workingpaper

Evaluating the Water Quality Dataset

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About the Research Project Team

The Resource Project Team comprises of Jessica Prendergast, Nicola Bradshaw, Chris Aitken, Lisa Bazalo, Jean-Charles Perquin, and Steph Versteeg. Each team member has placed a significant amount of time and effort into each Working Paper and the corresponding datasets.

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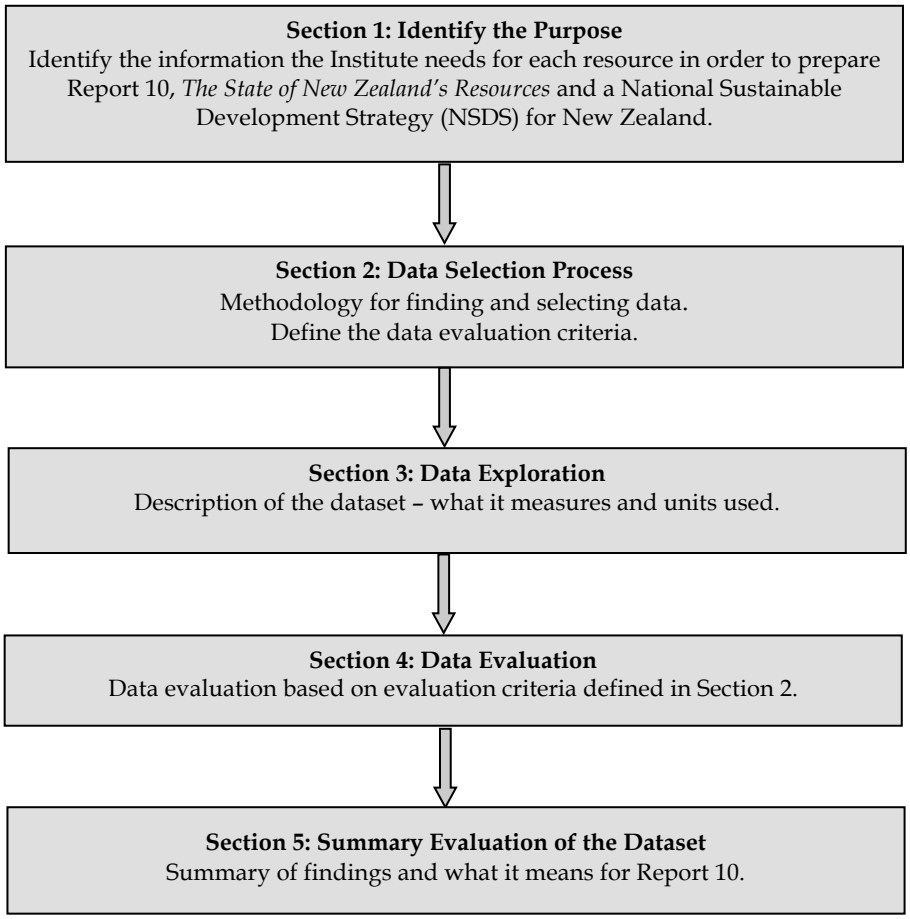
1. Purpose

This Working Paper is one of a series of 11 papers prepared as background to the Sustainable Future Institute's Report 10, *The State of New Zealand's Resources* (SFI, in press). Report 10 aims to provide an overview of available data and information covering a range of resources, and to discuss the use, availability and appropriateness of the data in the preparation of a National Sustainable Development Strategy (NSDS).

The purpose of this Working Paper is to describe the process by which the Institute collected, collated and presented a selection of water quality data. The datasets are summarised and evaluated for completeness, accuracy, relevance, appropriateness of sources and public availability. This paper also discusses the purpose for which the data was collected by its custodians, and why the Institute has selected this data for its reporting. The content of the dataset is not interpreted or analysed; rather, our purpose is to evaluate the usefulness of this dataset for the purposes of Report 10.

Following this evaluation any gaps and resulting limitations in using the selected data are assessed, as well as its relevance and reliability in relation to the Institute's purpose of using the comprehensive series of datasets to inform the development of an NSDS for New Zealand.

Figure 1 The Five-step Process for Evaluating the Institute's Datasets



1.1 The Sustainable Future Institute

The Institute is an independently funded think tank based in Wellington, New Zealand. Earlier work by the Institute has indicated that New Zealand is well behind other developed countries on its international obligations to develop and implement a National Sustainable Development Strategy (NSDS) (SFI, 2007). It is hoped that *Project 2058* will help inform ministers, policy analysts and members of the public about key events and trends in New Zealand's past, and alternative strategies for the future. With this in mind, this Working Paper is a step towards the Sustainable Future Institute's goal of preparing an NSDS for New Zealand in 2011.

