NERMN Estuarine Water Quality 2005

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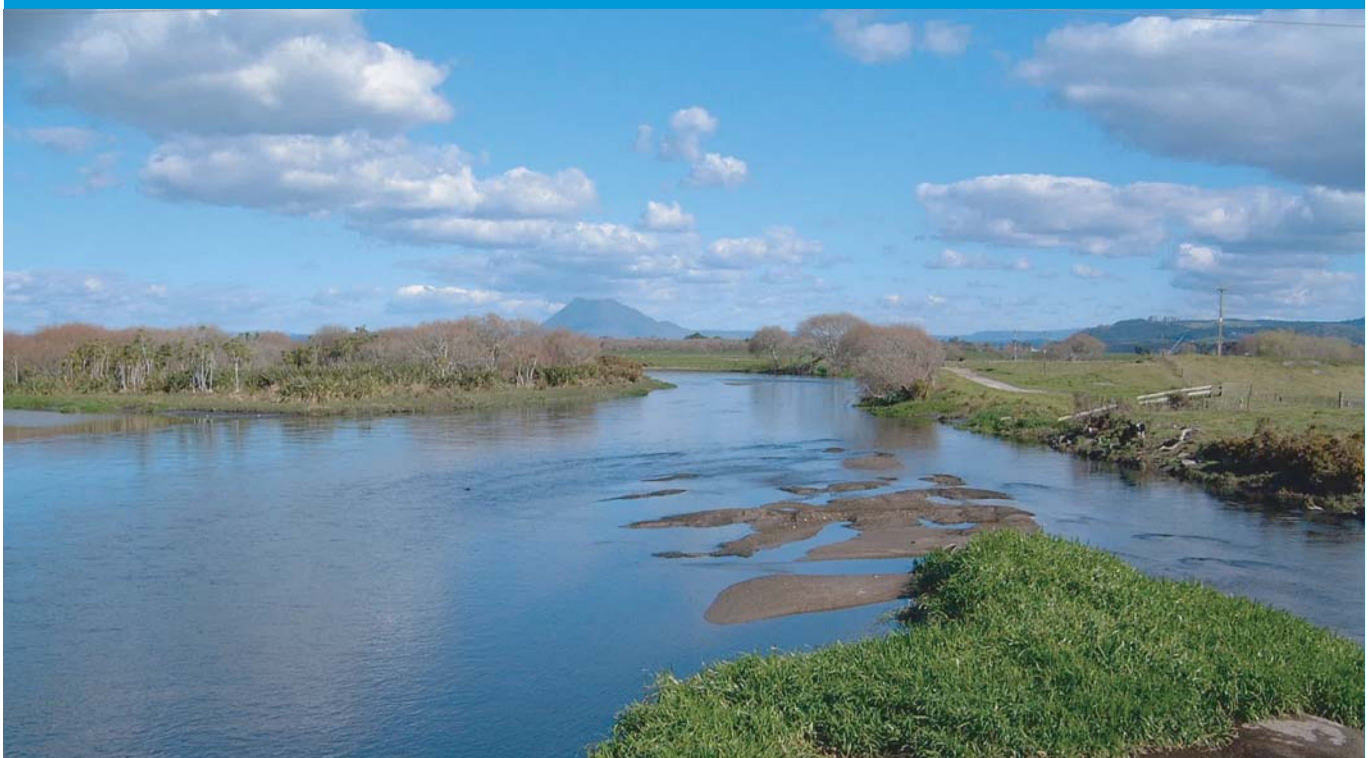

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Executive Summary

The monitoring of water quality within the Bay of Plenty Estuaries is part of Environment Bay of Plenty's Natural Environmental Regional Monitoring Programme (NERMN). Water quality data is collated and analysed to detect for changes in water quality. Monitoring is used to observe trends in water clarity, nutrient levels, suspended sediments, pathogens, and phytoplankton. Nine estuaries with twenty-one sites are monitored in the NERMN programme with changes in sites having occurred since monitoring began in 1990.

Reporting and monitoring of Bay of Plenty Estuaries is based upon objectives of the Operative Bay of Plenty Regional Coastal Environmental Plan and the Proposed Regional Water and Land Plan. The objective of the monitoring programme is to monitor water quality and water quality trends in the estuaries and to ascertain if water quality classifications for water quality are being met.

The water classifications of the two plans are met in terms of water clarity, temperature, and biological growths. On rare occasions the dissolved oxygen content of some estuaries has been under the 80 percent saturation, the value classified in the Regional Environmental Coastal Plan. The exception was the Tarawera Estuary which often does not meet the oxygen saturation classification. Indicator bacteria concentrations also occasionally exceed microbiological water quality guidelines classified under the Regional Environmental Coastal Plan and the Proposed Regional Water and Land Plan, primarily due to contamination from flood flows to some estuaries.

Long term water quality trends for Bay of Plenty estuaries are summarised in Table 1. Indicator bacteria levels are displaying an increasing trend in several estuaries (Table 1). Monitoring indicates that estuaries are for the most part within microbiological water quality guidelines with river estuaries tend to have the greatest bacterial levels.

Table 1 Trends of water quality determinands, Bay of Plenty Estuaries

Site	Analysis Period	Chla	Turbidity	SS	TP	NH_4N	NOxN	E.coli	Ent
Ohiwa Harbour	90 - 05	↓	-	↑	-	-	-	-	↑
Little Waihi	90 - 05	-	-	↑	↑	-	-	-	-
Maketu	91 - 05	-	-	↑	-	-	-	-	-
Tauranga Harbour									
Town Basin	91 - 05	↓	↓	-	↓	-	-	-	-
Otumoetai Channel	98 - 05	-	-	-	↓	-	↓	↑	-
South Basin	91 - 05	-	-	↑	↓	-	-	↑	↑
North Basin	91 - 05	↓ (92-04)	-	↑	-	↑	-	↑	↑
River Estuaries									
Opotiki	91 - 05	-	-	-	↑	↑ (95-05)	-	-	-

Site	**Analysis Period**	**Chla**	**Turbidity**	**SS**	**TP**	**NH_4N**	**NOxN**	**E.coli**	**Ent**
Whakatane	91 - 05	-	-	-	-	↓	⬇	↑	-
Rangitaiki	95 - 05	↑	-	-	-	-	-	↑	-
Tarawera	95 - 05	⬇ (96-05)	-	⬇	-	-	↑	-	-
Kaituna	95 - 05	-	-	-	↑	-	⬆	-	⬆
Matata Lagoon	01 - 05	↓	↓	↓	-	-	-	-	-

ND= no or limited data, ↑ =increasing trend, ↓= decreasing trend, "-" = no trend, the larger the arrow the greater the probability that the trend is real (95-05 = time trend)

Phytoplankton growth is generally low in most estuaries with five estuaries showing a decreasing trend and one estuary an increasing trend. Some estuaries display signs of being phosphorus limited with respect to phytoplankton productivity.

Dissolved inorganic nitrogen concentrations are generally greater than recommended trigger levels for estuaries and low land rivers. However, these guidelines may not be appropriate for Bay of Plenty conditions given the nitrogen rich oceanic waters that mix with fluvial waters in the estuarine environment. This report has adopted a comparison of water quality parameters with the 80^{th} and 20^{th} percentiles of water quality parameters, utilising over a decades worth of monitoring data. Water managers can then gauge an estuaries water quality for a given parameter against other Bay of Plenty estuaries to determine comparative water quality over the different parameters measured.

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Chapter 1: Introduction

Estuaries form a transitional environment between the land and the sea mixing together fresh and saline waters. In these unique coastal environments different mixtures of oceanic and freshwaters create many different habitat types, supporting an abundance of animal and plant wildlife. They act as an important resource for human cultural and economic development.

High levels of development pressure means that estuaries are subject to a range of direct and indirect impacts due to land use in the catchment, changes to hydrology and the direct use of the estuary waterways. The greatest impact in many estuaries is that of oceanic waters constantly draining in and out of an estuary with the changing tides.

Nutrients, sediments and toxins that originate within a catchment as a result of urbanisation, agricultural activities, vegetation clearing and industry, eventually end up in estuaries potentially affecting the water quality and estuarine ecosystem. As such, estuaries are often a sink for sediments and associated contaminants from such discharges. Our larger coastal estuaries are influenced by discharges that stem from multiple rivers, streams and stormwater discharges. Estuarine water quality can be a report card of their associated catchment(s).

Estuarine water quality is monitored in the major estuaries of the Bay of Plenty as part of the Natural Environment Regional Monitoring Network (NERMN). Monitoring in this report looks predominantly at the physico-chemical properties of estuarine waters as measured in Bay of Plenty estuaries. These water quality parameters show the quality of estuaries based on an assessment of biological, aesthetic and chemical quality.

Monitoring data extends back as far as 1990 and is used in this report to examine trends in environmental monitoring. From these trends conclusions are drawn on the changing state of estuarine water quality.

Policies driving this monitoring programme are found in the Proposed Regional Water and Land Plan (PRWLP) and Operative Bay of Plenty Regional Coastal Environmental Plan (RCEP). The policies found in these two plans form the *objectives* of the monitoring programme, which is to determine:

- The quality of estuarine waters in the Bay of Plenty and trends in their water quality.
- To have full regard to the water quality classifications (standards) for riverine and coastal estuaries.
- Potential adverse effects on water quality in the receiving environment.

The water quality classifications (standards) are noted in Appendix II.

Chapter 2: Methods

Nine estuarine environments are currently monitored under the NERMN programme. Twenty-one sites are sampled every two months over the high tide period and three sites over the low tide period. Dissolved oxygen (near the surface), temperature and salinity are measured in the field and samples are collected for analysis of turbidity, suspended solids, conductivity, salinity (laboratory), pH, chlorophyll *a*, nitrate-nitrogen, ammonium-nitrogen, dissolved reactive phosphorus, total phosphorus, and indicator bacteria. Laboratory methods for analysis are listed in Appendix I.

This report has utilised the data analysis software LakeWatch to provide graphical representation of data, to assist in the analysis of trends in data, and to examine the likelihood that trends are real. LakeWatch uses linear regression to examine seasonal patterns in the data and then removes seasonality to observe trends over time. Linear relationships between water quality parameters were determined using Pearson's correlation coefficient (r) and Bonferroni probability to test of level of significance is equal of greater than 95% (p=<0.05).

Site location and detail are listed in Table 2 and Figures 1 to 4.

Table 2 Location details for estuarine monitoring sites

Site No	Description	Estuary	NZMS 260 Map Ref	Current
BOP150001	Kukumoa	Opotiki Estuary	W15:8500-4750	Y
BOP150017	Opotiki Wharf	Opotiki Estuary	W15:8600-4670	Y
BOP150002	Ruatuna Road	Ohiwa Harbour	W15:7340-4550	Y
BOP150003	Port Ohope Wharf	Ohiwa Harbour	W15:7090-4940	Y
BOP150004	Boat Ramp	Whakatane Harbour	W15:6240-5420	Y
BOP150018	Jetty at Boat Ramp	Rangitaiki River	W15:5100-5840	Y
BOP150019	50m d/s of Matata/Thornton Rd	Tarawera River	V15:4320-6060	Y
BOP150010	Bridge to Domain	Matata Lagoon	V15:4080-6150	N
BOP150029	Control Structure	Matata Lagoon	V15:4295-6070	Y
BOP150006	50m offshore from Domain	Little Waihi Estuary	V14:1680-7650	Y
BOP150005	Boat Ramp	Maketu Estuary	V14:1460-7700	Y
BOP150020	River Diversion Structure	Kaituna River Estuary	V14:1100-7730	Y
BOP720004	Kulim Ave. Otumoetai	Tauranga Harbour	U14:8880-8870	Y
BOP720001	Grace Street	Tauranga Harbour	U14:8950-8390	Y
BOP150011	Maungatapu Bridge	Tauranga Harbour	U14:9140-8340	Y
BOP730024	Boat Ramp	Tauranga Harbour	U14:9080-8770	Y
BOP150021	Toll Bridge Marina	Tauranga Harbour	U14:9050-8750	Y
BOP150016	Tauranga Yacht and Boat Club	Tauranga Harbour	U14:8970-8880	N
BOP150012	Otumoetai, Beach Rd.	Tauranga Harbour	U14:8732-8854	Y

BOP150013 Te Puna Beach, Pitua Rd.	Tauranga Harbour	U14:8230-8920	Y
BOP710105 Matakana	Tauranga Harbour	U13:7400-0700	N
BOP150014 Omokoroa, Wharf.	Tauranga Harbour	U14:7980-9210	Y
BOP150026 Pahoia Beach Rd	Tauranga Harbour	U14:7515-9236	Y
BOP710107 Mid Harbour	Tauranga Harbour	U14:7500-0000	N
BOP150009 Katikati Boat Ramp	Tauranga Harbour	T14:7150-0180	N
BOP150023 Kauri Point Jetty	Tauranga Harbour	U13:7328-0509	Y
BOP720025 Ongare Point.	Tauranga Harbour	U13:7290-0680	Y
BOP150027 Tanners Point Jetty	Tauranga Harbour	U13:7087-0930	Y
BOP150022 Bowentown Boat Ramp	Tauranga Harbour	U13:7320-1186	Y
BOP150015 Bowentown, Entrance to Pio's	Tauranga Harbour	U13:7330-1050	N

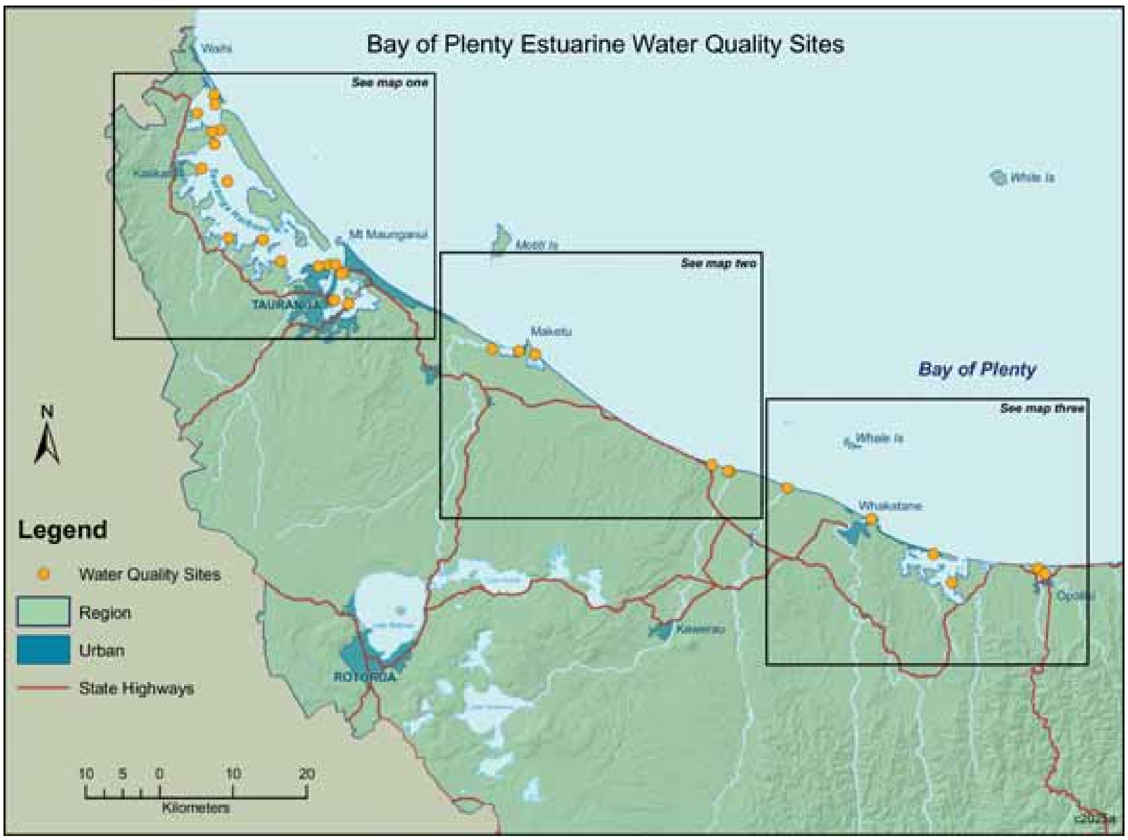


Figure 1 *Estuary monitoring sites, Bay of Plenty.*

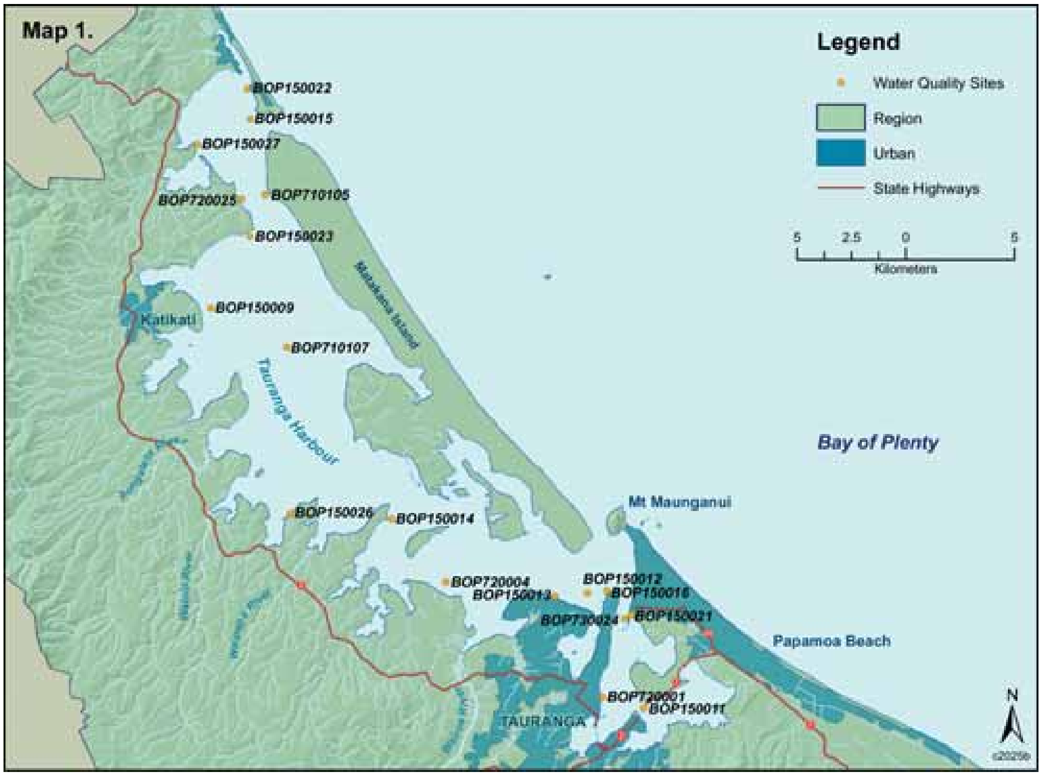


Figure 2 Estuary monitoring sites, Tauranga Harbour

Figure 3 Estuary monitoring sites, Kaituna River to Tarawera River.

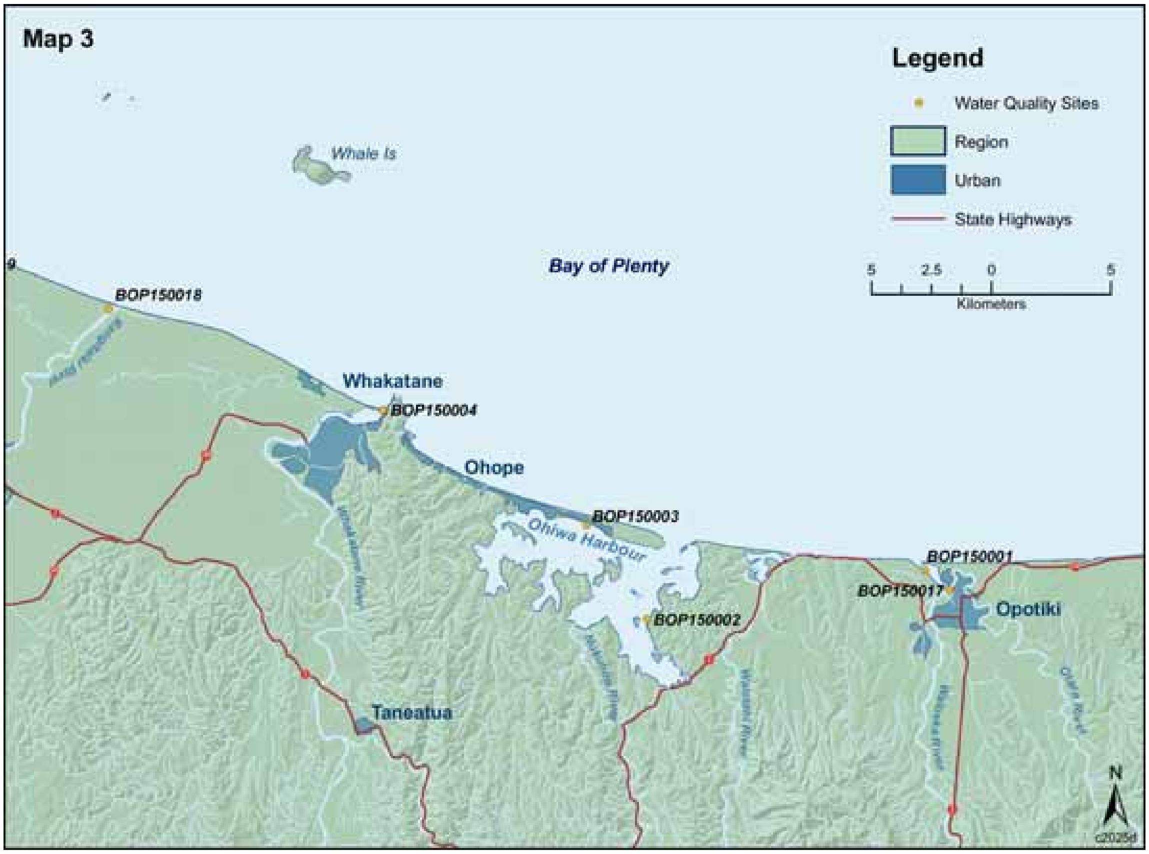


Figure 4 Estuary monitoring sites, Rangitaiki River to Opotiki Estuary.

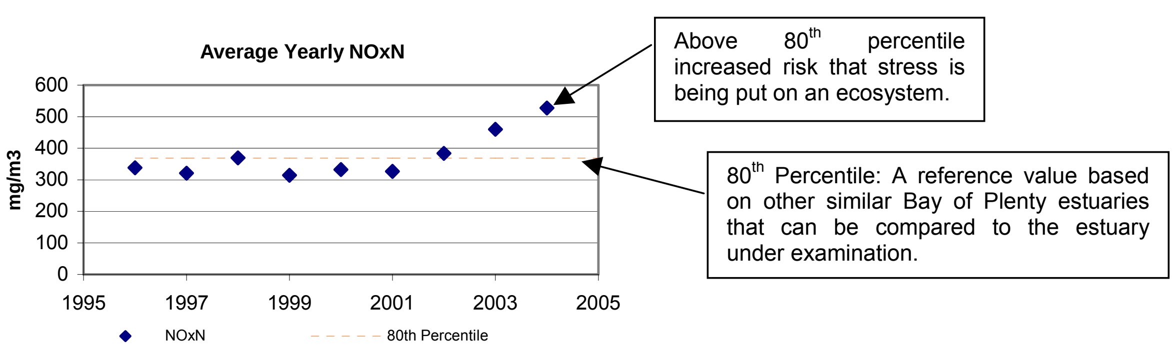
Chapter 3: Results and Discussion

A number of determinands are monitored in the estuaries. In reporting and analysing determinands, this report will focus upon: turbidity; the nutrients total phosphorus (TP), nitrate-nitrogen (NO_3N) and ammonium-nitrogen (NH_4N); chlorophyll *a* (Chla); dissolved oxygen; and indicator bacteria (*Escherichia coli* and enterococci).

By concentrating on these determinands, a picture of potential threats to estuarine water quality can be developed thereby helping to meet the objectives of the RCEP and PRWLP. Threats such as increasing sedimentation from urban development, erosion, and rural runoff, increased nutrients loads from intensive livestock farming, fertiliser runoff, and urban stormwater all have the potential to negatively impact on water quality. Algal blooms may occur as a direct result of increases in nitrogen and phosphorus. Reduced oxygen may result from excess ammonia and increased organic loading.

To help give a clearer picture as to the relevance of concentrations of a given determinand in the estuarine environment, this report makes use of the methods and trigger values for physical and chemical stressors for slightly disturbed ecosystems provided in the ANZECC Water Quality Guidelines (2000). Trigger values have been developed in these guidelines above which there is a greater risk that adverse conditions for biological organisms will occur. However, these trigger values may not represent a reliable or realistic measure of protection for Bay of Plenty waters as these values have been developed in different catchments with differing ecosystems. It is suggested that water quality managers develop their own physico-chemical indicators better suited to their respective regions.

The ANZECC guidelines (2000) suggest that where no studies on potential biological effects of stressors have been carried out it may be appropriate to use the 20^{th} and 80^{th} percentiles from a data set to reference or develop water quality targets. For stressors that cause problems at high concentrations, for example nutrients or suspended solids, comparison of data with the 80^{th} percentile of the reference data set provides measure of comparative water quality with a locally derived reference scale (see Figure below). At least five years of reference data is recommended to develop percentiles.



This report plots annual average concentrations along with the 20th and 80th percentiles for Bay of Plenty estuaries. The 80th percentiles provide no magic number above which adverse effects are more likely to occur, but serves to indicate that above this number there is an increased risk of stress to the ecosystem. Both percentiles also allow the reader to calibrate a water quality parameter in the context of other Bay of Plenty estuaries.

Percentiles for river estuaries have been calculated separately from other estuaries due to the contribution of freshwater in these environments. In most cases over a decade worth of data has been used to calculate percentiles, with a minimum of five years of data utilised.

There are no guideline values developed specifically for New Zealand estuaries, so this document will at times refer to the trigger values developed for south-east Australian estuaries as well as trigger values for New Zealand lowland rivers. These guidelines do not necessarily provide a number at which environmental problems occur, but provide an indication of low environmental risk.

Trigger values are set out in Table 3.

Table 3 Trigger values for stressors for slightly disturbed estuarine ecosystems. (ANZECC, 2000)

	Chl a mg/m^3	TP mg/m^3	NOxN mg/m^3	NH_4N mg/m^3	Turbidity NTU
Trigger value estuaries	4	30	15	15	10*
Trigger value lowland rivers	-	33	444	21	5.6

**Adopted from Murphy and Crawford, 2002.*

No value for suspended sediments or turbidity is given in the ANZECC guidelines for estuaries. However, as sediment is associated with resuspension or input of nutrients, and can reduce light penetration, smother organisms and block fish gills, it is important to consider its concentration in the estuarine environment. A turbidity trigger value for New Zealand lowland rivers is given at 5.6 NTU. For Tasmanian estuaries an indicator value for turbidity greater than 10 NTU is considered high (Murphy and Crawford, 2002).

For indicator bacteria, the Microbiological Water Quality Guidelines (2003) are used for comparative purposes and to see if the qualitative standard for the classification has been met. The guidelines use enterococci for comparison in marine waters and *Escherichia coli (E.coli)* for freshwaters. Since both fresh and saline waters occur in some estuarine environments, it is appropriate to examine both indicator bacteria. Table 4 displays the guideline values as recommended by the Microbiological Water Quality Guidelines, 2003.

Table 4 Microbiological Assessment Category (MAC) definitions (from MfE & MoH, 2003)

Marine waters	
Green Mode	No single sample < 140 Enterococci per 100 mL
Orange Alert	Single sample > 140 Enterococci per 100 mL
Red Alert	Two consecutive samples > 280 Enterococci per 100 mL

Freshwater	
Green Mode	No single sample < 260 Escherichia coli per 100 mL
Orange Alert	Single sample > 260 Escherichia coli per 100 mL
Red Alert	Single sample > 550 Escherichia coli per 100 mL

3.1 Opotiki Estuary

The Opotiki Estuary is a relatively small riverine estuary (0.5 km^2) joining with the confluence of the Waioeka and Otara Rivers to provide a common mouth for these rivers. The lower catchment for this estuary is dominated by intensive livestock farming, horticulture and the Opotiki urban environment, with the sewage treatment and disposal system for Opotiki located on the estuaries north-eastern bank.

Two sites are monitored in the Opotiki Estuary. One at the wharf, monitored since 1995, and one at Kukumoa at the Kukumoa creek mouth, monitored since 1990.

3.1.1 Chlorophyll a

Figure 5 shows the monitoring data for chlorophyll *a* (Chla) concentrations at two Opotiki Estuary sites. Kukumoa site has a higher average Chla concentration than at the wharf site which may be explained the by the proximity of the sampling location to the Kukumoa Creek mouth. Both sites show a slightly non-significant increase in Chla concentration over time. There is no obvious seasonal pattern.

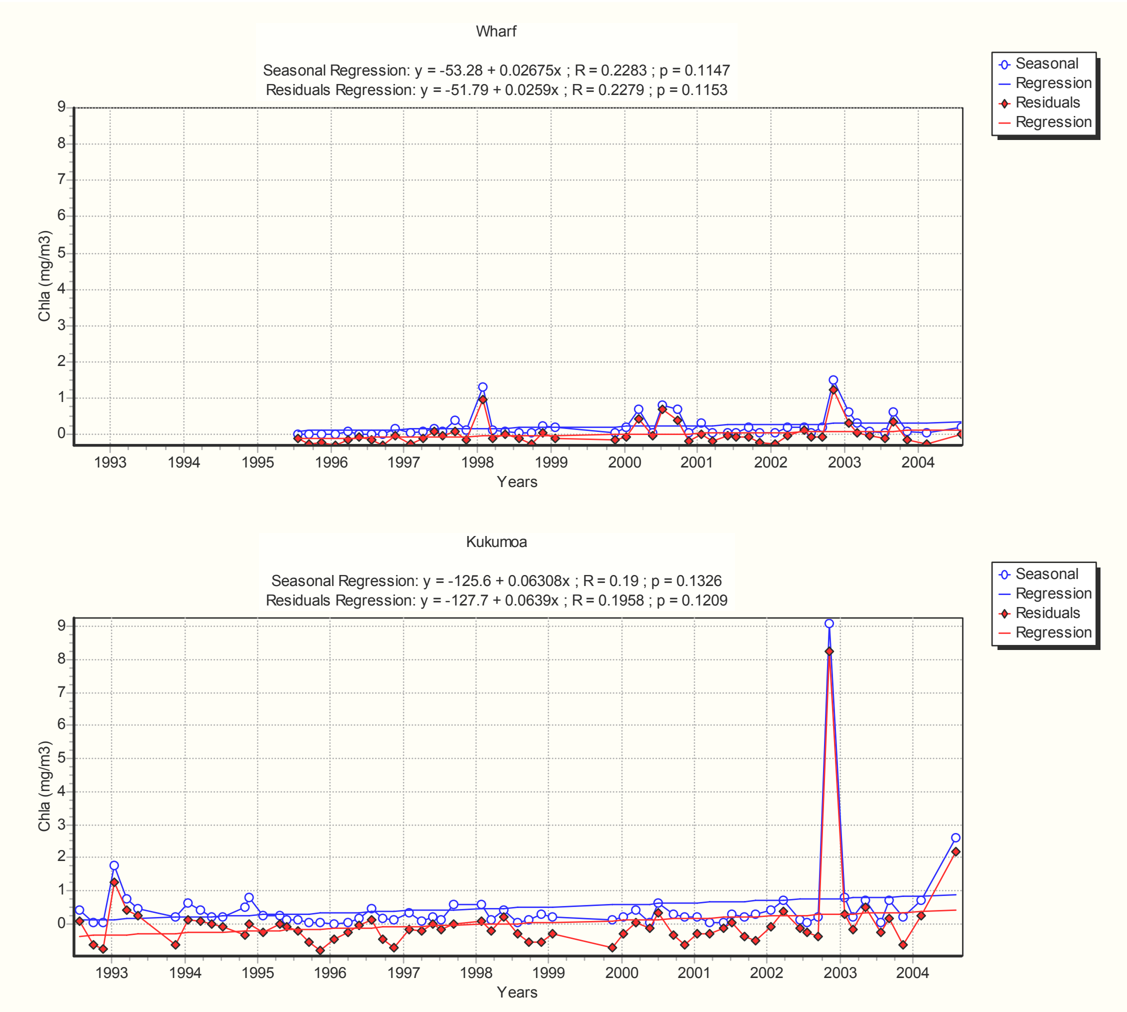


Figure 5 Chlorophyll a concentrations at the Wharf and Kukumoa sites, Opotiki Estuary.

3.1.2 Turbidity

Turbidity has been monitored at both sites since 1996. There are winter highs in the turbidity with no real trend in the turbidity data over the analysis period. Any increase in the turbidity trend is heavily biased by a significant storm event in June 2004 which created increased sediment loads and therefore increased turbidity. Turbidity is generally good, but is influenced by seasonal rainfall events.

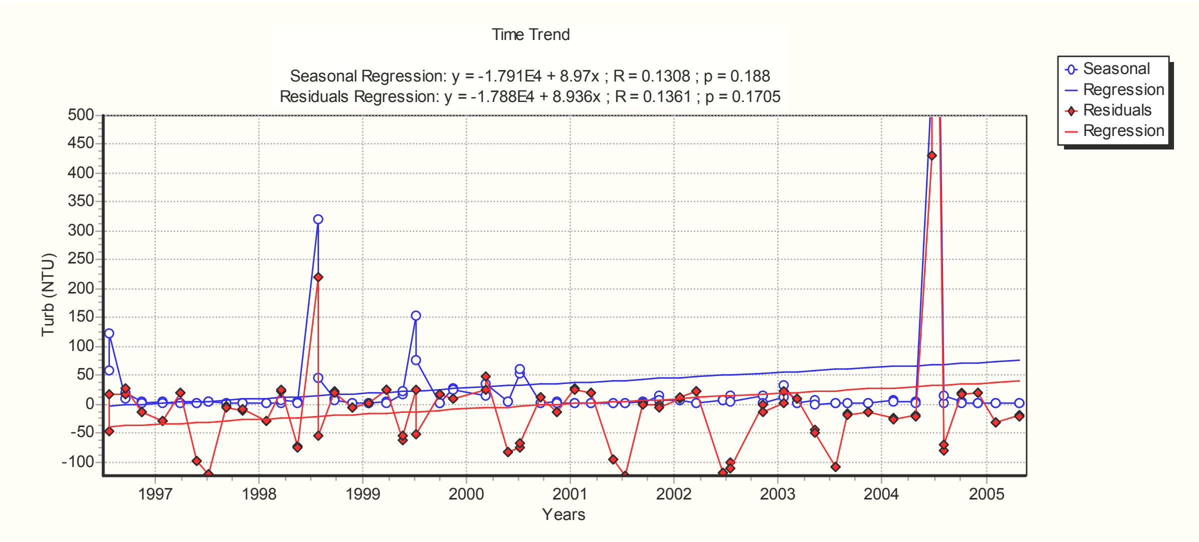


Figure 6 Turbidity at Wharf and Kukumoa sites, Opotiki Estuary.

3.1.3 Total Phosphorus

Both sites in the estuary show a similar average total phosphorus (TP) concentration with no real trend over the analysis periods. As to be expected TP shows a strong correlation with turbidity at both sites (Wharf: R=0.914, Kukumoa; R=0.986) and like turbidity, TP is influenced by rainfall events.

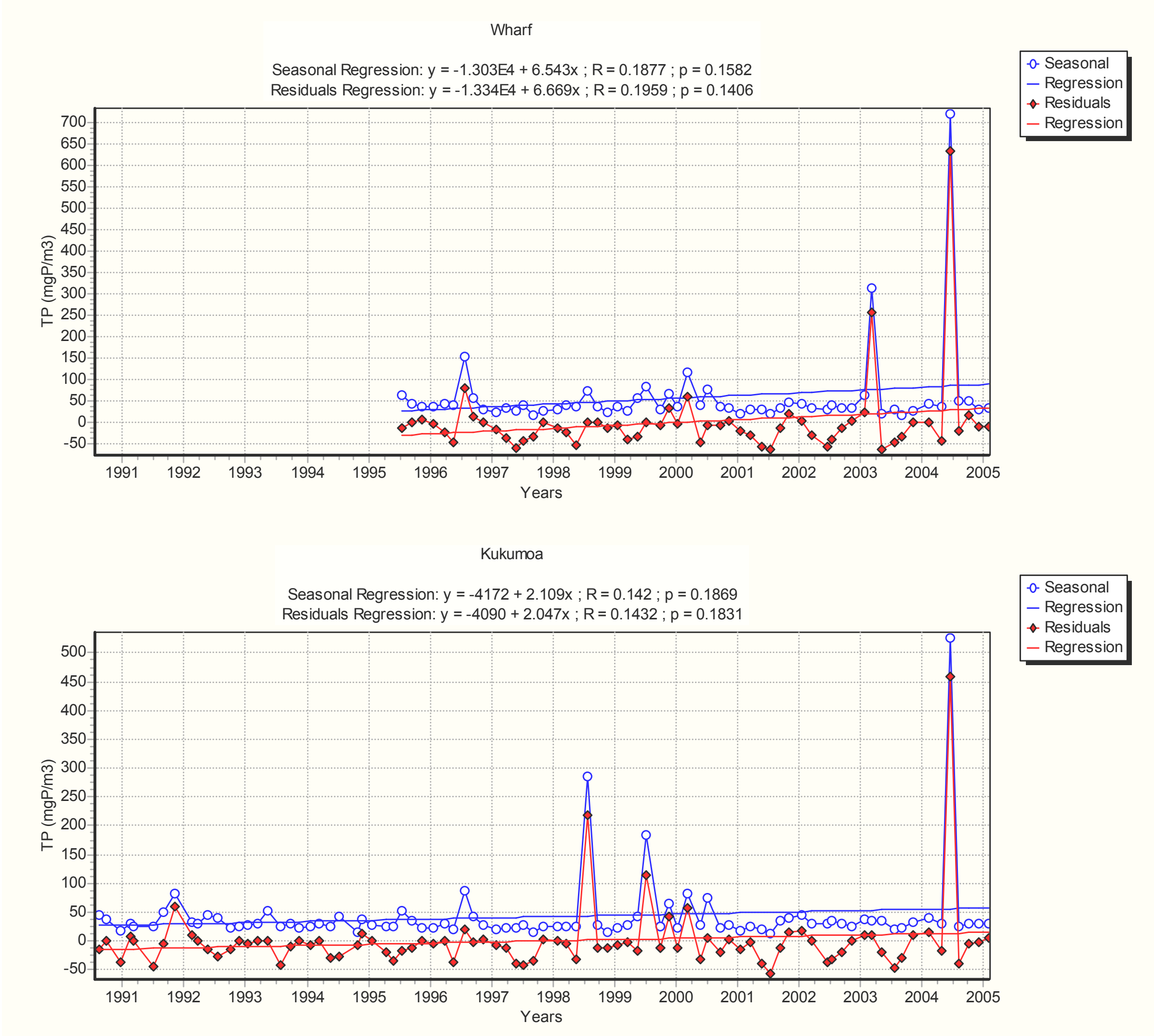


Figure 7 Total phosphorus concentrations for Wharf and Kukumoa sites, Opotiki Estuary.

3.1.4 Ammonium-nitrogen

Ammonium-nitrogen concentrations for the two sites show different trends over the differing analysis periods (Figure 8). At Kukumoa, the site with the longer data set, there is a significant decreasing trend showing concentrations have reduced. However, over a shorter analysis period (1996 to 2005) there is a significantly increasing trend in ammonium-nitrogen. Analysis of the combined data sets for the period 1996 to 2005 show this trend to hold true, that is that ammonium-nitrogen concentrations are increasing (p=0.055).

