term monitoring is started until these requirements become clear. However, there will be a need initially for more directed research studies to inform on the status of periphyton in individual catchments in which the NPS is being implemented.

The invertebrate monitoring programme was recently reviewed<sup>30</sup> and a number of changes made to the way data is collected and stored. This review also determined, amongst other things, how representative the monitored sites were in relation to the range of streams and rivers throughout the region. Preliminary results showed that some land use classes are under-represented in the monitoring programme.

<sup>29</sup> For example - MacKenzie, H. (2013) State of the Ōhiwa Harbour and Catchment. Environmental Publication 2013/07, Bay of Plenty Regional Council, Whakatāne.

<sup>30</sup> Suren, A.M. (2012) Review of BoP NERMN stream biomonitoring programme. Unpublished Report prepared for Bay of Plenty Regional Council, Whakatāne.

It was recommended that streams in under-represented land use classes be monitored including:

- For hill fed streams, increase the number of sites draining exotic forests in volcanic catchments, and the number of sites draining native bush in non-volcanic catchments.
- Possibly reducing the number of pasture streams in volcanic catchments.
- For lowland streams, increase the number of sites draining urban areas, the number of streams draining pasture areas in non-volcanic catchments, and the number of sites draining exotic forests in volcanic catchments.
- For lake fed streams, increase the number of streams draining exotic forests, pasture and natural areas in volcanic catchments.

Replicate samples will be needed to properly characterise the ecological health of streams draining a particular land use, so an additional 30 to 40 sites would be needed to cover under represented land-use classes. To achieve this, and keep the programme to a manageable size, it is recommended that monitoring cease at some of the current sites. Given the value of long-term data, the logical sites to drop would be those collected for seven or less years (10 sites). Other longer term sites would also need to be dropped to allow better site representation. The overall effect of this recommendation would be a modest increase in sites from 118 to 130.

*Table 14 Recommended monitoring regime for freshwater ecology.*

<b>Number of sites</b>	<ul style="list-style-type: none"> <li>• 130 sites.</li> </ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"> <li>• Annually (Dec - Feb).</li> </ul>
<b>Measured parameters</b>	<ul style="list-style-type: none"> <li>• Habitat assessments (including streambed conditions, riparian vegetation, stock access etc.</li> <li>• Invertebrates present.</li> </ul>

#### 4.6.2 Lake ecology

##### **Algae**

Algal monitoring in the Rotorua Lakes has been carried out under the NERMN programme since 1992. The monitoring is composed of two separate components:

- Quarterly phytoplankton sampling from discrete stations within each of the 12 lakes.
- Annual summer surveillance of selected (eutrophic) lakes with high recreational values for cyanobacteria (blue-green algae) blooms.

The results of the algal monitoring are meant to provide a snapshot of the current condition of each lake, detect any trends in overall lake health, and assist in determining whether the water quality objectives of the Regional Water and Land Plan are being achieved.

The algal monitoring has evolved over time. In the early 1990's all lakes (except Rotoiti and Rotorua) were sampled every two months, three sites in Lake Rotoiti and one site in Lake Rotorua were sampled monthly. Over the years, the sampling frequency has changed to increase efficiencies, or to better track unpredictable blooms. For example, prior to 1993, all samples were analysed individually but from July 1993, all samples were combined into a single annual composite sample for each lake. In 1997, there was an unpredictable bloom of a foam producing algae, so

samples were processed individually instead of pooling them so as to better track this bloom. Monthly samples are now collected from discrete locations in each lake and these are pooled into composite seasonal (quarterly) samples.

Table 15 Lake ecology monitoring regime.

<b>Number of sites</b>	<ul style="list-style-type: none"> <li>21 Sites from the 12 Rotorua Lakes.</li> </ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"> <li>Variable, ranging from sampling monthly, every two months, or seasonally.</li> </ul>
<b>Measured parameters</b>	<ul style="list-style-type: none"> <li>When processed, information on species/generic composition and cell counts.</li> </ul>
<b>Length of data record</b>	<ul style="list-style-type: none"> <li>20 years: Lakes Okareka and Rotoehu.</li> <li>19 years: Lake Rotorua.</li> <li>18 years: Lakes Rerewhakaaitu, Rotoiti, and Tikitapu.</li> <li>17 years: Lakes Ōkātina and Rotomahana.</li> <li>16 years: Lakes Ōkaro, Rotokakahi, Rotomā.</li> <li>15 years: Lake Tarawera.</li> </ul>

Despite the large volume of algal data now collected, only a few comprehensive reports have been produced<sup>31,32,33,34</sup>. The effects of land use and lake trophic status on phytoplankton composition have been analysed using data collected between October 2003 and October 2007<sup>35</sup>.

### **Lake aquatic plants**

In addition to algal monitoring aquatic vegetation is monitored using the LakeSPI (Submerged Plant Indicators) method to give an overall assessment of lake ecological health. The underlying principle of LakeSPI is that any New Zealand lake can be characterised by the composition of native and invasive plants growing in the lake and the depth to which they grow. Once key submerged plant indicators have been identified and recorded using the LakeSPI survey method, LakeSPI applies a simple scoring system to generate 3 LakeSPI indices (or scores):

- Native Condition Index - this captures the native character of vegetation in a lake based on the diversity and quality of native plant communities.
- Invasive Impact Index - this captures the invasive character of vegetation in a lake based on the degree of impact by invasive weed species.
- LakeSPI Index - this is a synthesis of components from both the native condition and invasive condition of a lake and provides an overall measure of the lake's ecological condition.

By using submerged plants as indicators, the effects of water quality and the impacts of catchment management and aquatic weed invasion can be assessed.

<sup>31</sup> Donald, R.C. 1993: Natural environment regional monitoring network. Freshwater ecology program, lakes component, 1991-1992. Bay of Plenty Regional Council, Technical Report No. 40.

<sup>32</sup> Donald, R.C. 1996: Rotorua lakes algal monitoring. Environmental Report 96/21. Environment BOP, Whakatāne.

<sup>33</sup> Donald, R.C. 1997: Rotorua lakes summary report. Environmental Report 97/21. Environment BOP, Whakatāne.

<sup>34</sup> Wilding, T. K. (2000). Rotorua lakes algae report. Environmental Report 2000/06. Environment Bay of Plenty, Whakatāne.

<sup>35</sup> Paul, W. J., D. P. Hamilton, et al. (2012). Catchment land use and trophic state impacts on phytoplankton composition: a case study from the Rotorua lakes' district, New Zealand. *Hydrobiologia*.

Each lake is now monitored once every two years although sporadic monitoring occurred for a number of lakes from the early 1980's. The programme was last reported on in 2013<sup>36</sup>.