1.2 Project 2058

The strategic aim of *Project 2058* is to promote integrated long-term thinking, leadership and capacity building so that Aotearoa/New Zealand can effectively seek and create opportunities, and explore and manage risks, over the next 50 years. In order to achieve this aim, the *Project 2058* team is working to:

1. Develop a detailed understanding of the current national planning landscape, and in particular the government's ability to deliver long-term strategic thinking;
2. Develop a good working relationship with all parties that are working for and thinking about the 'long-term view';
3. Recognise the goals of iwi and hapū, and acknowledge te Tiriti o Waitangi;
4. Assess key aspects of New Zealand's society, asset base and economy in order to understand how they may shape the country's long-term future, such as government-funded science, natural and human-generated resources, the state sector and infrastructure;
5. Develop a set of four scenarios to explore and map possible futures;
6. Identify and analyse both New Zealand's future strengths and weaknesses, and potential international opportunities and threats;
7. Develop and describe a desirable sustainable future in detail, and
8. Prepare a *Project 2058* National Sustainable Development Strategy. (SFI, 2009: 3)

The culmination of *Project 2058*, the development of a National Sustainable Development Strategy, depends on having an accurate assessment of key aspects of New Zealand society. Earlier reports have dealt in particular with points 1, 3, 5 and 6 above,[1] and this Working Paper is designed to help progress the fourth point: 'Assess key aspects of New Zealand's society, asset base and economy in order to understand how they may shape the country's long-term future …'

1.3 Water Quality Resources within an NSDS

Below we ask six strategic questions that drive this research. These are then expanded upon to discuss the use, availability and appropriateness of the data in the preparation of an NSDS.

[1] For a detailed list of published and upcoming reports, see *Project 2058 Methodology: Version 3* (SFI, 2009: 7).

Without accurate, comprehensive, relevant and accessible data to answer the following questions, it will be difficult to develop and execute an informed NSDS for New Zealand.

- **What** are the issues facing water quality in New Zealand? Are New Zealanders clear on exactly what these issues are? Does New Zealand have quality data and information to enable us to understand these issues as fully as possible? Are New Zealanders able to establish an informed understanding of the priorities?

- **Why** does New Zealand need to confront issues affecting our water quality? Are there improvements that can be achieved; or practices that need to change? Are current indicators relevant and meaningful to benchmark changes over-time? What is the purpose and the benefit in taking action?

- **When** should New Zealand start to address issues which impact on New Zealand's water quality? Is now the right time? Are current economic, social and environmental conditions conducive? Would it be beneficial to wait and monitor events as they evolve? Are current measures and indicators appropriate to monitor developments? Is there a risk of rushing into short-term action when a long-term approach is needed?

- **Where** do New Zealanders most need to concentrate their efforts to address New Zealand's water quality issues? Which aspects of the issue should be focused on first? Where should New Zealanders begin to ensure the most beneficial and sustainable outcome? Does New Zealand have sufficient knowledge, based on accurate and appropriate data, to assess outcomes?

- **Who** must be engaged to effectively address issues facing water quality in New Zealand? Who needs to be involved if New Zealand is going to successfully tackle these issues? Is data on water quality in New Zealand accessible and transparent to allow those interested to be accurately informed? Are data ownership issues affecting public involvement?

- **How** should New Zealand ensure we have effective water quality management? What is the best approach? What skills or techniques are needed? Does New Zealand have comprehensive and accurate information to enable effective management? How can New Zealand learn from international experience to assist in the maintenance, protection and improvement of water quality?

This working paper does not attempt to answer the above overarching questions. These overarching questions do however inform our purpose for Report 10 and in progressing an NSDS. Data collected for inclusion within this dataset has enabled us to understand the level of accuracy, relevance, comprehensiveness and issues of ownership that exist surrounding publicly available data in New Zealand. The above questions function as a bridge between the dataset, this Working Paper and Report 10; specific questions pertaining to how the selected Institute's dataset will inform the development of an NSDS are outlined in Table 1

2. Data Selection Process

2.1 Methodology

Report 10a, *Designing a Framework to Monitor New Zealand's Resources* (SFI, 2010) outlined the process through which the Institute developed the framework for collecting and presenting the data. With this framework in place, the steps towards the completion of Report 10 are: (i) building the datasets for the 11 resource types studied; (ii) evaluating the selected datasets, and (iii) reporting on the findings in relation to the Institute's aim of defining an NSDS for New Zealand. The datasets developed in step (i) are available on our website.[2] This Working Paper is one of 11 that form step (ii), the data evaluation. Step (iii) will be published in Report 10.

The source data for the Institute's Water Quality dataset was selected from a variety of static tables extracted from the Ministry for the Environment *Environmental reporting programme* section of the MFE website. The tables used are listed on the Institute's website under Project 2058 Publications and State of New Zealand's Resources. The Institute has taken the original data and reformatted it in an Excel spread sheet to facilitate use and analysis. The original data values have been preserved.

2.2 Sources of Data

The Institute supports the free availability of data relating to environmental statistics. With this in mind, we deliberately used only openly accessible data so that we were able to report on its availability and identify potential gaps. This enables us to report on the implications of using only freely available data, and to evaluate the information that can be extracted from these data sources.

We acknowledge that many sources of information exist on New Zealand's water quality that may or may not be publicly available or easily discoverable. Crown Research Institutes (CRIs), universities, national and local government, and other private and public organisations also collect and hold data on water quality.

For various reasons including privacy, commercial sensitivity, cost of dissemination or commercial sale price of the data, there are many datasets on New Zealand's resources that are inaccessible to the public. Without extensive research, funding or expertise to assist in the interpretation of the data, many others remain unavailable. The Institute has focused on open data; therefore no efforts have been made to retrieve the other datasets. This is a limitation of this project as gaps identified by the Institute could potentially be filled by these other data sources.