Both sites show a seasonal pattern with increasing concentrations around the end of summer beginning of autumn.

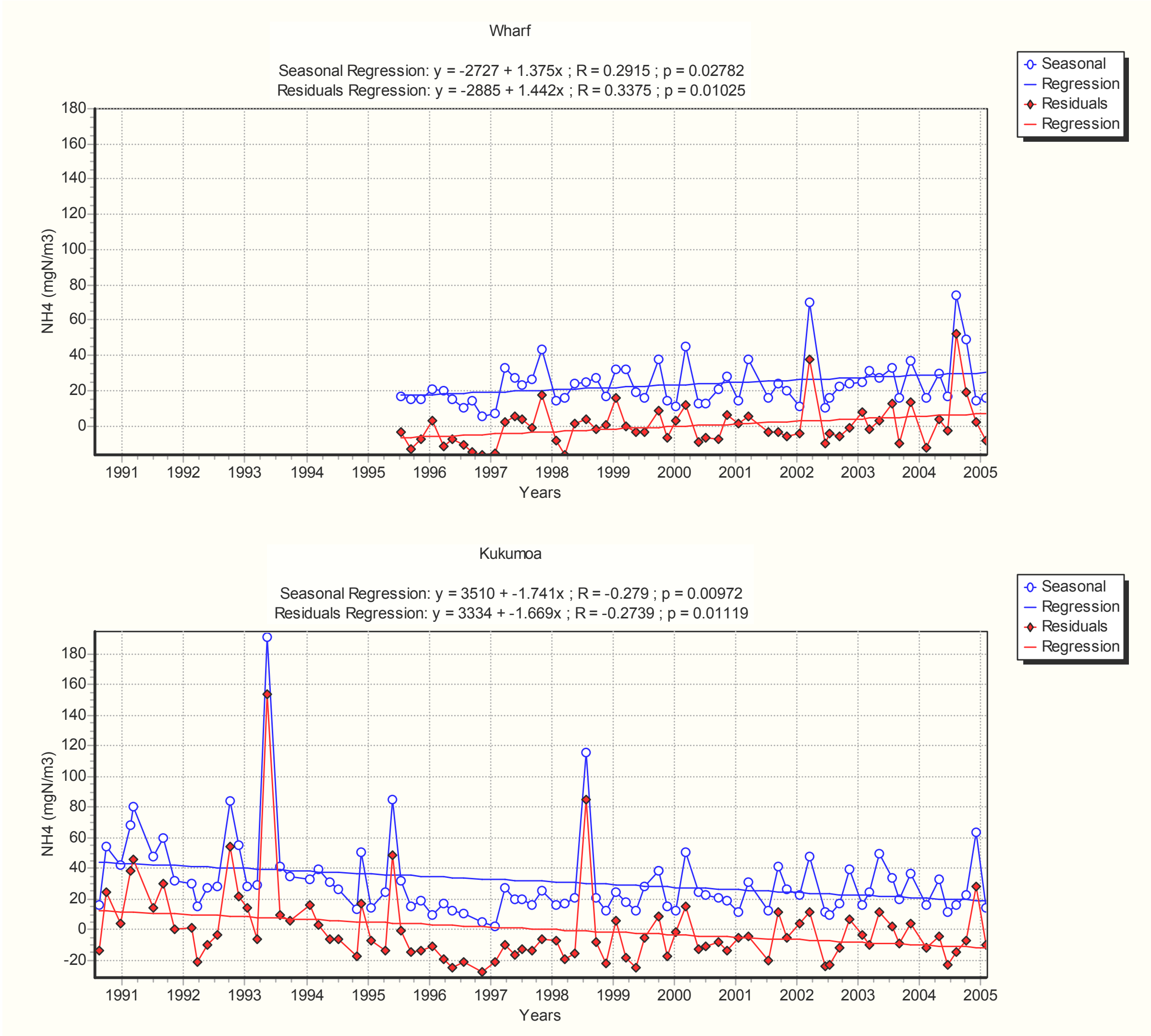


Figure 8 Ammonium-nitrogen concentrations for Wharf and Kukumoa sites, Opotiki Estuary.

3.1.5 Oxides of nitrogen

Nitrate-nitrogen (NO_xN) data displayed in Figure 9 for the two Opotiki Estuary sites shows concentrations at both sites to be fairly similar, with the wharf site having the higher average concentration over the analysis period. Both sites have fairly stable average concentrations with strong seasonal fluctuations. Fluctuations usually peak around June or with the onset of winter similar to the pattern seen in turbidity and TP.

As NO_xN has a similar seasonal pattern to turbidity and TP with winter maximums and summer minimums correlation between these determinands and salinity were examined. Results are shown in Table 5.

Turbidity and NO_xN had a weak correlation with a high likelihood of that trend is real for both sites, while TP only displayed a correlation at the Kukumoa site. Similarly, salinity displayed the same negative correlation for both sites indicating a stronger NO_xN concentration with increasing freshwater.

Table 5 Statistics for NO_xN vs turbidity, TP and salinity, Opotiki Estuary.

Site		Turbidity	TP	Salinity
Wharf	n	47	55	54
	r	0.421	0.171	-0.489
	p	<0.005	0.212	<0.005
Kukumoa	n	47	66	65
	r	0.464	0.421	-0.455
	p	<0.005	<0.005	<0.005

n = number of samples, r = Pearson correlation coefficient, p = Bonferroni probability

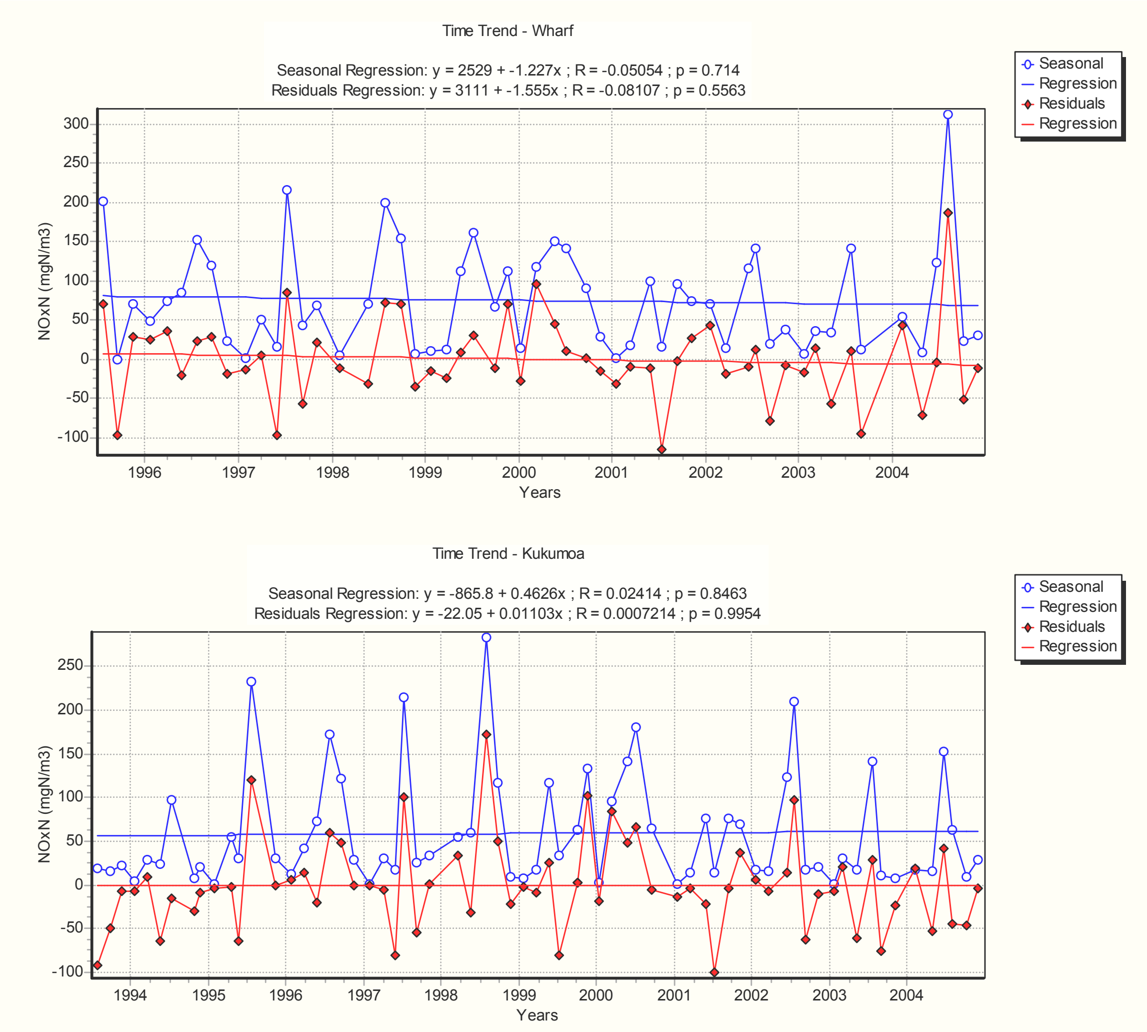


Figure 9 Oxides of nitrogen concentrations for Wharf and Kukumoa sites, Opotiki Estuary.

3.1.6 Indicator Bacteria

Figure 10 displays the combined site data for Opotiki Estuary for *Escherchia coli* (*E.coli*) and enteroccoci concentrations. Both indicator bacteria generally display increases in concentrations over the summer period. Data for both sites show little or no correlation with other determinands, apart from a good correlation between *E.coli* and faecal coliform data for both sites. Faecal coliform concentrations for the

Kukumoa site over the analysis period 1990 to 2005 show a significant decreasing trend ($p<0.05$).

Some data recorded in these periods exceed recommended bathing guidelines.

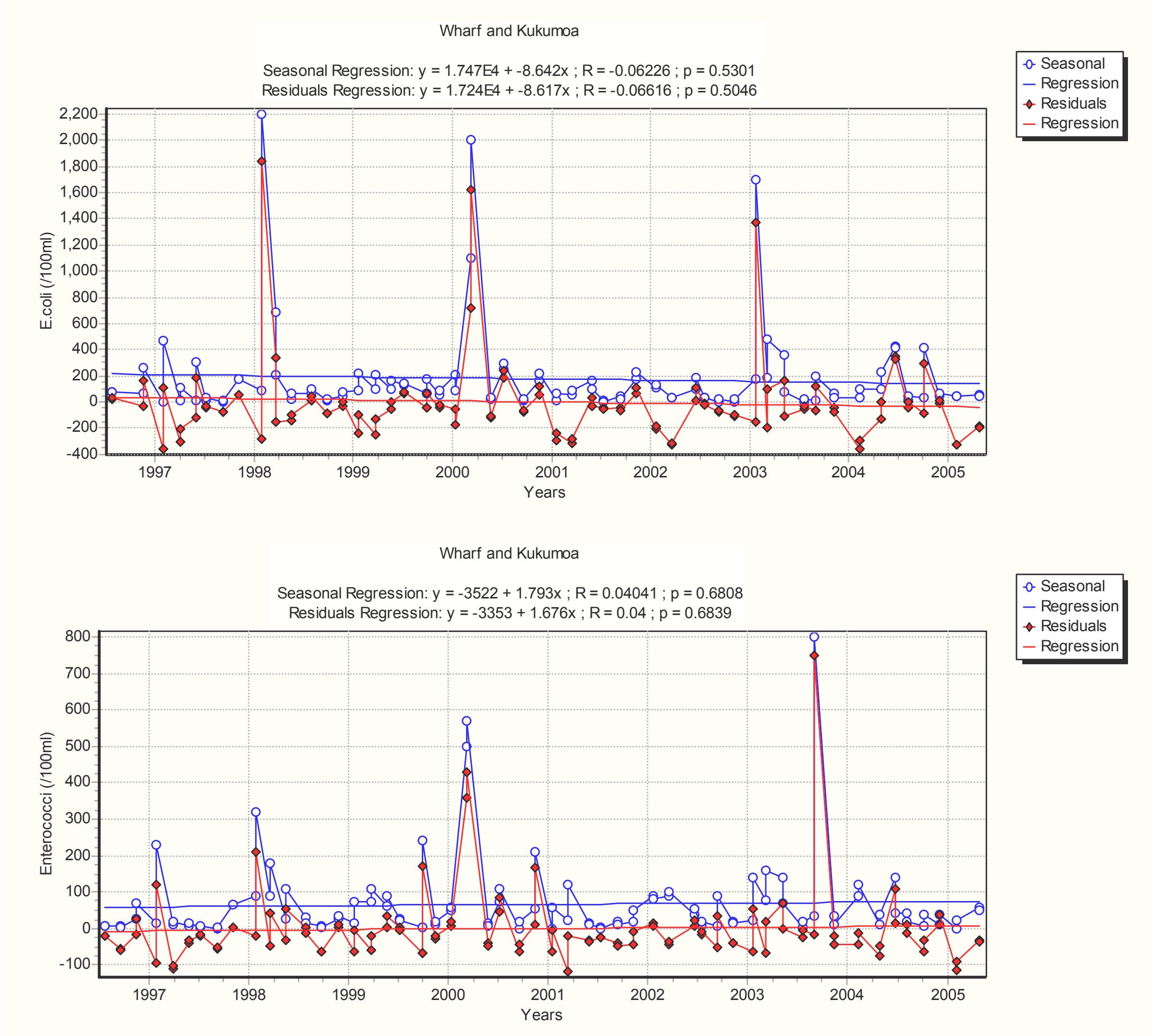


Figure 10 E.coli *and enterococci concentrations at the Wharf and Kukumoa sites, Opotiki Estuary.*

3.1.7 Dissolved Oxygen and Temperature

Temperature trends for both sites show no significant trends over the analysis periods. Combined data for both sites over the 1996 to 2005 analysis period display a 0.1°C decrease per year ($p=0.07$).

Dissolved oxygen (DO) concentrations display a slight decrease at both sites with a statistically significant decrease of –0.032 mg/m^3/day at Kukumoa over the 1990 to 2005 analysis period. Two samples over the analysis period did not meet the oxygen saturation standard of greater the 80% as per the RCEP.

3.1.8 Discussion

Examining water quality trends over the last decade and a half in the Opotiki Estuary shows that for most determinands conditions are relatively stable.

Only ammonium-nitrogen displayed a highly probable trend (i.e. a greater than 95% probability). The long term trend was one of declining ammonium-nitrogen, however the more recent trend (since 1995) is one of increasing ammonium-nitrogen concentration within the estuary.

Turbidity, nitrate-nitrogen and TP concentrations display seasonal patterns usually having maximums over winter. Ammonium-nitrogen partially deviates from this pattern having end of summer and beginning of spring maximums. While nitrate-nitrogen maximums are expected in winter months, turbidity and TP are influenced by greater rainfall and consequent flood flows in rivers and streams.

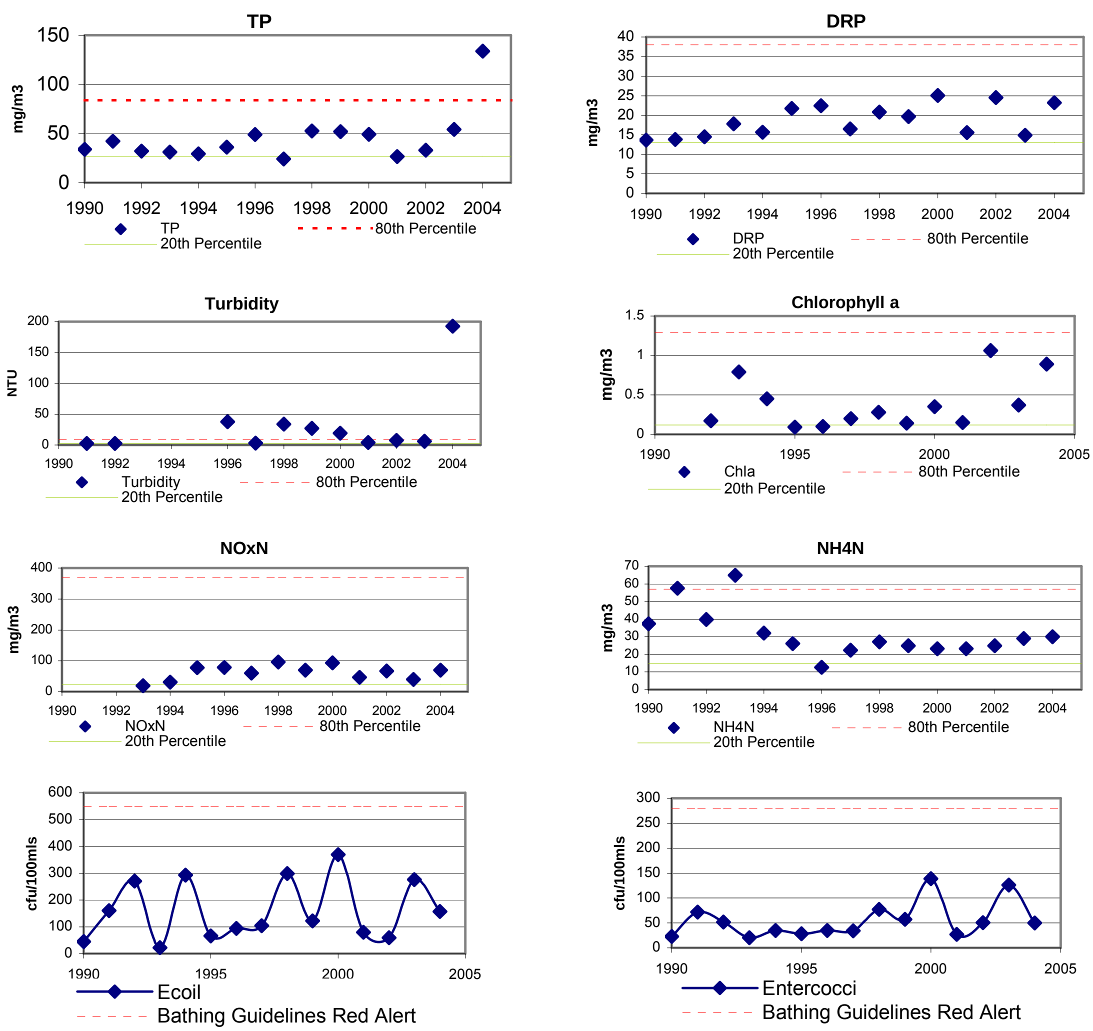


Figure 11 Average yearly concentrations and BOP river Estuary 80th & 20th percentiles and guidelines, Opotiki Estuary.

Comparison of yearly average concentrations with relevant water quality guidelines and 80^{th} and 20^{th} percentiles are shown in Figure 11. TP and turbidity both show recent levels above 80^{th} percentile, but both have yearly averages strongly influenced by river flow events. Dissolved reactive phosphorus (DRP) levels are relatively high compared to recent oceanic water samples taken at the 10 metre contour (see Park, 2005). This suggests DRP concentrations are often a function of river inputs which are generally above the ANZECC trigger level for lowland rivers (10 mg/m^3).

The yearly averages for ammonium-nitrogen (NH_4N) display the pattern mentioned above, that is one of declining levels over the long term, but increasing over the short term. NH_4N is at levels generally above its respective trigger levels. Yearly averages for oxides of nitrogen (NOxN) while above the estuarine trigger level, are well below the trigger level for lowland river system. NOxN levels are greater in winter and are associated with freshwater rather than saline. Levels are well below the 80^{th} percentile and can be considered relatively low in the context of Bay of Plenty river estuaries. Only chlorophyll *a* (Chla) remains well below its trigger level (4mg Chla/m^3) and this may because phytoplankton do not proliferate in this environment with strong fluxes in salinity and flow.

The indicator bacteria *E.coli* and enterococci both display yearly average concentrations below bathing guideline levels, however in some years the level of bacteria approaches the orange alert level for the bathing guidelines.

3.2 Ohiwa Harbour

Ohiwa Harbour is an approximately 26.4 km^2 shallow estuary having 83% of its area exposed at low tide. The estuary is enclosed by Ohope and Ohiwa spits and is rapidly changing with coastal sediment providing a plentiful supply for the infilling of the estuary.

Fresh water inflows to the estuary are dominated by the Nukuhou River which drains part of the 171 km^2 Ohiwa catchment. Pastoral farming dominates the land use in the catchment followed by indigenous forest and production forest. Urban areas are restricted to northern end of the estuary predominantly at the Ohope side.

Monitoring takes place at two sites in the estuary, one at Port Ohope Wharf and the other at Ruatuna Road (Figure 4).

3.2.1 Chlorophyll a

Chla concentrations from two sites within Ohiwa Harbour display a significant decrease over the 1992 to 2005 analysis period (Figure 12). No seasonal trends are obvious and Chla concentrations on the whole are relatively low.

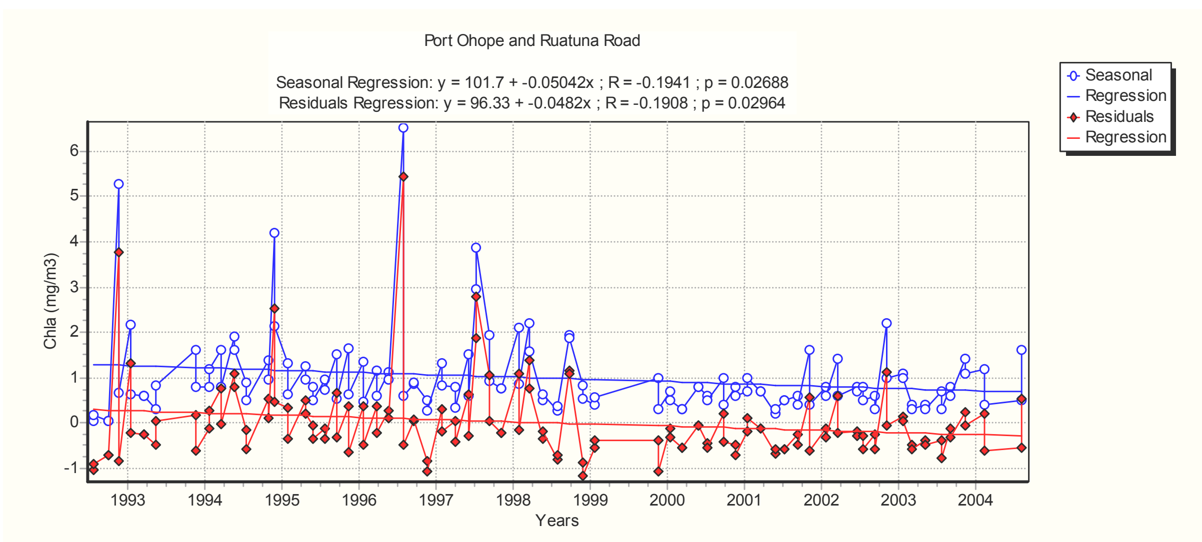


Figure 12 Chlorophyll a concentrations at both Port Ohope Wharf and Ruatuna sites, Ohiwa Harbour.

3.2.2 Turbidity

Figure 13 show the combined turbidity data for the two monitoring sites in Ohiwa Harbour. No significant trend is apparent with values over 15 NTU generally associated with strong winds creating wave action which in turn disturbs sediment causing it to rise into the water column.

Turbidity is strongly correlated with suspended sediment (r=0.733, p<0.001) and although there appears to be a rising trend in suspended sediments over the last decade and a half (p<0.001) this trend is primarily a function of sampling during high wind events.

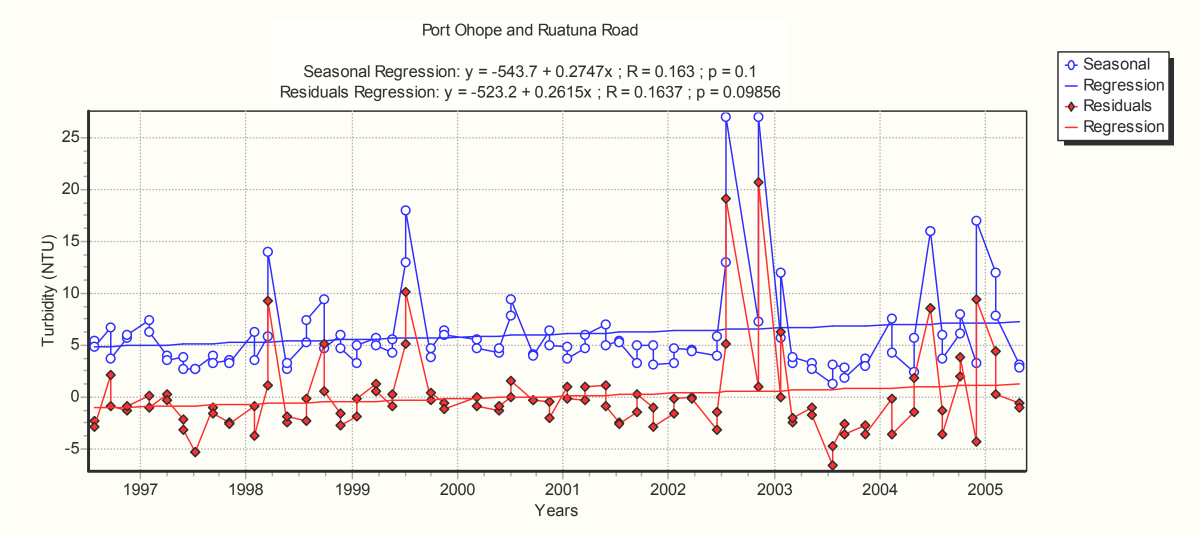
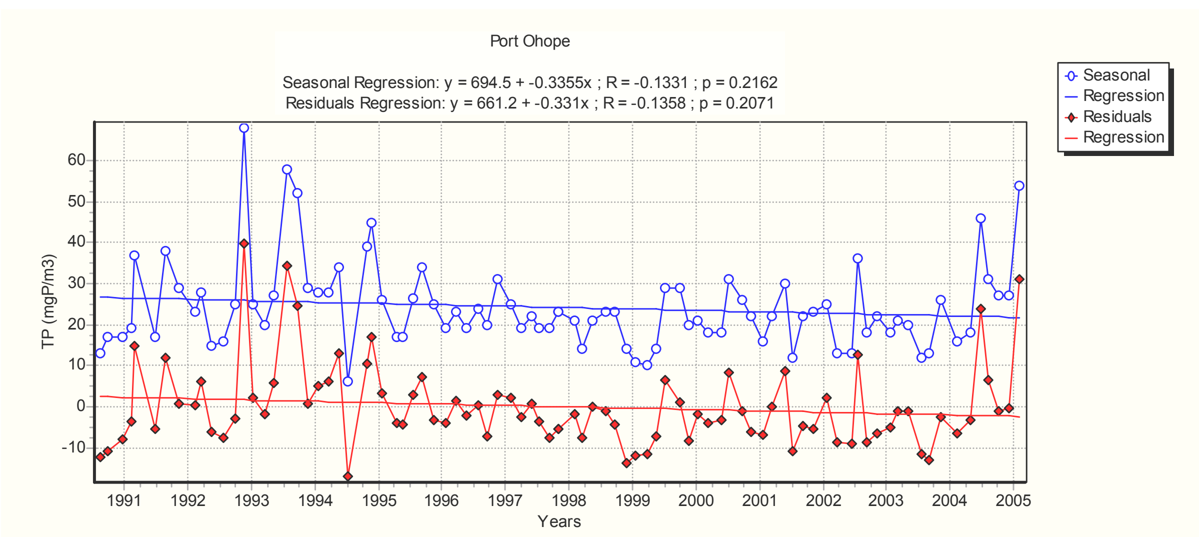


Figure 13 Turbidity at both Port Ohope Wharf and Ruatuna sites, Ohiwa Harbour.

3.2.3 **Total Phosphorus**

TP concentrations at both sites in Ohiwa Harbour show no significant change over the last decade and a half (Figure 14). Trends in TP at both sites are similar with correlation statistics of: Pearson r=0.604, p<0.001. Likewise both sites show some correlation with turbidity (Figure 15). Correlation of TP with the longer data set of suspended sediment shows a similar relationship as turbidity. So like turbidity and suspended solids, TP is likely to be elevated during strong winds although there will be variability because of the relatively high component of dissolved reactive phosphorus in the water column.



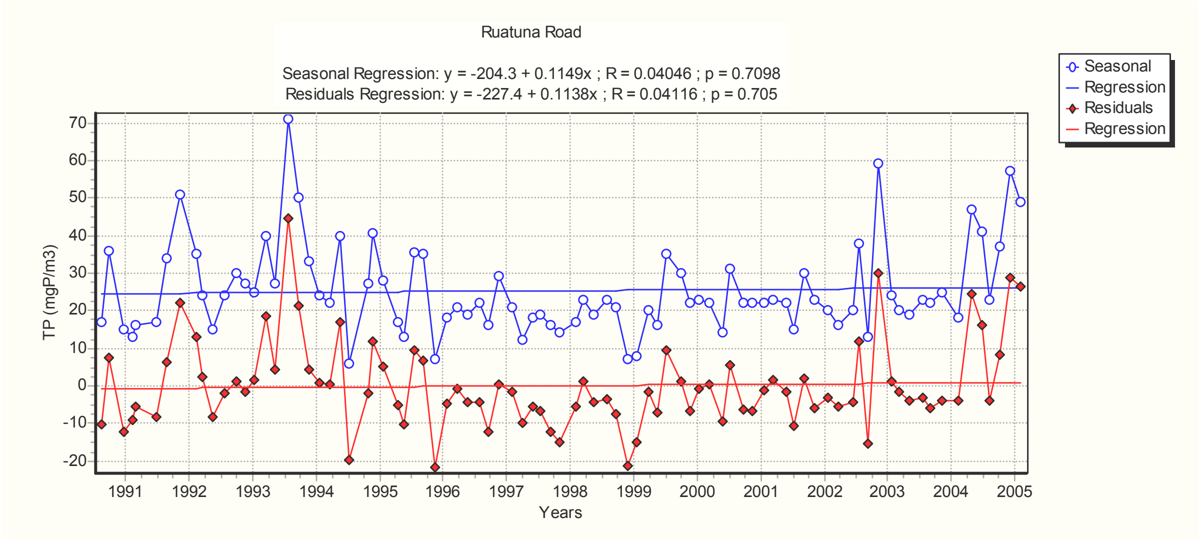


Figure 14 TP concentrations at Port Ohope Wharf and Ruatuna sites, Ohiwa Harbour.

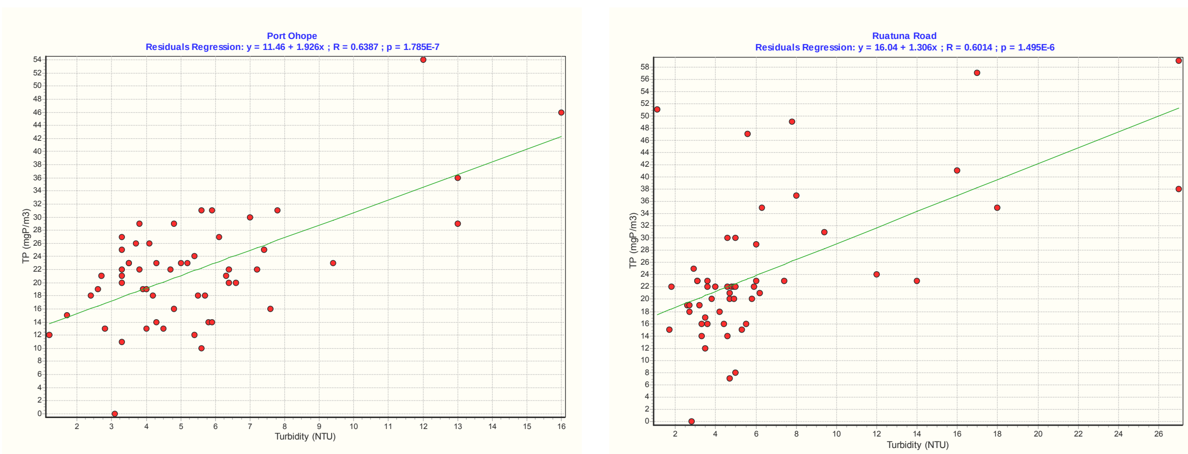


Figure 15 Turbidity vs TP at Port Ohope Wharf and Ruatuna sites, Ohiwa Harbour.

3.2.4 Ammonium-nitrogen

There is no significant trend over time shown in the data recorded at the two Ohiwa Harbour sites (Figure 16). There has been the occasional high concentration of NH_4N over the years but these have not been sustained.

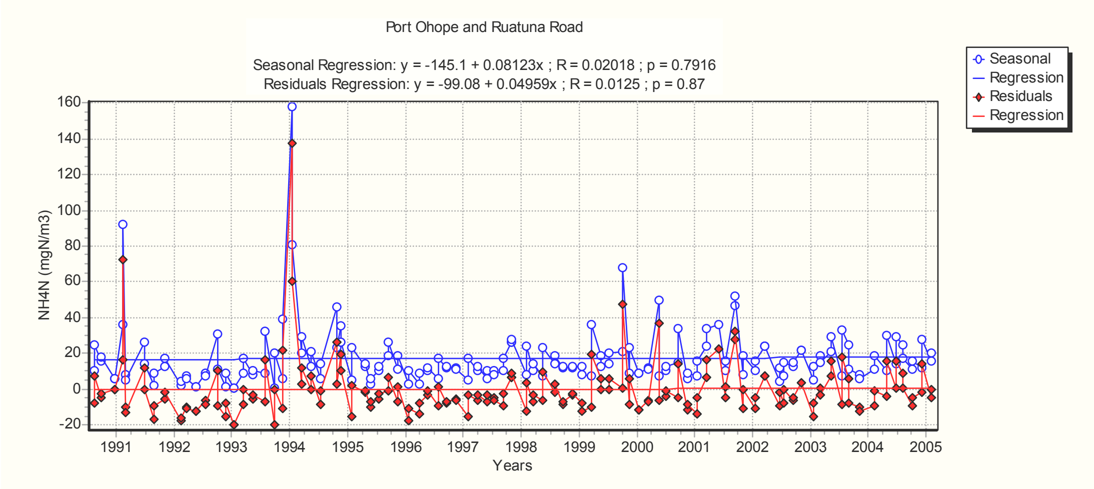


Figure 16 *NH_4N concentrations at both Port Ohope Wharf and Ruatuna sites, Ohiwa Harbour.*

3.2.5 Oxides of nitrogen

Figure 17 displays the regression analysis and time series data for NO_xN concentrations at both Port Ohope and Ruatuna Road sites. Analysis from 1993 to 2005 displays no significant trend. Elevated concentrations as expected occur predominantly in the winter period.

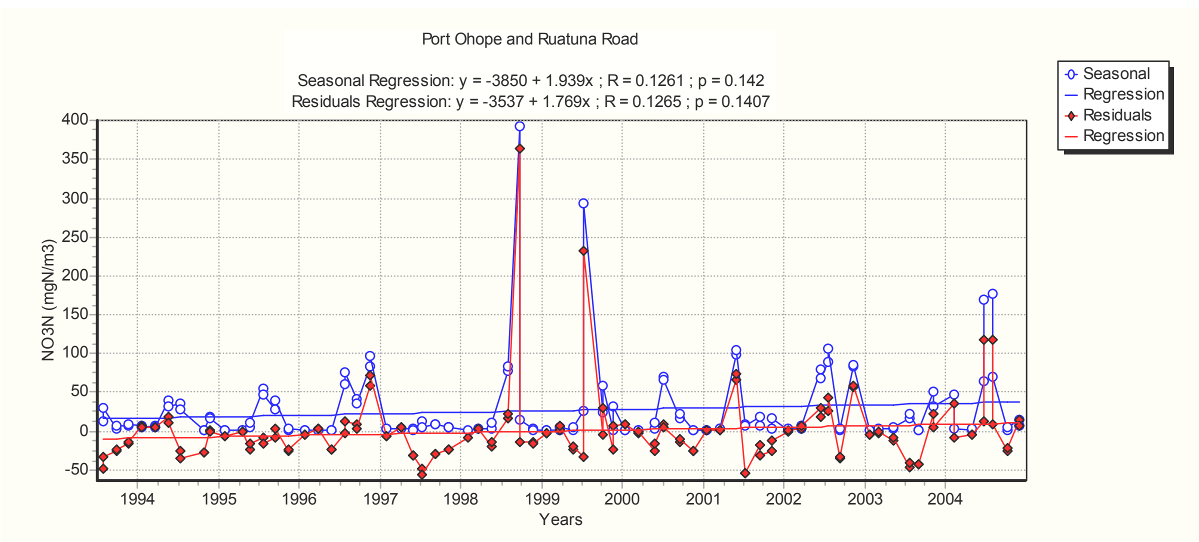


Figure 17 *NO_xN concentrations at both Port Ohope Wharf and Ruatuna sites, Ohiwa Harbour.*

3.2.6 Indicator Bacteria

Figure 18 displays the *E.coli* and enterococci data monitored at both sites in Ohiwa Harbour. Both indicator bacteria show a slight rise in levels in the past few years, although for *E.coli* this rise is not significant (1 outlier removed, 320 *E.coli*/100ml, 10/11/03). There is a significant trend in enterococci in the estuary dominated by increasing levels at the Ruatuna site.

E.coli shows a weak correlation with enterococci at both sites and a seasonal trend peaking at the beginning of summer is apparent for both indicator bacteria.

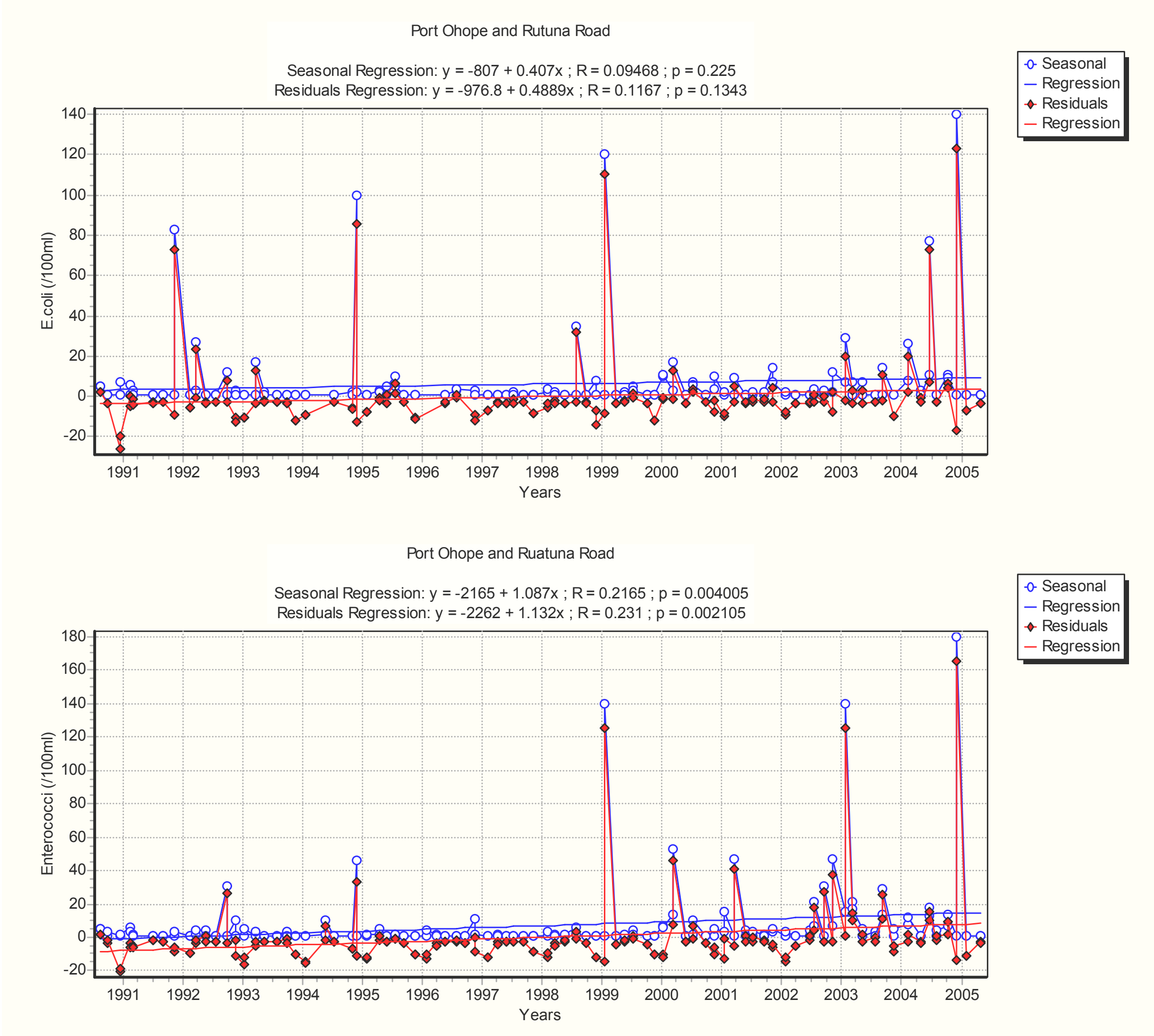


Figure 18 *Indicator bacteria concentrations at Port Ohope Wharf and Ruatuna sites, Ohiwa Harbour.*

3.2.7 Dissolved Oxygen and Temperature

There is no significant trends in temperature with the yearly average temperatures ranging from 16.2°C to 18.7°C over the 1990 to 2005 period.