### **Recommended future state**

Both the phytoplankton and cyanobacteria monitoring programmes have been reviewed and a number of issues highlighted. The current lake phytoplankton monitoring programme appears inadequate when measured against the NERMN objectives, reflecting a number of factors:

- Much of the data collected has not been analysed or reported to any extent.
- Most of the data existed as disparate excel spreadsheets with little internal consistency making it difficult to analyse efficiently.
- There is a lack of specific biotic metrics that the phytoplankton data can be summarised by. Thus no numeric guideline values can be established to determine whether components of the phytoplankton community are meeting, or failing to meet specific targets.

A lake's trophic status has a large effect on the resultant phytoplankton community<sup>37</sup>. Thus, the existing phytoplankton data could be used to create a new biotic index of lake "health". Moreover, the phytoplankton data may represent an ideal dataset by which to assess the effects of intervention techniques. For example, if a phytoplankton index could be developed summarising a particular component of lake health then the effects of interventions, such as the Ohau channel diversion wall or P-locking of lake sediments, could more easily be assessed. An index like this could be incorporated into policy in the form of targets (in the same way as the TLI), or simply be used as another measure to summarise and report on lake health.

The cyanobacteria monitoring appears to fulfil more of the NERMN objectives. The main weakness is the lack of long term analysis and interrogation of the data. Apart from brief commentary on the duration of health warnings in some lakes (e.g. the Lakes Rotorua and Rotoiti Action Plan 2007), little long term analysis has examined trends in either the duration or severity of blooms. However, interesting patterns are evident when this is done, with, for example, clear improving trends in the duration of algal blooms in Lake Rotoehu.

Council now has a large dataset of phytoplankton and cyanobacteria communities over many years. Discussions with scientists from Cawthron Institute and the University of Waikato have highlighted a number of interesting techniques that could be used to determine whether this data can provide further useful information on lake health. Until this analysis has been undertaken, it is recommended that the current monitoring programme for phytoplankton and cyanobacteria continue.

LakeSPI monitoring is providing additional insight into the ecological condition of the lakes and should continue as currently. A number of lakes are currently not monitored (some are privately owned and some are hydro-generation lakes) and these should be considered for inclusion in the programme on a case by case basis.

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<sup>36</sup> Edwards, T. and Clayton, J. 2013: The ecological condition of the Rotorua Te Arawa Lakes using LakeSPI – 2013. Prepared for Bay of Plenty Regional Council, June 2013.

<sup>37</sup>Paul, W.J., Hamilton, D.P., Ostrovsky, I., Miller, D., Zhang, A and K. Muraoka 2012. Catchment land use and trophic state impacts on phytoplankton composition: a case study from the Rotorua lakes' district, New Zealand. *Hydrobiologia*, November 2012, Volume 698, Issue 1, pp 133-146.

Table 16 Recommended monitoring regime for lake ecology.

	Phytoplankton	Submerged aquatic plants – Lake SPI
<b>Number of sites</b>	<ul style="list-style-type: none"> <li>21 Sites from the 12 Rotorua lakes.</li> </ul>	<ul style="list-style-type: none"> <li>12 Rotorua lakes.</li> </ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"> <li>Variable, ranging from sampling monthly, every 2 months, or seasonally.</li> </ul>	<ul style="list-style-type: none"> <li>Every 2 years per lake.</li> </ul>
<b>Measured parameters</b>	<ul style="list-style-type: none"> <li>When processed, information on species/generic composition and cell counts.</li> </ul>	<ul style="list-style-type: none"> <li>LakeSPI Index.</li> </ul>

## 4.7 Marine ecology

The following monitoring is carried out under the marine ecology module of the NERMN:

- Benthic macrofauna in harbours, estuaries and on the open coast.
- Sediment contaminants in harbours and estuaries.
- Seagrass, saltmarsh and mangrove distribution in harbours and estuaries.
- Sea lettuce abundance and nutrient status in Tauranga Harbour.
- Open ocean primary productivity monitoring.

Each of these is described in more detail below.

### 4.7.1 Benthic macrofauna

Annual coastal and estuarine benthic macrofauna monitoring began in 1990, the full dataset was last reported on in 2012<sup>38</sup>. The monitoring involves recording the diversity, density and size of benthic organisms such as crustaceans, worms, snails and shellfish. Initially 15 open coastal and 33 sheltered soft-shore sites were monitored but this has progressively been reduced to four and 17 sites respectively. These represent a core set of stable and sensitive sites that best reflect potential impacts and future changes from development pressure.

### 4.7.2 Sediment contaminants

Sediment contaminant surveys are undertaken at a range of harbour and estuarine sites at three-yearly intervals. This involves collection of sediment samples and analysis of these for pesticides, herbicides and other organic compounds. The results are compared against physical sediment characteristics (e.g. particle size, organic content) and benthic macrofauna data to give an overall assessment of sediment health. The results of the contaminant monitoring were last reported in 2009<sup>39</sup>.

<sup>38</sup> Park, S.G. (2010). Coastal and Estuarine Benthic Macrofauna Monitoring Report 2010. Environmental Publication 2012/03, Bay of Plenty Regional Council, Whakatāne.

<sup>39</sup> Park, S.G. 2009. Bay of Plenty Marine Sediment Contaminants Survey 2008. Environment BOP Environmental Publication 2009/01. Environment Bay of Plenty, PO Box 364, Whakatāne.

### 4.7.3 Seagrass, saltmarsh and mangroves

The distribution and extent of seagrass, saltmarsh and mangroves is mapped in Tauranga and Ōhiwa Harbours using high resolution aerial photography and where necessary field survey to ground truth the photography information. The frequency of mapping is generally carried out at 7-10 year intervals and this is considered adequate. The results of the monitoring were last fully reported in 2005 for Tauranga Harbour and 2013 for Ōhiwa Harbour<sup>40,41</sup>.

### 4.7.4 Sea lettuce

Since 1991 sea lettuce abundance has been measured every second month at three sites in Tauranga Harbour, monitoring of water and tissue nutrient content is carried out at the same time. In 2010 sea lettuce was sampled at 18 sites and analysed for tissue nutrient and nitrogen stable isotope content. The results of all of the monitoring were last reported in 2011 and at that time recommendations were made on further research needed to better understand the factors that trigger sea lettuce blooms<sup>42</sup>.

### 4.7.5 Primary productivity monitoring

Baseline coastal productivity monitoring was initiated in anticipation of large scale aquaculture development in coastal waters in the eastern Bay of Plenty. A key aim of the monitoring is to create a baseline of the carrying capacity which could be used to safeguard naturally occurring shellfish resources and other filter feeding species. The monitoring is based on recording of growth and condition of green-lipped mussels (*Perna canaliculus*), water chemistry, data logging of phytoplankton fluorescence and quantitative counts of phytoplankton species. A monitoring site was set up in 2009 and the initial results were reported in 2011<sup>43</sup>.