For example, NIWA's National Centre for Water Resources (NCWR) provides public information on river, lake, and groundwater conditions across New Zealand including water quantity and quality. It also acts as a distribution point for new technology and management tools for water-related issues. Examples include the development of linked databases containing a wide variety of aquatic information. Scientists at the Centre are active in monitoring and researching New Zealand's freshwater systems, particularly the influences of

[2] www.sustainablefuture.info

changes in land-use and climate variability on both the physical and biological aspects of rivers, lakes, wetland and aquifers (NIWA, 2010).

Regional councils also have important responsibilities for environmental and water quality and quantity management under the Resource Management Act (RMA) 1991 (RMA, 1991). Further, the National Groundwater Quality dataset is a federation of regional council groundwater data collated by GNS Science. There is therefore a wealth of very relevant information that NIWA, GNS Science and regional councils could provide which would make the Institute's water quality dataset more comprehensive. Some of this data has been included and is presented as part of the MfE data, the primary source of this report.

The Institute searched for and compiled its dataset in 2009. What we have selected for inclusion in this dataset and for discussion within this Working Paper reflects data which fits our purpose and was available within the environmental data landscape at the time of research.

As data availability increases rapidly on an on-going basis, it would not be practical to include within this Working Paper all datasets relevant to water quality in New Zealand. Report 10 investigates the past, present and future of the environmental data landscape in New Zealand. It also provides a list of alternative sources of information pertaining to New Zealand resources. When appropriate, we have mentioned complimentary data sources in this Working Paper.

Data on New Zealand resources is often produced and targeted to industry experts. This makes a thorough analysis and evaluation of datasets a complex task for the uninitiated. We have referred to the original source documents to support our evaluation of the datasets.

2.3 Water Quality Dataset Evaluation Criteria

The Institute has developed a series of criteria to support the effective evaluation of its datasets and to consider the data in the context of our wider work programme. Each criterion is supplemented with questions to direct attention to relevant areas for consideration. The aim is to structure the analysis of each dataset in a way that is consistent and replicable across the 11 datasets. In this Working Paper, these criteria are applied to the Water Quality Dataset as a whole and to the different indicators and sources that comprise the dataset.

The criteria and guiding questions are outlined in Table 1.

Table 1 Criteria for Evaluating the Institute's Datasets

Criteria for evaluation	Guiding questions
Comprehensive time series	For how long has the data been collected? Are there gaps in the records? Are data/indicators consistent and comparable over time?
Quality data	What is the scope and range of indicators; are there any gaps? Is data comprehensive and detailed?

	How is data classified/categorised? Is the data local/regional/national? Is the data internationally comparable and valid? Is the data accurate – is there any sampling bias? Are error bars calculated? Is the data relevant and able to be interpreted with meaning?
Appropriate sources	How many sources are drawn on, and what are they? Who owns the data? Why, how and where is data collected/measured? Is the data original data, self-reported/obtained by survey? Is the data collection and analysis informed by sound assumptions? Is data reliable, independent, verifiable and/or of international standard? Is the data subject to (external) review?
Publicly available	Is the data easy to access? Is the data located online, in publicly available reports or databases, or within an institution? Is the data freely available?

2.4 Selected Sources

In order to find possible sources of water quality data to establish a baseline portrait of water quality in New Zealand, the websites of agencies and organisations with relevant links to New Zealand's water quality were reviewed for all publications which provided information and data on freshwater, including river water, lake water and groundwater, as well as trends in freshwater and seawater recreational water quality. A search was undertaken to find online datasets and statistics, documentation on the data collection and its uses, and specific publications on freshwater and seawater quality as well as general relevant publications such as annual reports.

The Institute's primary source of publicly available data on New Zealand's water quality was found to be the Ministry for the Environment (MfE). Data for both freshwater and seawater quality was originally gathered by the National Institute for Water and Atmospheric Research (NIWA), district and regional councils, and the Institute of Geological and Nuclear Sciences (GNS Science), and then compiled and made publicly available on MfE's website under the Environmental Reporting and Freshwater and Oceans sections.

Regional councils also usually have access to or share information with water resource data held on the Ministry of Health's Water Information New Zealand (WINZ) database which is managed by Environmental Science and Research (ESR), a Crown Research Institute. The database holds information from sampling of all drinking water supplies in New Zealand. The WINZ database not only holds information on drinking water but also the source waters

that the water supply is extracted from. Some of this information may have been used by regional councils in their National reporting to MfE.

The selected MfE data includes information on: (i) river water quality, focusing on five key measures – bacteria, macroinvertebrates (small aquatic animals), nutrients, visual clarity, and water temperature and dissolved oxygen; (ii) lake water quality, which uses the Trophic Level Index to consider the following variables – phosphorus levels, nitrogen levels, visual clarity and algal biomass; (iii) groundwater quality, measuring nitrate levels and bacteria (Escherichia coli) levels, and (iv) recreational water quality, which measures the concentration of E. coli and Enterococci in saline waters.

Data for seawater quality was obtained from the MfE website utilising the oceans recreational water quality database, which provides data on the concentrations of Enterococci at selected New Zealand coastal beaches. The measure of Enterococci is the favoured indicator bacteria in seawater as it was found to have a better correlation with illness from contact with seawater. Further, E. coli is an excellent indicator in freshwaters, but dies off too rapidly in sunlit salt water.