Likewise dissolved oxygen concentrations are consistent over the analysis period ranging from a yearly average of 7.5 mg/l to 8.5 mg/l. Only one sample over the analysis period had an oxygen saturation level below 80%.

3.2.8 Discussion

Water quality parameters show the water quality of Ohiwa Harbour to be relatively stable. Only chlorophyll *a* concentrations have a declining trend, however concentrations are low indicating phytoplankton growth not to be problematic.

Enterococci displayed an increasing trend at Ruatuna Road. Enterococci have a weak correlation with suspended sediments so like suspended solids, the rise in levels may be partly due to sampling during strong winds over the past few years. However, enterococci levels have a seasonal component with highs over the summer period, a seasonal trend not seen in the sediment data suggesting another reason for elevated enterococci on some sampling occasions.

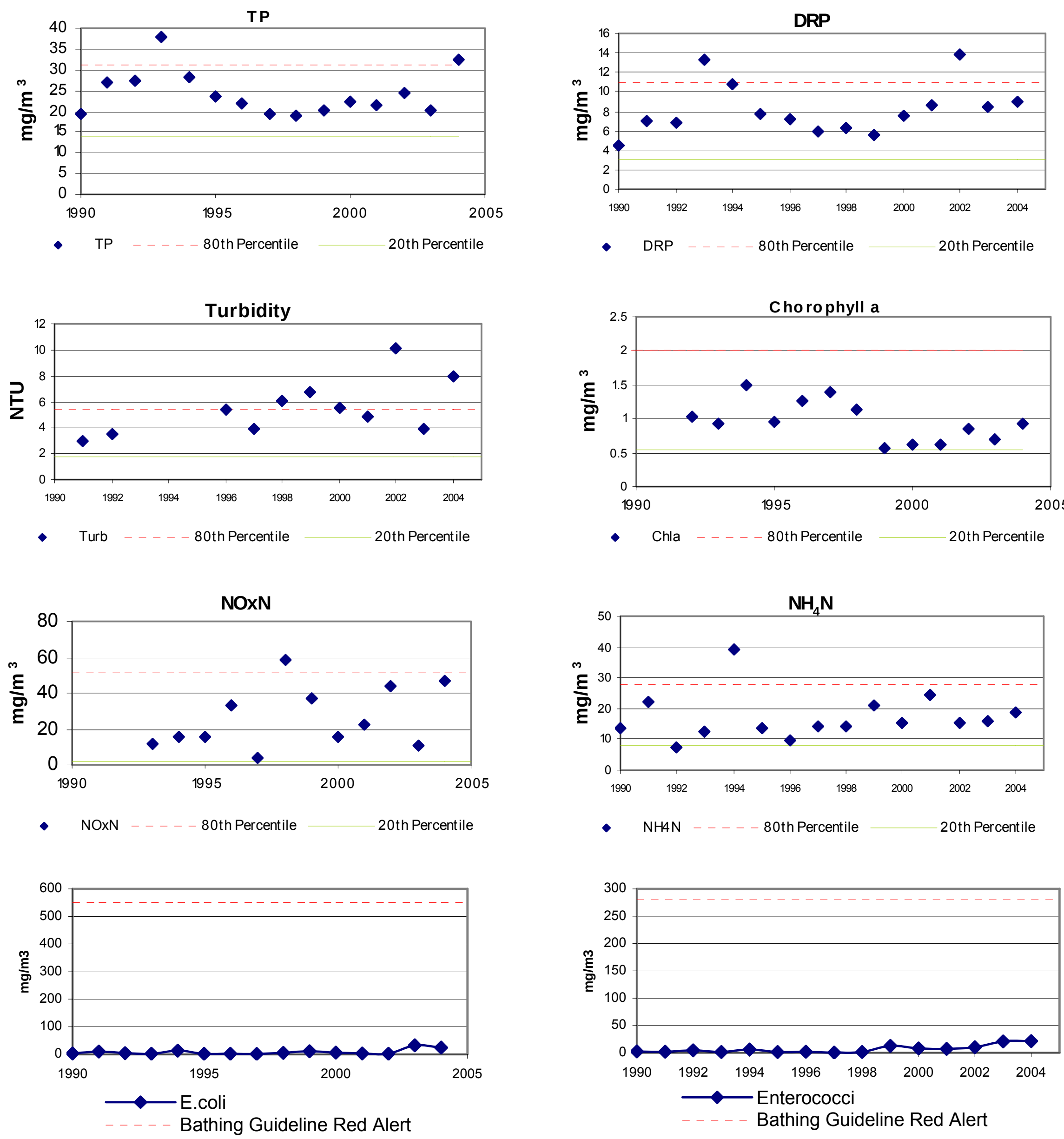


Figure 19 Average yearly concentrations and BOP Estuary 80th & 20th percentiles and guidelines, Ohiwa Harbour.

Indicator bacteria levels have not exceeded the bathing water quality guidelines red alert level over the monitoring period, with yearly average levels only a fraction of this guideline (Figure 19).

Comparison of other water quality parameters with the ANZECC water quality guidelines for south-eastern Australian estuaries in Figure 20 shows most parameters for most of the time to be below, at, or just above the trigger level. TP levels are similar to near shore oceanic water samples with the exceptions usually associated with strong winds kicking up estuarine sediments. DRP follows a similar trend to TP, however concentrations are appear to be influenced by oceanic waters.

Average turbidity in the harbour has in recent years been above the 80^{th} percentile and this is function of both wind stirring up sediments and sediment supplied from oceanic waters. Ohiwa Harbour is rapidly infilling with land derived sediments dominating the mudflats in the upper harbour reaches (Parks, 2005).

Oxides of nitrogen and ammonium-nitrogen yearly averages range between the 80^{th} and 20^{th} percentile for Bay of Plenty estuaries indicating changing nitrogen loads. This is likely to be dominated by input from oceanic waters.

Chlorophyll *a* is at a low level indicating low productivity.

3.3 Whakatane River Estuary

The highly modified Whakatane Estuary is approximately 1.3 km^2 in size and is largely influenced by the freshwater flow from the Whakatane River. The catchment (1,768km^2) is predominantly in native and exotic forest with intensive livestock agriculture dominating the lowlands.

Previous water quality studies are limited to a study of Board Mill discharges in 1983 and a Catchment Board study in 1988 (see Bay of Plenty Regional Council, 1991).

The Whakatane Boat Ramp is currently the monitoring site for the estuary although some monitor also occurs at Quay Street and adjacent to the Yacht Club.

3.3.1 Chlorophyll a

Chla data show no significant trends with most data indicating low productivity with a concentration below 1 mg/m^3. No seasonal trend is indicated. There is a weak correlation with salinity ($r=0.415$, $p<0.05$, $n=62$) indicating productivity to be associated with oceanic waters rather than river water.

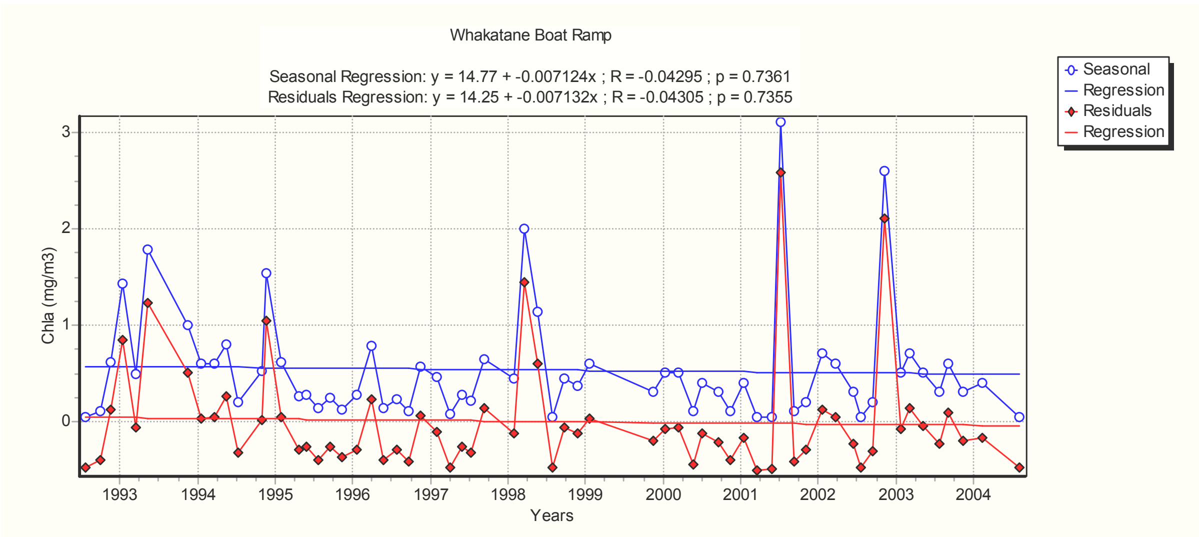


Figure 20 Chlorophyll a concentrations at Whakatane Boat Ramp, Whakatane Estuary.

3.3.2 Turbidity

No long term trends are shown by the turbidity data in the Whakatane estuary. Elevated turbidity is likely to be result of increased flow in the river due to rainfall events as indicated by a weak relationship with salinity (Pearson r=-0.459, p<0.05, n=50, Boat Ramp site). No real seasonal trend is apparent although elevated values do occur more frequently in winter months.

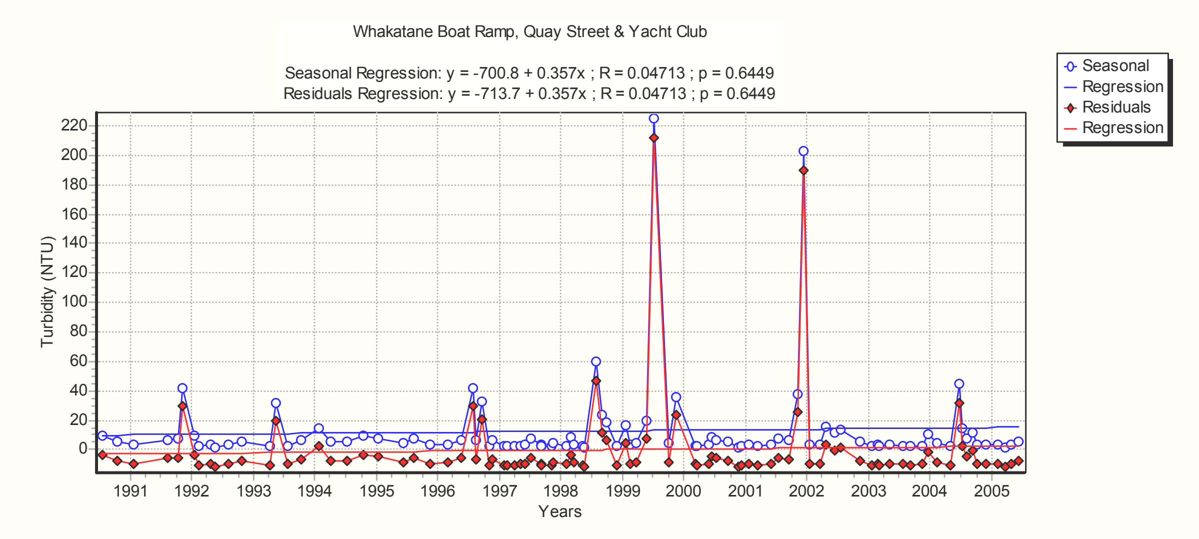


Figure 21 Turbidity at Whakatane Boat Ramp, Quay Street and Yacht Club, Whakatane Estuary.

3.3.3 Total Phosphorus

TP has a similar data spread to turbidity and shows a moderate correlation (Pearson r=0.560, p<0.001, n=96). Like turbidity, elevated TP concentrations are a result of increased river flow. No significant trend is indicated over the analysis period.

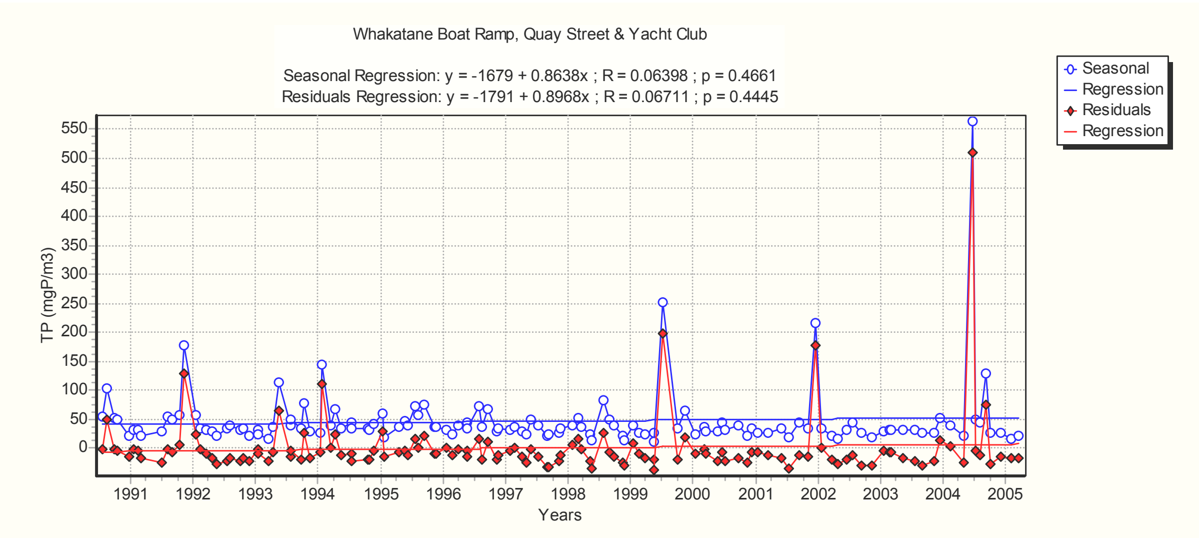


Figure 22 TP concentrations at Whakatane Boat Ramp, Quay Street and Yacht Club, Whakatane Estuary.

3.3.4 Ammonium-nitrogen

Ammonium-nitrogen displays a significant decreasing trend over the analysis period primarily due to high concentrations exhibited over the earlier part of the 1990s (Figure 23). This trend is not displayed from 1996 to present, with concentrations being relatively stable and generally elevated over winter.

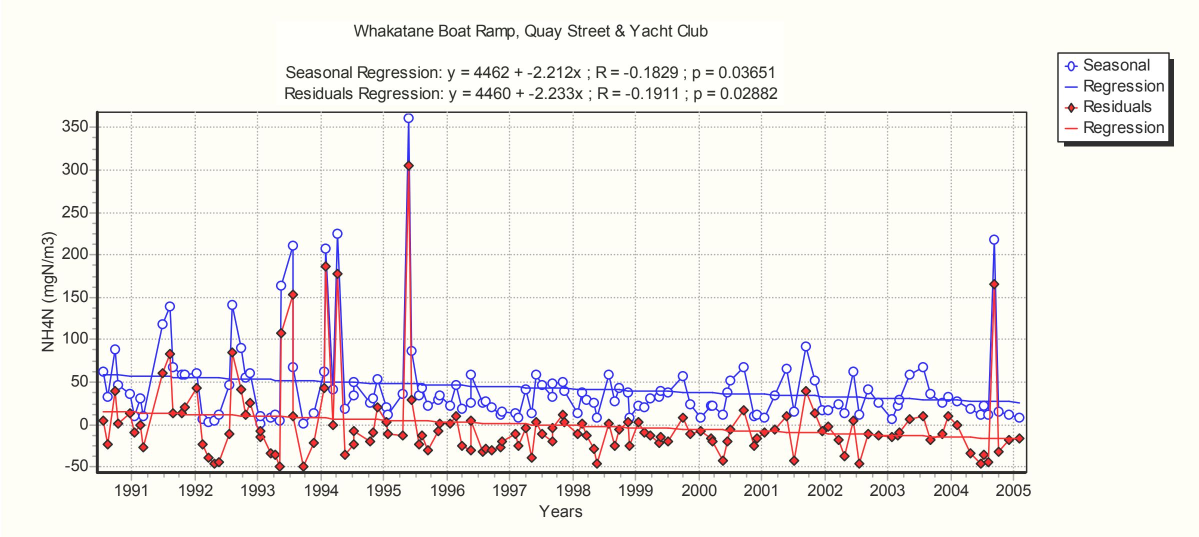


Figure 23 NH_4N concentrations at Whakatane Boat Ramp, Quay Street and Yacht Club, Whakatane Estuary.

3.3.5 Oxides of Nitrogen

Figure 24 shows a significantly decreasing trend in NOxN concentrations in the Whakatane Estuary. This trend is due to elevated results prior to 1994 which may be a result of different laboratory methods, but may also be due to discharges to the estuary around this period. There is no significant trend in results from 1994 to 2005 although there is an expected seasonal pattern of maximum concentrations experienced over winter.

NOxN shows a moderate correlation with pH (Pearson r=0.649, p<0.001, n=67; Boat Ramp), DRP (Pearson r=-0.689, p<0.001, n=66; Boat Ramp) and salinity (Pearson r=-0.653, p<0.001, n=64; Boat Ramp). This indicates that nitrate is predominantly sourced from freshwater flows and may have similar origins to DRP.

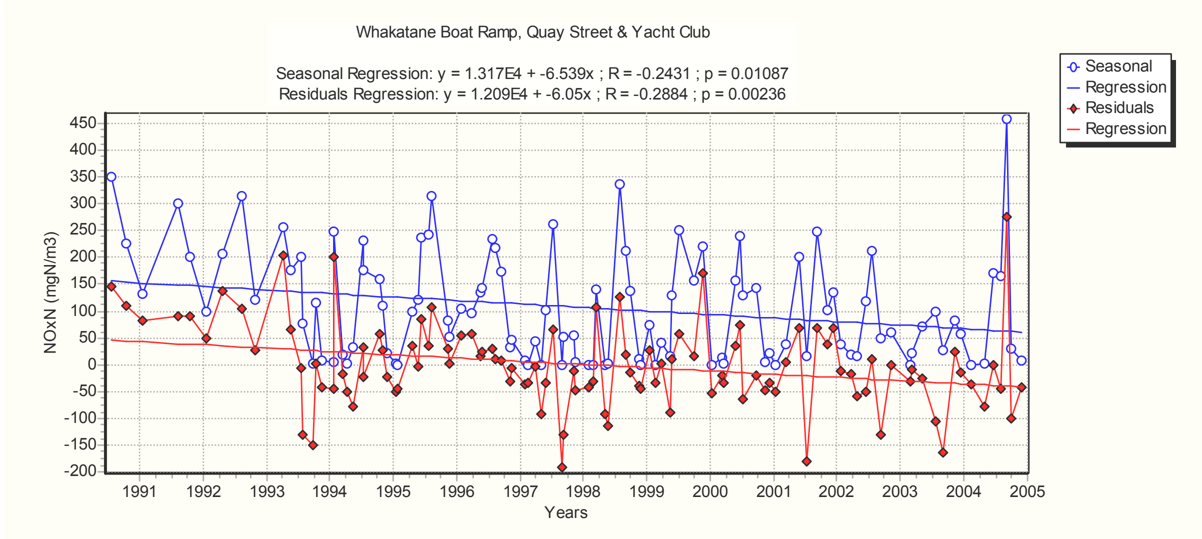


Figure 24 *NOxN concentrations at Whakatane Boat Ramp, Quay Street and Yacht Club, Whakatane Estuary.*

3.3.6 **Indicator Bacteria**

Entercocci and *E.coli* concentrations and trends over the analysis period 1990 to 2005 are displayed in Figure 25. While no long term trend is indicated by the enterococci data, *E.coli* concentrations are showing a significant increase with levels at times above the recommended bathing guideline. No seasonal pattern is dominant in the data.

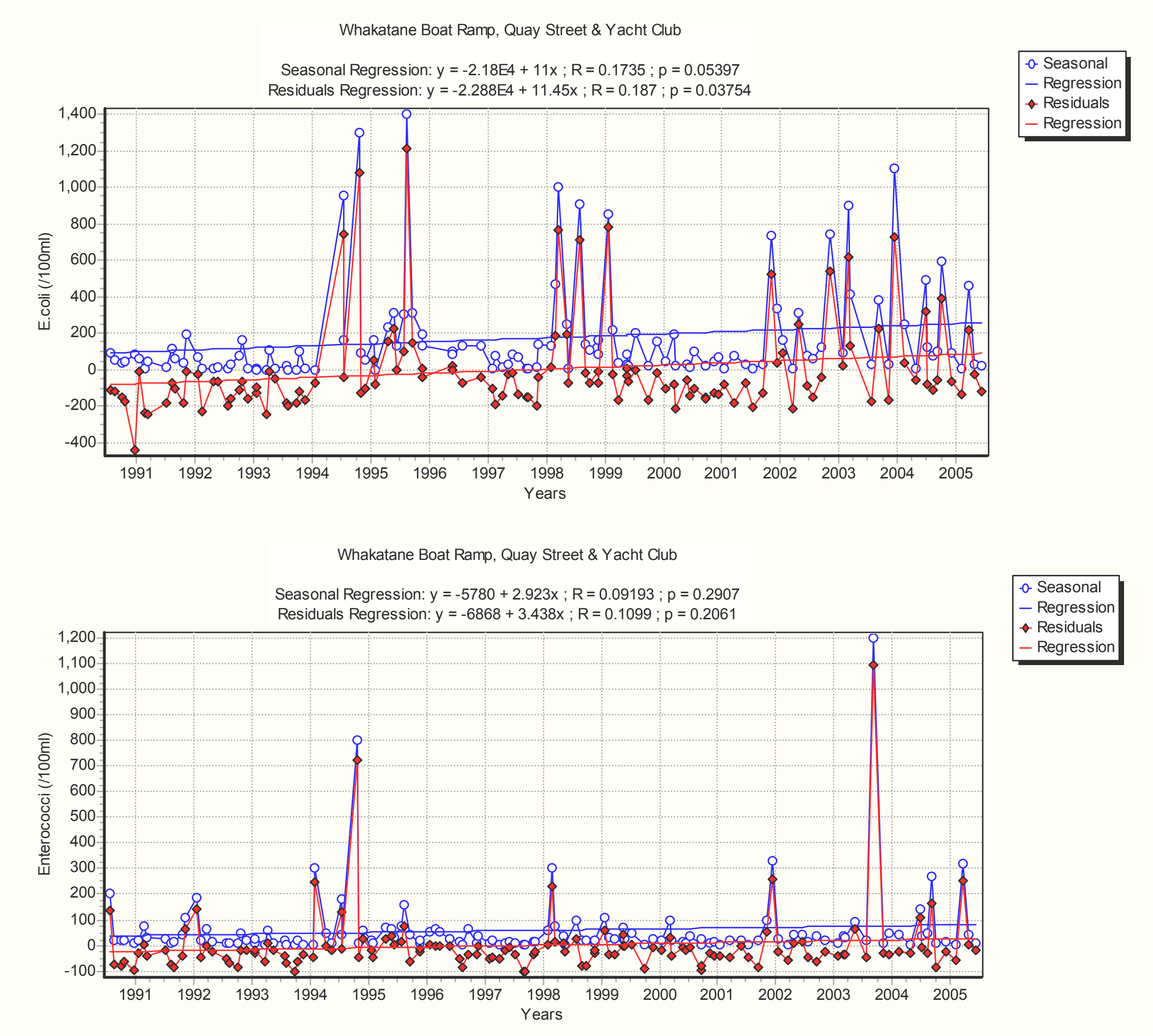


Figure 25 Indicator bacteria concentrations at Whakatane Boat Ramp, Quay Street and Yacht Club, Whakatane Estuary.

3.3.7 Dissolved Oxygen and Temperature

DO and temperature show opposite seasonal patterns as to be expected, as DO increases with lower temperature. No trends are seen over the analysis period (1990 to 2005) for either parameter. On one sampling occasion the standard for greater than 80% oxygen saturation has not being met.

3.3.8 Discussion

Constant freshwater flows and sediment input from the Whakatane River to the estuary maintain phytoplankton growth at a low level within the estuary. On average chlorophyll *a* levels remain below 1 mg/m^3 well below the 80^{th} percentile for river estuaries in Bay of Plenty (Figure 26).

Both NH_4N and NOxN displayed decreasing long term trends with recent concentrations well down on pre-1995 concentrations. Improvements to dairy effluent discharges over the decade particularly regarding discharges to water will have improved these nutrient levels. Since 1995 levels have remained relatively steady, however concentrations are at times above the ANZECC water quality guidelines for lowland rivers. Ammonium nitrogen has a weak correlation with dissolved oxygen levels (Pearson r=0.493, $p<0.001$, n=85) and may be partially responsible for low oxygen content at times. Moderate correlations were also found between dissolved nutrients and pH (Pearson r=-0.578, $p<0.001$, n=106).

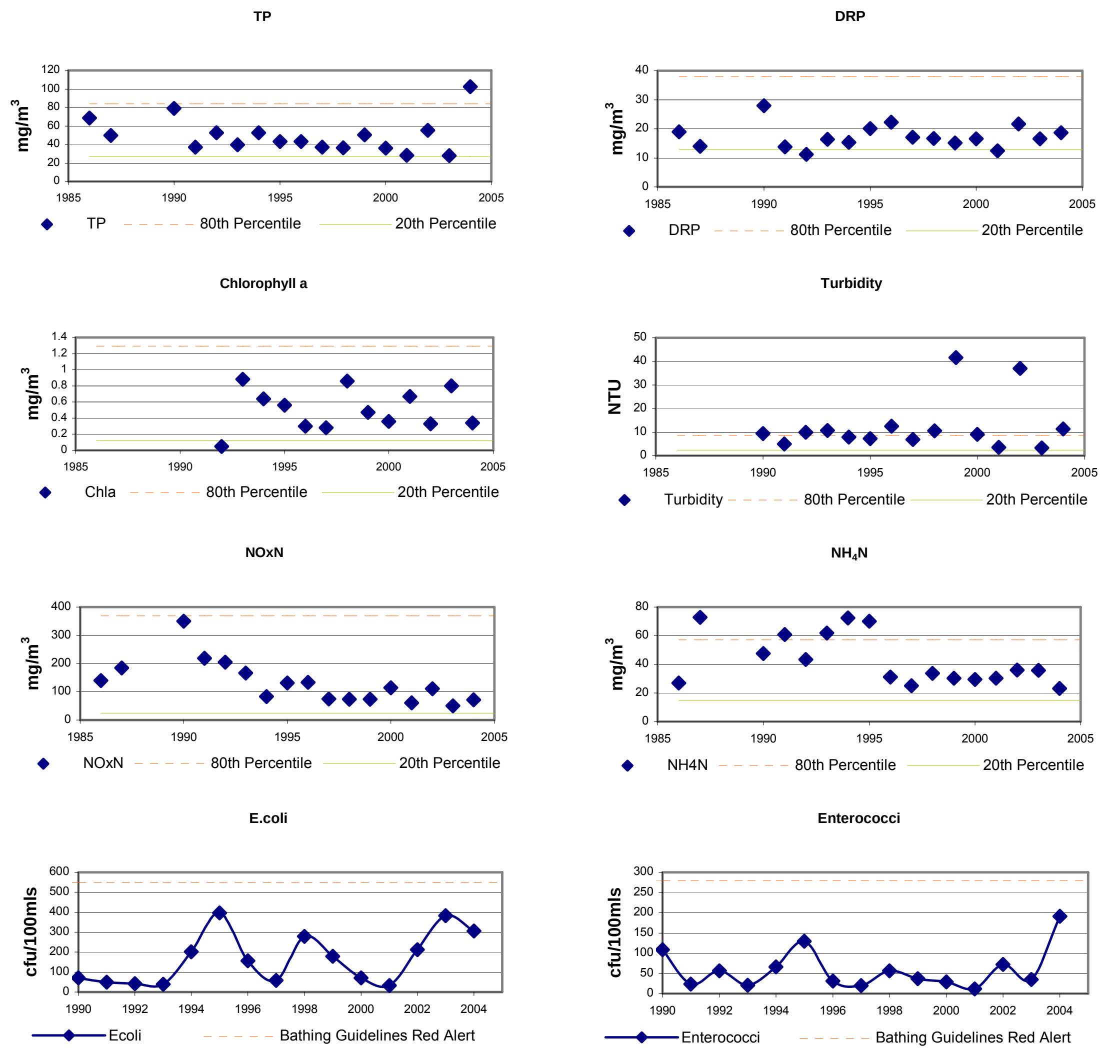


Figure 26 Average yearly concentrations and BOP Estuary 80th & 20th percentiles and guidelines, Whakatane Estuary.

NH_4N and NOxN have winter maximums. Nitrate-nitrogen is expected to be high in winter as groundwater levels are higher, plant uptake of this nutrient is less, and run-off is increased due to increased rainfall, less infiltration and evaporation. NH_4N has winter maximums for similar reasons to NOxN, and as microbial activity is reduced in the cooler months and the conversion of NH_4N to other forms of nitrogen are also reduced over winter months.

Average yearly phosphorus concentrations are generally between the 80^{th} and 20^{th} percentiles for Bay of Plenty river estuaries, and are at concentrations similar to those measured offshore. Phosphorus concentrations have a moderate correlation with turbidity. However, turbidity unlike phosphorus has average annual turbidity levels near or above the 80th percentile indicating the estuary to have a high sediment content compared to other Bay of Plenty estuaries.

Enterococci and *E.coli* concentrations on average are below the red alert level as defined by the Microbiological Water Quality Guidelines (2003). However, on occasions levels have been sampled over these guideline values and *E.coli* show an increasing trend. *E.coli* levels monitored at a station further up the river (before the water treatment plant) are lower than those monitored in the estuary (Scholes, 2004). This indicates that there may be another source of this indicator bacteria from other urban and rural stream entering the estuary or that as the bacteria carried in freshwater mixes with the saline waters flow is reduced and flocculation occurs concentrating sediment and bacteria in the estuary. Both reasons may be valid, however as ammonium nitrogen levels at the river site above the estuary are also lower than those measured in the estuary other potential sources of contaminants are implied.

The most likely source of indicator bacteria is intensive livestock agriculture, but as dissolved inorganic nitrogen levels tell a story of improving discharges *E.coli* seems to have a conflicting message. Future trend analysis and waterways monitoring may help revel what may be occurring in the estuary to this regard.

3.4 Rangitaiki River Estuary

Like the Whakatane Estuary, the small Rangitaiki Estuary is influenced by large continuous fresh water input and is a popular recreational area for fishing and boating.

The Rangitaiki catchment is approximately 3005 km^2 ranging from the native forest dominated Te Urewera National Park to the Rangitaiki coastal plains. Two power schemes form dams in the river system, one at Lake Anawhenua and the other being Matahina dam. Galatea and Rangitaiki plains are dominated by dairy farming with pastoral farming supporting sheep, drystock and deer farms. Cropping and horticulture are also scattered over the plains with exotic forestry the primary land use on surrounding hill country as far back as the start of Te Urewera National Park. The townships of Te Teko and Edgecumbe are located on the lower banks of the Rangitaiki and at Edgecumbe the Fonterra Dairy Factory is a large user of river water and discharges waste water used in processing to the river.

The jetty adjacent to the boat ramp provides the monitoring location within this estuary.

3.4.1 Chlorophyll a

Figure 27 shows Chla concentrations monitored in the Rangitaiki Estuary. The trend since 1995 is a significantly increasing one with the increase occurring at a rate of 0.29 mg Chla/m^3/yr. There is a strong seasonal pattern with maximum concentration occurring during summer. Chla has a moderate negative correlations with oxides of nitrogen (Pearson r=-576, p<0.001, n=45).

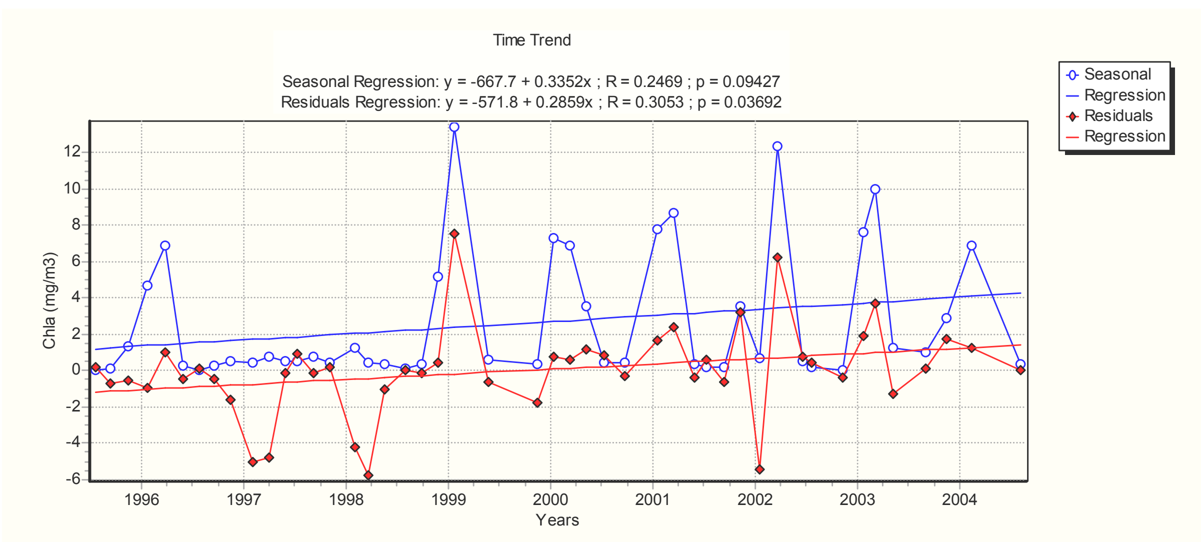


Figure 27 Chlorophyll a concentrations, Rangitaiki Estuary.

3.4.2 Turbidity

Turbidity is usually below 10NTU and over the last few years has shown fairly constant levels. Spikes in the figures in 1996 and 1999 are due to rainfall events carry sediment laden waters to the estuary. While the trend is of significantly decreasing turbidity, spikes in the earlier years of the data set bias this trend. Maximums in the turbidity occur during the winter months when river flows are generally higher.

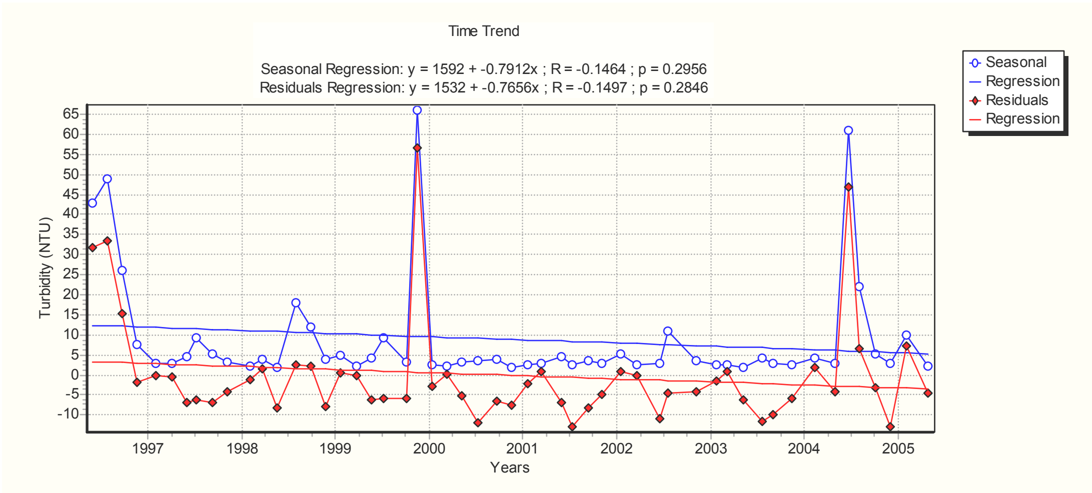


Figure 28: Turbidity, Rangitaiki Estuary.

3.4.3 Total Phosphorus

TP displays no significant trend over the analysis period and has a very weak seasonal pattern, tending towards maximums in spring and summer. Elevated results in 2004 occurred after periods of rainfall in what was a very wet winter. A moderate correlation with suspended solids (Pearson r=0.502, p<0.001, n=58) indicates that TP concentrations are partially sediment derived.

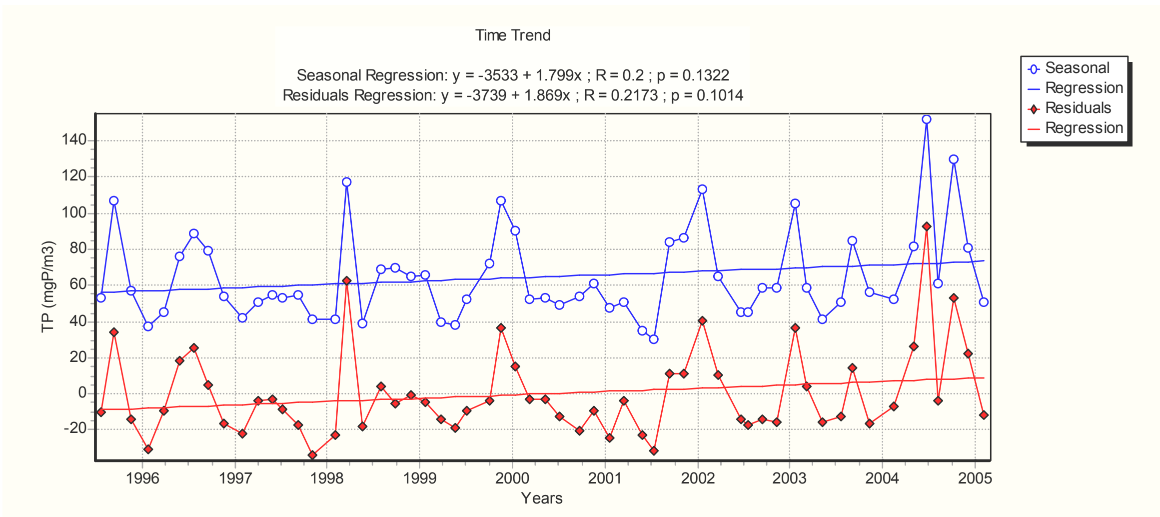


Figure 29 TP concentrations, Rangitaiki Estuary.