Table 17 Marine ecology monitoring regime.

<b>Benthic macrofauna</b>	<ul style="list-style-type: none"><li>Four open coastal and 17 sheltered soft-shore sites, annual monitoring of diversity, density and size.</li></ul>
<b>Sediment contaminants</b>	<ul style="list-style-type: none"><li>Tauranga and Ōhiwa Harbours, Maketū and Little Waihi Estuaries, three year frequency.</li></ul>
<b>Seagrass, saltmarsh and mangrove distribution</b>	<ul style="list-style-type: none"><li>Tauranga and Ōhiwa Harbours, 7-10 year frequency.</li></ul>
<b>Sea lettuce</b>	<ul style="list-style-type: none"><li>Tauranga Harbour, three sites monitored every two months for abundance, water quality and tissue nutrient content.</li></ul>
<b>Primary productivity monitoring</b>	<ul style="list-style-type: none"><li>One site, mussel growth rate, phytoplankton counts, water chemistry annually.</li></ul>

<sup>40</sup> Park, S.G. 2005. Aspects of Mangrove Distribution and Abundance in Tauranga Harbour. Environmental Report 2004/16. Environment Bay of Plenty, Whakatāne.

<sup>41</sup> MacKenzie, H. 2013. State of the Ōhiwa Harbour and Catchment. Environmental Publication 2013/07. Bay of Plenty Regional Council, Whakatāne.

<sup>42</sup> Park, S.G. 2011. Sea Lettuce and Nutrient Monitoring in Tauranga Harbour 1991-2010. Environmental Publication 2011/06. Bay of Plenty Regional Council, Whakatāne.

<sup>43</sup> Park, S.G. 2011. Bay of Plenty coastal productivity monitoring - 2010. Environmental Publication 2011/10. Bay of Plenty Regional Council, Whakatāne.

## Recommended future state

It is recommended that the current marine ecology monitoring programme be continued.

## 4.8 Biodiversity

Biodiversity became part of the NERMN Programme following a review in 2001<sup>44</sup>. This resulted in the addition of two new modules; wetlands (FWW) and terrestrial ecology (TIB). The basis of the biodiversity module is monitoring the extent and condition of broad ecosystem types. A review of these modules was undertaken in 2005<sup>45</sup>.

Condition, for biodiversity monitoring, is defined as Ecological Integrity. In terms of the components of ecological integrity, both extent and condition need to be measured to determine species occupancy (to avoid extinctions), indigenous dominance (to maintain natural ecological processes by native biota) and ecosystems representation (to maintain 'a full range of ecosystems')<sup>46</sup>.

The Regional Councils' Biodiversity Working Group (RCBDWG) is developing a national framework for monitoring biodiversity, aligned with the Department of Conservation's inventory and monitoring system, to build a national picture for the state of New Zealand's biodiversity. A number of indicators are proposed including land area under indigenous vegetation, biodiversity condition, weeds and animal pests, habitat loss and climate change. The national RCBDWG framework aims to fulfil the Regional Council's monitoring requirements under the RMA, which is where the biodiversity NERMN programme is derived from. Current NERMN modules align reasonably well, and the development of future monitoring will be specifically designed to fulfil our contribution to those indicators.

The biodiversity module is divided into the broad ecosystem types as discussed in the following sections.

### 4.8.1 Freshwater wetlands

Mapping the extents of freshwater wetlands has been completed, with over 500 individual wetlands mapped. 'New' wetlands that are found to have been missed in the original mapping exercises will be added as they are 'discovered'. A regional sampling scheme has been developed which identifies 79 wetlands for regional monitoring<sup>47</sup>. The next phase is to trial a system for monitoring at the selected sites in terms of sampling intensity, number and size of plots per site.

### 4.8.2 Dunelands

Extent mapping of the dunelands 'wild and undeveloped' vegetation was mapped in the field in 2008 and 2009. Measures of condition were included, relating to impacts on dune vegetation and indigenous versus exotic species dominance, and photo-points. This achieved complete 'ground-truthed' coverage.

<sup>44</sup> Environment Bay of Plenty (2001). NERMN Review. Environmental Report 2001/07.

<sup>45</sup> Environment Bay of Plenty (2005). Review of the NERMN Modules: Freshwater Wetlands and Terrestrial Indigenous Biodiversity. Environmental Publication 2005/10.

<sup>46</sup> Lee, W.G and Allen, R.B. (2011). Recommended monitoring framework for regional councils assessing biodiversity outcomes in terrestrial ecosystems. Prepared for the Regional Council Biodiversity Forum by Landcare Research.

<sup>47</sup> Landcare Research (2013). A priority framework for monitoring Bay of Plenty wetlands. Contract Report LC1334 prepared for Bay of Plenty Regional Council, May 2013.

The baseline report has been completed<sup>48</sup>. A series of 165 transects were part of the original mapping and the intention is to re-measure these transects at five yearly intervals, next due in 2014. Although the system lacks a truly quantitative element it delivers sufficient information to determine management issues that might be addressed through operational works and/or policy.

#### 4.8.3 Geothermal

Geothermal site extents have been mapped three times<sup>49</sup>, looking for change over time. Some condition monitoring was installed at some sites specifically identifying whether or not prostrate Kanuka was being maintained over time, as a unique sub-species confined to geothermal sites. There are two plots at three sites plus a plot at Parimahana (at Kawerau) which is being monitored under the conditions of a resource consent. The number of sample sites is inadequate and the module would benefit from improving the condition monitoring element, both in terms of the sampling scheme across and within sites, and the method applied.

#### 4.8.4 Frost flats

Preliminary mapping of frost flats has also been completed however it needs to be refined over 2010/2011 photography to provide the baseline for this ecosystem type. Condition monitoring has been installed with 15 plots at six sites, although the sampling has a bias to large sites under Department of Conservation administration and will need to be supplemented in the future. The resulting data does provide for our needs in terms of monitoring condition in relation to measures of ecological integrity.

#### 4.8.5 Forest and scrub

There has been no development of a general forest and scrub module for the NERMN programme, although other sub-modules have been progressed (discussed below).

A sampling strategy is currently proposed based on the 8 x 8 km grid network that has been applied by DOC and the carbon monitoring programme nationally. However a complementary regional sampling strategy will have to be devised in order to achieve a regionally representative sample incorporating areas of more fragmented forest outside the large contiguous areas in the eastern part of the region and the Kaimai Ranges.