It is interesting to note here that the MfE report, *Environment New Zealand 2007* (MfE, 2007a: 5) for which the above data was gathered for, raises the point that national-level environmental monitoring in New Zealand is mostly carried out in locations known, or expected, to have poor environmental quality. This is also true for recreational sites, where the places that have the heaviest recreational use (and therefore most likely to be degraded) are most likely to be monitored to protect public health and manage water quality at the sites – or to provide public advice. This can mean that 'healthy' areas of the environment are not well represented in the data collected. For example, water quality in New Zealand's national parks network is not regularly monitored and reported on, as water quality in national parks is known, from occasional monitoring, to be generally very good. Any general deductions made on water quality in New Zealand based on collected data, need to take this into consideration.

The fact that all the data used for the development of the Institute's Water Quality Dataset comes from government sources should not be seen as an endorsement of these official sources over private companies, but as an artefact of the limitations of the availability of data at time of data collection.

2.5 Purpose for which the Data was Initially Collected

MfE is responsible for reporting to government and all New Zealanders on the state of our environment at national scale. That responsibility encompasses reporting on water quality throughout the country. The primary source of its online datasets is the 'state of the environment' report *Environment New Zealand 2007*, which 'uses national environmental indicators to present information on key aspects of the New Zealand environment and track how these have changed over time' (MfE, 2007a). The water quality data selected by the Institute for inclusion in the Water Quality Dataset was obtained from this report.

2.6 Additional sources

The Institute's 11 working papers, prepared as background papers to Report 10, *The State of New Zealand's Resources,* are selective in their use of specific information and data from within a broader pool of information. The boundaries set for these working papers were tightly focused on openly accessible online data available as at February 2009, the original time of data collection for the Institute's accompanying datasets. For further reading and comparisons which fall outside of our collection strategies we suggest the following additional sources. Please note that the findings of these reports have not been included within this working paper due to the reasons outlined above, but that references to these additional sources are included in the reference list at the back of this paper.

Recent reports

Ballantine et al. (2010) and Ballantine & Davies-Colley (2010) have updated the state of knowledge (water quality state and trend) on New Zealand river systems based on both the NRWQN run by NIWA, and regional council State of the Environment monitoring datasets. Likewise Verburg et al. (2010) have updated and greatly expanded the state of knowledge on New Zealand lake systems, by considering trends as well as state based on regional council lake monitoring datasets. Verburg et al. (2010) report on lake water quality in New Zealand (measured by regional councils), considered ecological condition (as indexed by LakeSPI), as well as the Trophic Level Index (TLI), and considered trends in TLI as well as state.

In Press

A review paper on New Zealand's most comprehensive national-scale monitoring effort, the National Rivers Water Quality Network (NRWQN) operated by NIWA is currently in press (Davies-Colley et al. 2011 in press).

Water quality trend analysis

For a detailed understanding on water quality trend analysis and its relationship to water quality state, which highlights the crucial requirement of consistency in water quality monitoring (as regards sites, variables, methods), is overviewed (in the New Zealand context and relevant to the NRWQN) by Davies-Colley et al. (2011 in press) and also Smith et al. (1996).

Databases and Tools

NRWQN is available, on registration, from NIWA's Water Quality Information System.[3]

NIWA provides a tool for time trend analysis of water quality data (which accounts for seasonality).[4]

[3] NRWQN is available at https://secure.niwa.co.nz/wqis/index.do

[4] This time trend tool is available at http://www.niwa.co.nz/our-science/freshwater/tools/analysis

3. Data Exploration

The definitions relating to water quality that have been adopted for this Working Paper and Report 10 are those used by the Ministry for the Environment (MfE), and include:

- Freshwater water quality: The 'health' of freshwater, as defined by measures of its physical, biological, and chemical properties, as well as other attributes valued by users (such as its aesthetic quality). (MfE, 2007b: 427)
- Aesthetic/amenity values: The natural or physical features of an area or thing that contribute to people's appreciation of it, such as its visual appeal. Aesthetic quality of freshwater refers to whether the water's appearance is appealing to a drinker or user of it (that is, whether it looks clear and clean). (ibid: 404)
- Groundwater: Water that flows beneath the land surface through pores and fissures in rock and soil. Permeable underground zones where groundwater accumulates are known as aquifers. (ibid: 413)
- Recreational water quality includes: Water quality that is defined by the microbiological health risk it poses to swimmers or others undertaking contact recreation on or in the water. (ibid: 420)
- Coastal waters: Seawater extending from the coast to 12 nautical miles offshore. Coastal waters also include seawater in estuaries, fiords, inlets, harbours, and bays. (ibid: 406)

New Zealand's water quality is interconnected with the well-being of most other resources. Therefore, a comprehensive understanding of the state and trends apparent in water quality is vital for future planning. To help achieve this understanding, the Water Quality Dataset is divided into five sub-categories. The selected metadata is summarised in Table 2: (a) river water; (b) lake water; (c) groundwater; (d) freshwater recreational water, and (e) seawater recreational water.