3.4.4 Ammonium nitrogen

No trend is displayed over the 1995 to 2005 analysis periods for ammonium nitrogen (Figure 30). Concentrations fluctuate greatly but such fluctuations do not seem to have a seasonal influence.

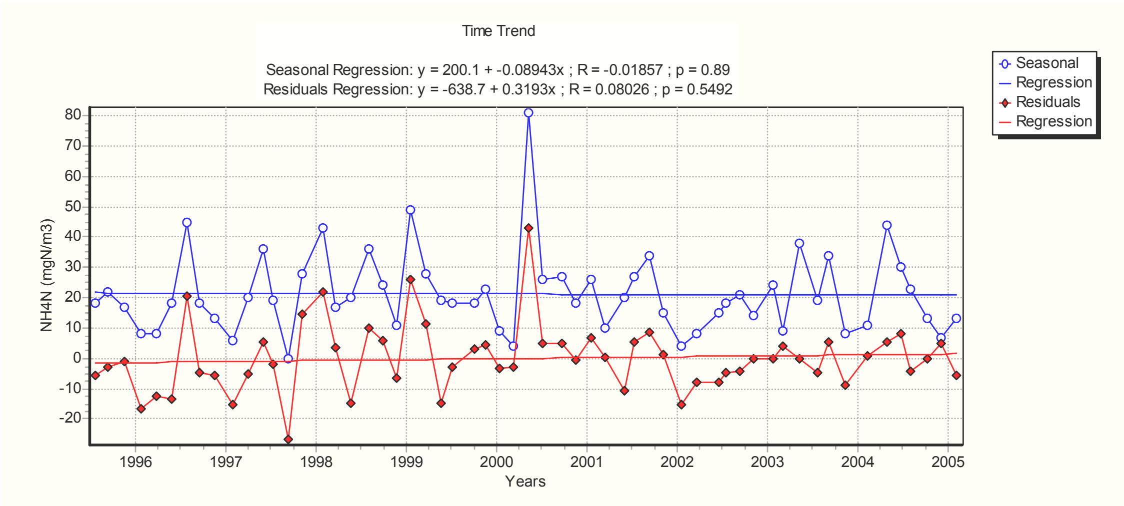


Figure 30 Ammonium nitrogen concentrations, Rangitaiki Estuary.

3.4.5 Oxides of Nitrogen

Oxides of nitrogen display the expected seasonal pattern with maximums during winter and minimums over summer, but show no significant longer term trend over the analysis period (Figure 31). Elevated results in 2004, like TP and turbidity, are likely to be the results of a wet winter.

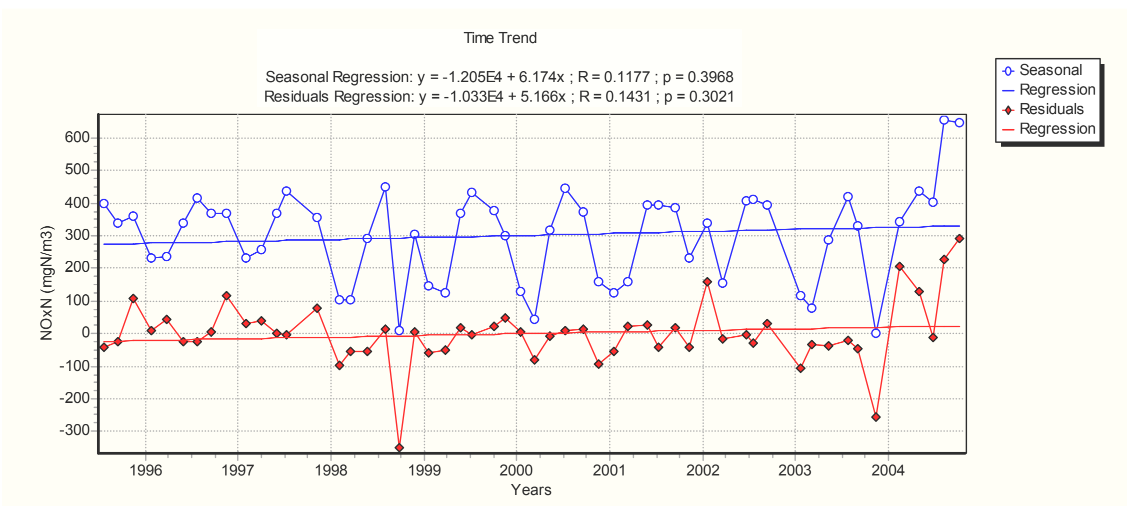


Figure 31 Oxides of nitrogen concentrations, Rangitaiki Estuary.

3.4.6 Indicator Bacteria

Figure 32 displays *E.coli* and enterococci concentrations in the Rangitaiki Estuary and their deseasonalised residuals. Analysis of entercocci data over the analysis period shown in Figure 32 indicate no significant trend while a significant trend is shown for *E.coli*. The increasing *E.coli* trend is largely biased by a high result sampled in April 2004. Without this result no significant trend would be observed.

Comparison of data with guidelines for fresh and marine water (*E.coli* and enterococci respectively) show occasional exceedences indicating that water are at times not suitable for contact recreational pursuits. Enterococci has a moderate correlation with ammonium nitrogen (Pearson r=0.509, p<0.005, n=58) which may help in understanding the derivation of this bacteria.

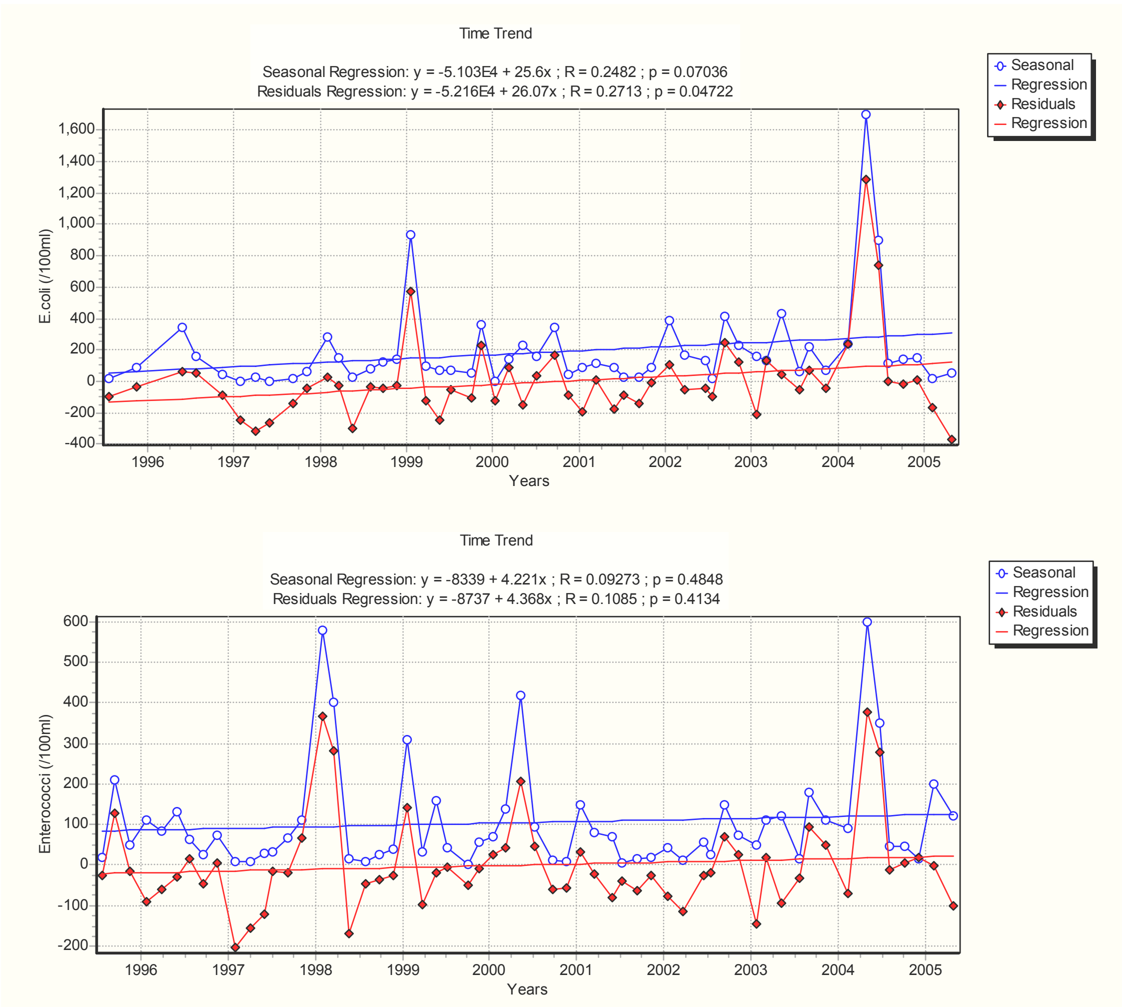


Figure 32 Indicator bacteria concentrations, Rangitaiki Estuary.

3.4.7 Dissolved Oxygen and Temperature

Dissolved oxygen and temperature display no significant trends with only 1.7% of sampling events not meeting the standard for oxygen saturation concentration in estuaries.

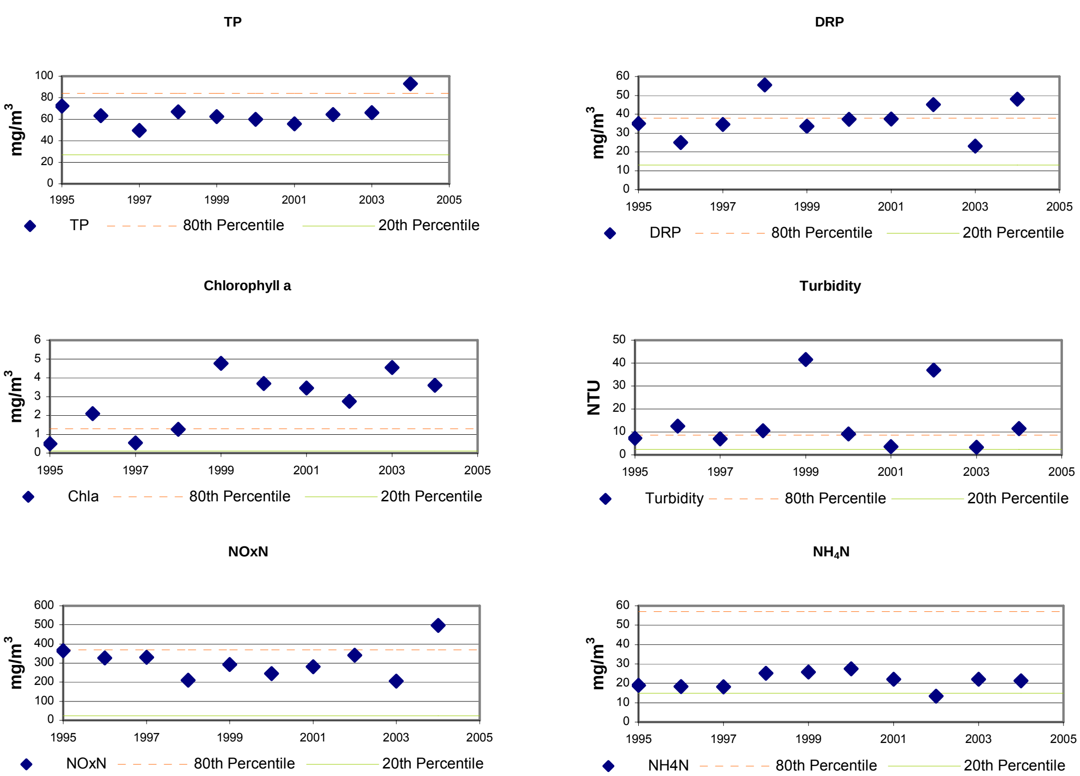
3.4.8 Discussion

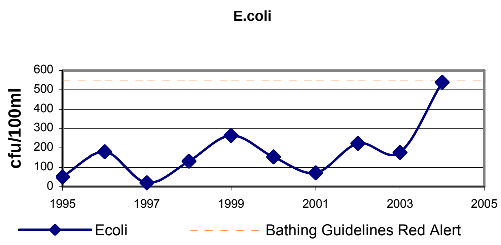
Salinity levels in the Rangitaiki Estuary are almost always low with the average over the 1995 to 2005 analysis period being 1.69 o/oo. This means the system is predominantly a freshwater system with a salt water wedge mixing into the estuary under low flow conditions.

Phytoplankton productivity as measured by chlorophyll *a* is high in this estuary compared to other Bay of Plenty estuaries. This can be seen in Figure 33 with most of the yearly average concentrations above the 80th percentile for Bay of Plenty river estuaries. Dams on this river may influence algal productivity resulting in the higher chlorophyll *a* concentrations seen in the estuary. Monitoring would be needed to confirm this. A negative correlation of chlorophyll *a* with nitrate concentrations may indicate that phytoplankton utilise nitrate in the warmer summer months to increase their numbers.

Other physico-chemical parameters show no real trends over the decade of monitoring. Turbidity and phosphorus levels are on average high when compared to the 80th percentile for Bay of Plenty river estuaries (Figure 33). There is an industrial discharge into the river over eight kilometres above the estuary and this contributes to elevated phosphorus and suspended solids.

Oxides of nitrogen are also elevated but ammonium nitrogen is relatively low in comparison to the 80th percentile, and there is some correlation of this parameter with enterococci concentrations. This correlation may indicate that ammonium nitrogen and enterococci are generated from similar sources such as effluent discharges.





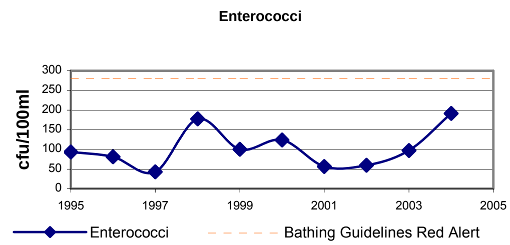


Figure 33 Average yearly concentrations and BOP Estuary 80th & 20th percentiles and guidelines, Rangitaiki Estuary.

Indicator bacteria on average are below red alert bathing guideline levels, but on occasion levels exceed these guidelines. Concentrations over the guideline occurred twice in 2004 increasing the yearly average.

3.5 Tarawera River Estuary

The Tarawera River Estuary is a small estuary of approximately 0.72 km^2 with a catchment of approximately 984 km^2 in size extending from the Okataina Volcanic Centre. The upper catchment is a mixture of indigenous forest, pasture and exotic forestry and scrub. The lower catchment contains the township of Kawerau and the Tasman industrial complex which processes wood based products and is a large user of Tarawera River water. This complex discharges water once used in industrial processes back to the river after treatment. Stormwater and treated sewage from the Edgecumbe township also flow into the river by way of the Omeheu/Awaiti canal system. The plains of the lower catchment are dominated by intensive dairying with some horticulture and crops grown.

3.5.1 Chlorophyll a

Figure 34 displays Chla concentrations monitored in the Tarawera Estuary. Concentrations are generally of a low level with no real trend apparent over the analysis period 1995 to 2005.

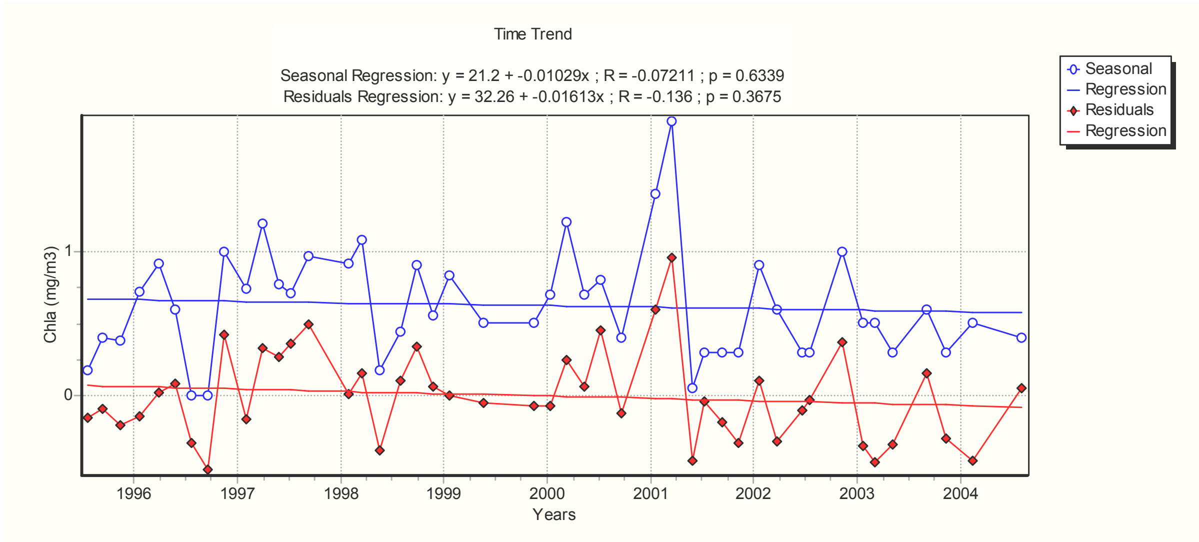


Figure 34 Chlorophyll a concentrations, Tarawera Estuary.

3.5.2 Turbidity

Turbidity and suspended solids concentrations have displayed a significantly decreasing trend (one outlier removed: 24NTU from 03/08/04), although an increase occurred in 2004. The increase in turbidity in 2004 is likely to be because of the wet autumn/winter experienced in this year. Turbidity is higher over the winter months.

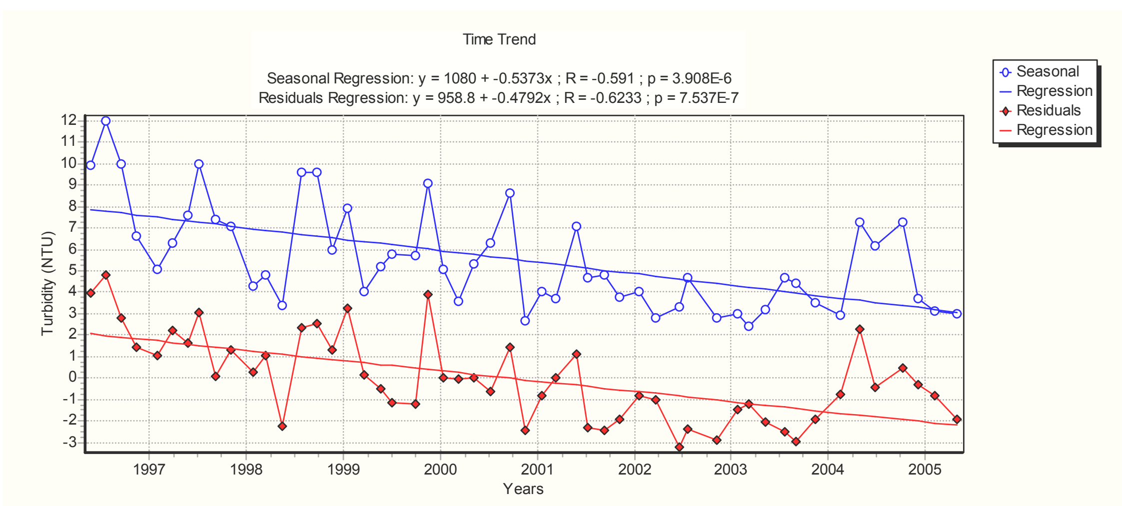


Figure 35 Turbidity, Tarawera Estuary.

3.5.3 Total Phosphorus

Figure 36 shows the changes in TP concentrations since 1995. No significant trend is detected over the long term analysis period and no seasonal pattern is obvious. Short term trends have occurred with an increase in TP up until midway through 1988 followed by a decrease.

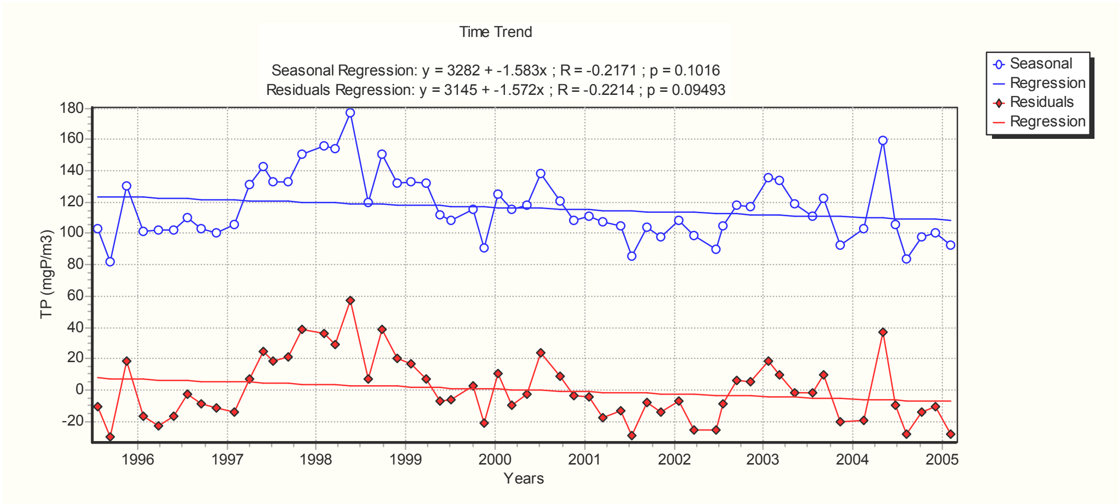


Figure 36 TP concentrations, Tarawera Estuary.

3.5.4 Ammonium nitrogen

Figure 37 shows ammonium nitrogen concentrations over the period 1995 to 2005. Over this period there is no significant trend, however over the years of 1999 to 2005 the is a significant increasing trend (p=0.01). There is only a weak seasonal trend with maximums tending towards the winter months.

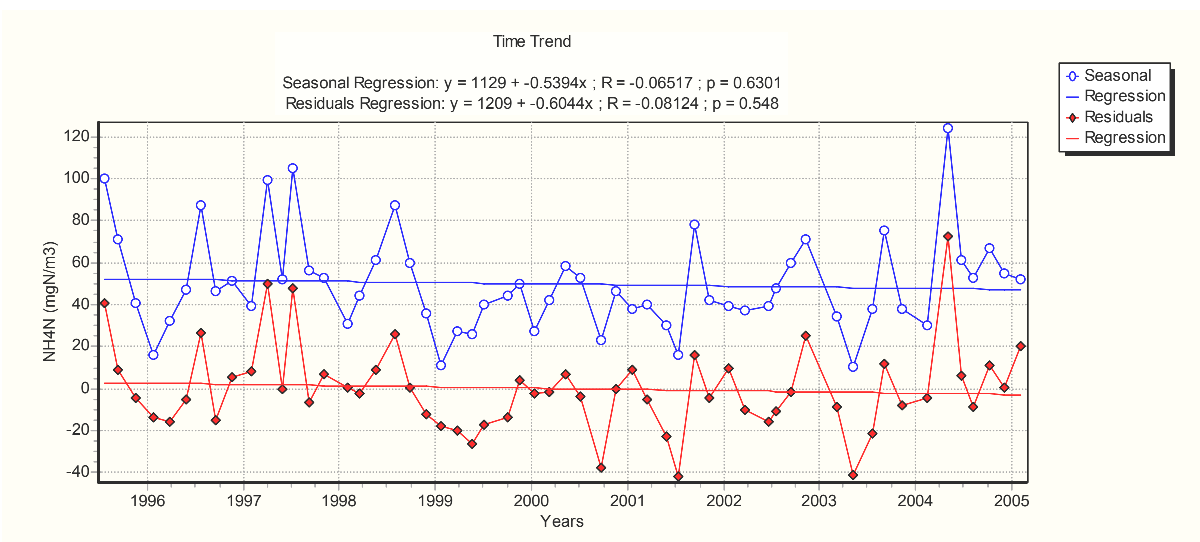


Figure 37 NH_4N concentrations, Tarawera Estuary.

3.5.5 Oxides of nitrogen

Oxides of nitrogen show a significant increase over the analysis period (Figure 38). Like ammonium nitrogen, oxides of nitrogen have winter maximums as is expected, and there is a correlation with ammonium nitrogen (Pearson r=0.569, p<0.005, n=52).

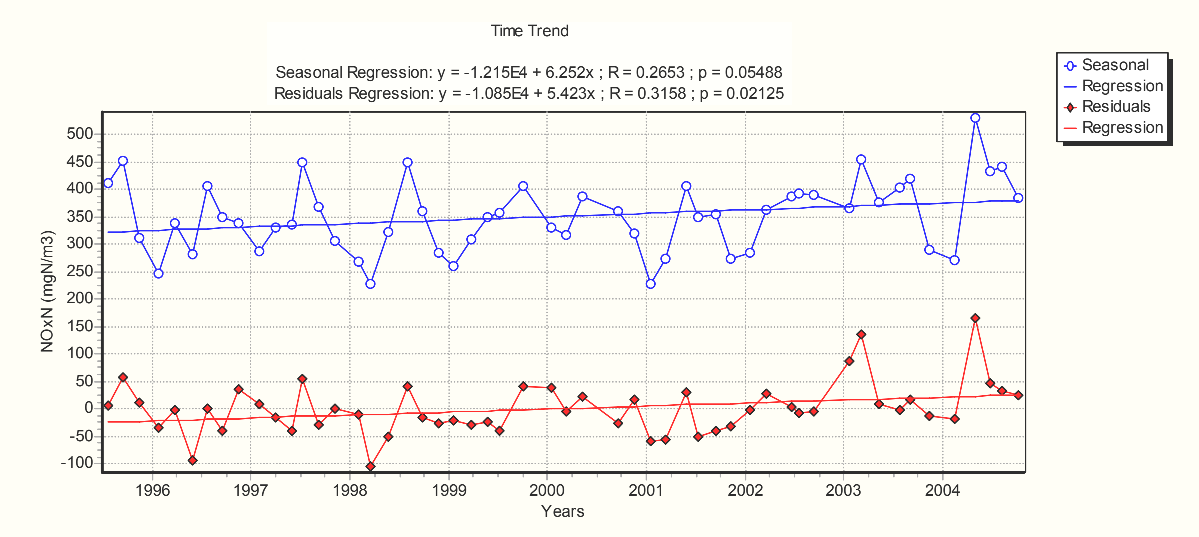


Figure 38 NOxN concentrations, Tarawera Estuary.

3.5.6 Indicator Bacteria

Figure 39 displays the *E.coli* and enterococci concentrations in the Tarawera Estuary over the 1995 to 2005 period. No significant trends are detected and no strong seasonal patterns are displayed, although enterococci maximums tend to occur in mid to late summer.

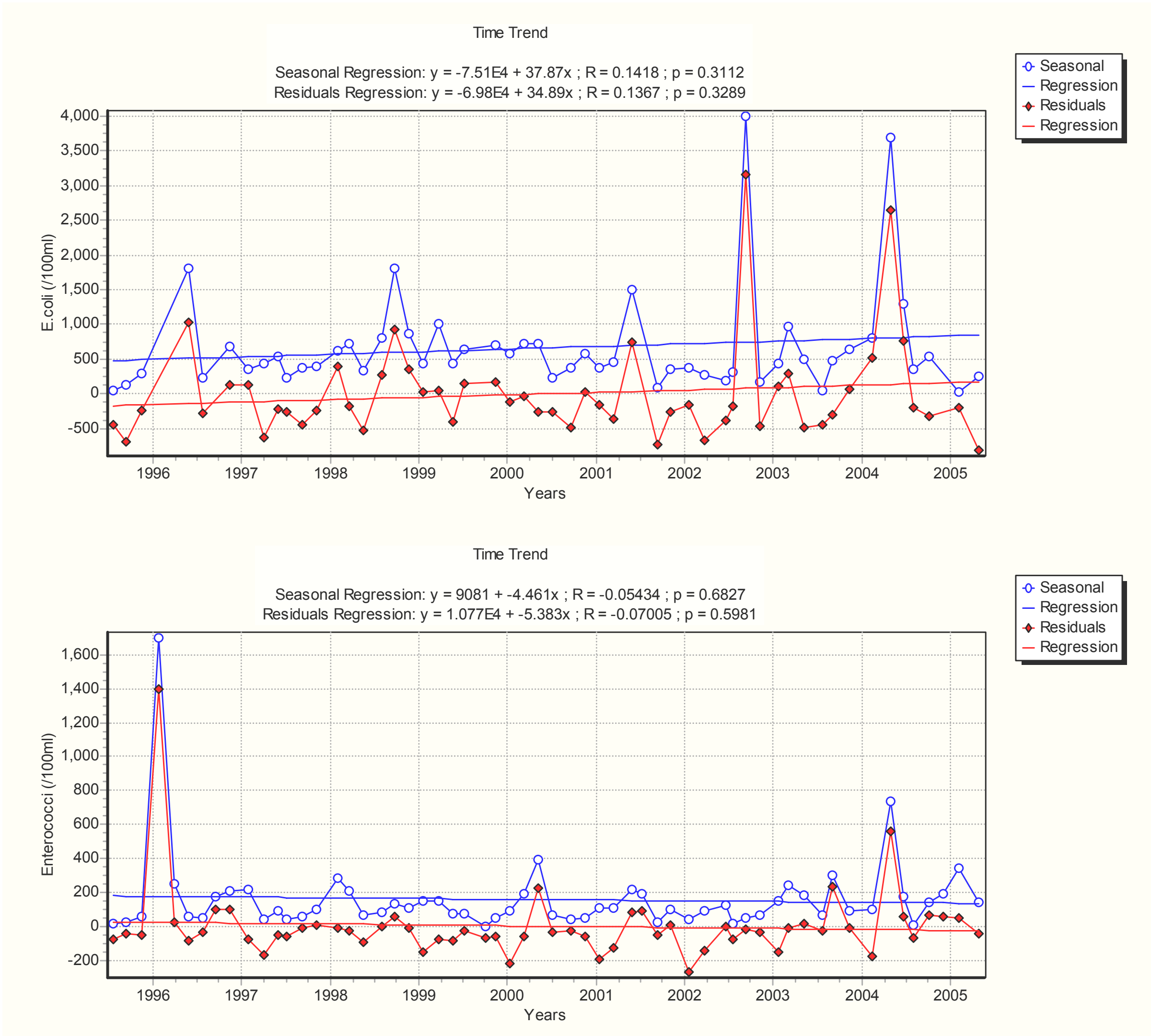


Figure 39 E.coli and enterococci concentrations, Tarawera Estuary.

3.5.7 Dissolved Oxygen and Temperature

Dissolved oxygen content of the estuary shows no appreciable change remaining steady, however concentrations have been below 5 mg/l on occasion. Temperature over the 1995 to 2005 analysis period does show a very slight but significant decrease (<0.1 °C per year).

3.5.8 Discussion

Trends over the 1995 to 2005 analysis period includes an increase in nitrate levels and a decrease in suspended solids (turbidity). Improvements in industrial discharges, such as a reduction in solids and colour discharged from the treatment ponds and improvements in stormwater treatment have reduced in the suspended solids load and improved turbidity to the estuary. Turbidity is generally under the 80th percentile for Bay of Plenty river estuaries (Figure 40).

An increase in oxides of nitrogen does not seem to have affected the productivity of the estuary with chlorophyll *a* levels remaining within the 80th and 20th percentiles for Bay of Plenty estuaries (Figure 41).

The Tarawera Estuary has met the standard of oxygen saturation, as per the RCEP, on less than 6% of sampling occasions since July 1995. Sampling is predominantly of freshwater and even though sampling occurs during mid to high tide, little oceanic water is sampled. River water is likely to contain higher levels of organic matter stemming from a variety of sources. Organic material will utilise the dissolved oxygen content of the water predominantly through microbial activity, but also by oxidation of inorganic nutrients.

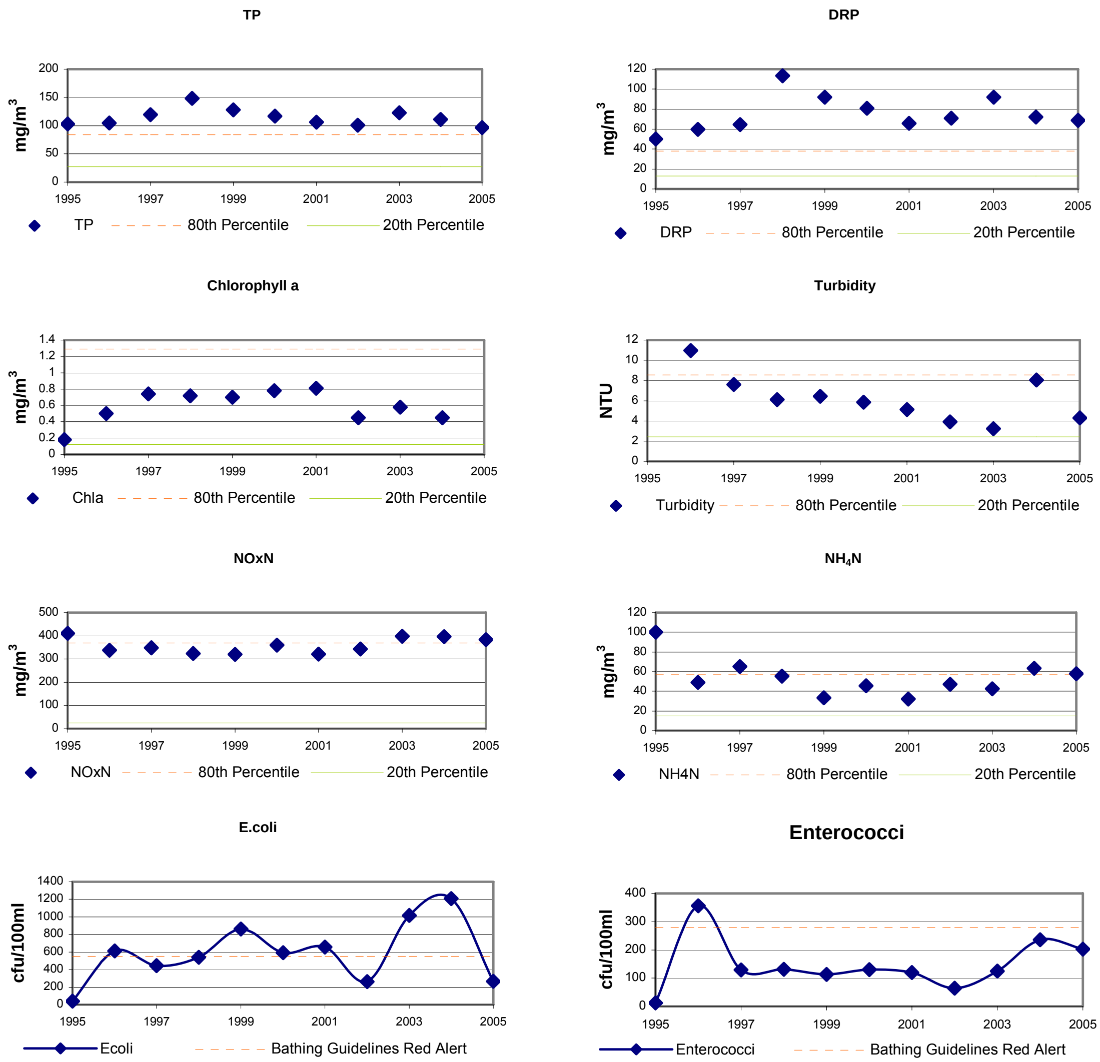


Figure 40 *Average yearly concentrations and BOP Estuary 80th & 20th percentiles and guidelines, Tarawera Estuary.*

Phosphorus levels are high in the estuary for both total and dissolved content (Figure 40). This may give an indication of the source(s) of organic loading in the river. Correlations with dissolved oxygen concentrations show relationships with DRP (Pearson $r=-0.52$, $p<0.001$, $n=56$) and NOxN (Pearson $r=-0.516$, $p=0.001$, $n=52$).

Microbiological bathing water quality standards have been exceeded on several occasions with the freshwater guideline (*E.coli*) exceeded more often that the marine guideline (Enterococci). As the waters are predominantly fresh *E.coli* are the more applicable organism for comparison. High bacteria levels have been monitored in the Matata Lagoon and these are periodically flushed into the estuary. The predominant source of indicator bacteria from the lagoon is water fowl, although Matata is an unsewered community which is also contributing the bacterial load.

3.5.9 Matata Lagoon

Matata Lagoon is a predominantly shallow, freshwater basin separated from the ocean by a narrow strip of sand dunes. The Lagoon is divided into two sections by a causeway and a 1.2 metre diameter pipe provides a link between the two sections. The two sections are physically distinct (Bioresearches, 1975).

The north-west lagoon as around 600 metres long by 200 metres wide and is fed by the Awatarariki Stream, ground water flows, saline intrusions and a few small drains. In March 2005 a weather bomb delivered 44 mm of rain in one hour at Thornton to an already saturated catchment. This resulted in a debris flow down the Awatarariki Stream infilling the north-west lagoon and parts of the south-east lagoon. As this event has resulted in the loss of the primary monitoring site in the north-west lagoon the reader is directed towards Scholes, 2005 for further details on the water quality at this site. This section will focus on the water quality of the second site in the south-east lagoon located at the control structure near the Tarawera River. Sampling has occurred at this site since May 2001.

The south-east lagoon has a partially open end at around 400 metres long and 200 metres wide and extends a further 1800 metres to the Tarawera River. The lagoon is supplied freshwater from the outlet from the north-west lagoon, Waitepuru Stream, saline intrusions, and ground water inflows. Both sections of the lagoon are around 0.5 metres deep with the south-east end having a deeper channel in sections.

The rate of sedimentation in the lagoon has been seen as one of the lagoons greatest threats. Various measures have been put in place to slow sedimentation, such as a sediment trap as the Awatarariki Stream enters the lagoon, raupo control, and sand dune stabilisation.

Since the 1960s eutrophication has also seen as a potential problem primarily due to the inflow of nutrients to the basin and the lack of flushing. APR Consultants (1993) concluded that both the Awatarariki and Waitepuru Streams contribute a significant nutrient loads.

3.5.10 Chlorophyll a

Figure 41 displays Chla concentrations over short period that monitoring has taken place at this structure. The trend is a significant decline in Chla concentration over the analysis period. Concentrations are relatively high compared to other estuaries and displays a seasonal pattern of summer highs.

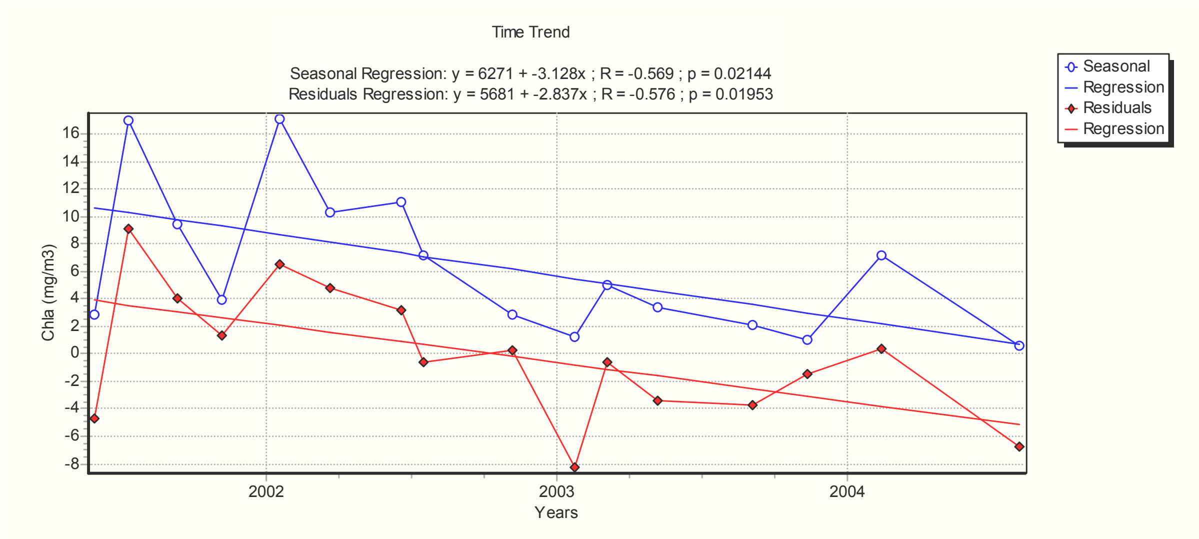


Figure 41 Chla concentrations, Control structure, Matata Lagoon.