Coastal forest and Pohutukawa/Rata around the Rotorua Lakes were both identified as high priority sub-sets of the forest and scrub modules early in the development of TIB. Both were loosely defined in terms of extent and used a coarse condition scale of low/medium/high which was found to provide little information. For coastal forest the photo-points method will be continued as it provides a visual record of the coastal fringe Pohutukawa as an indication of condition. However given the lack of specific methods to apply the Rotorua Lakes Pohutukawa/Rata monitoring has not been repeated and the aerial component of coastal forest discontinued.

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<sup>48</sup> Willems, N. (2010). Bay of Plenty Dune Lands - Baseline Report for NERMN programme. Bay of Plenty Regional Council Environmental Publication 2010/19, August 2010.

<sup>49</sup> For the latest report see Fitzgerald, N.B. and Smale, M.C. (2010). An updated assessment of geothermal vegetation in the Bay of Plenty Region based on 2007 aerial photography. Landcare Research Contract Report LC0016 prepared for Environment Bay of Plenty, August 2010.

Thornton Kanuka extent was mapped in the field over aerial photography by the Department of Conservation in 2008. Condition monitoring consists of 51 permanently marked 5 m x 5 m plots in the main block of Thornton Kanuka around Walker Road. It covers public and private land. The data analysis and a baseline report characterising the current state was completed in July 2013<sup>50</sup>.

### Recommended future state

The recommended monitoring for wetlands (FWW) and terrestrial ecology (TIB) is described in the following table.

Table 18 Recommended Biodiversity monitoring regime.

Monitoring task	Timeframe	Established/ last monitored	Next due	Notes
Wetlands extent	10 yearly	Completed 2008.	2014-2015 photography.	
Wetlands condition			2013-2014 photography.	Implementation of sampling strategy being developed early 2013.
Dunelands extent (desktop only.)	5 yearly	Feb-Mar 2009.	Feb-Mar 2014 photography.	To match condition measures on transects. Dependent on aerial photography.
Dunelands condition (transects)	5 yearly	Feb-Mar 2008 & 2009.	Feb-Mar 2013 & 2014.	Monitor over summer for plant ID. Mapping transects and desktop for obvious extent changes.
Dunelands vegetation mapping	10 yearly	Feb-Mar 2008 & 2009.	Feb-Mar 2018 & 2019.	Monitor over summer for plant ID.
Geothermal extent	5-10 yearly	1996 aerial photography/ 2007 aerial photography.	Approx. 2017 photography.	Last report completed 2009. Dependent on aerial photography cycles.
Geothermal condition	5 yearly	2007.	2013.	At three sites.
Frost flats extent	5-10 yearly	2003 aerial photography.	2011 photography.	Complete in 2013/2014.
Frost flats condition	5 yearly	Jan-Feb 2012.	2017.	Add sites.
Forest and scrub extent (whole region)	5-10 yearly			Currently relying on LCDB iterations.
Forest and scrub condition (whole region)	Yet to be determined, standard is 5-10 yearly			Commission development of a sampling strategy for the region to provide better information for costing.

<sup>50</sup> Payton, I. and Forrester, G. 2013. Influence of fire, grazing and land tenure on coastal kānuka communities at Thornton, eastern Bay of Plenty. Prepared by Landcare Research for Bay of Plenty Regional Council, July 2013.

Monitoring task	Timeframe	Established/ last monitored	Next due	Notes
Coastal forest (photo-points)	5 yearly	Mar 2004 & 2007/Mar 2012.	Mar 2017.	
Thornton Kanuka extent and condition	5 yearly	Sept-Oct 2012.	Sept-Oct 2017.	Aim for completion over September and avoid spring flush if possible.

## 4.9 Coastal dynamics

Over 74% of the Bay of Plenty coastline is sandy and this is generally in dynamic equilibrium but will respond to natural changes to establish a new equilibrium. The sandy coastline is the subject of change (accretion or erosion) from time to time as a result of changes to sediment supply, sea level, wind, wave and climate cycles.

Human activities, such as coastal land development, dredging, and the damming of rivers can all have effects on the equilibrium of the coastline as can local climate cycles and global climate change.

It is the change to the beach profile that is of interest resource managers and there are many examples of both accretion and erosion along the Bay of Plenty coast in recent times that have resulted from natural climate cycles and human induced changes. Such changes can and already have altered the equilibrium of beaches resulting in coastal hazard. The prospect of global climate change causing sea level rise has compounded the hazard risk to existing development.

To monitor such changes a total of 53 coastal cross section (CCS) sites are profiled from Ōpape to Waihi Beach on an annual basis within the current physical coastal monitoring programme. Monitoring commenced in 1990. Some selected sites are monitored quarterly, others are monitored as necessary (e.g. after storm events or where a beach is considered to be of significant concern to the public due to impacts on private property). A full description and analysis of this dataset can be found in the latest monitoring report<sup>51</sup>.

### Recommended future state

At the quarterly CCS sites over 70 profiles and in some cases nearly 150 profiles (CCS11 - West End) have been collected. Therefore a good understanding of short term beach dynamics now exists (and statistical distributions can be determined with a high level of confidence).

A new monitoring programme should now be implemented which has a reduction in the frequency of profile measurements. This can be achieved with the removal of the quarterly surveys (currently being performed at Waihi Mount/Pāpāmoa, Pukehina, Ōhope beaches). The annual monitoring schedule will still allow Council to detect any developing trends in beach planform. The on-going dataset will be further enhanced by post storm data collection which cannot be routinely scheduled but will be part of the monitoring requirement. A full discussion including methodologies can be found in the recent review document<sup>52</sup>.

<sup>51</sup> Iremonger, I. 2011. NERMN beach profile monitoring, Environmental Publication 2011/14. Bay of Plenty Regional Council, Whakatāne.

<sup>52</sup> Iremonger, S. 2013. Physical Coastal NERMN Review. Bay of Plenty Regional Council internal memorandum, 7 March 2013 (Obj. ref. A1529494).

Analysis and reporting of the collated data should be maintained at a five yearly frequency. Analysis of portions of the dataset may be required for specific jobs or projects, such as reviewing resource consent applications or coastal hazard analysis, and will be undertaken on an as required basis.

Table 19 Recommended coastal dynamics monitoring regime.

<b>Sites</b>	53 coastal cross section (CCS) sites are profiled from Ōpape to Waihi Beach.
<b>Frequency</b>	Annually, or as required based on events or issues.

#### 4.10 River and stream channel

Prudent river management requires an adequate understanding of both the movement of gravel down rivers and the effects of gravel extraction. Before 1993, only intermittent re-surveying of river cross-sections took place on some rivers. Gravel extraction declaration returns from commercial extractors were not detailed and did not provide sufficient information on the extraction locations.