Table 2 Water Quality Dataset Summary Table

Dataset Category	Data Presented		Dates	Measures	Data Reporting Frequency	Data Sampling
Freshwater Quality	River water quality trends	Nitrogen	1989–2007	milligram per litre ($mg.L^{-1}$)	Annual	Monthly from 77 sites on 35 rivers
		Dissolved reactive phosphorous				
		Ammoniacal nitrogen	N/A	milligram per litre ($mg.L^{-1}$)	N/A	N/A
		E. coli	2005–2007	n/1000 ml	Annual	Monthly from 77 sites on 35 rivers
		Visual clarity	1989–2007	metre	Annual	
		Water temperature	2007	degrees Celsius (°C)	Annual (calculated from annual median data)	

		Dissolved oxygen	2007	mg.L^{-1}	Annual (calculated from annual median data)	
		Macroinvertebrate Community Index (MCI)	1990–2007	Macroinvertebrate Community Index (MCI)	Annual	Annually from 66 sites on 35 rivers
		Macroinvertebrate richness	1989–2007	The percentage of Ephemeroptera: mayflies; Plecoptera: stoneflies, and Trichoptera: caddisflies in a river or stream (% EPT)	Annual	
	Lake water quality trends	Total nitrogen	2004–2006	mg.L^{-1}	Trend established over a 3-year period	Monthly or four times a year from 94 lakes
		Total phosphorus				
		Visual clarity		metre		
		Algal biomass		mg.L^{-1}		
	Groundwater quality trends	Nitrate trends	1995–2008	mg.L^{-1}	Trend established over a 13-year period	Four times a year from 973 sites
		E. coli		n/100 mL		
	Recreational water quality trends	Proportion of samples at site complying with *E. coli* guidelines	2007–2009	Number of sites	Trend established over a 3-year period	Once a week in summer from 206 sites
Seawater Quality	Recreational water quality trends	Proportion of samples at site complying with *Enterococci* ~~*E. coli*~~ guidelines	2007–2009	Number of sites	Trend established over a 3-year period	Once a week in summer from 343 coastal sites

Freshwater quality

River water quality trends

The Institute's Water Quality Dataset assesses river water quality as per the variables listed in Table 2. An excerpt from the dataset is provided below in Figure 2. Note that data from 1989 to 2005 is excluded below for representation purposes.

Figure 2 Excerpt from the River Water Quality Trends Dataset
Source: SFI, 2010b

Indicator	Attribute				Data 2006	Data 2007	Data source table #
10.1 Freshwater quality	river water quality trends	nitrogen trends	rivers with lowest concentrations (5th percentile)	$mg.L^{-1}$	0.004	0.003	10a
			median rivers		0.139	0.108	
			rivers with highest concentrations (95th percentile)		0.981	0.989	
		dissolved reactive phosphorous trends	rivers with lowest concentrations (5th percentile)		0.0007	0.0007	10b
			median rivers		0.0048	0.0041	
			rivers with highest concentrations (95th percentile)		0.0220	0.0250	

Lake water quality trends

The lake water quality dataset compares water quality variables for lakes in pasture against those in natural catchments. Of the monitored lakes, 39 were in natural catchments and 55 were in pasture catchments (MfE, 2007b). The comparison occurs over a three-year period from 2004 to 2006. Data presented is for the 2004–2006 period and is the only data point available.

Figure 3 Excerpt from the Lake Water Quality Trends Dataset
Source: SFI, 2010b

Indicator	Attribute				2004	2005	2006	2007	Data source table #
10.1 Freshwater quality	lake water quality trends	total nitrogen	natural catchment (39 monitored lakes)	$mg.L^{-1}$	0.174			..	10h
			pasture catchment (55 monitored lakes)		0.733			..	
		total phosphorous	natural catchment (39 monitored lakes)		0.0083			..	
			pasture catchment (55 monitored lakes)		0.051			..	
		visual clarity	natural catchment (39 monitored lakes)	metre	6.4			..	
			pasture catchment (55 monitored lakes)		1.2			..	
		algal biomass	natural catchment (39 monitored lakes)	$mg.L^{-1}$	0.0017			..	
			pasture catchment (55 monitored lakes)		0.0094			..	

Groundwater quality trends

The groundwater quality dataset assesses regional nitrate trends and *E. coli* levels at sites across New Zealand. The figures shown for nitrate trends are the percentage of sites from 1995–2008: (i) with a significant decreasing trend; (ii) with no significant trend, and (iii) with a significant increasing trend. Data presented is for the 1995–2008 period and is the only data point available.

Figure 4 Excerpt from the Groundwater Quality Trends Dataset
Source: SFI, 2010b

Indicator	Attribute				2000	2001	2002	Data source table #
10.1 Freshwater quality	groundwater quality trends	nitrate trends mg.L^{-1}	% of sites with significant increasing trend	Auckland		14.30		10i
				Bay of Plenty		5.70		
				Canterbury		29.80		
				Hawke's Bay		17.80		
				Manawatu		9.50		
				Marlborough		21.70		
				Northland		8.10		
				Otago		12.20		
				Southland		19.50		
				Taranaki		7.10		
				Tasman		25.00		
				Waikato		32.70		
				Wellington		5.60		
				West Coast		50.00		
				New Zealand total		**19.98**		

Recreational water quality trends

The freshwater recreational quality dataset presents a count of the proportion of samples that comply with *E. coli* guidelines at monitored freshwater swimming spots throughout New Zealand. The figures represent the average compliance for the 2007–2008 and 2008–2009 summers. Data presented is for the 2007-2009 period as it was the only data point available for each regional council area at the time our research was conducted. The Institute acknowledges that all datasets within the Institute's Resource Datasets have a national focus, and as such, the data presented here at a regional level is not consistent with data presented in the other datasets. However, due to the initial collection of this information from regional areas, and the vast differences in water quality between New Zealand regions, the Institute believes it is appropriate to present this data by region. Regional information is arguably also more meaningful, as national information tends to average out trends.