3.5.11 **Turbidity**

Turbidity monitoring in the south-east Matata Lagoon displays a declining trend over the analysis period. This indicates a declining trend in suspended solids concentrations over the past few years.

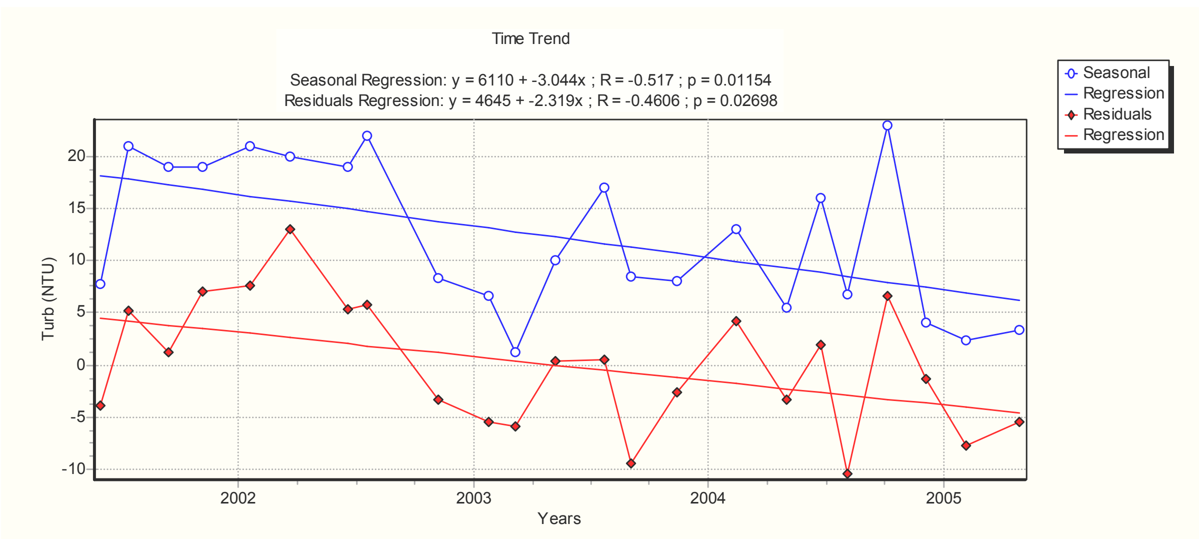


Figure 42 Turbidity, Control structure, Matata Lagoon.

3.5.12 **Total Phosphorus**

TP shows no significant trend over the past few years (Figure 43) and only a very weak seasonal pattern of minimums during winter. This is more pronounced in the DRP data and like TP concentrations, DRP concentrations are at a similar level as found in the Tarawera Estuary.

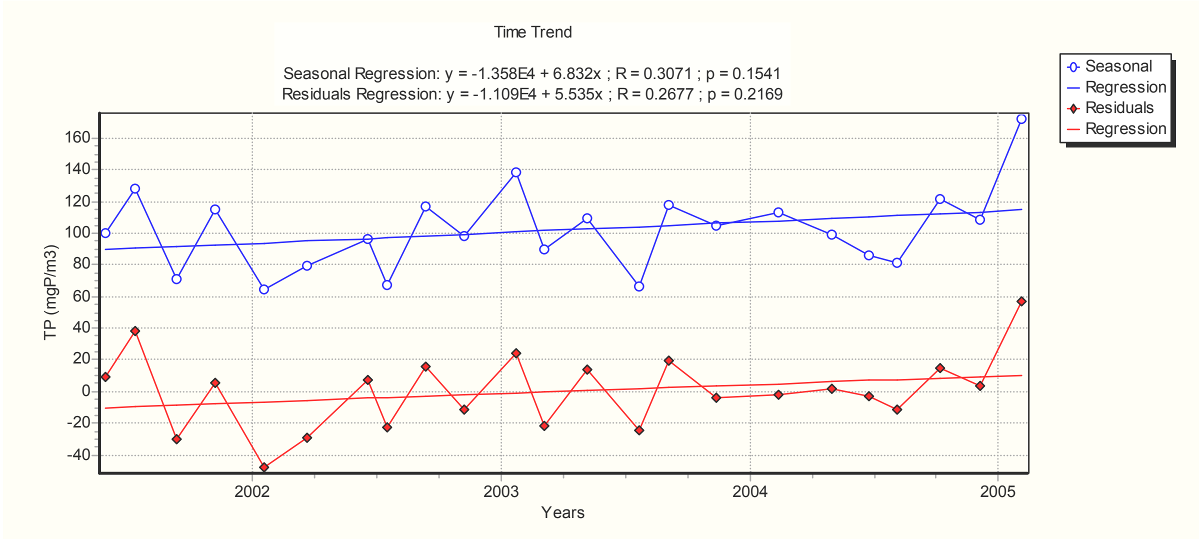


Figure 43 TP concentrations, Control structure, Matata Lagoon.

3.5.13 Ammonium nitrogen

Figure 44 shows that there has been no observable trend in the ammonium nitrogen concentrations over the analysis period 2001 to 2005. There is a marked fluctuation in concentrations, however on average concentrations remain relatively steady.

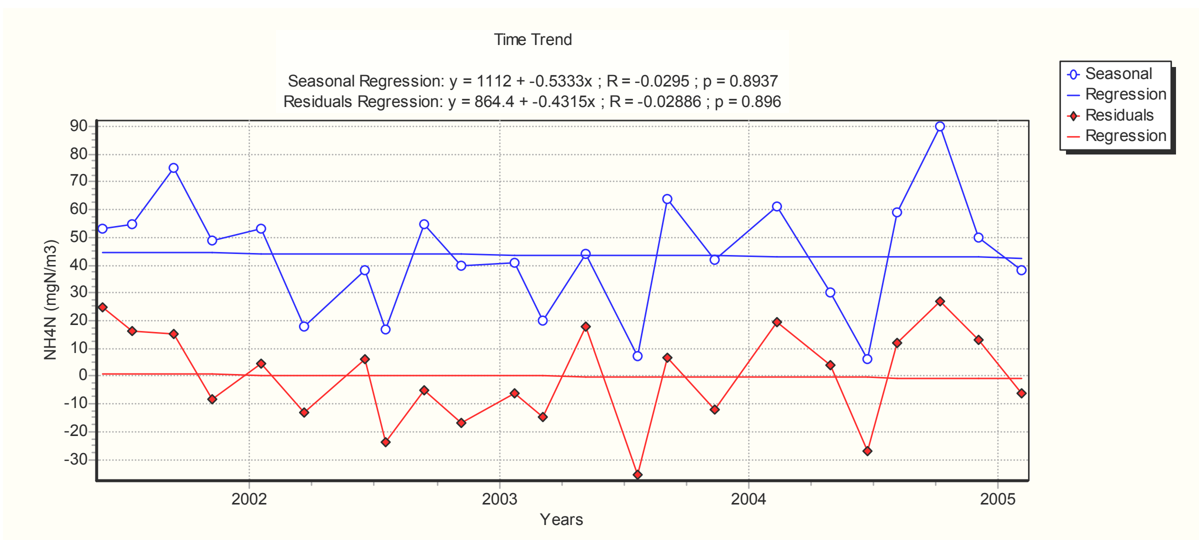


Figure 44 NH_4N concentrations, Control structure, Matata Lagoon.

3.5.14 Oxides of nitrogen

Regression analysis over the 2001 to 2005 period shows there is no significant trend in NOxN levels in the lagoon, although the non-significant trend is an increasing one. No real seasonal pattern obvious from the data.

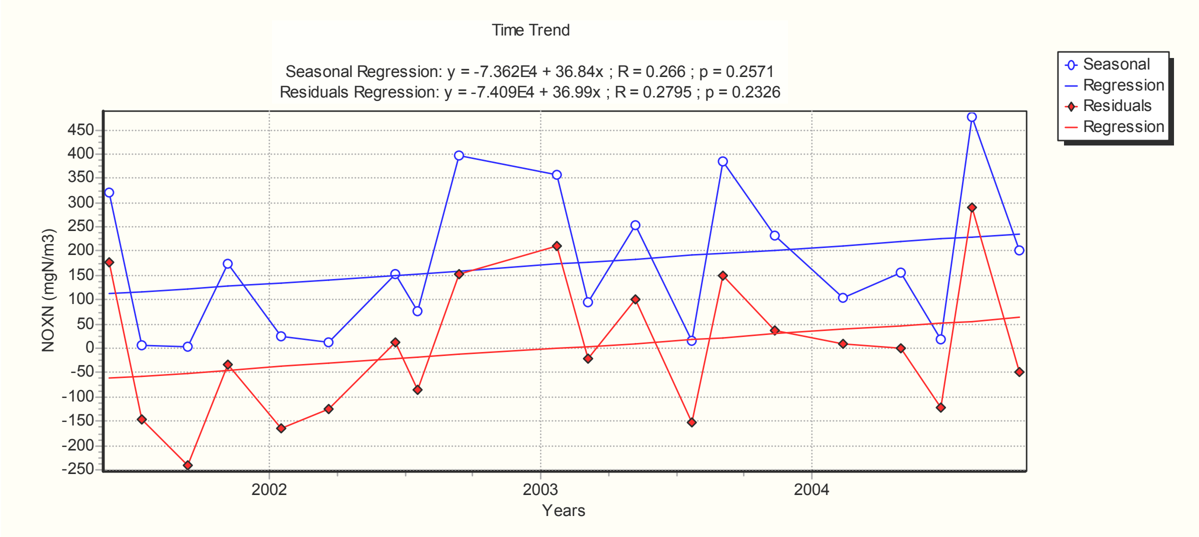
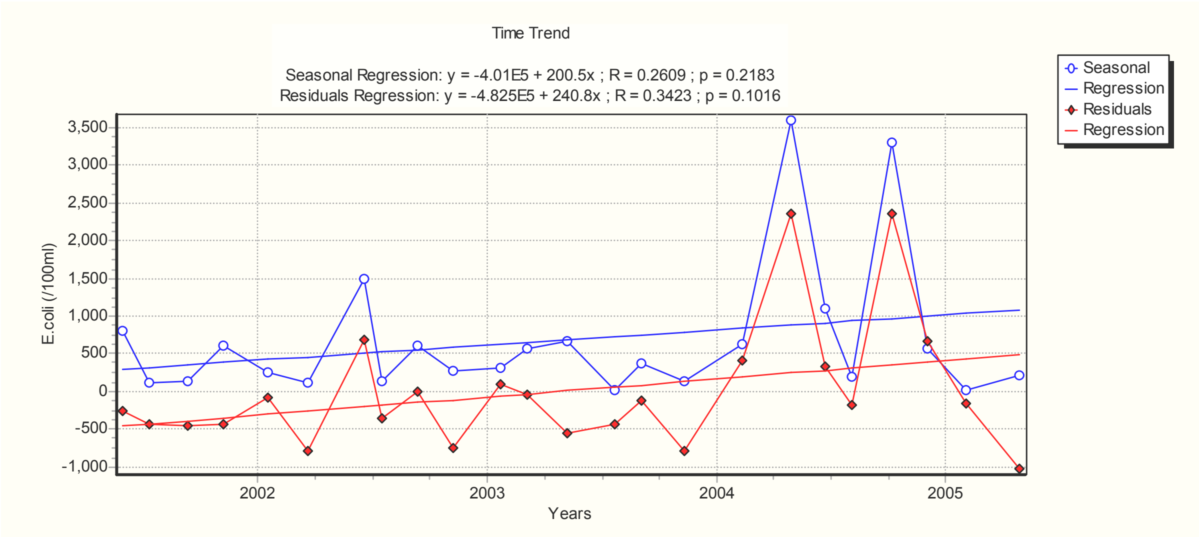


Figure 45 NOxN concentrations, Control structure, Matata Lagoon.

3.5.15 **Indicator Bacteria**

No significant trend is shown for either *E.coli* or enterococci concentrations in the south-east lagoon.



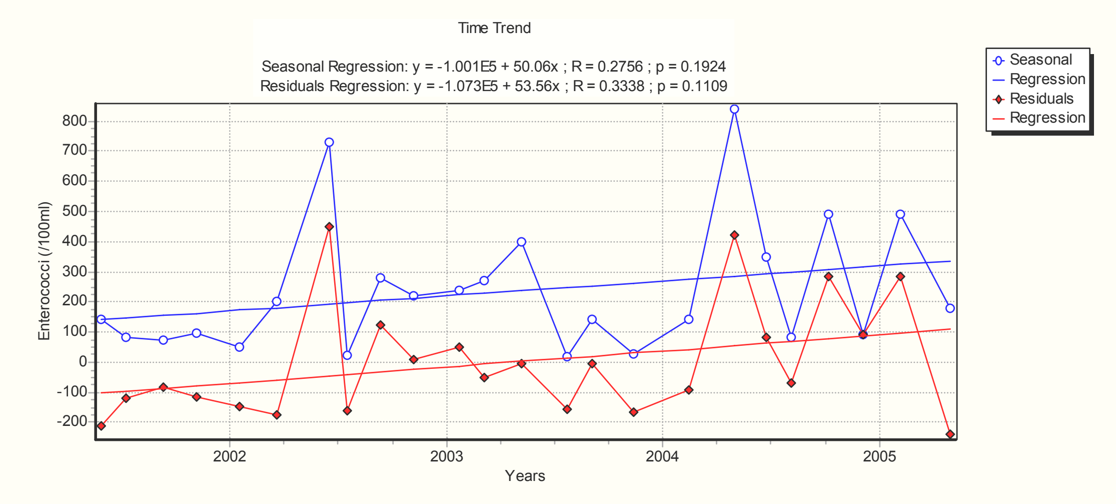


Figure 46 E.coli and enterococci concentrations, Control structure, Matata Lagoon.

3.5.16 Dissolved Oxygen and Temperature

There is no significant trend in dissolved oxygen concentrations. Concentrations have reached below 3 mg/l on occasion. Temperature shows a non-significant increasing trend.

3.5.17 Discussion

This freshwater lagoon makes comparison with other estuarine environments difficult due to its low level of saline inputs, its flow dynamics and strong vegetation component. Thus no percentile comparison is made here.

Of the water quality parameters monitored only turbidity and Chla displayed any significant trends, both of which were decreasing. This indicates some short term water quality improvement. However, considering Chla has negative correlations with DRP and NOxN the indication is there is plenty of available nutrient to stimulate phytoplankton growth, but a positive correlation with turbidity shows that suspended sediment may limit phytoplankton growth.

Dissolved oxygen concentrations has summer lows that reach levels that may not provide enough oxygen content for some organisms survival. DO does not correlate with conditions within the Tarawera Estuary and so factors within the lagoon wetland system are likely to be responsible for depleted DO concentrations.

E.coli and enterococci concentrations regularly exceed the guidelines for microbiological water quality. High levels of these indicator bacteria are also found in the north-west lagoon and have a strong contribution from the plentiful water fowl population as well as local streams and drains that run through an unsewered community.

Water quality at this site in the short term is likely to worsen as a direct result of the infilling of the north-west lagoon.

3.6 Little Waihi Estuary

The 2.4km^2 shallow tidal inlet that forms Little Waihi Estuary is impounded by a long spit upon which the Pukehina community has settled. Much of the estuary dries at low tide with the main channel providing the conduit of water to a few narrower channels.

The estuary is fed freshwater from a number of stream fed drainage canals. These waters pass through a catchment of exotic and native forests in the headwaters to mixed horticulture, sheep, beef farms and dairy farms on the rolling hill country and plains. Drains tend to provide a high level of nutrients and bacteria to the estuary and there is also septic tank contamination from the local Little Waihi community.

3.6.1 Chlorophyll a

Figure 47 shows that there is no significant trend in Chla concentrations over the analysis period. Only one sample has shown productivity at an elevated level and this may have been an isolated bloom event.

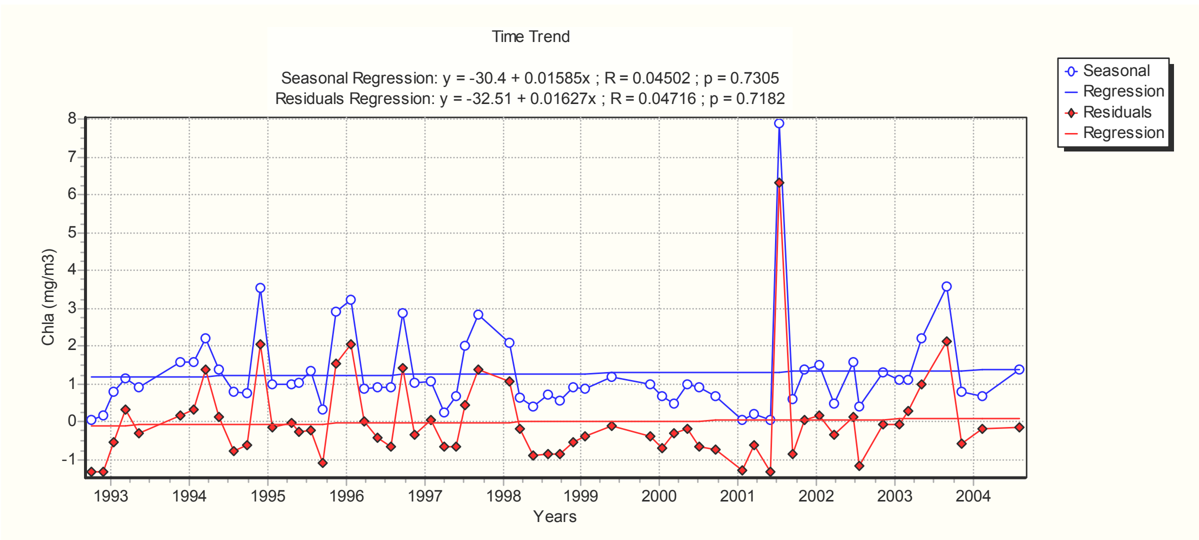


Figure 47 Chlorophyll a concentrations, Little Waihi Estuary.

3.6.2 Turbidity

Turbidity in the estuary has been measured since 1996 to 2005 (Figure 48). No significant trend is apparent over this analysis period, however a significant trend is displayed in suspended solids data over the period 1990 to 2005 ($p=0.006$). There is a reasonable correlation of turbidity with suspended solids (Pearson $r=0.810$, $p<0.001$, $n=57$), however it is not apparent if elevated suspended sediment levels stem from freshwater sources, are wind generated in the shallow estuary, or are from oceanic sources.

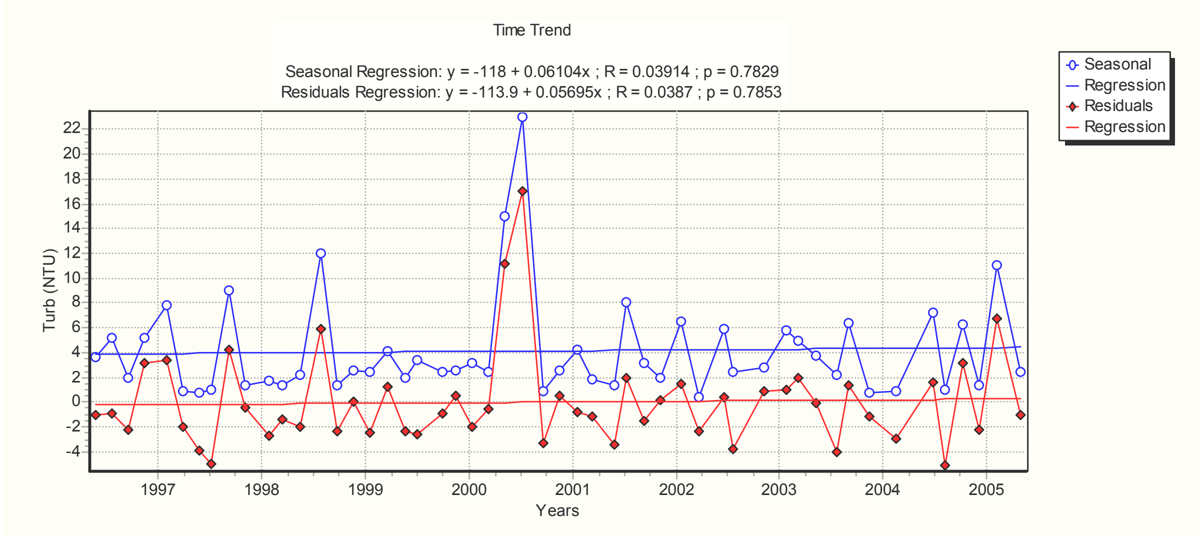


Figure 48 Turbidity, Little Waihi Estuary.

3.6.3 Total Phosphorus

Figure 49 displays TP concentrations and deseasonalised residuals monitored in Little Waihi Estuary. There is a significant decease in concentrations from 1990 to 2005 ($p<0.05$).

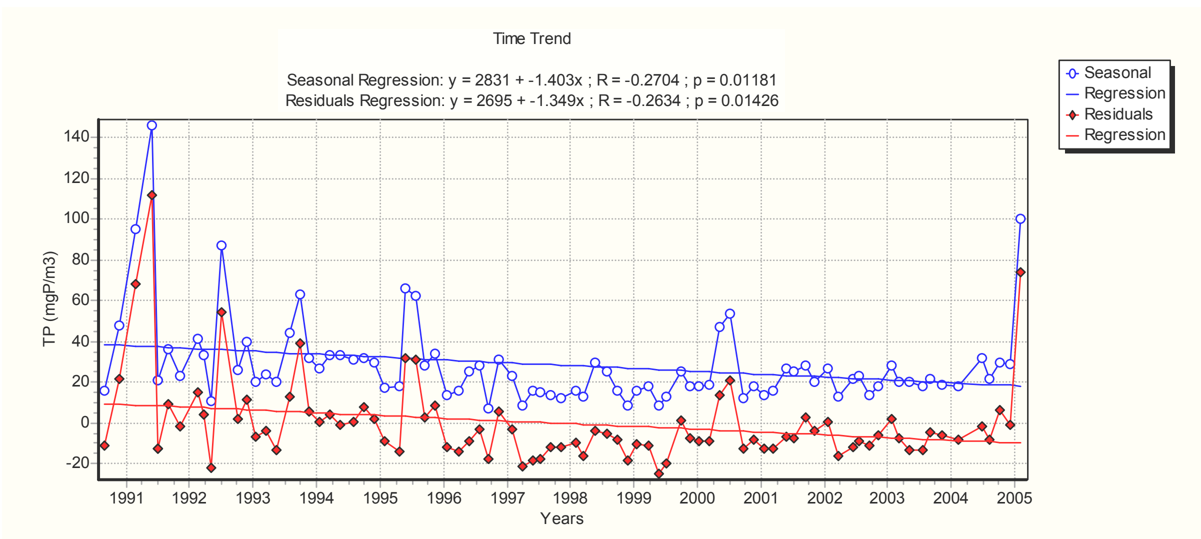


Figure 49 TP concentrations, Little Waihi Estuary.

3.6.4 Ammonium nitrogen

Ammonium nitrogen concentrations show no significant trend over the 1990 to 2005 analysis period. There is an elevation in concentrations in the past year (2004, start of 2005) as has been displayed in previous years. During this period conductivity and salinity is lower on average indicating greater freshwater influence at time of sampling. As the correlation of ammonium nitrogen with conductivity displays a weak relationship (Pearson r=-0.574, p<0.001, n=82) the assumption can be made that ammonium nitrogen levels are influenced by freshwater inflows.

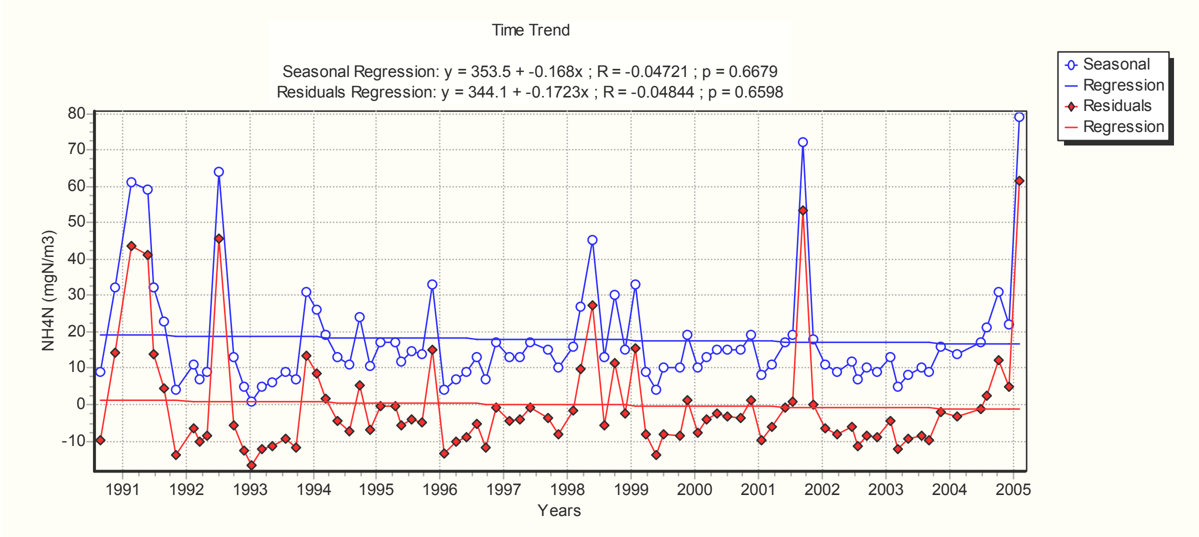


Figure 50 NH_4N concentrations, Little Waihi Estuary.

3.6.5 Oxides of nitrogen

Oxidised nitrogen is one parameter that displays a strong seasonal trend having its maximum peaks generally in winter (Figure 51). No significant temporal trend is displayed over the analysis period with concentrations as expected fluctuating between winter highs and summer lows.

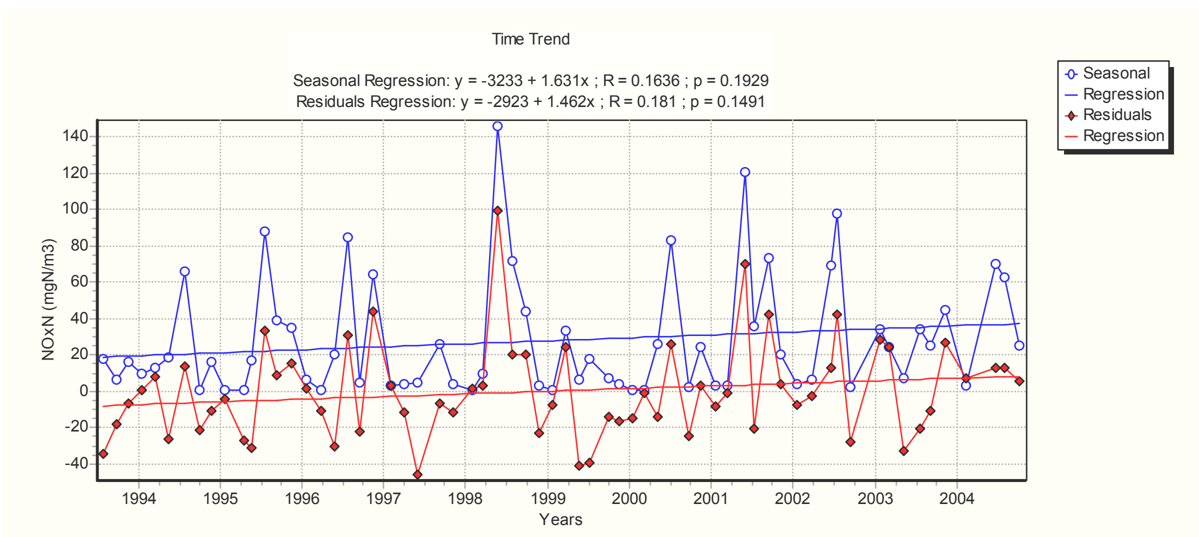


Figure 51 NOxN concentrations, Little Waihi Estuary.

3.6.6 Indicator Bacteria

Figure 54 displays the indicator bacteria concentrations measured under mid to high tide conditions in the Little Waihi Estuary. The data analysis shows no significant trend over the analysis period for both *E.coli* and enterococci. Concentrations are well within bathing water quality guidelines with only one exceedence in *E.coli* monitored.

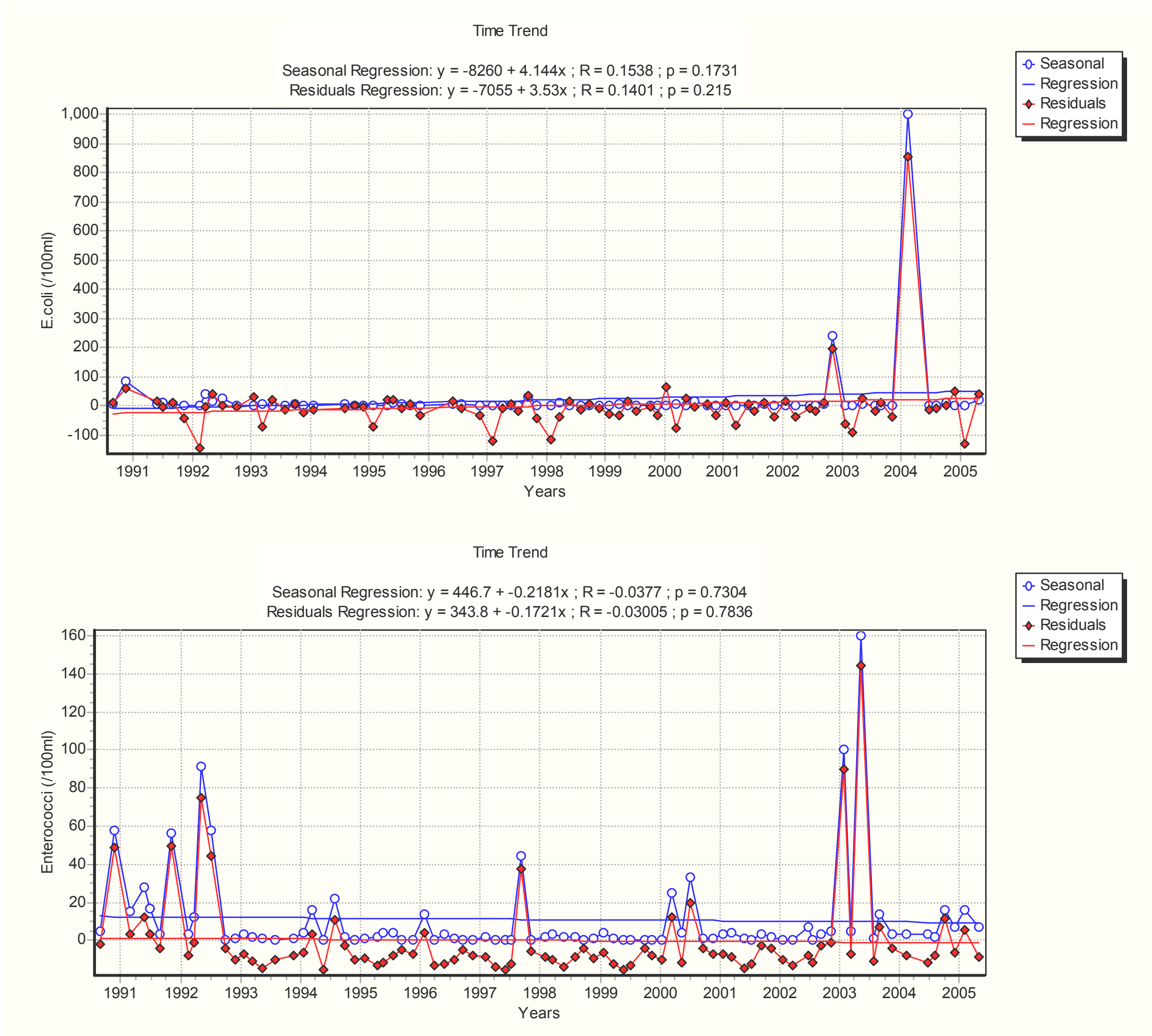


Figure 52 E.coli and enterococci concentrations, Little Waihi Estuary.

3.6.7 Dissolved Oxygen and Temperature

Dissolved oxygen concentrations and temperature display no significant trends with dissolved oxygen well sustained within the estuary.

3.6.8 Discussion

The water quality of the Little Waihi Estuary is generally good with most water quality parameters under the 80th percentile for Bay of Plenty estuaries (Figure 53). Only DRP levels have been elevated above the 80th percentile over the past few years even though TP levels have declined since the early 1990s.

DRP levels are generally higher than DRP in oceanic water sampled off Pukehina in years 2003/2004, suggesting that some of the DRP load has terrestrial origins. There is a correlation of DRP with NOxN (Pearson r=0.740, p<0.001, n=47) and NH_4N (Pearson r=0.754, p<0.001, n=56) also potentially indicating terrestrial origins of some of these nutrients. This is backed up by monitoring during low tide conditions in water of low salinity having greatly elevated nutrient levels in comparison to mid to high tide monitoring data displayed in this report. Also, samples with greater freshwater content (i.e. lower salinity) generally have higher ammonium nitrogen content.

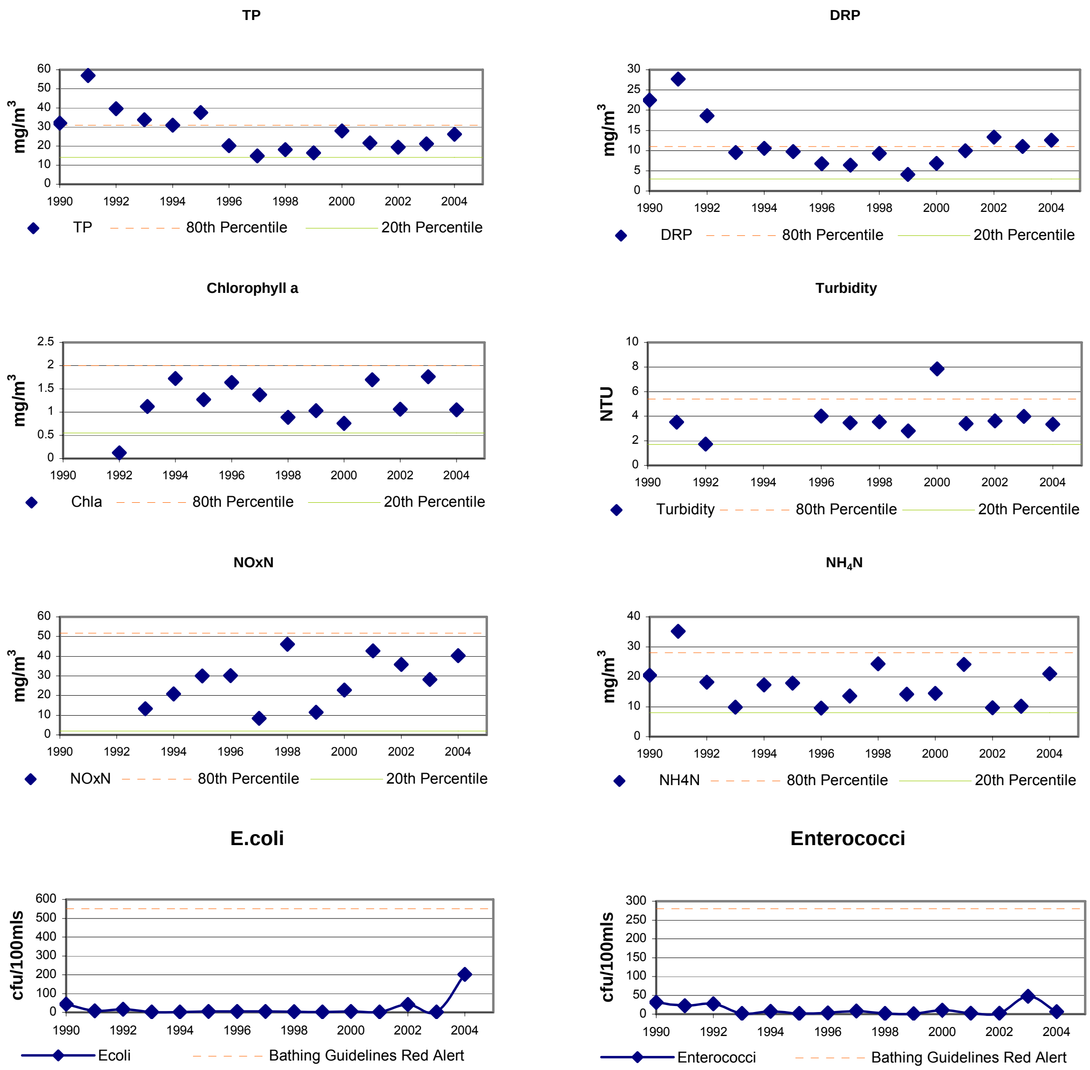


Figure 53 Average yearly concentrations and BOP Estuary 80th & 20th percentiles and guidelines, Little Waihi Estuary.

Suspended sediment levels have shown a rising trend with no clear correlation that an increase in suspended sediment is due to stronger wind conditions during sampling, which has been the case in other shallow estuarine sites.

Indicator bacteria are generally present in low levels. An elevated yearly average in 2004 is the result of one high sample (Figure 53) with all other levels remaining low.

Oxygen levels are rarely below 7 mg/l.

3.7 Maketu Estuary

The 2.3 km^2 Maketu Estuary is contained in the Kaituna River catchment where a barrier spit forces the entrance of the estuary towards Okurei Point. The major fresh water input is from the Kaituna River diverted at Te Tumu with several smaller additions from minor streams and drains. Water from the Kaituna was re-introduced to the estuary by a diversion scheme in October 1995 after an absence of 39 years.

The lower catchment is similar in nature to the Little Waihi catchment. It is dominated by intensive livestock agriculture and horticulture with the additions of the discharges associated with the township of Te Puke and industrial discharges from AFFCO freezing works. Kaituna upper catchment encompasses the Rotorua and Rotoiti Lakes catchments as Lake Rotorua discharges through Lake Rotoiti and down the Kaituna River.

3.7.1 Chlorophyll a

There is no significant trend indicated in the Chla data over the last decade with one elevated monitoring result occurring at the beginning of the summer of 2003/2004.

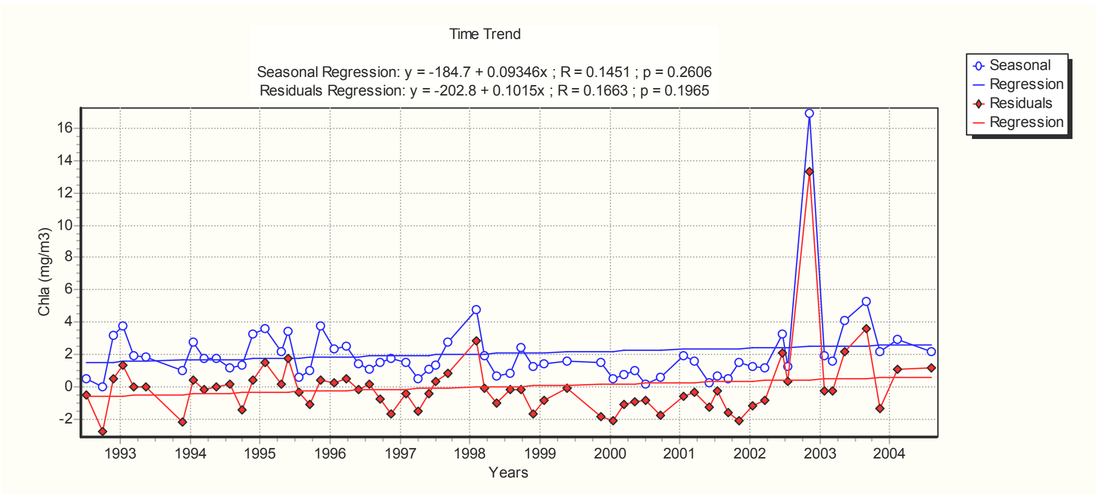


Figure 54 Chlorophyll a concentrations, Maketu Estuary.