River and stream channel monitoring was included as part of the NERMN in 1993/1994. The river and stream channel monitoring programme provides the Bay of Plenty Regional Council with:

- Reliable data to identify the quantity of gravel available for extraction and the present extraction rates in the Bay of Plenty region.
- Data to allow setting maximum annual extraction rates available based on river control and river maintenance criteria.
- Data with which the Bay of Plenty Regional Council can meet its statutory obligations under the Resource Management Act, and more effectively manage the region's resources.

Cross section surveys are carried out regularly on 15 rivers and streams, with occasional additional surveys. The data is entered into a cross sections archive system, which is used as the main tool to store and analyse the data.

Details of gravel extraction are included in NERMN reports<sup>53</sup>. The monitoring programme allows an overall management strategy to be applied to gravel resources. The objectives of this are to:

- Maintain bed levels within a desirable range.
- Minimise erosion.
- Maintain desirable river alignments.
- Keep gravel extraction in balance with natural supply rates.

For example, when last reported it was recommended that extraction on the Otara River be encouraged and that extraction on the Waimana River should be limited in the upper reaches, except where major build-ups are surveyed. Appropriate locations on a particular river can also be targeted.

<sup>53</sup> For example: Pak, I. and Bates, D. NERMN River and Stream Channel Monitoring Programme 2005/06-2009/10. Bay of Plenty Regional Council Environmental Publication 2010/16, August 2010.

## Recommended future state

The current river and stream channel monitoring regime is working well and no changes are proposed.

Table 20 River and stream cross-section survey programme.

River/stream name	No. of cross sections	Recommended frequency of survey	Relative gravel extraction pressure
Otara	37	2-5 year	Low
Waioeka	20	2-5 year	Med
Waimana*	35	1-2 year	Med
Whakatāne (below Pekatahi Bridge)	35	2-5 year	Med
Whakatāne* (above Pekatahi Bridge)	34	1-2 year	Med
Rangitāiki (Lower)	67	3-5 year	
Rangitāiki (Waiohau)	12	5 year	Low
Rangitāiki (above Aniwhenua)	28	5 year	High
Whirinaki*	8	1-2 year	Med
Tarawera	18	5 year	
Ohutu*	6	1-2 year	Med
Mangamate*	7	1-2 year	Med
Ruarepuae*	7	1-2 year	Med
Horomanga*	14	1-2 year	Med
Kopuriki*	9	1-2 year	Med
Kaituna (below Te Matai)	26	3-5 year	
Kaituna (above Te Matai)	17	3-5 year	
Mangorewa	3	3-5 year	
Waiotahi	7		Low
Waikokopu*		2 year	Med
* More frequent surveys may be appropriate to match extraction activities.			

## 4.11 Soil health

Soil quality or soil health monitoring has been carried out under the NERMN Programme since the late 1990's. This started with participation in the '500 Soils Project' involving various regional councils in New Zealand<sup>54,55</sup>. Since then a total of more than 70 soil quality monitoring sites have been progressively established under various land uses. The sites were categorised by land use which include; cropping (maize), dairy, sheep and beef, deer, kiwifruit and forests (indigenous and plantation). Sampling frequencies differ and depend on the degree of soil disturbance or cultivation expected for each land use.

Trace element sampling of soils has more recently been included in the soil quality/health monitoring programme. This was due to concerns regarding the potential risk of accumulation associated with some past and present-day land use practices such as fertiliser application and disease control. For example, cadmium is an unavoidable contaminant in phosphate fertilisers, facial eczema treatment contains high levels of zinc, and copper is used to control fungal and bacterial infections in orchards (more recently the kiwifruit vine *Pseudomonas*, or PSA, disease).

Samples for trace element analysis are taken from the existing soil quality monitoring sites and analysed for a range of metals. Archived soil samples have also been used to give data as far back as 1999/2000 for many sites.

Table 21 Soil health monitoring regime.

<b>Number of sites</b>	<ul style="list-style-type: none"> <li>70 sites, cropping (maize), dairy, sheep and beef, deer, kiwifruit and forests (indigenous and plantation).</li> </ul>
<b>Sampling frequency</b>	<ul style="list-style-type: none"> <li>Cropping every three years, dairy, sheep and beef, deer, and kiwifruit sites every five years, forest sites every 10 years.</li> </ul>
<b>Measured parameters</b>	<ul style="list-style-type: none"> <li>Health/quality parameters: pH, total carbon (C), total nitrogen (N), anaerobically mineralisable N, Olsen phosphorus (P), bulk density and macroporosity, C/N ratio (calculated).</li> <li>Trace elements: arsenic, cadmium, chromium, copper, lead, mercury, nickel, uranium and zinc.</li> </ul>
<b>Length of data record</b>	<ul style="list-style-type: none"> <li>More than 10 years for most sites.</li> </ul>

Reporting on soil health has most recently occurred for dairy pasture and maize cropping sites<sup>56</sup> and for dry stock (sheep/beef and deer pastures) and kiwifruit orchard sites<sup>57</sup>. Reporting of trace elements in soil was last completed in 2011<sup>58</sup>.

### Recommended future state

The soil quality monitoring programme is invaluable in informing landowners and land managers of changes in soil quality over time, particularly when there are clear trends in declining soil health. It is therefore recommended that the monitoring of soil health/quality and trace elements continue in its current form.

<sup>54</sup> Sparling, G. and Schipper, L. 2002. Soil quality at a national scale in New Zealand. *Journal of Environmental Quality* 31:1848–1857.

<sup>55</sup> Sparling, G. and Schipper, L. 2004. Soil quality monitoring in New Zealand: trends and issues arising from a broad scale survey 1995–2001. *Agriculture, Ecosystems and Environment* 104: 545–552.

<sup>56</sup> Guinto, D. 2009. Soil quality in the Bay of Plenty: 2009 update. Environmental Publication 2009/14. Environment Bay of Plenty, Whakatāne, New Zealand.

<sup>57</sup> Guinto, D. 2010. Soil quality in the Bay of Plenty: 2010 update. Environmental Publication 2010/22. Bay of Plenty Regional Council, Whakatāne, New Zealand.

<sup>58</sup> Guinto, D. 2011. Trace Elements in Bay of Plenty Soils. Environmental Publication 2011/16. Bay of Plenty Regional Council, Whakatāne, New Zealand.