Figure 5 Excerpt from the Freshwater Recreational Water Quality Trends Dataset
Source: SFI, 2010b

Indicator	Attribute					2006	2007	2008	2009	Data source table #
10.1 Freshwater quality	recreational water quality trends	proportion of samples at site complying with *E.coli* guidelines	Northland	NSS[5]		..	1			10i
				95 - 100%		..	1			
				90 - 94.9%		..	1			
				75 - 89.9%		..	9			
				<75%		..	8			
				Total nb of site		..	**20**			

Seawater quality

Recreational water quality trends

This dataset is similar to that for freshwater recreational quality. It presents a count of the proportion of samples that comply with Enterococci guidelines at monitored coastal swimming spots throughout New Zealand. The figures represent the average compliance for the 2007–2008 and 2008–2009 summers. Data presented is for the 2007–2009 period as it was the only data point available for each regional council area at the time our research was conducted. The data is presented by region, and therefore not consistent with the Institute's other datasets which have a national focus. In this instance and in consideration of the reasons outlined, the Institute believes this is the most appropriate format for presenting data on seawater quality.

Figure 6 Excerpt from the Seawater Recreational Water Quality Trends Dataset
Source: SFI, 2010b

Indicator	Attribute					2006	2007	2008	2009	Data source table #
10.2 Seawater quality	recreational water quality trends	proportion of samples at site complying with *enterococci* guidelines	Northland	NSS		..	1			10k
				95 - 100%		..	28			
				90 - 94.9%		..	8			
				75 - 89.9%		..	10			
				<75%		..	0			
				Total nb of site		..	47			

4. Data Evaluation

In this section we evaluate the data presented in the Water Quality Dataset, based on the criteria set in Table 1.

4.1 Comprehensive Time Series

Lack of historical records prior to 1989 for river water quality trends

The most comprehensive data available on water quality is that pertaining to river water quality, for which there is data available on nitrogen trends, dissolved reactive phosphorous trends, visual clarity, macroinvertebrate richness (since 1989) and MCI (since 1990). Although this may be sufficient for looking at trends in the last 20 years, the period of collection does not support the establishment of a time series. This highlights the current lack of consistent *national-scale* monitoring of lakes, and (particularly) coastal waters.

Annual data reporting calculated from annual median data provided for lake water, groundwater and recreational water quality trends

A consistent problem across these indicators is the lack of data available to calculate trends over time. The freshwater recreational water quality trends dataset and the seawater recreational water quality trends dataset provide data that is available for only one point in time. For example, data for average compliance at monitored freshwater and coastal swimming spots is only reported by MfE for the summers of 2007–2008 and 2008–2009, which results in data only being presented for the 2008 year. Data on lake water quality trends, obtained from a comparison of Trophic Level Index water quality variables between lakes in pasture catchments and lakes in natural catchments, is only available from 2004–2006. Groundwater data is reported in regional trends in nitrate from 1995–2008 and is only recorded as a single data point.

The data presented only provides a snapshot of the current levels of water quality for these indicators, thus additional information must be sought to establish trends.

Single-point reporting of data can be used as a baseline

While it is not possible to carry out a comprehensive analysis of long-term trends for the indicators mentioned above, they can be used as a baseline for the future development of trends in water quality in New Zealand, providing sampling is conducted on an on-going basis.

Single-point reporting of data is not an indicator of short-term and on-going changes in water quality

For a relevant and useful comparison of water quality over time it is necessary to consider reporting periods of short duration, as rapid changes can occur. This is especially so for those variables (such as E.coli) which are affected by weather, discharges and seasonal activity. For example, when only a few samples are taken per year it is important to know the weather just before sampling as E.coli numbers go up by orders of magnitude after significant rainfall (McKergow & Davis-Colley, 2010).

Chemical variables are less changeable (especially groundwater), but to obtain a detailed overview of water quality based on selected chemical variables, data would need to be reported on at least four times per year (preferably monthly) to cover all seasons (P. Prendergast, Ministry of Health, personal communication, 2010). The current level and frequency of monitoring of groundwater quality – four times a year from around 1000 sites throughout New Zealand, and collection in accordance with the national protocol for state of the environment groundwater sampling – provides a minimum long-term ability to monitor groundwater quality effectively throughout the country. However by reporting annually short-term changes cannot be identified.

Annual reporting calculated from annual mean data on most of the variables does not provide a comprehensive understanding of the water quality. Reporting on trends established over 'x' number of years does not disclose short and medium-term changes in water quality.

4.2 Quality Data

Comprehensive sampling methodologies across selected indicators

Data relating to river water quality is collected regularly from over 800 sites on rivers and streams throughout New Zealand. Of these sites, 77 are located on 35 rivers which make up the National River Water Quality Network (MfE, 2007c). This monitoring is mainly done under the National River Water Quality Network programme operated by NIWA and as part of monitoring networks operated by regional councils.