3.7.2 Turbidity and Suspended Solids

Figure 55 displays turbidity and suspended solids in the Maketu Estuary since 1996. No significant trend is displayed over the analysis period, however a significant increasing trend is seen in the suspended solids data over the analysis period 1990 to 2005 (p=0.004). Turbidity tends to peak over the winter months with suspended solids peaking near the beginning of spring. Consequently turbidity and suspended solids have one of the weaker correlations for all estuaries (Pearson r=0.682, p<0.001, n=60) and no obvious correlations with other water quality determinands.

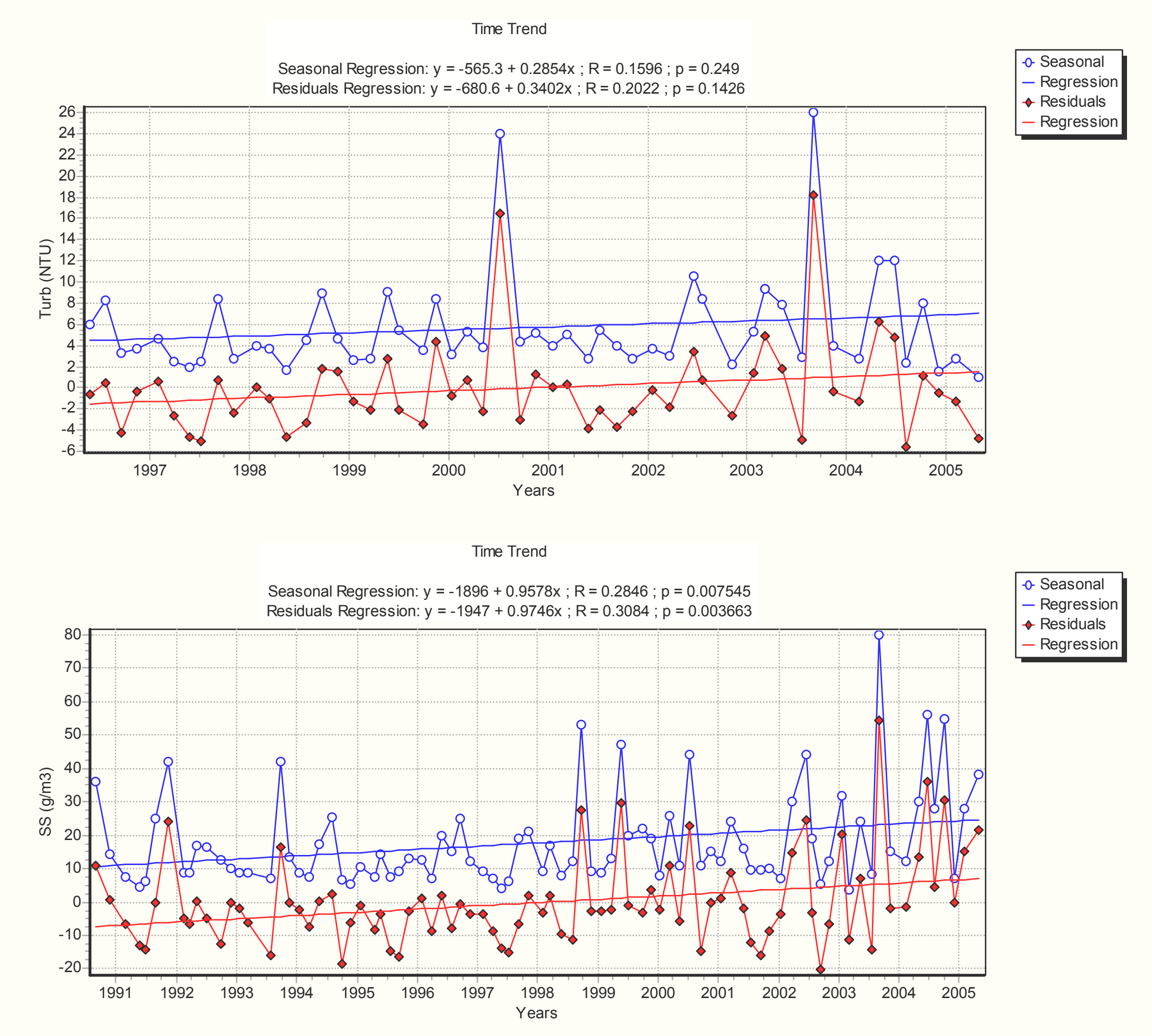


Figure 55 Turbidity and suspended solids concentrations, Maketu Estuary.

3.7.3 Total Phosphorus

Total phosphorus shows no significant trend in the Maketu Estuary over the analysis period. No seasonal pattern is displayed in the data with one spike in the data occurring in early 2004. This spike is a result of sample being taken at a lower tide and having a larger fresh water influence and this can be seen in other water quality determinands. Inclusion of this point in the data set does not significantly alter the trend.

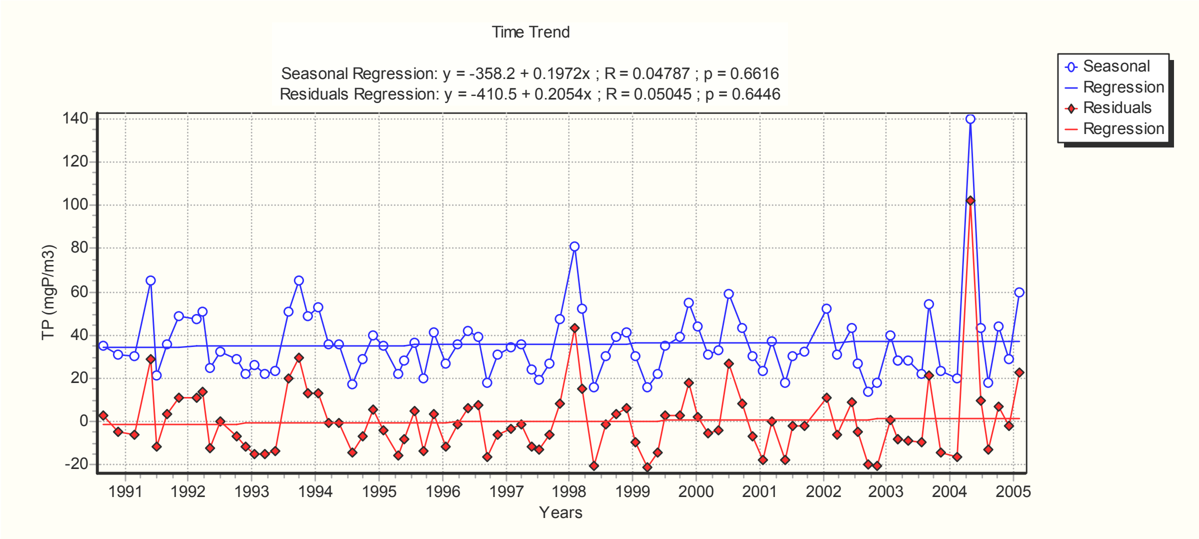


Figure 56 Total phosphorus concentrations, Maketu Estuary.

3.7.4 Ammonium nitrogen

There are no significant trends in ammonium nitrogen concentrations in the estuary (Figure 57). Like TP there is no obvious seasonal pattern to changes in concentrations and also there is a high value experienced when the sample contained a greater amount of freshwater.

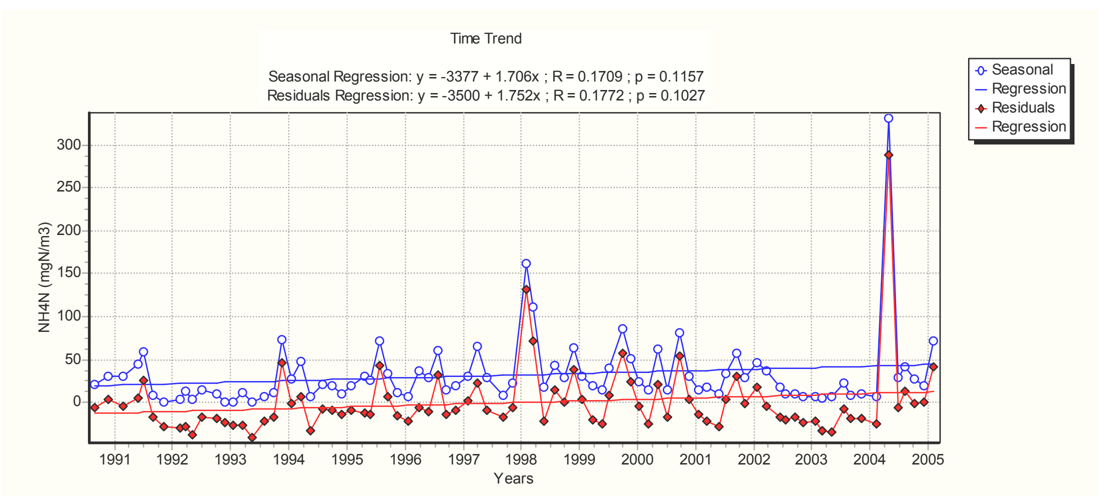


Figure 57 NH_4N concentrations, Maketu Estuary.

3.7.5 Oxides of nitrogen

Figure 58 displays NOxN concentrations over the analysis period 1990 to 2004. No significant trend is shown over the analysis period. NOxN concentrations tend to be highest over the winter period as is expected.

A spike in NOxN occurred on an early 2004 sample with this sample being less saline than other samples taken. This could indicate freshwater inputs to be contributing higher concentrations of NOxN than oceanic water. Such a relationship is indicated by the negative correlation of NOxN with conductivity (Pearson r=-0.696, P<0.001, n=62).

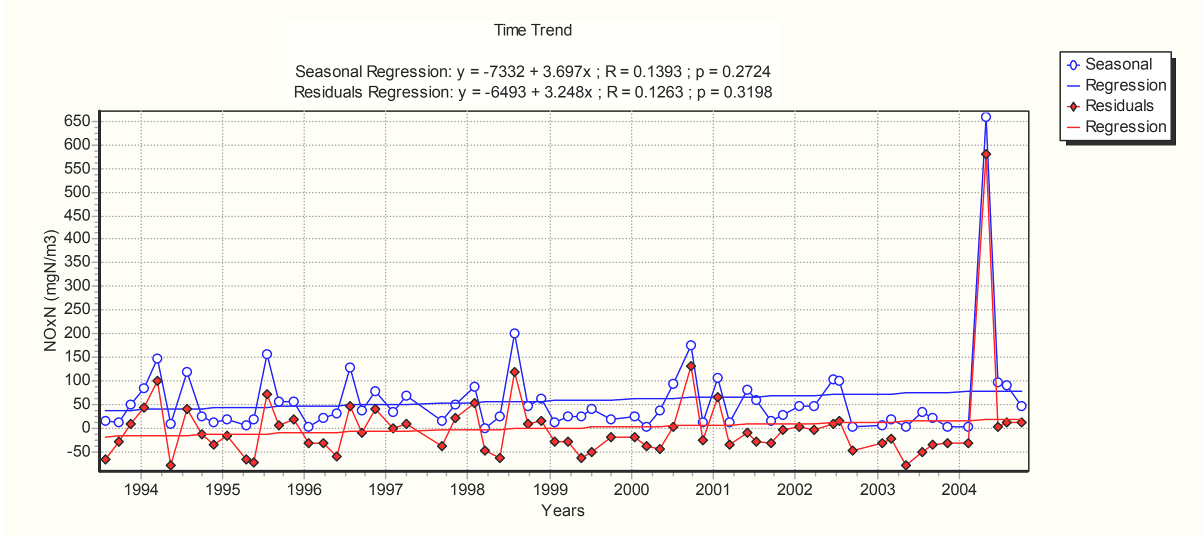


Figure 58 NOxN concentrations, Maketu Estuary.

3.7.6 Indicator bacteria

Indicator bacteria show no significant trends over the analysis period. *E.coli* does show a non-significant increasing trend (p>0.05), but this is heavily influenced by two elevated samples. *E.coli* tend to have the highest concentrations over the late summer/early autumn while enterococci tend to be higher over mid-summer.

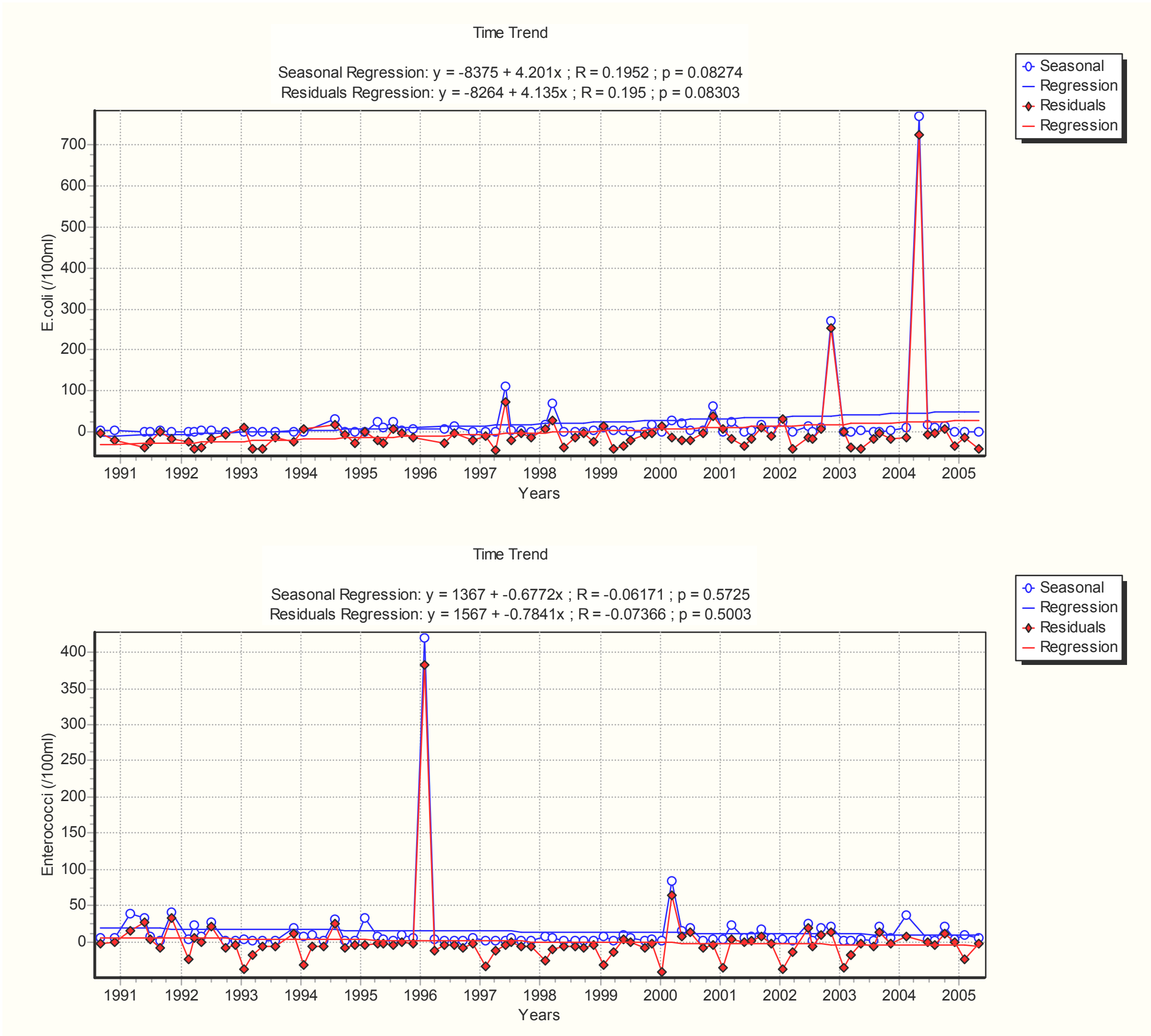


Figure 59 E.coli and enterococci concentrations, Maketu Estuary.

3.7.7 Dissolved Oxygen and Temperature

Dissolved oxygen levels show no significant trend over the analysis period 1990 to 2005. Concentrations of oxygen have reached as low as 6.9 mg/m^3 and have been below 80% saturation on two monitoring events. Temperature displays no significant trend.

3.7.8 Discussion

The water quality of the Maketu Estuary remains relatively stable over the analysis period of 1990 to 2005. Comparison of average yearly nutrients in the estuary with the 80th percentile of concentrations for Bay of Plenty estuaries shows Maketu Estuary to be varied (Figure 60).

Phosphorus concentrations on average tend to be just above the 80th percentile of concentrations for Bay of Plenty estuaries while inorganic nitrogen (NOxN + NH_4N) levels range from the 20th percentile to above the 80th and similarly so does chlorophyll *a* and turbidity (Figure 60).

On average nutrient levels seem to have improved. Nutrient levels before the diversion were of a concern (Rutherford *et al*., 1989) with mean DRP and TP concentrations around 30 and 50 mg/m^3. These are now around 15 and 30 mg/m^3, also the median inorganic nitrogen levels were 60-100 mg/m^3 in the last five years and they are now at a median of 45 mg/m^3.

No real trends have been observed with respect to the re-introduction of Kaituna River water to the estuary. Only one trend in water quality data was revealed over the analysis period of 1990 to 2005. An increasing trend in suspended solids. Suspended solids did not correlate as well as other estuaries with turbidity and this may be due to the quality and flow dynamics of the Kaituna River input. Rougher water and stronger winds generally are associated with higher suspended solids levels, but this is not always the case. Larger freshwater inflows during flood periods also generate increased sediment and cause elevations in suspended solids. The Kaituna River has experienced an increase in flood flow frequency since 1998 which is likely to contribute to more suspended solids to the estuary with the restoration of flow in 1995.

The estuary is predominantly saline with salinity levels generally just below that of oceanic waters (35 o/oo), however at times of increased rainfall salinity is decreased. As salinity decreases it would appear that nitrate levels increase and this increase is more prevalent in winter.

Chlorophyll *a* concentrations have been elevated in the past few years (Figure 60) indicating an increase in productivity within the estuary.

Indicator bacteria levels are on average a fraction of the red alert microbiological water quality guidelines for fresh and marine waters (Figure 60). These guidelines have only being exceeded once in the monitoring data presented here.

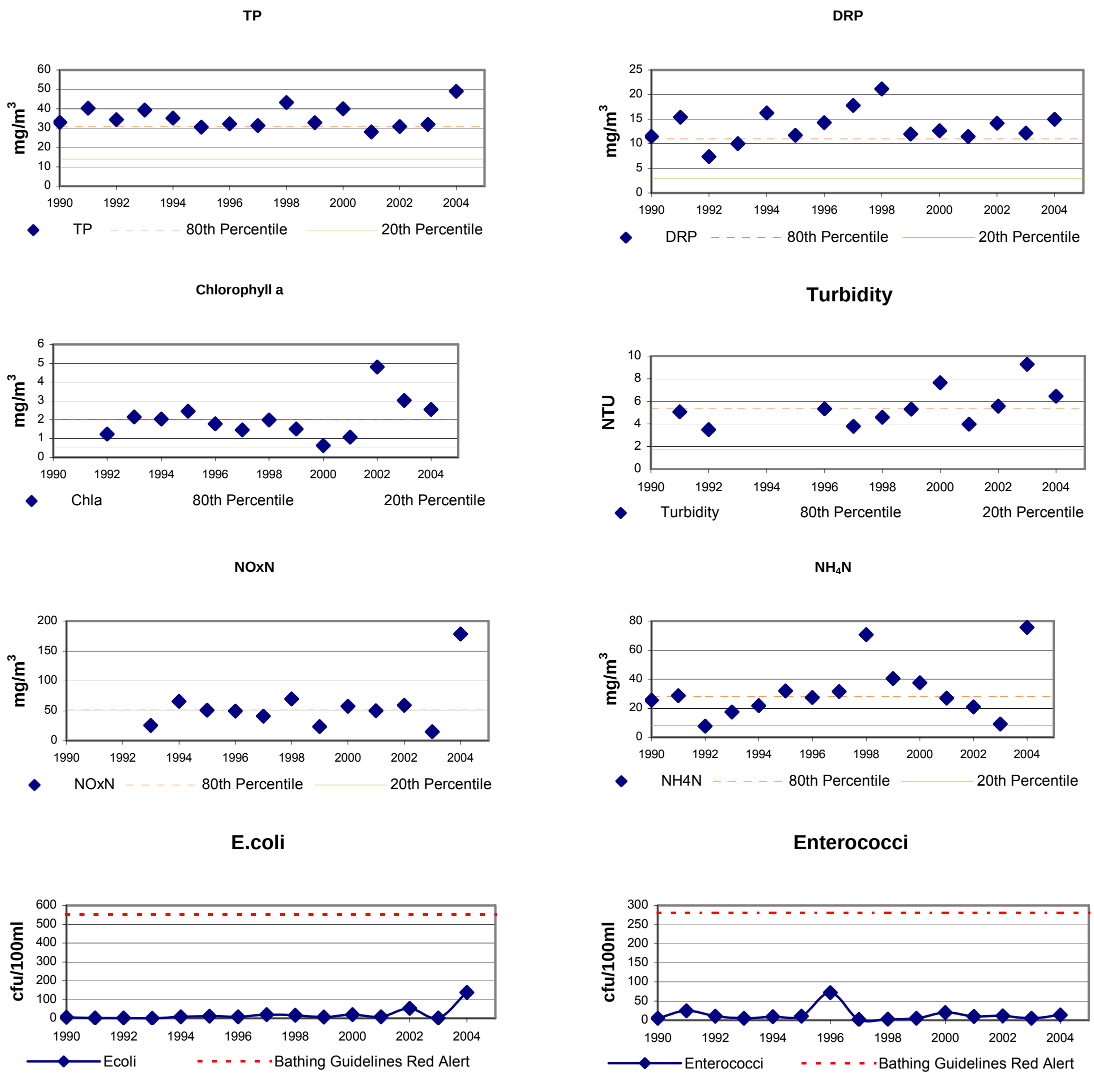


Figure 60 Average yearly concentrations and BOP Estuary 80th & 20th percentiles and guidelines, Maketu Estuary.

3.8 Kaituna River Estuary

The Kaituna River Estuary is approximately 0.2 km^2 and exits to the ocean at Te Tumu around 3.3 kilometres west of the Maketu Estuary mouth. Originally a flood led to the Kaituna River breaking out at Te Tumu in 1907, but the river migrated back to the Maketu Estuary with help. The river mouth was again diverted through the Te Tumu cut in 1956 with flood control works taking place in 1979.

The catchment area below Lake Rotoiti is approximately 620 km^2 with around the same area again forming the upper catchments of Lakes Rotoiti and Rotorua. Fluctuations and hence water quality in the river tends to be controlled by the lower tributaries due to the buffering effect of the lakes.

Eutrophication of Lakes Rotoiti and Rotorua has continued even with the implementation of the Upper Kaituna Catchment Control Scheme in 1975, and removal of Rotorua's treated sewage in 1991. In the lower catchment continued horticultural and livestock intensification, industrial discharges and Te Puke treated effluent discharges are likely to be the main drivers of water quality in the Kaituna Estuary.

3.8.1 Chlorophyll a

Figure 61 displays Chla concentrations in the Kaituna Estuary from 1995 to 2004. No significant trend is observed over the analysis period with concentrations in recent years showing a slight increase. Increases in Chla have also occurred in the lakes at the headwaters of the river. Concentrations are generally higher than those observed in local oceanic waters.

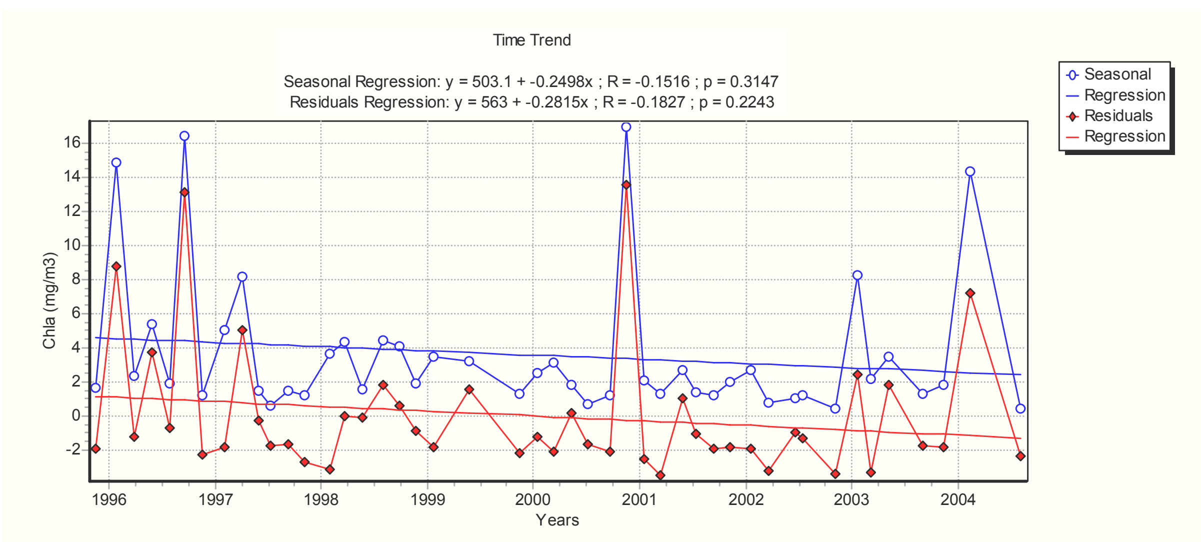


Figure 61 Chlorophyll a concentrations, Kaituna Estuary.

3.8.2 Turbidity

Turbidity in the Kaituna Estuary shows no significant trend over the analysis period. Flood flows have contributed to high turbidity experienced in early 2004. Turbidity is highest usually over the winter months.

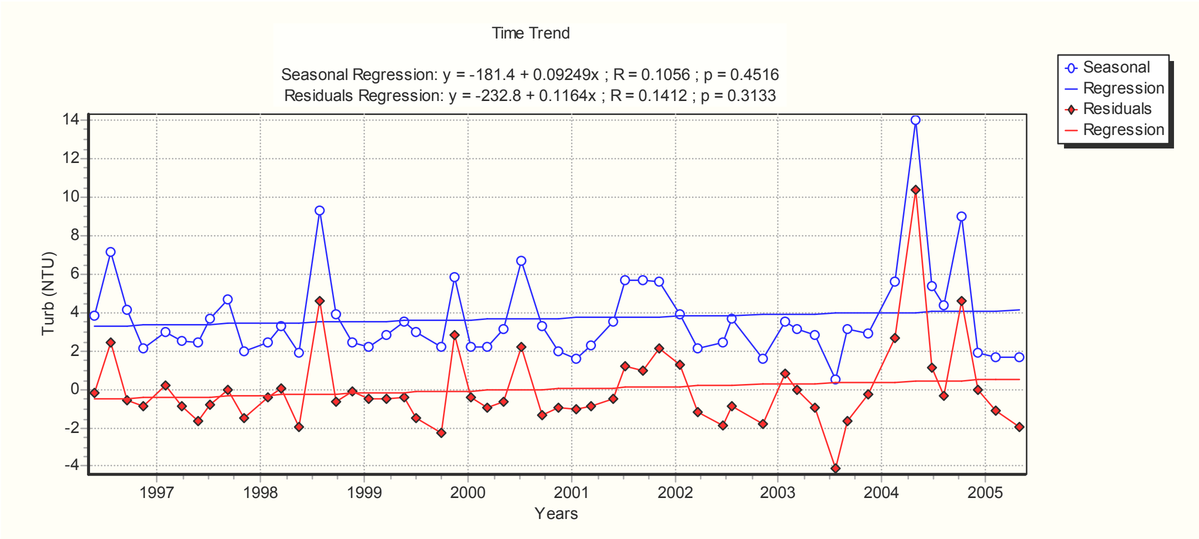


Figure 62 Turbidity, Kaituna Estuary.

3.8.3 Total Phosphorus

Figure 63 displays a significantly increasing trend for TP concentrations over the analysis period. One outlier has been removed from the data set (TP=855mg/m^3 on 29/04/04). Two trends can be seen in the data with levels decreasing from 1995 to 1999 and then increasing from 1999 to 2005. DRP concentrations have a similar trend to TP ($p<0.001$) although the correlation of DRP to TP is a weak one (Pearson $r=0.464$, $p<0.05$, $n=53$).

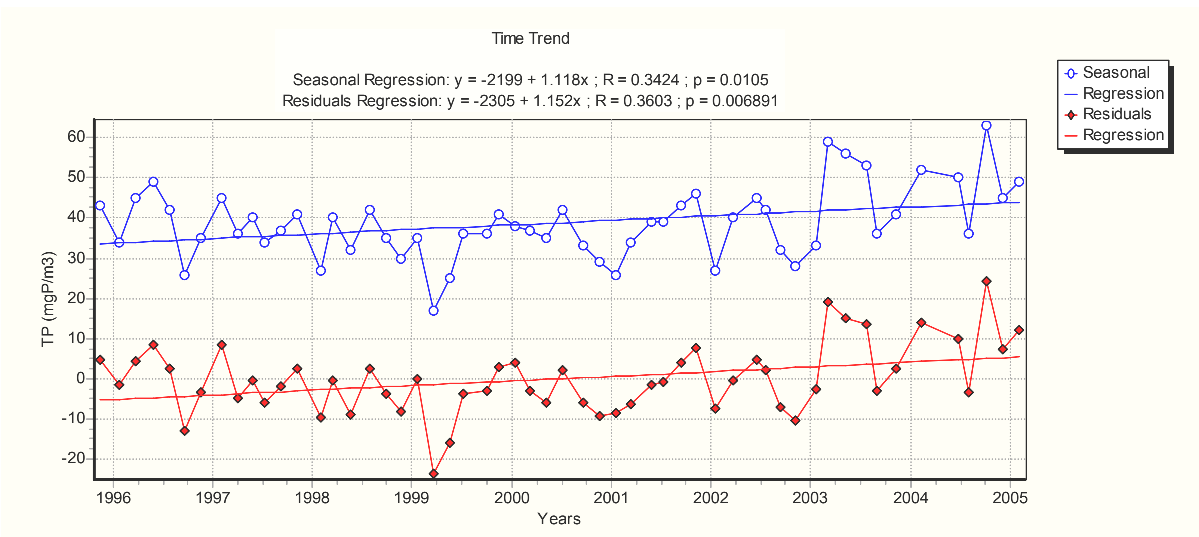


Figure 63 Total phosphorus concentrations, Kaituna Estuary.

3.8.4 Ammonium nitrogen

Ammonium nitrogen concentrations display no significant trend over the analysis period (Figure 64). Concentrations remain relatively consistent with fluxes being greatest generally over the winter months.

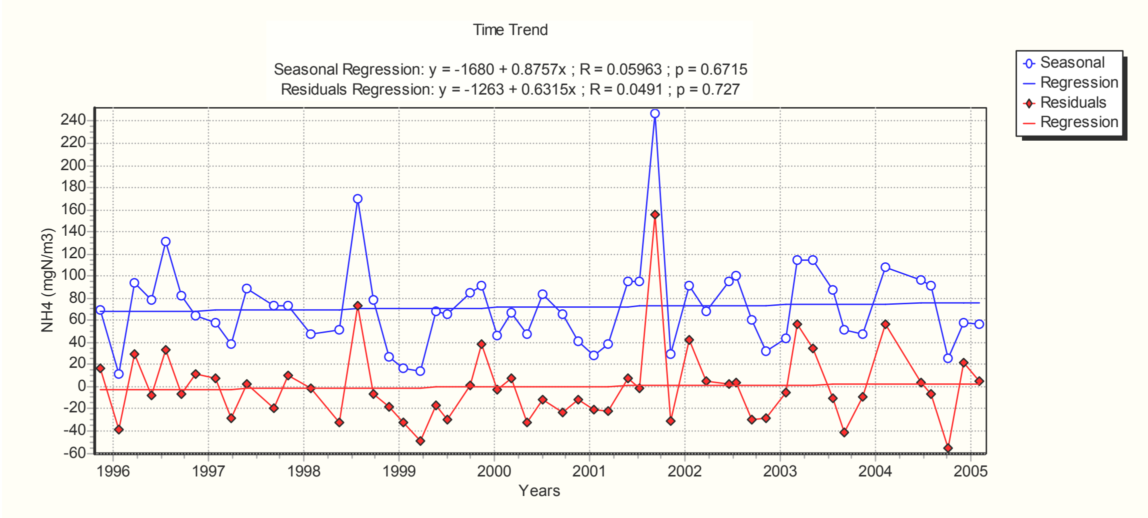


Figure 64 NH_4N concentrations, Kaituna Estuary.

3.8.5 Oxides of nitrogen

Figure 65 shows the NOxN concentrations for the Kaituna Estuary over the period 1995 to 2004.

Before and after adjusting for seasonality there is an increasing trend in concentrations over the analysis period. NOxN has relationships with TP (Pearson r=0.655, p<0.001, n=51) and conductivity (Pearson r=-0.701, p<0.001, n=52) indicating that higher concentrations are freshwater influenced as are TP concentrations. An increase in the number of freshwater dominated sampling events in the past couple of years will be partially responsible for this increasing trend.

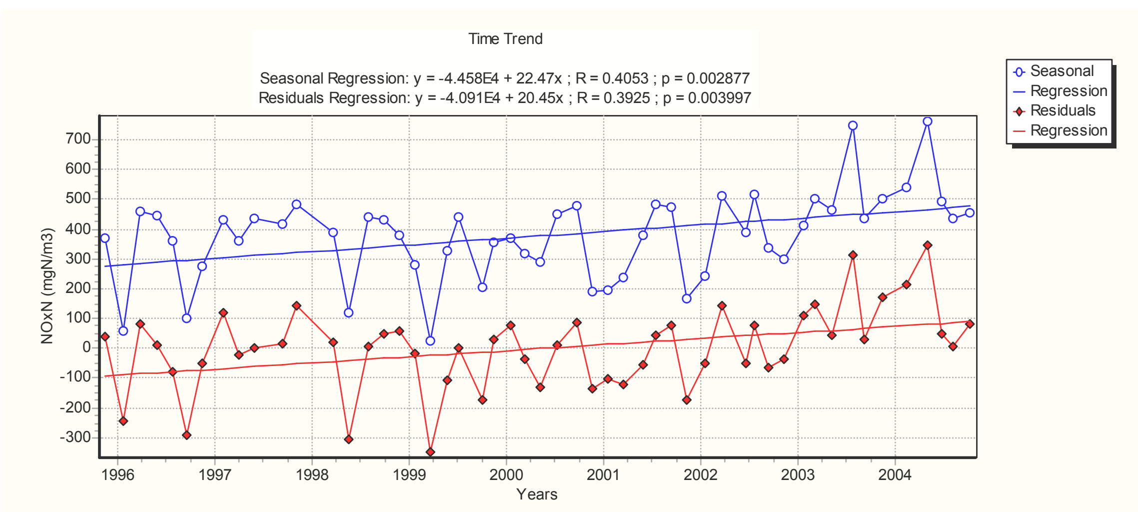


Figure 65 NOxN concentrations, Kaituna Estuary.

3.8.6 Indicator Bacteria

Of the two indicator bacteria species only enterococci show a significantly increasing trend over the analysis period. However, *E.coli* do show an increasing trend since 1999 (p=0.01, one outlier removed from data set: *E.coli*=13,000 on 29/04/04). The bathing red alert microbiological water quality guideline has been exceeded twice in recent monitoring for *E.coli* but not at all for enterococci.

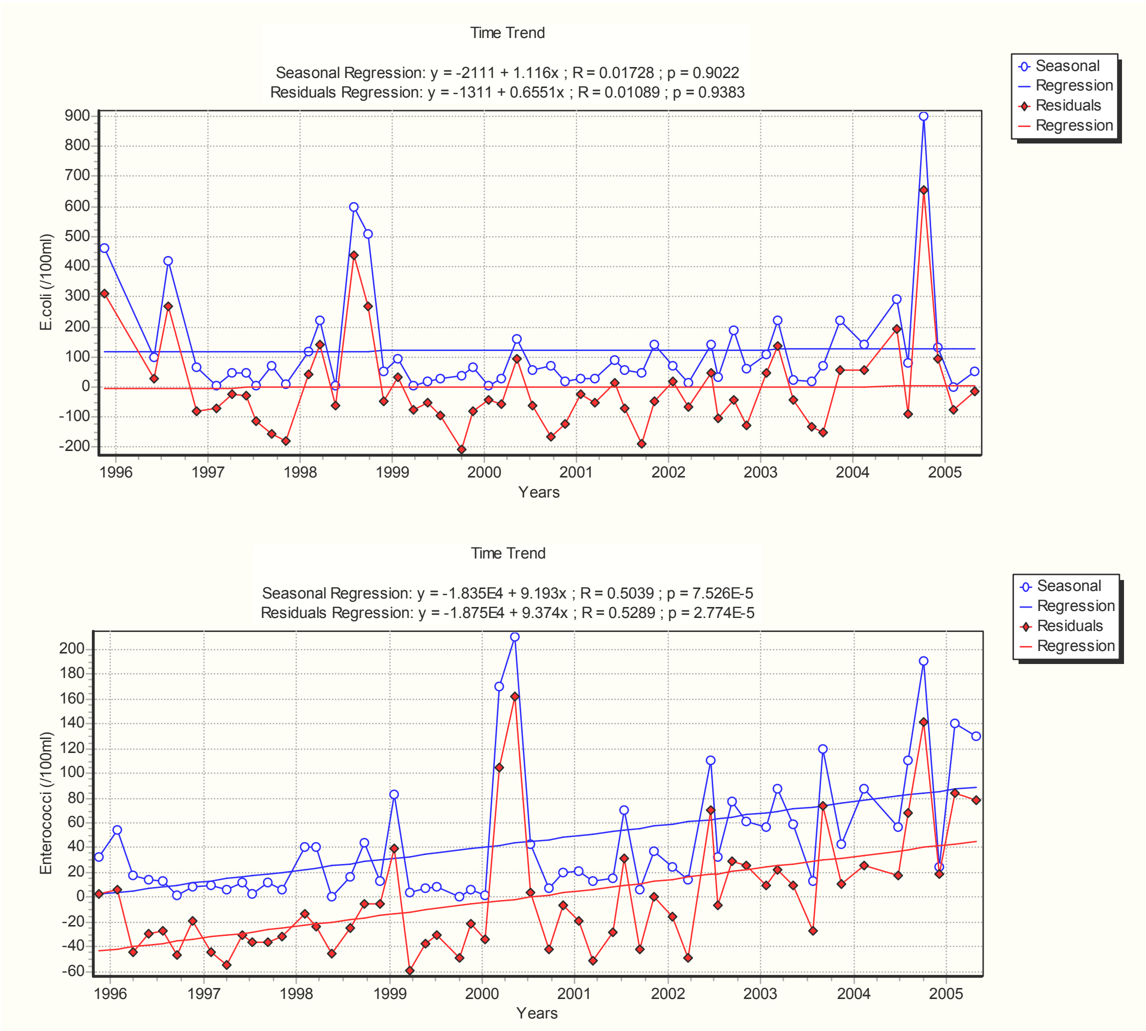


Figure 66 E.coli and enterococci concentrations, Kaituna Estuary.