## Part 5: Summary and recommendations

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### 5.1 Key findings and recommendations

The NERMN Programme has been operating for some 25 years and has evolved to provide wide regional coverage of a range of natural resources. In general the parameters monitored are appropriate and are needed to adequately manage these resources. However, for some resources there is a need to increase monitoring frequency and/or geographical coverage to meet future needs. These changes arise due to the anticipated future regional development of land and water, and due to legislative requirements that will likely impose additional monitoring on councils, for example:

- Monitoring which will follow the setting of water quality and quantity limits under the NPS for Freshwater.
- The need to monitor against proposed national 'bottom line' objectives for water (as a result of the proposed amendments to the National Policy Statement for Freshwater Management).
- The enactment of the Environmental Reporting Bill. This is expected to further the progression toward more consistency in environmental monitoring, including the development of national environmental monitoring standards.

A summary of the key recommendations from the review, justification and cost breakdown is given in Table 22. While monitoring can be reduced in some areas (air quality and coastal dynamics monitoring), the overall effect would be an increase in the funding required to support the NERMN Programme as follows:

- An increase in annual operational expenditure of approximately 47% (\$1.27 million) by 2020. Note that this assumes a progressive five year implementation ('ramp up') period but has not been adjusted for inflation.
- An increase in annual capital expenditure of approximately 14% (\$45,000). This increase would also apply between now and 2020 and has not been adjusted for inflation.

If these recommendations are adopted further work would be required to refine the cost estimates and incorporate them into the planning process for the 2015-2025 Long Term Plan.

### 5.2 Reporting

The current reporting framework for the NERMN has been discussed in Part 3 of this report and a recommended environmental report publication schedule is given in Appendix 2. This schedule covers core technical reporting but it is recognised that this form of communication does not suit all stakeholders. For this reason it is recommended that other opportunities be explored further to improve the accessibility of the information, these include:

- Increase and refine the 'live' reporting that is available on the Regional Council website (i.e. from continuous sites measuring for example river flow, air quality and lake water quality).

- Support national websites which allow access to environmental information. An example is the LAWA website<sup>59</sup> which carries up to date summary information on river water quality from across New Zealand, including the Bay of Plenty. The site will be expanded in the future to include other 'domains' such as air quality and coastal water quality.
- Support the development of applications that enable easy access to regional council data. An example is 'Earth Beneath our Feet' which is a web based application<sup>60</sup> that shows the main geological units down to bedrock plus a range of information about groundwater in the Bay of Plenty. Landowners and contractors can use this information to help with drilling decisions without having to initially involve the Council. A smart phone application is also available which gives access to a point on the ground surface identified by the cell phone's GPS.
- Expand the use of GIS (Geographical Information Systems) to improve the ability to communicate complex data sets and allow real time modelling of a range of scenarios (for example the effects of land use change on water quality).

Finally, there is a need to consider whether Council should produce a 'Regional State of the Environment' (SOE) report. The last report was published in 2008 in hard format and included information on a wide range of environmental, social, cultural and economic indicators. Similar information could be made available in a web format, perhaps linked to existing sources to ensure the information remains up to date.

### 5.3 Cultural Health Assessments

Māori Cultural Health Index (CHI) assessments have been developed as an alternative approach to assessing stream health<sup>61</sup>. Underpinning the cultural values intrinsic to tangata whenua is that of the life giving force and spiritual concept of mauri. A central concept of mauri is that all things in the natural world are interconnected, and that life supports life. Water is the sustaining element for all life, and if the Mauri of streams, lakes and the ocean are affected to a detrimental and unsustainable level, then society as we know it must also be similarly affected. Māori Cultural Health Indices are designed, in part, to try and encapsulate this essence of mauri in a simple, numerical way.

The CHI is comprised of three components:

1. The Site Status, identifying whether it is of traditional significance to tangata whenua and whether tangata whenua would return to the site in future;
2. Mahinga Kai, recognising that Mauri is tangibly represented by the physical characteristics of freshwater resources including its fitness, cultural usage; and
3. The cultural stream health measure (CSHM), based on assessing individual indicators. This is regarded as being the most objective and accurate reflection of tangata whenua evaluations of overall stream health<sup>62</sup>.

<sup>59</sup> Land and Water Aotearoa: <http://www.lawa.org.nz/>

<sup>60</sup> Earth Beneath our Feet' is a partnership between Bay of Plenty Regional Council and GNS Science: <http://data.gns.cri.nz/ebof/index.jsp>

<sup>61</sup> Tipa, G.; Teirney, L. 2003. A cultural health index for streams and waterways. Indicators for recognising and expressing Maori values. Ministry for the Environment.

<sup>62</sup> Tipa, G.; Teirney, L. 2006. A cultural health index for streams and waterways: a tool for nationwide use., p 54. Ministry for the Environment, Wellington, New Zealand.

Unlike Western scientific methods which identify and measure individual aspects of "stream health", cultural assessments consider a more holistic approach to stream health, and recognise that the combined is greater than the sum of the individual components. It is arguable that cultural methods are also more subjective than western science assessments, and based on not only current observations of conditions at a site, but also based on collective in-depth experience of different iwi/hapu groups who have had intergenerational experience with a particular waterway.

A recent study has been conducted in the Te Arawa/Rotorua lakes area to compare CSHM scores with a number of indicators from the NERMN invertebrate monitoring programme. The results have not yet been published but the preliminary findings suggest a high level of agreement between the two methods in terms of assessing stream health. These methods will be investigated further to determine whether they can be incorporated into the NERMN Programme and as a method to improve the level of discussion on stream health and values with iwi.

#### 5.4 **Monitoring technology**

This review has not specifically included an evaluation of new monitoring technology but the following are likely to be used more in the future to enhance the current programme and to improve the efficiency of data collection:

- Continuous 'live' water quality monitoring as is currently done using buoys on the Rotorua Lakes, and in some rivers systems (e.g. turbidity and dissolved oxygen monitoring).
- Data loggers and 'sondes' that collect data over time (e.g. dissolved oxygen or flow loggers) or space (e.g. vertical profilers that can measure parameters such as temperature, oxygen and algal biomass at different depths).
- Aerial 'drones' to allow image capture of environmental events such as algal blooms, and potentially as a sampling platform.
- Satellite imagery.

These technologies are developing rapidly and will be implemented as they become cost competitive with existing monitoring methods.

Table 22 Recommended changes to the NERMN Programme, justification and preliminary cost estimates above current budget.