Data on lake water quality is collected primarily by regional councils, but also by NIWA, at about 120 lakes (MfE, 2007d) in New Zealand. Samples are usually taken monthly or at some sites, four times a year. This data is collected to measure the nutrient status, and to enable monitoring of the impact of land use on lake water quality and bacteria levels.

Groundwater quality data is typically gathered four times a year from around 1000 sites throughout New Zealand by regional councils and GNS Science (MfE, 2009). Data is collected on pollutants such as nutrients and bacteria to monitor land use impact in accordance with the national protocol for state of the environment groundwater sampling in New Zealand.

Regional and district councils obtain data on water quality for recreation at around 200 sites on rivers and lakes, and around 350 coastal sites. Recreational water quality data is generally taken once a week in summer. This data, relating to both freshwater and seawater, is collected to enable maintenance and protection of water quality for public health and resource management issues. Basically, water quality data is collected over the country but not collated

on a national basis. Being collected by regional councils it is in theory publicly available (regional councils are subject to the Official Information Act (OIA)) but may not be easily accessible – people have to know what and where to look for it.

Appropriate variables measured

The Institute's dataset is divided into five sub-categories assessing water quality, variable s are measured according to a variety of attributes. These include, but are not limited to bacterial levels, chemical levels, nutrients, algal levels, macroinvertebrates, temperature and visual clarity, and relevant and appropriate units of measurement are used. In most instances the variables used are appropriate to measure and judge changes in water quality at monitored areas. However, it is unfortunate that E.coli has not been monitored for lakes. This is a surprise as there are many recreational sites on lakes and popular lake beaches that the Institute would have expected regional councils to have monitoring sites on. It may be presumable that MfE just decided not to include these in its reports. Further, as mentioned above in Section 4.1, across all variables the data reporting frequency is insufficient to provide a meaningful assessment of water quality in New Zealand.

The perception of high water quality has become one of the defining features of New Zealand's national identity, affecting our national image, our performance in international markets and our top sector earners, in particular primary production and tourism. Lack of international comparison in the datasets, especially with respect to the other 30 OECD countries, hinders the potential for full planning and analysis for the future of water quality in New Zealand. For example, it would be useful to know how Australia and the United Kingdom monitor water quality in order to identify how consistent, accurate, comparable and comprehensive our datasets are.

4.3 Appropriate Sources

Official data sources

The data in the Institute's Water Quality Dataset is sourced from New Zealand's government environmental agency, the Ministry for the Environment. MfE compiles data on water quality from across 16 regions, collected by local government and Crown Research Institutes. MfE is one of the official sources of water quality information in New Zealand and the Institute deems this source to be trusted. Notwithstanding this, additional information and details from other research by NIWA and regional councils would be of interest to provide a more complete picture of water quality.

Different technical expertise between each regional council

Regional and district councils self-report against national water quality measures and have inherent differences in technical expertise, resources and needs. Standards and guidelines to ensure high levels of water quality are set to counteract regional differences in collection methods (QP, 2007). However, there is still a major problem with obtaining a national-scale picture given the inconsistency of regional council monitoring. To further counter act this problem, current action by MfE in creating a Technical Advisory Group (TAG) (convened by Lian Potter co-operatively with the RC SWIM group) aims to improve monitoring consistency.

Regional and district councils can select whether to incorporate water quality standards within regional plans, however it is not obligatory to do so. The Resource Management Act 1993 (RMA) (s69) allows standards to be set regionally, and provides direction for regions wishing to do this. Setting water quality standards in regional plans establishes a benchmark against which to measure cumulative effects as well as providing clear guidance for processing resource consents. The provision for setting national water quality standards is provided under section 43 of the RMA.

4.4 Public Availability

All data publicly available and well documented

It is the aim of this project to assess publicly available data, i.e. data that is able to be accessed by parties independent of those who collect or present it. MfE's reports fit this criterion; the reports are freely available to the public via the agency's website. However source data from NIWA and regional councils published in the MfE report does not fit this working papers definition of being publicly available online. Regional council's data is (usually) available on request under the OIA and data from NIWA is publicly available from the Water Quality Information System (WQIS) upon (free) registration.

5. Summary Evaluation of the Dataset

The Institute chose the data presented in the MfE *Environment New Zealand 2007* report (MfE, 2007a) to inform its upcoming Report 10 and an NSDS, as it was deemed to be comprehensive and reliable. Whilst the dataset has some limitations, it provided the Institute with the information necessary to establish a baseline of water quality trends in New Zealand. Table 3 below summarises the Institute's evaluation of the dataset.

Table 3 Summary of Water Quality Data Evaluation

	Strengths	Weaknesses
Comprehensive time series	▪ River water quality trends has the most comprehensive time series data, spanning over 20 years.	▪ Lack of historical records prior to 1989 for river water quality trends and none available for all other indicators (water quality data was collected prior to 1989 by Water and Soil Directorate of Ministry of Works and Development (MWD) of which NIWA water quality Centre was then a part. All that information would have been archived with the abolition of the MWD and not electronically recorded. ▪ Single-point data provided for lake water, groundwater and river water and seawater recreational water quality trends. This data can only be used as a baseline. ▪ Single-point data not an indicator of short-term change.