3.8.7 Dissolved Oxygen and Temperature

Dissolved oxygen concentrations in the estuary display a significant but only slightly decreasing trend (-0.01 mg/l/year, p=0.03) over the 1995 to 2005 analysis period. For 7.3% of sampling occasions the standards set in the RCEP for oxygen saturation were not met. These occasions occurred in the last four years and samples were predominantly fresh water.

Temperature has also a significantly declining trend (p=0.02) over the analysis period with a change of approximately 0.15°C per year. Both trends in DO and temperature may be due to a greater number of samples being taken under low salinity conditions, that is when river water dominated the estuary as opposed to oceanic waters.

3.8.8 **Discussion**

The Kaituna River Estuary is displaying increasing trends in nutrients and bacterial levels. Phosphorus and nitrate concentrations levels are increasing and there is a correlations between these nutrients indicating the river as the major source of nutrients. Freshwater samples have dominated the sampling regime in the past couple of years and this may have influenced the rising trend of nutrients in the estuary. Such trends can also be seen in a decrease in DO and temperature which again indicates a dominance of freshwater flows to the estuary during the past few years sampling events. Sources of nutrients to the river include intensive livestock agriculture, Affco NZ Limited treated effluent discharge and Te Puke's treated effluent discharge.

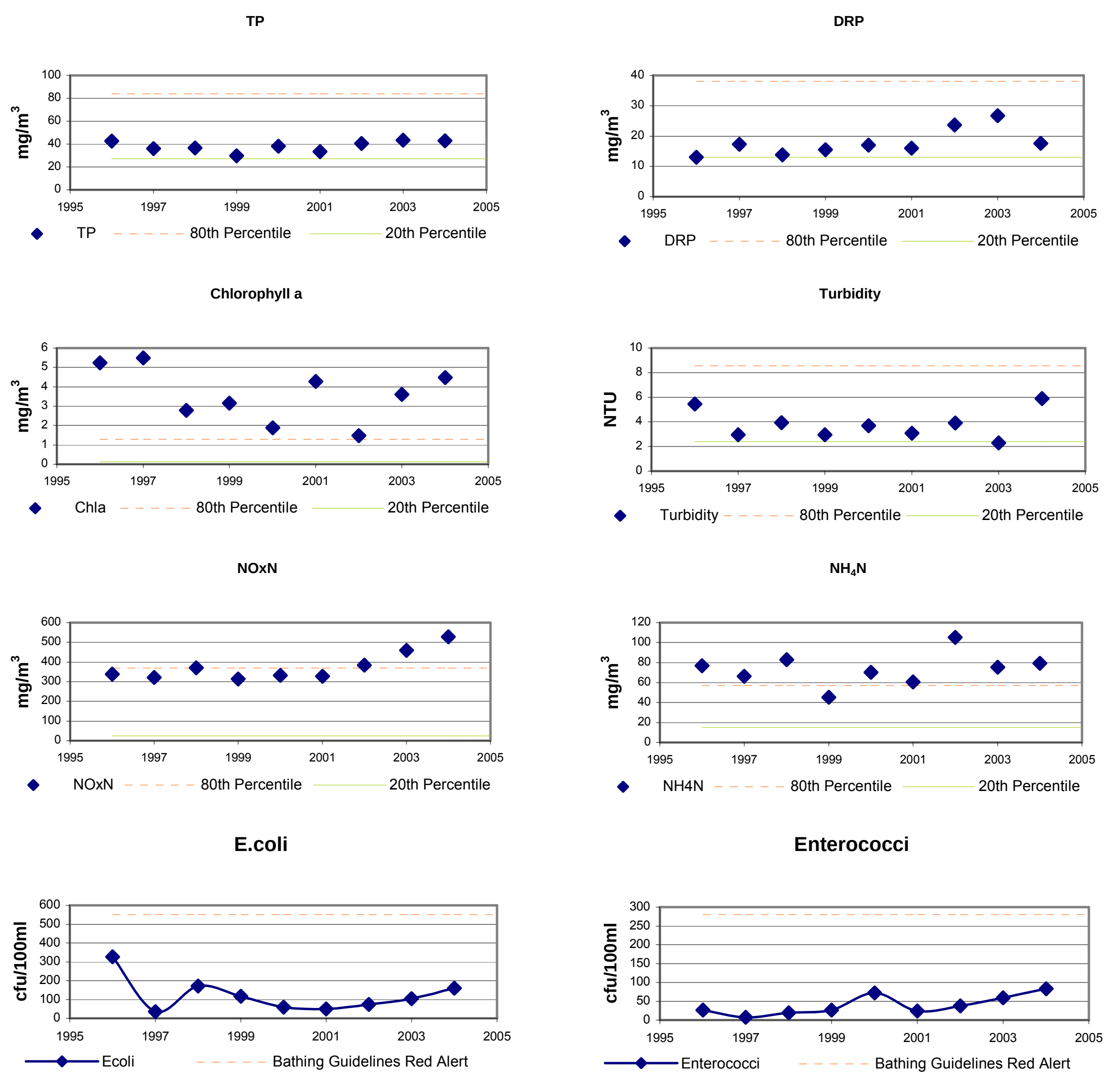


Figure 67 Average yearly concentrations and BOP Estuary 80th & 20th percentiles and guidelines, Kaituna Estuary.

This may not be the case for the increasing trend of indicator bacteria. The strongest trend is displayed in the increase in enterococci levels which survive longer in saline conditions. On average bacterial levels are well below the bathing guidelines red alert level. *E.coli* show a correlation with turbidity (Pearson $r=0.671$, $p<0.001$, $n=52$), a relationship not repeated with suspended solids. It is likely that these nutrients and bacteria stem from multiple sources such as agricultural runoff, industrial and urban derived discharges.

Phosphorus levels (TP and DRP) are generally below the 80th percentile for Bay of Plenty river estuaries (Figure 67), unlike the nitrogen parameters (NOxN and NH_4N) which are around or above the 80th percentile. On average over the last few years nutrient parameters reported here are above the ANZECC water quality guidelines trigger level for lowland rivers. However, few streams with their origins in the Central Volcanic Region meet the ANZECC water quality guidelines trigger level for lowland rivers.

Yearly averages for chlorophyll *a* concentrations are all above the 80th percentile for Bay of Plenty river estuaries, indicating the Kaituna estuary to be one of the more phytoplankton rich estuaries.

3.9 Tauranga Harbour

Tauranga Harbour is a large tidal estuarine inlet with two entrances with a total area of 201 km^2. The estuarine lagoon is impounded by a barrier island (Matakana Island) and two barrier tombolos. Mount Maunganui at the southern entrance and Bowentown to the north (Park, 1991). The estuary is predominantly shallow with approximately 66% of its total area being intertidal.

There are three predominant harbour basins. The largest basin is in the north and this is separated from the southern basins by intertidal flats in the central of the harbour. The other basin is smaller and includes several sub-estuaries and large bays. At mean high water the northern basin has a volume of approximately 177,702,000 m^3 and the southern basin a volume of 277,518,000 m^3.

The northern harbour catchment is the smallest with a total area of 270 km^2 and a mean freshwater inflow of 4.1 cms^{-1}. The Wairoa River catchment at 460 km^2 and mean freshwater inflow of 17.6 cms^{-1} is the largest feeding into Tauranga Harbour. In the northern harbour the freshwater inflow represents only 0.1% of the harbour volume per tidal cycle while the southern input represents 0.48%.

The harbour catchment covers an area of approximately 1,300 km^2 and is used extensively for horticulture and agriculture. At the southern end of the harbour, the city of Tauranga and surrounding area supports a large residential population (around 100,000). Near the southern entrance the harbour has well developed port facilities. For more detail on sub-catchment areas and land use see Park, 2003.

3.9.1 Southern Harbour

The southern catchment has a total area of 1,030 km^2 and a mean freshwater inflow of 30.5 cms^{-1}. It encompasses most of the Tauranga city urban area and so has the greatest population numbers in its catchment.

For the purposes of presenting water quality data the southern basin has been split into two parts. One area is represented by sampling points located in Rangataua and Waipu Bays, known as Town Basin the other area is the Otumoetai Channel in the main southern part of the harbour just to the east of the Wairoa Estuary. Water quality trends for the Southern Harbour are summarised in Table 6.

Table 6 Water quality trends, Town Basin and Otumoetai Channel Tauranga Harbour.

Site	Analysis Period	Chla	Turb	SS	TP	NH_4N	NOxN	E.coli	Ent
Maungatapu	90 - 05	-	-	↑ (p<0.001)	↓ (p=0.03)	-	-	-	-
Toll Bridge Marina	98 - 05	-	-	↑ (p<0.01)	-	-	↓ (p=0.05)	-	-
Grace Street *Low tide*	91 - 05	ND	-	-	-	-	-	-	-
Otumoetai	91 - 05	↑ (p=0.03)	↑ (p=0.04)	↑ (p<0.01)	-	-	-	↑ (p=0.04)	-
Otumoetai Low tide	91 - 05	ND	-	-	↓ (p=0.05)	-	↓ (p=0.03)	ND	ND
Yacht Club	92 - 99	ND	-	-	↓ (p<0.01)	-	-	-	-

ND= no or limited data, ↑=increasing trend, ↓= decreasing trend, - = no trend, p = Bonferroni probability.

3.9.2 Town Basin

Monitoring is presented from the combined data of three sites: Maungatapu Bridge; Grace Street; and Toll Bridge/Marina. Grace Street is monitored during low tide conditions and analysis has only occurred for nutrients, SS and turbidity while the other two sites are monitored during high tide conditions. It is random whether sampling occurs on an incoming or outgoing tide so a wide range of tidal conditions are monitored.

3.9.3 Chlorophyll a

Monitoring data is limited for Chla concentrations within the Town Basin, but as Figure 68 displays there has been a significant decrease in concentrations since 1992/1994. From 1998 to 2005 no trend is apparent with Chla levels remaining stable. Concentrations tend to be greatest over the summer period as productivity increases with the warmer temperatures. There is little low tide data from the Grace Street site so trends are base on mid-tide to high tide monitoring.

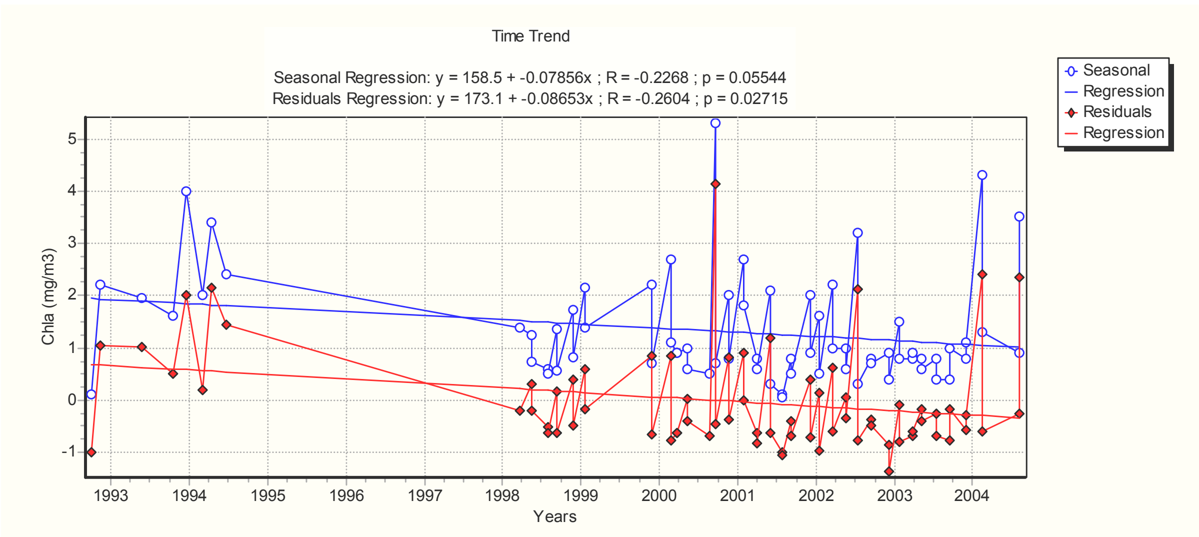


Figure 68 Chlorophyll a concentrations, Town Basin, Tauranga Harbour.

3.9.4 Turbidity and Suspended Solids

Figure 69 displays the turbidity and suspended solids levels for the Town Basin. There exists a larger data set for SS than turbidity, so data in this case has been examined over different periods.

Monitoring of the Town basin for SS shows no significant trend over the analysis period, however for the Toll Bridge/Marina and Maungatapu site a significant trend is seen (Table 6). There is a correlation between SS data between the Maungatapu and Toll Bridge/Marina sites (Pearson $r=0.737$, $p<0.001$, $n=43$; one outlier removed). A similar relationship also exists between Otumoetai and Toll Bridge/Marina and for both these sites a correlation of wind speed with SS exists ($p=0.01$). Wind activity has been stronger in the past two years. Such activity creates greater wave action stirring up sediments into the water column and is likely to be the main driver in increasing SS concentrations trends seen in this basin.

No increasing trends are seen in the turbidity, rather the opposite is seen in a significant but slight decreasing trend. Turbidity and SS do not correlate at the Toll

Bridge/Marina and Maungatapu sites but there is a strong correlation between these two parameters at Grace Street (Pearson r=0.939, p<0.001, n=50). Turbidity and SS concentrations are higher during low tide than high tide and as there is no correlation of turbidity and SS at the high tide monitoring sites. as well as the change in hydrodynamics, freshwater input in the shallow channels at low tide is a source of different sediment compared to oceanic dominated waters at high tide. It is possible that little fine material is suspended in the water column with re-suspension of sediment through wave action at mid to high tide. Instead coarse sand is suspended, which adds to the SS load but does not significantly effect the turbidity of the water.

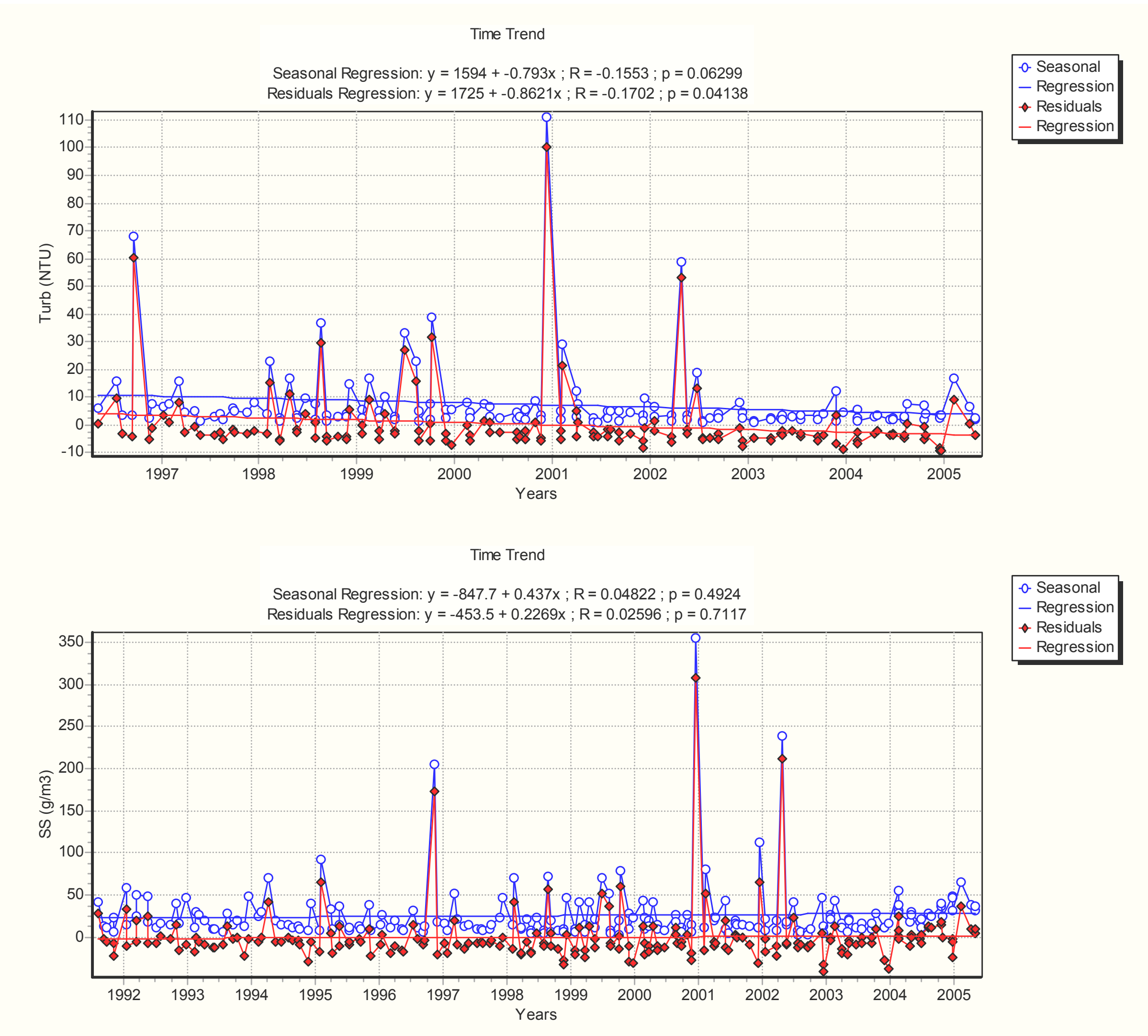


Figure 69 Turbidity and SS concentrations, Town Basin, Tauranga Harbour.

3.9.5 Total Phosphorus

TP concentrations in the Town Basin has a significantly deceasing trend over the analysis period (Figure 70). Only one site, Maungatapu (Table 6), displayed this same trend at a statistically significant level. No seasonal trend is obvious in the data.

The Toll Bridge/Marina site is distinct from the other two sites in that it does not correlate with SS data. Grace Street (Pearson r=0.897, p<0.001, n=81) and

Maungatapu (Pearson r=0.804, p<0.001, n=80) show reasonable correlations possibly indicating a phosphorus rich source distinct to these sites. DRP did not show any similar correlations to TP.

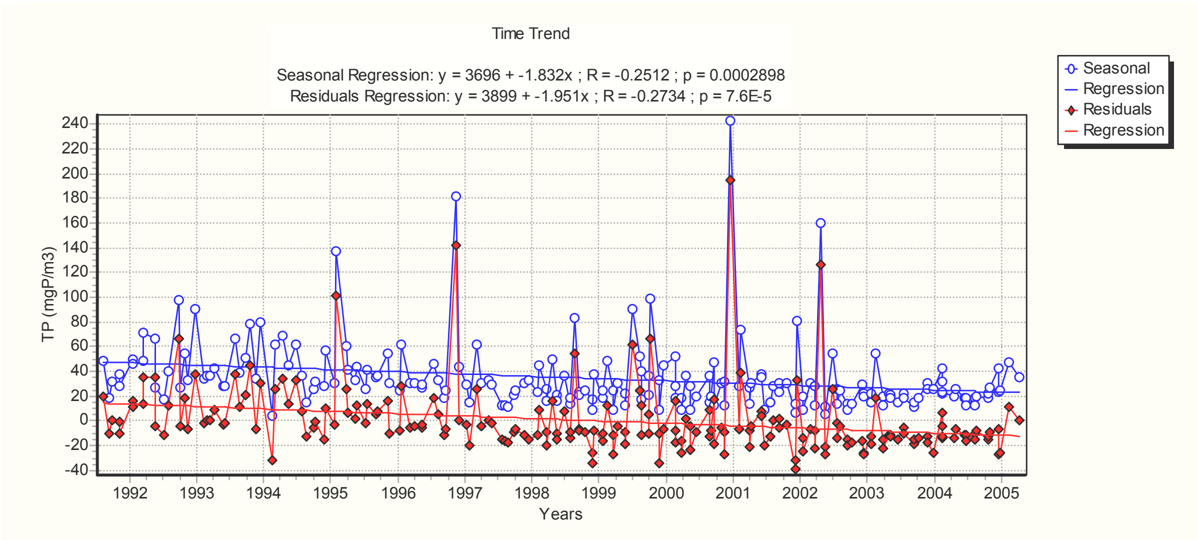


Figure 70 TP concentrations, Town Basin, Tauranga Harbour.

3.9.6 Ammonium nitrogen

Figure 71 shows the ammonium nitrogen concentrations in the Town Basin over the analysis period 1991 to 2005. No significant trend is shown for this analysis period and this is the same for individual sites. However, a significantly decreasing trend is displayed for the period 1996 to 2005 (p=0.04).

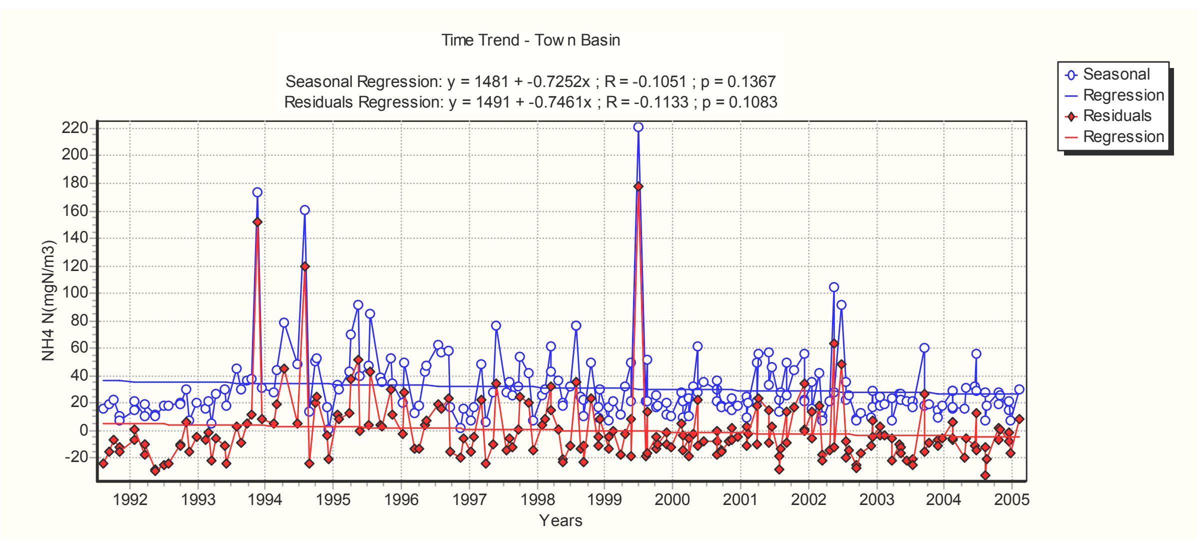


Figure 71 NH_4N concentrations, Town Basin, Tauranga Harbour.

3.9.7 Oxides of nitrogen

Figure 72 displays non-significant decreasing trend for NOxN over the analysis period. Only one site displays a significant decrease and that is Toll Bridge/Marina (Table 6). NOxN concentrations as expected are highest over the winter months. NOxN has a negative relationship with conductivity at low tide (r=-0.625, p<0.001, n=45) indicating that fresh water flows under low tide conditions introduce NOxN enriched waters to the estuary.

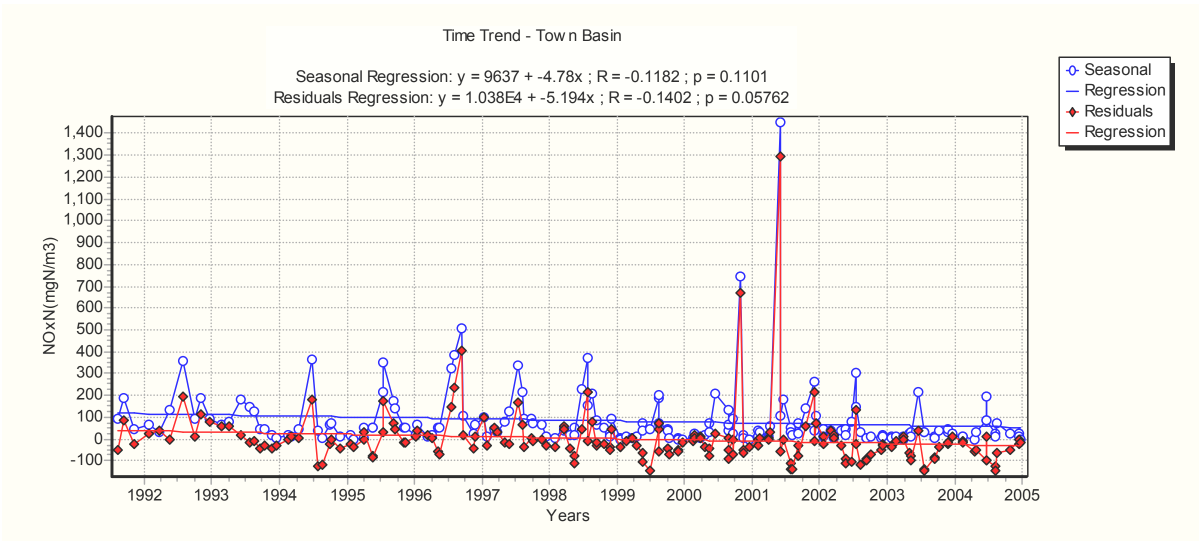


Figure 72 NOxN concentrations, Town Basin, Tauranga Harbour.

3.9.8 Indicator bacteria

Indicator bacteria data for the two Town Basin sites of Maungatapu and Toll Bridge/Marina are presented in Figure 73. No significant trends are found over the analysis period. Enterococci and *E.coli* data do correlate at both sites (p<0.001) indicating bacteria come from a similar source.

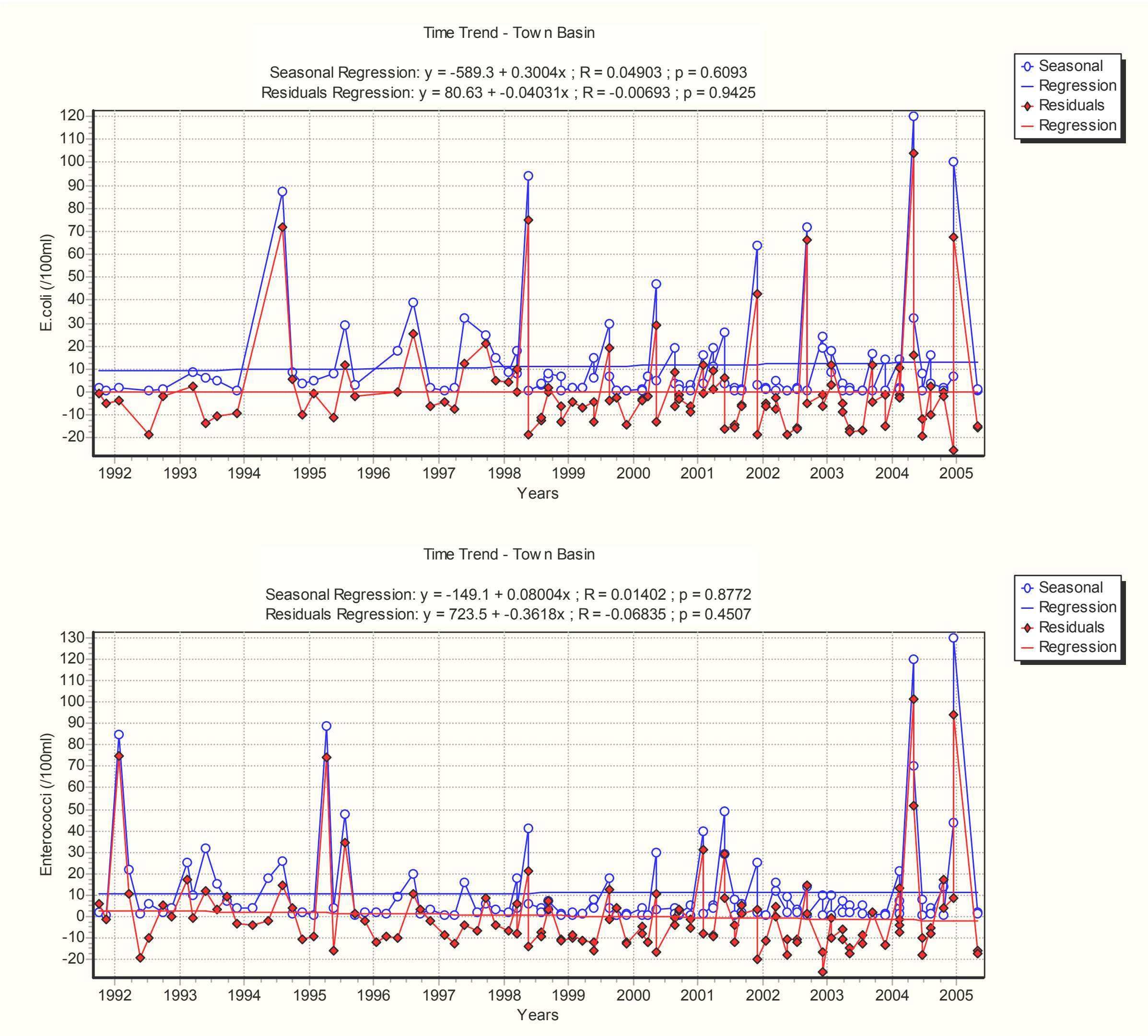


Figure 73 E.coli and enterococci concentrations, Town Basin, Tauranga Harbour.

3.9.9 Other Parameter Results

Temperature at the Toll Bridge/Marina site has shown a significant decreasing trend since 1998 with a decrease of 0.15°C/yr. This corresponds to a significantly increasing DO concentration at this site. Only one sample did not comply with RCEP oxygen saturation standard of 80% or greater.

3.9.10 Discussion

Generally water quality in the Town Basin is stable and showing some improvement in recent times over some water quality parameters.

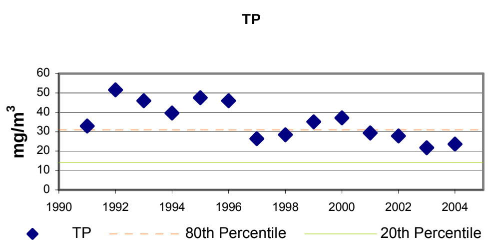
Total phosphorus levels are deceasing with yearly averages now under the 80th percentile for Bay of Plenty estuaries (Figure 74). DRP concentrations remain relatively steady with no obvious trends shown. Correlations of TP with SS in the Town Basin may indicate a phosphorus source being picked up in the southern Town Basin sites. One potential source is the Balance Agri-Nutrients fertilizer works were the discharge plume has been shown to enter the Town Basin on the incoming tide.

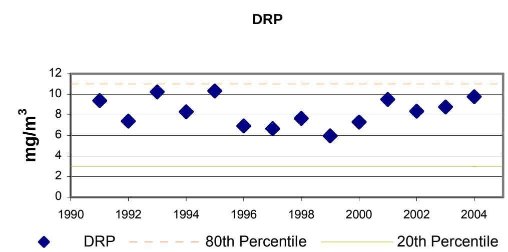
Chlorophyll *a* concentrations have also improved and this may be in part due to less prolific sea lettuce blooms in recent years.

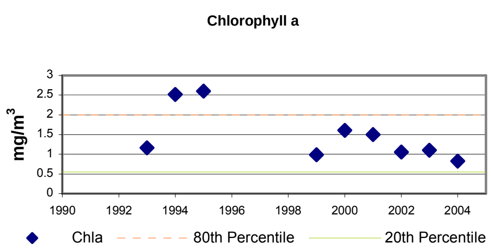
Turbidity levels have been high in the past in this basin but in the last few years have showed some improvement to be on average below the 80th percentile for Bay of Plenty estuaries. However, suspended solids concentrations have shown an increase in recent years due mostly to increased turbulence in the water column causing sediment to be suspended. Why this has not affected turbidity must be a function of grain size and dominance of clearer oceanic waters.

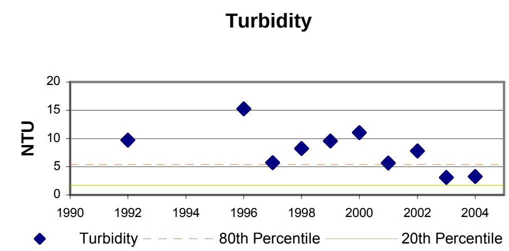
While NOxN concentrations have shown some improvement in the past few years the trend is not significant. However, average levels have improved to be under the 80th percentile for Bay of Plenty estuaries. Likewise NH_4N levels are displaying a significantly decreasing trend over the past ten years with levels also dipping below the 80th percentile for Bay of Plenty estuaries.

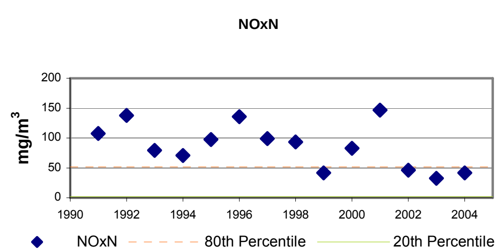
Indicator bacteria are within guideline limits with no exceedences over the red alert microbiological water quality guideline. *E.coli* and enterococci correlate well indicating a similar source although it is not clear what the source(s) might be.

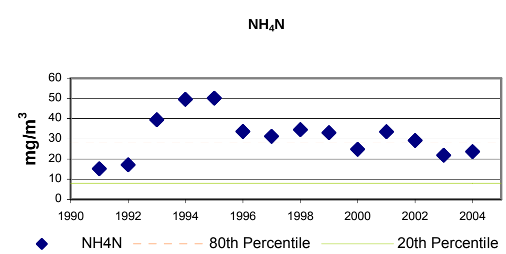












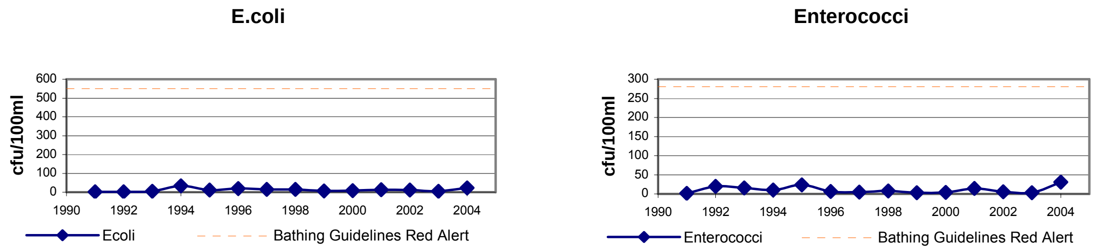


Figure 74 Average yearly concentrations and BOP Estuary 80th & 20th percentiles and guidelines, Town Basin, Tauranga Harbour.

3.9.11 Otumoetai Channel

Monitoring of the Otumoetai Channel is performed at three sites named Otumoetai Beach Road (high tide), Yacht Club (high tide) and Otumoetai Kulim Avenue (low tide). The Yacht Club site was discontinued in 1999.

3.9.12 Chlorophyll a

Figure 74 shows Chla concentrations monitored in the Otumoetai Channel over the analysis period. No significant trend is displayed over the analysis period for the channel as a whole, however there is a significantly increasing trend for Chla concentrations at Otumoetai Beach site (Table 3). At this site Chla has a relationship with SS (Pearson r=0.599, p=0.002, n=40) indicating that a substantial proportion of the suspended solids is organic material. This supposition is not well supported by previous organic solids determination.

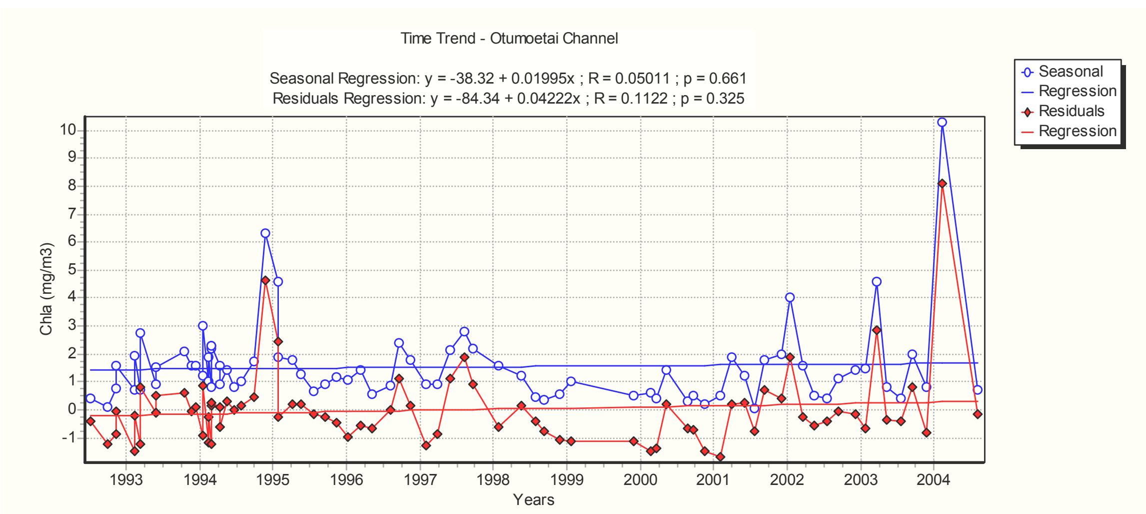


Figure 75 Chlorophyll a concentrations, Otumoetai Channel, Tauranga Harbour.

3.9.13 Turbidity and Suspended Soilds

The Otumoetai Channel does not exhibit any trends in turbidity or SS over the analysis period. However the Otumoetai Beach site has a significantly increasing trend in both turbidity and SS. Like, the Town Basin sites SS can be correlated to increased wind speed. As high wind speeds have been experienced predominantly during monitoring in the last few years, a trend is exhibited.

Also similar to Town Basin, there is good correlation between turbidity and SS at the low tide site (Pearson r=0.938, p<0.001, n=51), but not for the high tide site.