NERMN Module	Recommended changes	Justification	Preliminary cost estimates above current budget	
			Operational	Capital
<b>Air monitoring</b>	Decommission 3 particulate (PM <sub>10</sub> ) sites and 2 hydrogen sulphide (H <sub>2</sub> S) sites, add 1 PM <sub>2.5</sub> particulate site.	Sufficient data has been collected at the PM <sub>10</sub> and H <sub>2</sub> S sites and/or the data collected to date shows a low level of concern. PM <sub>2.5</sub> monitoring will improve our understanding of this parameter.	-\$92,000	\$0
<b>Hydrology</b>	Add an additional 1-2 flow monitoring sites per annum over the next 5 years. Priority would be given to those catchments where implementation of the NPS for Freshwater Management is occurring.	Regional monitoring coverage of river and stream flow needs to be improved. More information is needed on flow rates to support water allocation decisions and the implementation of the NPS for Freshwater.	\$100,000	Funded from existing capital
<b>Geothermal</b>	New monitoring bores on the Rotorua field. Automate monitoring of bores on the Tauranga warm-water field and increase water quality sampling.	New bores are needed to clarify the behaviour of the field and due to the loss of several monitoring sites over time. Automation of data collection and more frequent water quality monitoring will improve our ability to detect trends.	\$128,000	\$150,000
<b>Groundwater</b>	Substantial increase involving new bore and lysimeter sites, and additional sampling of springs. Priority given to the NPS for Freshwater Management catchments and for catchments where allocation pressure has been identified.	Regional monitoring coverage of groundwater needs to be improved. More information is needed on groundwater systems to support water allocation decisions and the implementation of the NPS for Freshwater.	\$500,000	Funded from existing capital
<b>Surface water quality</b>	Increase sampling frequency to monthly at all river and stream sites monitored.	Quarterly sampling at river and stream sites reduces our ability to detect trends and is contrary to national recommendations.	\$510,000 (note – does not include lake buoys)	\$75,000
	Increase the number of samples taken at bathing suitability sites to 20 per site for each summer sampling season.	The current bathing suitability monitoring does not fully meet national monitoring guidelines (MfE/MoH).		
	Ensure resourcing is available for the continued operation of the lake water quality monitoring buoys.	Lake monitoring buoys are providing valuable data and should be retained for long term monitoring.		

NERMN Module	Recommended changes	Justification	Preliminary cost estimates above current budget	
			Operational	Capital
	Increase sampling at all estuarine sites to monthly.	Improve trend detection and the ability to assess performance against water quality classifications across the tidal range.		
	Increase monitoring in Tauranga Harbour to include open water nutrients (fortnightly) at 2-4 sites and continuous sediment load monitoring at a minimum of 2 stream sites.	Nutrients and sediment are key issues yet current monitoring coverage is considered inadequate to inform management of Tauranga Harbour.		
Freshwater ecology	Increase river and stream invertebrate sites from 118 to 130.	Improve regional site coverage including better representation of different land-use classes.		
	Implement periphyton monitoring at susceptible river and stream sites when national bottom line standards are enacted.	Additional monitoring would be required to assess compliance against national bottom line standards.	\$50,000	\$0
	Maintain the current lake ecology monitoring but continue to review the algae component and the need for new LakeSPI sites.	The current programme is meeting requirements, however more information is needed on algal monitoring techniques before a decision is made on the future of this component.		
Marine ecology	No change.	The current monitoring programme is meeting requirements.	\$0	\$0
Biodiversity	Additional monitoring of wetlands, frost flats, and forest and scrub.	Improved monitoring coverage is needed for these habitats.	\$70,000	\$0
Coastal dynamics	Reduce quarterly monitored sites to annual monitoring. Implement post-storm monitoring at sites as necessary.	Good understanding now exists of short term beach dynamics and statistical distributions can be determined with a high level of confidence.	-\$2,000	\$0
River and stream channel	No change.	The current monitoring programme is meeting requirements.	\$0	\$0
Soil health	No changes.	The current monitoring programme is meeting requirements.	\$0	\$0
<b>Total additional annual cost</b>			<b>\$1,274,000</b>	<b>\$45,000</b>
<b>Current annual cost</b>			<b>\$2,700,000</b>	<b>\$324,000</b>

Note: Operational costs are annual as at 2020. Capital costs are one off and total has been spread over 5 years. No inflation adjustment has been applied.



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# Appendices

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# Appendix 1 – Regional policy summary: NERMN Programme

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## Regional Policy Statement

### 5.3.11 Monitoring

#### 5.3.11(a) Objective

Sufficient information on the state of the environment and the effects of resource use, development and protection to enable assessment of the effectiveness of this policy statement and regional and district plans and measurement of progress towards the sustainable management of the natural and physical resources of the region.

#### 5.3.11(b) Policies

5.3.11(b)(i) To maintain and acquire sufficient information on the state of the environment:

- (a) To determine the effects of resource use, development and protection;
- (b) To assess the suitability and effectiveness of the Statement and regional and district plans for the region;
- (c) To assess the effectiveness of the Statement and regional and district plans in achieving their objectives and policies.

#### 5.3.11(c) Methods of Implementation

Environment Bay of Plenty will:

5.3.11(c)(x) Maintain and where appropriate, develop and expand its Natural Environment Regional Monitoring Network to monitor indicators of the state of the region's:

- (a) Surface (fresh) water resources and associated ecosystems;
- (b) Groundwater resources;
- (c) Geothermal resources;
- (d) Coastal land and water resources and associated ecosystems (in conjunction with the Department of Conservation);
- (e) Land resources;
- (f) Air resources; and
- (g) Natural hazards.

5.3.11(c)(xi) Document and report on the state of the region's natural and physical resources and associated ecosystems, and the effects of the use, development and protection of these resources.

**Regional Water and Land Plan (see also the following example matrix which shows the Methods that relate to regional monitoring in the Water and Land Plan)**

Policy 22 To research and monitor the effects of land use practices on surface and groundwater quality, and take appropriate action within the framework of this regional plan (including future plan changes) where such investigations indicate land use has significant adverse effects on water quality, or there is a high risk that future development would adversely affect water quality. This is particularly relevant to lakes, and groundwater used for municipal water supply.

Policy 28 To develop and maintain accurate information on soil and water (including groundwater) resources in the region.

Policy 29 To continue to monitor and investigate the cause and effect of biological responses to the adverse effects of use and development activities. This includes, but is not limited to, aquatic weed, algal blooms and lake 'foams'.

Method 66 Continue to monitor the state of the environment in the Bay of Plenty in accordance with Environment Bay of Plenty's Natural Environment Regional Monitoring Network ('NERMN'), and existing compliance and impact monitoring programmes.

**Regional plan for the Tarawera River Catchment**

Policy 19.3.3(a) To acquire and maintain sufficient information on natural and physical resources through:

- Natural Environment Regional Monitoring;
- Compliance monitoring;
- Impact monitoring;
- Other monitoring as required.

Policy 19.3.3(b) To maintain sufficient monitoring facilities and programmes to ensure the adequate monitoring of the resource management issues addressed in this regional plan.

Method 19.3.4(a) Maintain the present Natural Environment Regional Monitoring programme within the Tarawera River catchment in order to provide baseline data and trend monitoring of natural and physical resources.