Quality Data	▪ Comprehensive sampling methodologies across selected indicators ▪ Appropriate variables measured	▪ Data monitoring E.coli levels in lakes is not reported upon in the sources used for this report ▪ Lack of consistency between regional councils monitoring and procedures. For example, some councils do not monitor visual clarity (despite visual clarity standards in the Resource Management Act 1991)
Appropriate Sources	▪ Official data sources ▪ Data based on comprehensive water quality national standards and guidelines	▪ Different technical expertise between each regional council may hinder comparison of data between each region
Publicly available	▪ All data from *MfE Environment New Zealand 2007* report publicly and freely accessible	▪ Source data by NIWA and regional councils used for the MfE report not publicly available as per the definition used for this working paper

The Institute acknowledges that other sources will need to be consulted in order to gain a complete and comprehensive overview of water quality in New Zealand. The Institute's dataset does not answer the questions outlined in Section 1.3, but can provide background statistics to support reporting, analysis and argumentation, especially in regards to river water quality trends as this is the most complete dataset

References

Ballantine D. J., Booker D., Unwin M., and Snelder T. H. (2010). *Analysis of national river water quality data for the period 1998–2007*. NIWA client report to Ministry for Environment CHC2010-038. 71 p. Retrieved May 9, 2011 from http://www.mfe.govt.nz/publications/water/analysis-of-national-river-water-quality-data-1998-2007/index.html

Ballantine, D. J.; and Davies-Colley, R. J. (2010). *Water quality trends at NRWQN sites for the 21 years: 1989-2009*. NIWA client report HAM 2010-142 for Ministry for Environment, November 2010. 14 p. [soon to be available on MfE website]

Davies-Colley, R. J.; Smith, D. G.; Ward, R.; Bryers, G. G.; McBride, G. B.; Quinn, J. M.; and Scarsbrook, M. R. (2011). Twenty years of New Zealand's rivers water quality monitoring network. Benefits of careful design and consistent operation. *Journal of the American Water Resources Association.* (accepted for publication contingent on minor edits, January 2011).

McKergow, L. M.; Davies-Colley, R. J. (2010). Hydrological processes 24:276-289. *Storm dynamics and loads of faecal pollution in a large mixed land use catchment.* Retrieved July 1, 2010 from http://onlinelibrary.wiley.com/doi/10.1002/hyp.7480/abstract

Ministry for the Environment (MfE) (2007a). *Environment New Zealand 2007*. Wellington: Ministry for the Environment. Retrieved July 1, 2010 from http://www.mfe.govt.nz/publications/ser/enz07-dec07/

Ministry for the Environment (MfE) (2007b). *Land use and lake water quality*. Retrieved July 1, 2010 from http://www.mfe.govt.nz/environmental-reporting/freshwater/lake/land-use.html

Ministry for the Environment (MfE) (2007c). *River water quality.* Retrieved July 1, 2010 from http://www.mfe.govt.nz/environmental-reporting/freshwater/river/

Ministry for the Environment (MfE) (2007d). *Lake water quality*. Retrieved July 1, 2010 from http://www.mfe.govt.nz/environmental-reporting/freshwater/lake/

Ministry for the Environment (MfE) (2009). *National groundwater quality indicators update: state and trends 1995-2008.* Retrieved July 1, 2010 from http://www.mfe.govt.nz/publications/ser/groundwater-quality-trends-2008/

National Institute for Water and Atmosphere (NIWA) (2010). *Freshwater.* Retrieved November 8, 2010 from http://www.niwa.co.nz/our-science/freshwater

Quality Planning (QP) (2007). *Plan topics: Surface water quality.* Retrieved November 8, 2010 from http://www.qualityplanning.org.nz/plan-topics/surface-water-quality.php#regionalwqp

Resource Management Act (RMA) (1991). Part 4, s30, Functions of regional councils under this Act. Retrieved November 8, 2010 from http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html

Smith D. G.; McBride G. B.; Bryers G. G.; Wisse J.; and Mink D.F.J. (1996). Trends in New Zealand's river water quality network. *New Zealand Journal of Marine and Freshwater Research 30*: 485-500.

Sustainable Future Institute (SFI) (2007). *A National Sustainable Development Strategy: How New Zealand measures up against international commitments*. Report 1. Retrieved March 10, 2010 from http://www.sustainablefuture.info

Sustainable Future Institute (SFI) (2009). *Project 2058 methodology: Version 3*. Retrieved March 10, 2010 from http://www.sustainablefuture.info

Sustainable Future Institute (SFI) (2010). *Designing a framework to monitor New Zealand's resources*. Report 10a. Retrieved May 12, 2010 from http://www.sustainablefuture.info

Sustainable Future Institute (SFI) (2010b). *Dataset 10: Water quality*. Retrieved July 1, 2010 from http://www.sustainablefuture.info

Sustainable Future Institute (SFI) (in press). *The state of New Zealand's resources*. Report 10.

Verburg P.; Hamill K.; Unwin M.; and Abell J. (2010). *Lake water quality in New Zealand 2010: status and trends*. NIWA and Opus International. NIWA Client Report to Ministry for Environment. 48 p. Retrieved May 9, 2011 from http://www.mfe.govt.nz/publications/ser/lake-water-quality-in-nz-2010/index.html