Method 19.3.4(b) Document and report on the natural and physical resources of the catchment of the Tarawera River and the effects of the use, development and protection of these resources.

**On-site Effluent Treatment Regional Plan**

Policy 1 To research and monitor the effects of on-site effluent discharge on surface and groundwater quality, and take appropriate action where such investigations indicate discharges are having significant adverse effects on water quality.

Policy 21 To carry out monitoring to assess the state of the environment regarding the impact of on-site effluent treatment.

Policy 22 To carry out monitoring to establish the impact of on-site effluent treatment systems on key sites and to determine the effectiveness of particular systems.

Method 31 Develop and maintain a detailed programme for State of the Environment and Impact Monitoring. This will be implemented by Environment Bay of Plenty.

### **Regional Coastal Environment Plan**

Policy 9.2.3(h) To continue to monitor and report on the water quality of the Bay of Plenty coastal marine area.

Methods of Implementation - Services 9.2.5(b) Continue to operate the coastal component of its Natural Environment Regional Monitoring Network, in accordance with the provisions of its annual plan.

Methods of Implementation – Information 14.2.7 Environment Bay of Plenty will continue routine monitoring of beach erosion in order to identify long term trends in local beach dynamics.

### **Rotorua Geothermal Regional Plan**

Method 11.5.3(a)(i) Continue field monitoring and research, and make resources available in accordance with the requirements of the Resource Management Act 1991(section 35).

Method 11.5.3(a)(ii) Upgrade, as appropriate, the current field model of the Rotorua geothermal resource.

Method 11.5.3(a)(iii) Ensure that data input to the field model is of a defined high quality.

Method 11.5.3(a)(iv) Design, establish, calibrate and maintain a dynamic mathematical model of the Rotorua geothermal resource.

Method 11.5.3(a)(v) Direct monitoring resources, as appropriate, towards calibrating and testing the field model.

Policy 12.3.3(a)(i) Establish Minimum Geothermal Aquifer Water Levels measured in calibrated field monitor bores to avoid or remedy adverse effects on fluid outflow from geothermal surface features.

Policy 12.3.3(a)(ii) Monitor the minimum geothermal aquifer water levels for the field relative to field data and model scenarios to provide an ongoing information base relating the minimum geothermal aquifer water levels and the natural outflow from geothermal surface features.

### **Regional Air Plan**

Policy 2 When the effects of discharges of contaminants into air are not adequately understood or are unknown, the discharges should be avoided, and if the discharges cannot reasonably be avoided, they should be monitored so that the effects become known, understood and effectively managed.

Method 39 Identify the major sources, locations and characteristics of air emissions in the region by means of an emissions inventory which estimates the total quantities of contaminants released into the air in the region, by June 1998 and on a 5 yearly basis or as appropriate.

Method 40 Develop by June 1998 and review as required a “State of the Environment” air quality monitoring programme for the Bay of Plenty region.

Method 41 Collate information on the existing air quality of the region, identifying where information is required and the types of information required by June 1999.

Method 42 Develop and implement by July 1999 air quality impact monitoring programmes as appropriate and compare these results with recognised standards including the NESAQ and Ministry for the Environment’s Ambient Air Quality Guidelines where possible.

## **Regional River Gravel Management Plan**

Policy 16 To monitor physical and environmental attributes of rivers in order to determine the need for and the effects of gravel excavation activities.

Method 17 Carry out ongoing monitoring and collate data to effectively determine maximum and minimum levels of excavation and any adverse effects of excavation on the environment including cumulative effects.

Methods relevant to Regional Monitoring in the Regional Water and Land Plan

Regional Water and Land Plan monitoring requirements	Air quality			Surface water hydrology					Geothermal			Groundwater		Surface water quality				Freshwater ecology			Marine ecology			Biodiversity			Soil health							
	Air quality	Rotorua	Other	Rainfall	River level	River flow	Lake level	Tidal level	Geo groundwater	Geo surface features	Geo Water level tga	Geo Waimangu	By subregion	Rivers and streams	lakes	Harbour and estuary	Bathing	River and stream	lake	Benthic macrofauna	Sediment contaminants	Seagrass saltmarsh	Sea lettuce	Primary productivity	Wetlands	Dunelands	Geothermal	Frost flats	Forest and scrub	Coastal dynamics	River and stream channel	Soil health		
Method 66			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
Method 67		●							●		●		●	●		●		●		●	●	●	●		●	●	●	●	●	●	●	●		
Method 69																		●																
Method 70				●	●	●	●							●	●		●	●														●		
Method 78				●	●	●	●							●	●		●	●														●		
Method 116				●	●	●	●							●	●		●	●							●	●						●		
Method 131													●	●		●	●			●	●	●	●		●									
Method 175				●	●	●	●					●																						
Method 185				●	●	●	●					●																						
Method 197				●	●	●	●																											
Method 199				●	●	●	●																											
Method 227																		●	●						●					●				
Method 249								●	●	●	●																							
Method 253								●	●	●	●															●								
Method 275						●	●																	●										

## Appendix 2 – Environmental report publication schedule

Module		Recommended frequency	Last report
<b>Air</b>	Air quality monitoring	3 yearly	2012
<b>Surface hydrology</b>	Flow, level and rainfall monitoring	7-10 yearly	2007
<b>Geothermal</b>	Rotorua field monitoring	As required	2001
	Geothermal surface features	As required	2001
<b>Groundwater</b>	Groundwater level and quality monitoring	5 yearly	2013
<b>Water quality</b>	Rivers	5 yearly	2011
	Estuaries	7-10 yearly	2005
	Lakes	Annually (summary) 5-7 yearly (comprehensive)	2013 2011
	Bathing/shellfish	Annually	2012
<b>Freshwater ecology</b>	Rivers and streams	5-7 yearly	2001
	Lake SPI	Annually	2013
	Lake algae	7-10 yearly	2011
<b>Coastal &amp; estuarine ecology</b>	Benthic macrofauna	5-7 yearly	2012
	Coastal productivity	3 yearly	2011
	Sea lettuce	5 yearly	2011
	Mapping (mangroves, seagrass, coastal wetlands)	7-10 yearly	2004, 2013 (Ōhiwa)
	Sediment contaminants	3 yearly	2009
<b>Coastal dynamics</b>	Beach profile monitoring	5 yearly	2011
	Coastal hazard indicator	3 yearly	2008
<b>River &amp; stream channel</b>	Monitoring	5-7 yearly	2010
<b>Biodiversity</b>	Various habitats	5-7 yearly	2010
<b>Soils</b>	Soil health and trace element monitoring	3-5 yearly	2011