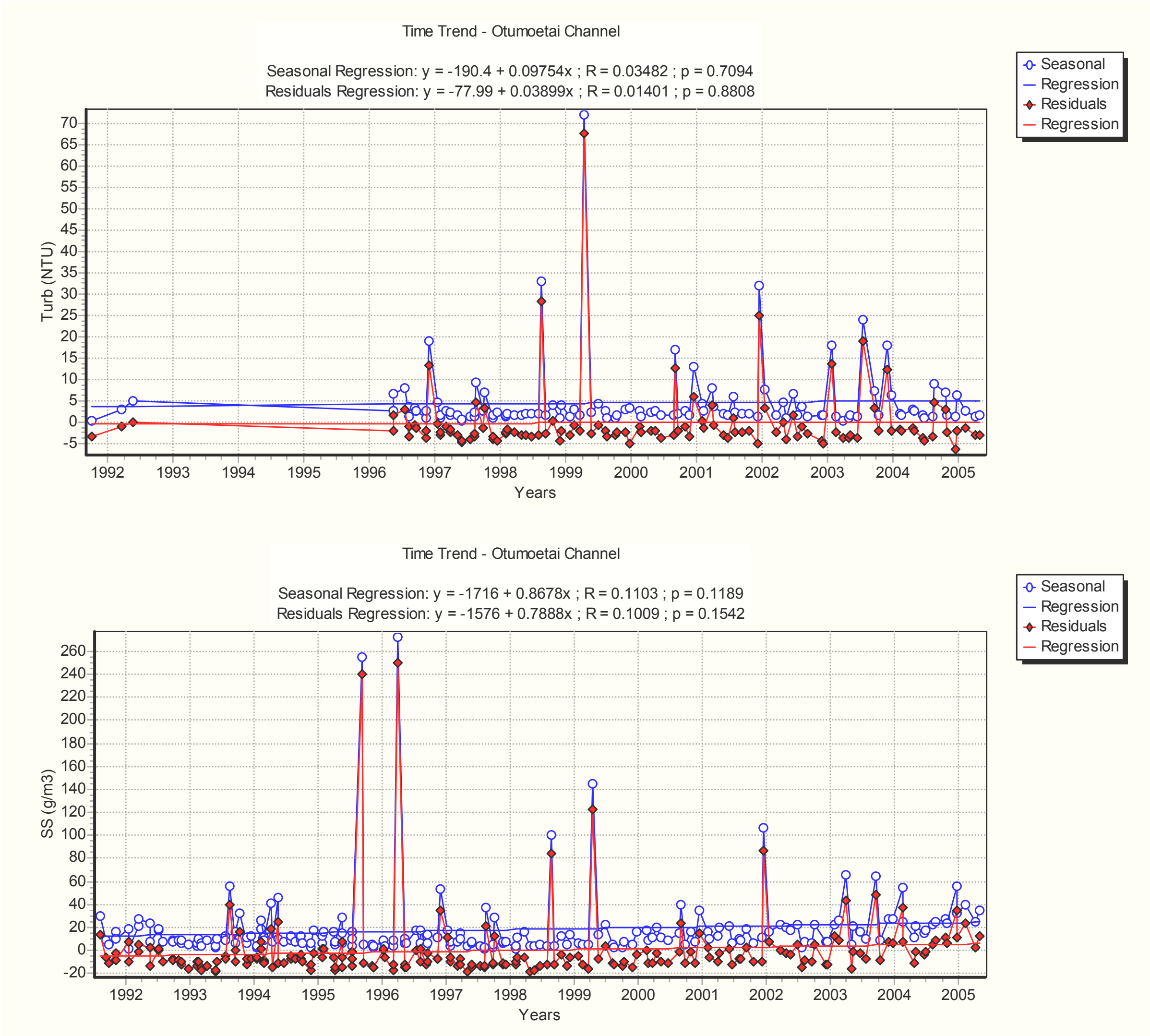


Figure 76 Turbidity and SS concentrations, Otumoetai Channel, Tauranga Harbour.

3.9.14 Total Phosphorus

Figure 77 displays TP concentrations for the Otumoetai Channel from 1991 to 2005. The trend over this period is a significantly decreasing one for both deseasonalised data and monitoring data. Individually, the Kulim Avenue and Yacht Club sites both show significantly decreasing trends, with Otumoetai Beach having a downward trend for the analysis period.

TP displays a relationship with SS at both the Otumoetai Beach site (Pearson r=0.504, p<0.001, n=81) and the Kulim Avenue site (Pearson r=0.917, p<0.001, n=81).

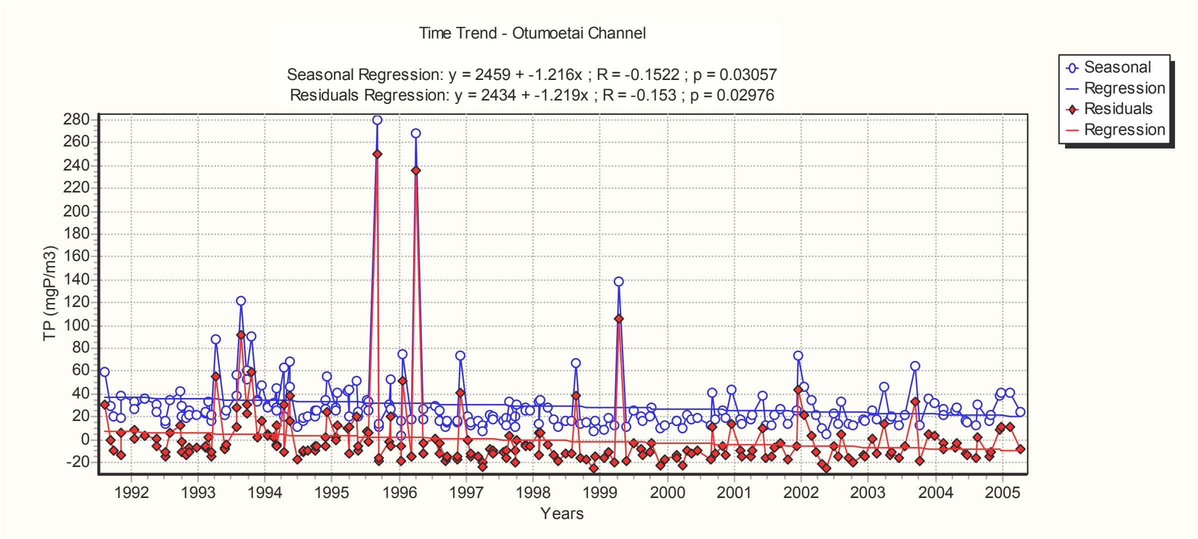


Figure 77 TP concentrations, Otumoetai Channel, Tauranga Harbour.

3.9.15 Ammonium nitrogen

NH_4N concentrations in the Otumoetai Channel show no significant trends over the analysis period (Figure 78). Fluctuations have occurred with levels rising periodically, but these have been more stable over the past few years.

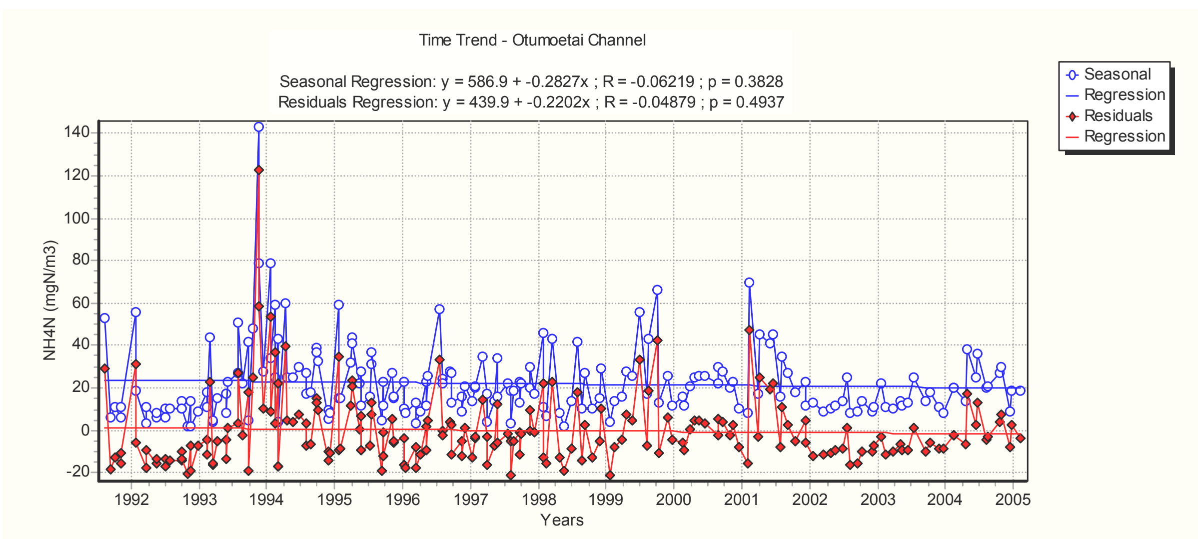


Figure 78: NH_4N concentrations, Otumoetai Channel, Tauranga Harbour.

3.9.16 Oxides of nitrogen

Figure 79 shows a significant trend in the deseasonalised data for NOxN concentrations in the Otumoetai Channel (one outlier removed). The Kulim Avenue site is the only individual site to show a significantly decreasing trend (Table 6). As expected maximum concentrations occur over the winter months.

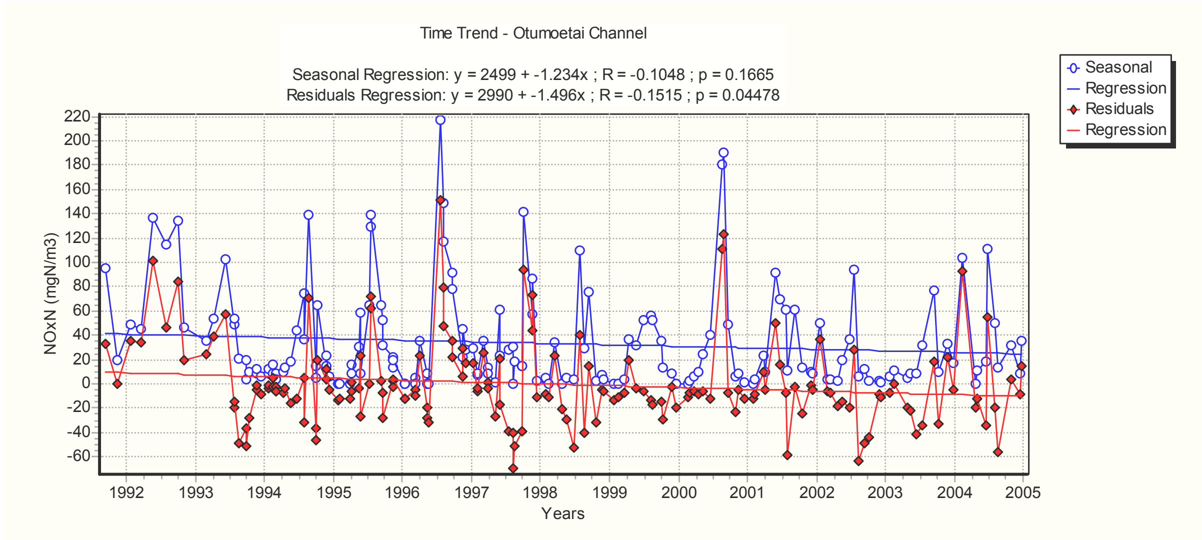


Figure 79 NOxN concentrations, Otumoetai Channel, Tauranga Harbour.

3.9.17 Indicator Bacteria

Indicator bacteria data only exist for the high tides sites. *E.coli* show a significantly increasing trend over the analysis period (Figure 80), while enterococci show no trend. However, analysis of data after 1992 indicates a significantly increasing trend for enterococci, as an outlier is removed. These increasing trends display no correlation with other water quality attributes.

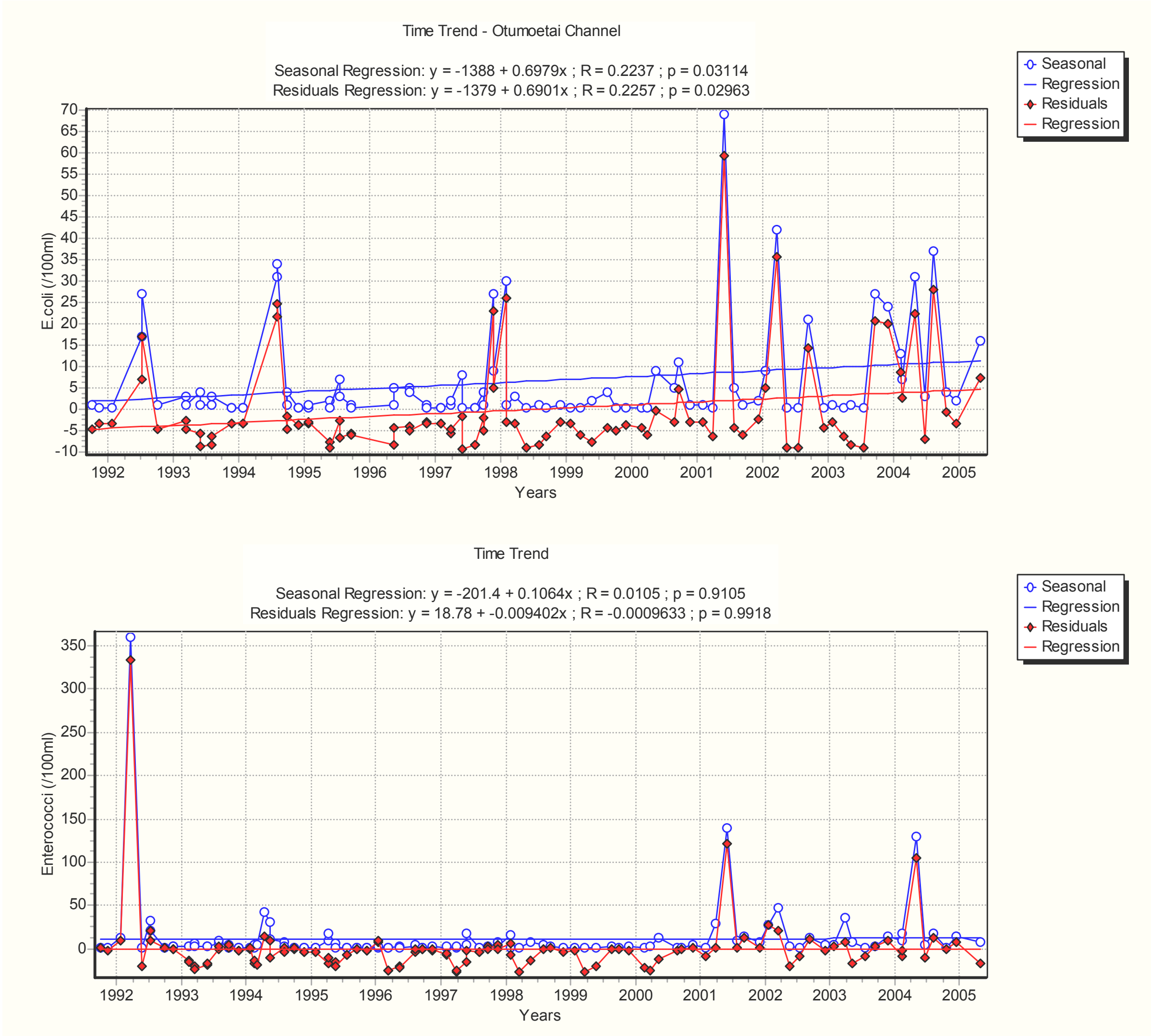


Figure 80 E.coli and enterococci concentrations, Otumoetai Channel, Tauranga Harbour.

3.9.18 **Other Parameter Results**

DO is measured at high tide sights only. DO content has not met the RCEP standard for 80 percent oxygen saturation 3 times in the last 14 years of monitoring. However DO concentrations in the channel have been showing an increasing trend (p=0.03). This may again be due to sampling during turbulent conditions due to increased wind speeds.

3.9.19 Discussion

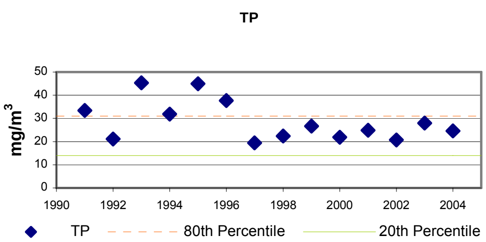
The water quality in the Otumoetai Channel is influenced not only by urban discharges but also from the Wairoa River. Even with these influences water quality is relatively stable and showing some improvements in nutrient levels but deterioration in bacterial water quality.

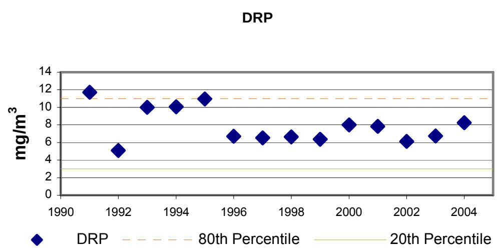
Total phosphorus levels are deceasing with yearly averages under the 80th percentile for Bay of Plenty estuaries (Figure 81) for the last seven years. Yearly average DRP concentrations show a similar trend.

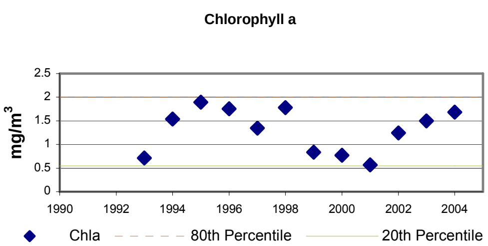
Chlorophyll *a* concentrations are at a low level in the channel and are within the 80th percentile for Bay of Plenty estuaries. Blooms of sea lettuce abundance shows little correlation with chlorophyll *a* concentrations although blooms have been a dominant feature in recent years. Ammonium nitrogen concentrations do show similar fluctuations to sea lettuce abundance and this may be caused by the break down of sea lettuce.

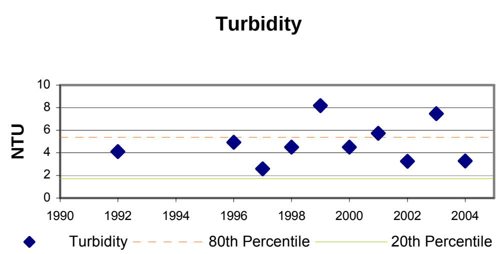
Like the Town Basin, the Otumoetai suspended solids levels seem to be governed by re-suspension of sediment by wind energy. However, this is not the case for turbidity at high tide, only at low tide.

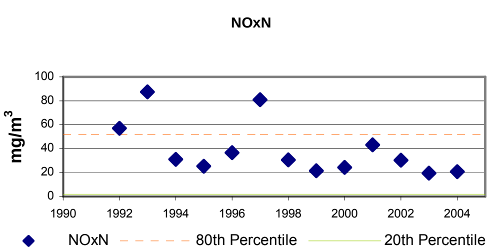
Average yearly DIN levels are well within the 80th percentile for Bay of Plenty estuaries (Figure 81). NOxN concentrations have shown a decreasing trend and this may in part be due to removal of the output of treated sewage to the Otumoetai Channel since 1996.

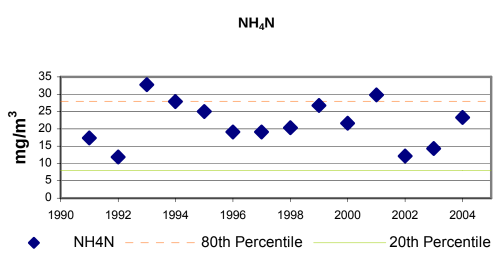


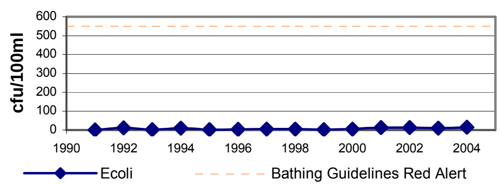












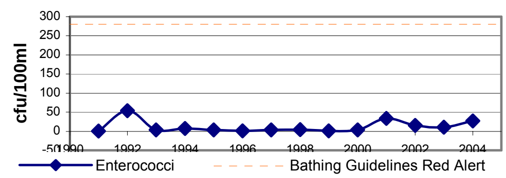


Figure 81 Average yearly concentrations and Bay of Plenty Estuary 80th & 20th percentiles and guidelines, Otumoetai Channel, Tauranga Harbour.

Indicator bacteria levels are on average below the red alert microbiological water quality guidelines, but have been showing a trend of increasing in the past few years.

3.9.20 South Basin

The South Basin water quality has been monitored predominantly by two sites, Te Puna and Omokoroa with a third site added at Pahoia in 1998. All sites are monitored mid-tide to high tide. Table 4 displays the trends analysis for the three sites over the sites monitoring periods.

Analysis of the South Basin over the period 1991 to 2005 has used data from Te Puna and Omokoroa sites with another analysis examining data from 1998 to 2005 for the Pahoia site (Table 5).

Table 7 Water quality trends, South basin, Tauranga Harbour.

Site	**Analysis Period**	**Chla**	**Turb**	**SS**	*TP*	**NH_4N**	**NOxN**	**E.coli**	**Ent**
Te Puna	91 - 05	-	-	↑ ($p<0.001$)	-	-	-	↑ ($p=0.03$)	↑ ($p<0.005$)
Omokoroa	91 - 05	↓ ($p<0.001$)	-	↑ ($p<0.005$)	↓ ($p<0.005$)	-	-	-	↑ ($p=0.03$)
Pahoia	98 - 05	-	-	-	-	-	-	-	-

ND= no or limited data, ↑=increasing trend, ↓= decreasing trend, " –" = no trend, p = Bonferroni probability.

3.9.21 Chlorophyll a

Figure 82 displays the Chla concentrations at two sites within the South Basin from 1992 to 2004. No significant trend is displayed over this analysis period, however a significant decline in Chla concentrations is seen at the Omokoroa site (Table 7). Chla levels generally reach a maximum over summer as temperatures increase.

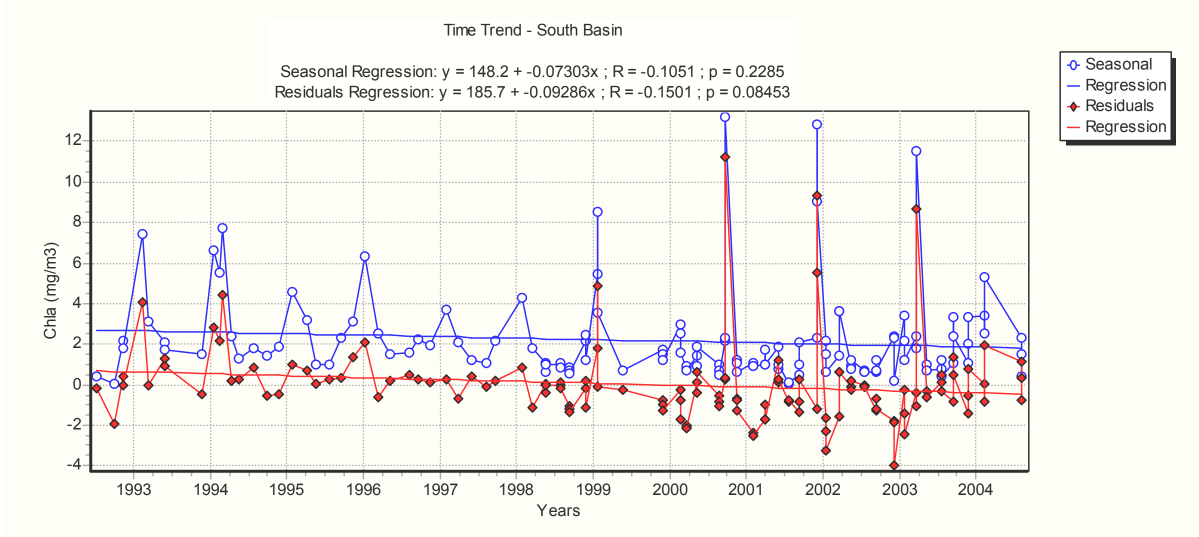
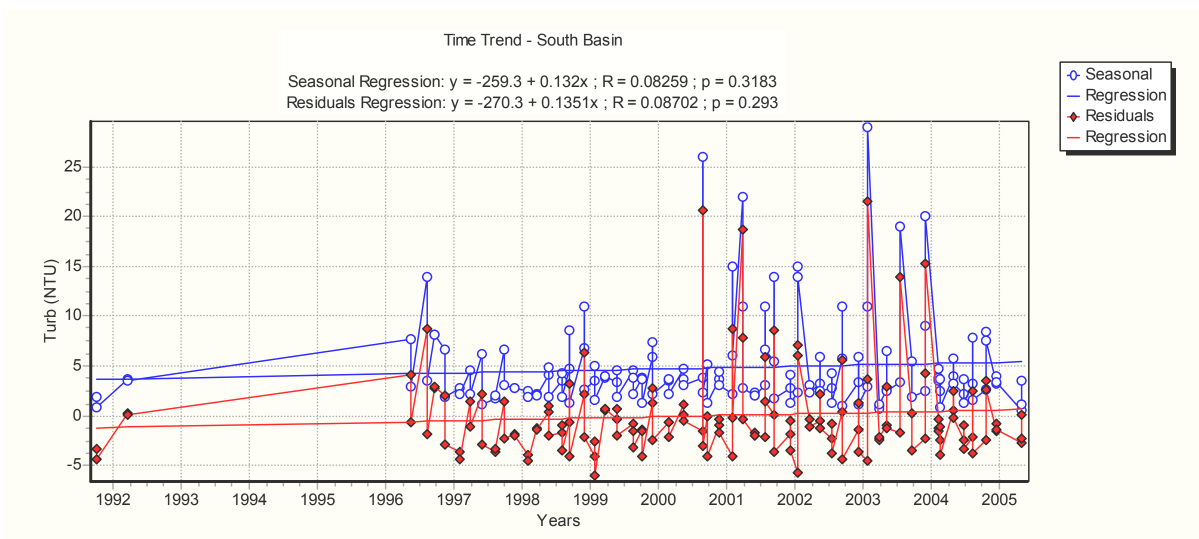


Figure 82 Chlorophyll a concentrations, South Basin, Tauranga Harbour.

3.9.22 **Turbidity and Suspended Solids**

Turbidity monitoring in the South Basin displays no significant trends over the analysis period (Figure 83). SS monitoring does show an increasing trend over the 1991 to 2005 analysis period and this trend becomes steeper from 1998. Only the Pahoia site does not display this increasing trend in SS levels. Turbidity and SS do not correlate for any of these sites.

The Te Puna site is similar to the Otumoetai and Town Basin sites in that an increase in SS levels in recent times is a function of sampling during high wind events. This does not hold true for Omokoroa and Pahoia sites.



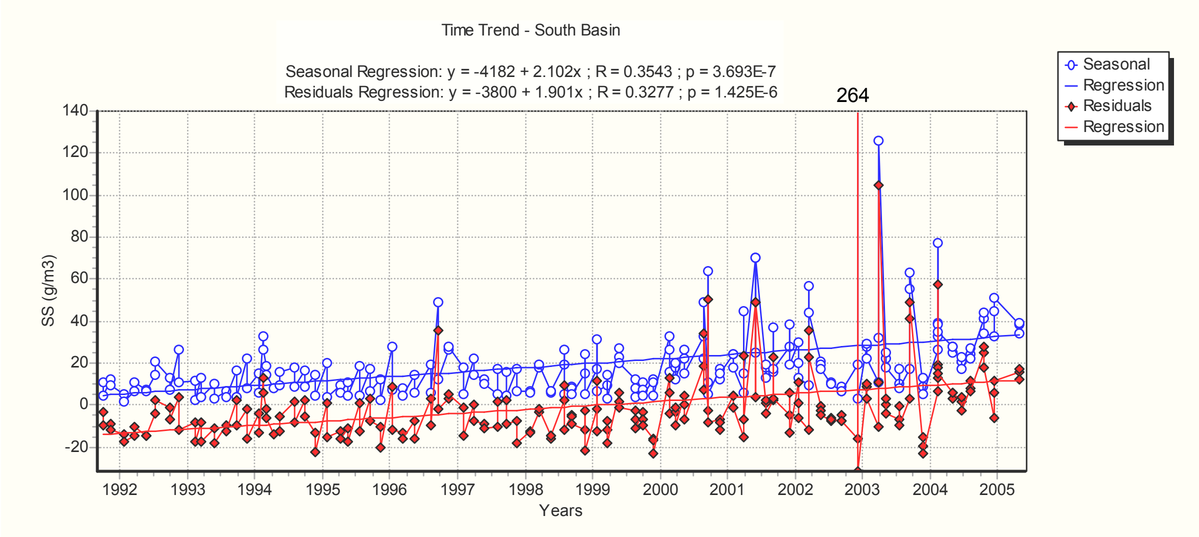


Figure 83 Turbidity and SS concentrations, South Basin, Tauranga Harbor.

3.9.23 **Total Phosphorus**

Figure 84 displays a significant trend of decreasing TP concentrations in the South Basin. No seasonal trend in obvious in the data. All sites show a correlation of TP with Chla (Pearson r=0.513-0.706, p<0.001). As both parameters show a decrease at various sites phytoplankton productivity may be limited with respect to phosphorus.

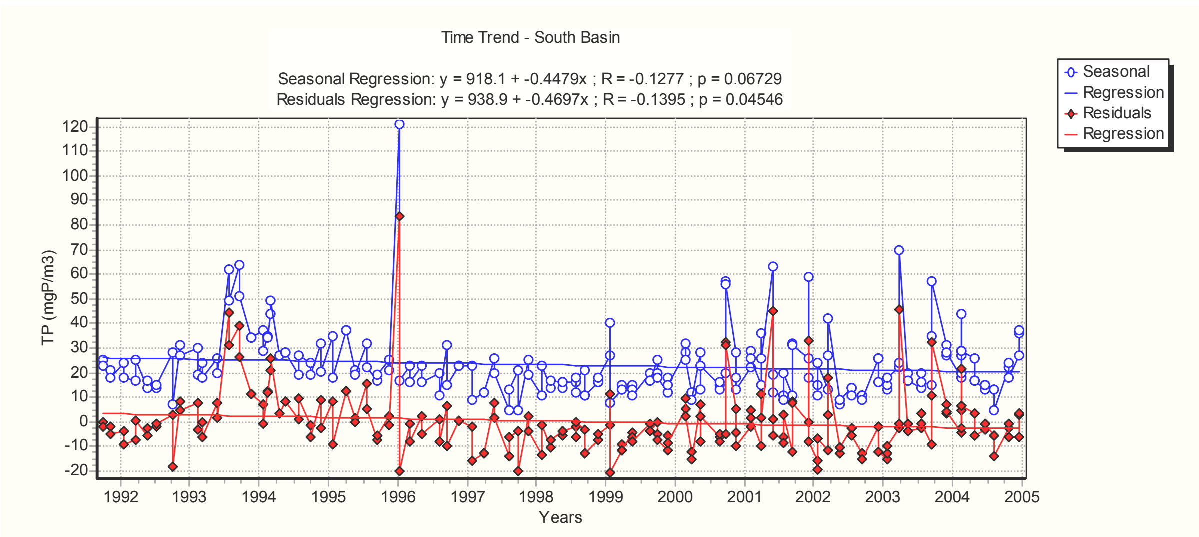


Figure 84 TP concentrations, South Basin, Tauranga Harbor.

3.9.24 **Ammonium nitrogen**

Ammonium nitrogen show no significant trends over the analysis period. After relatively low levels monitored from the end of 1991 to midway through 1993 levels increased to subside back to a more regular pattern of winter highs and summer lows.

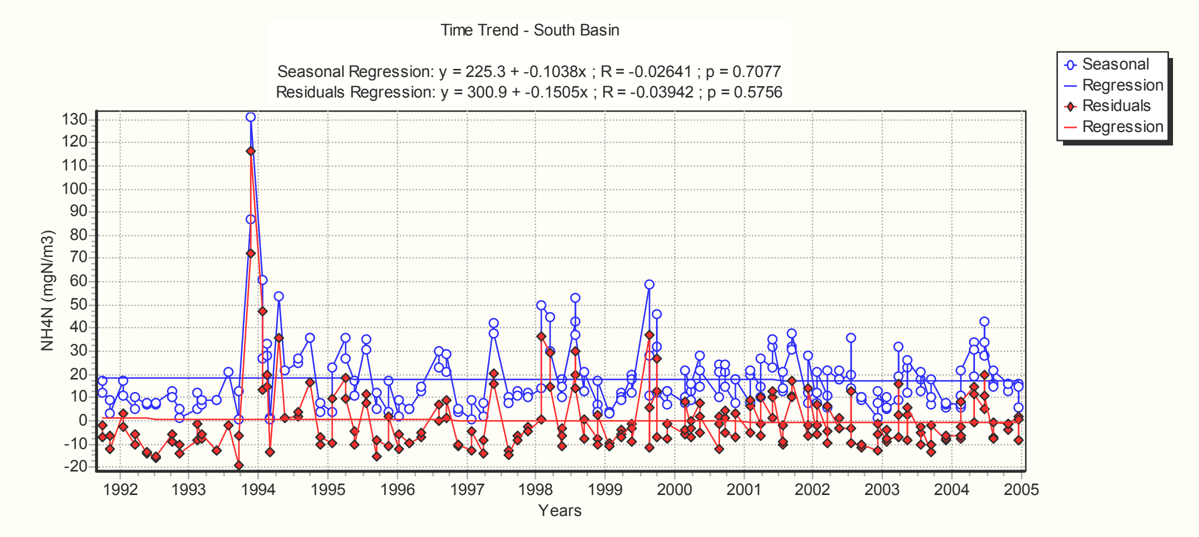


Figure 85 NH_4N concentrations, South Basin, Tauranga Harbor.

3.9.25 Oxides of nitrogen

Figure 86 displays NOxN concentrations and deasonalised residual data for South Basin. No significant trend is seen in the residual analysis over the analysis period. No individual site displays a significant trend over their respective analysis periods (Table 7). A strong seasonal pattern is shown with maximum NOxN concentrations occuring over the winter months. Such a seasonal pattern is usual in estuarine waters as phytoplankton reduce their uptake of NOxN during the colder months. This also means that any nutrient rich bottom waters upwelling to the surface can accentuate the NOxN signature because of the reduced phytoplankton.

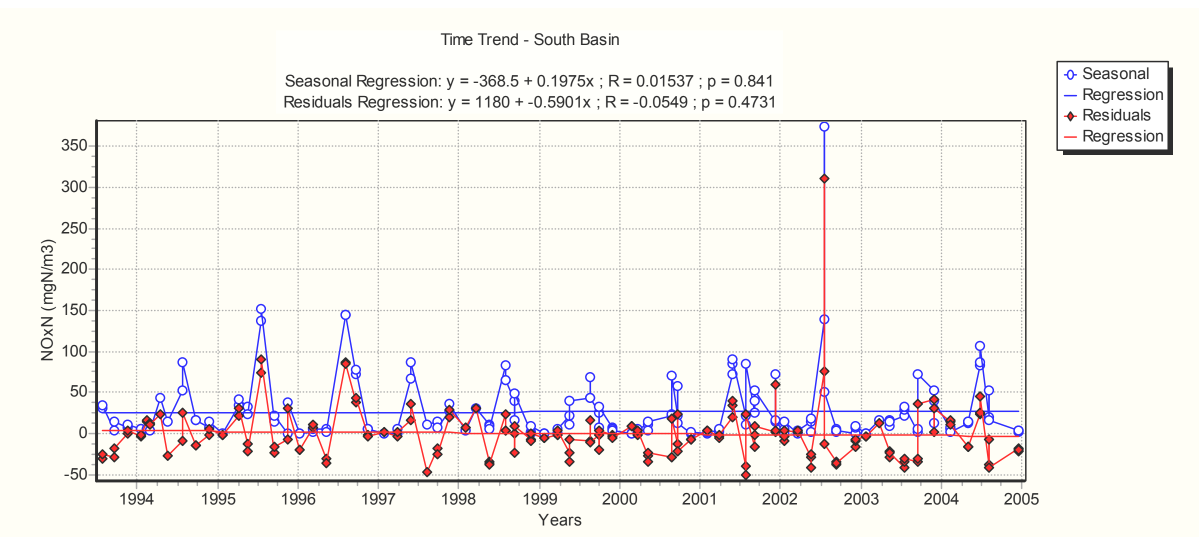


Figure 86 NOxN concentrations, South Basin, Tauranga Harbor.

3.9.26 **Indicator Bacteria**

There are significantly increasing trends for both bacteria species in the South Basin. No significant trend is found for the shorter analysis period at Pahoia although the trend is an increasing one.

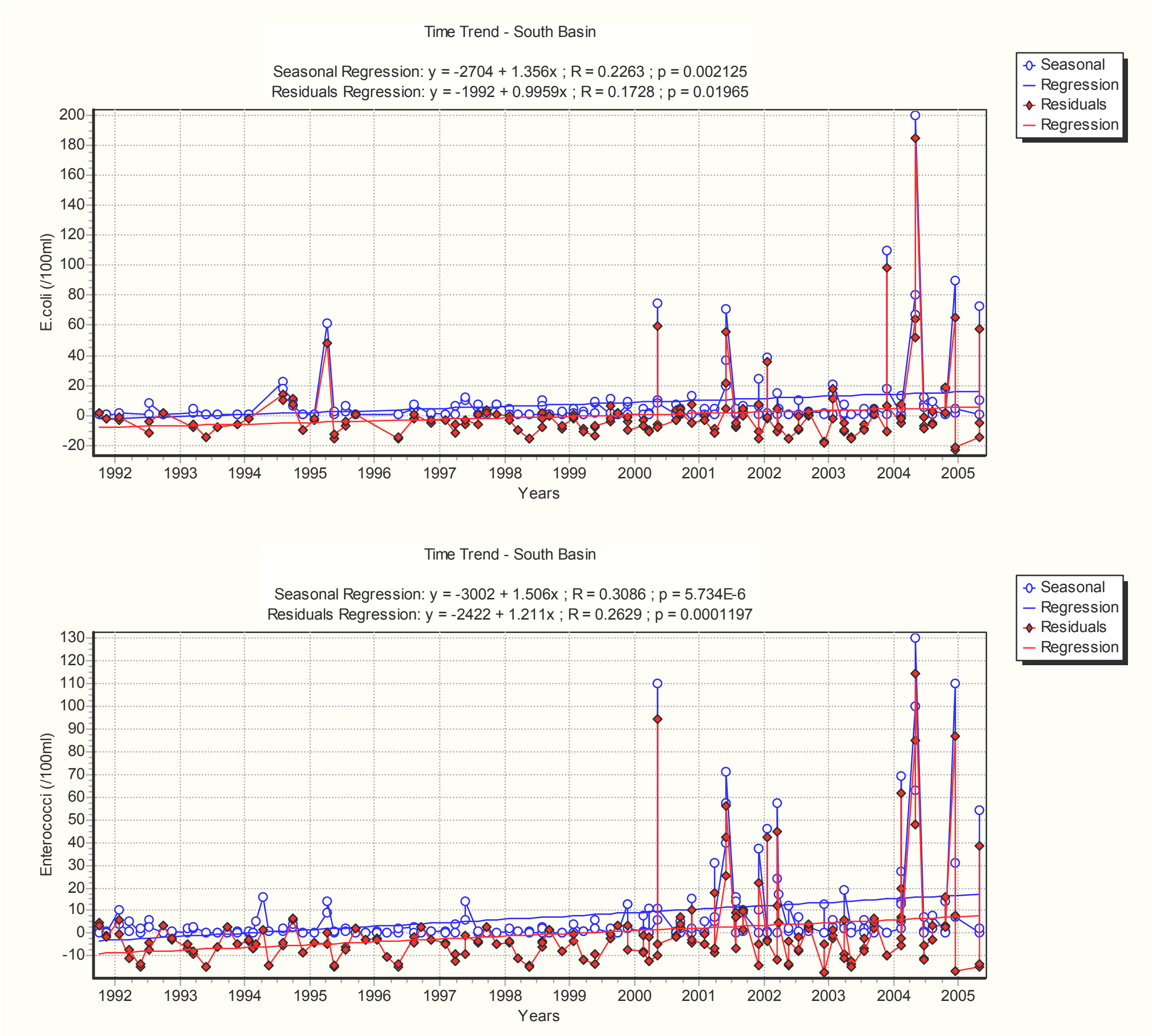


Figure 87 E.coli and enterococci concentrations, South Basin, Tauranga Harbor.

3.9.27 **Other Parameter Results**

Both temperature (p<0.001) and DO (p=0.02) show significantly increasing trends over the 1991 to 2005 analysis period. Over the last few years the rate of increase in DO has increased while temperature displays a decreasing trend.

At the three sites monitored in the basin over the respective analysis periods the 80% dissolved oxygen saturation standard was not met on five occasions.

3.9.28 **Discussion**

The water quality of the South basin is generally stable with most water quality parameters at a moderate level with respect to other Bay of Plenty estuaries.

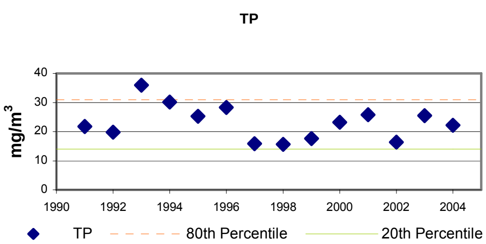
TP is one parameter that has exhibited a significant decrease in the past fourteen years. Average yearly levels have been under the 80th percentile for Bay of Plenty estuaries as have DRP levels (Figure 88). Average DRP levels are low compared to other estuarine systems.

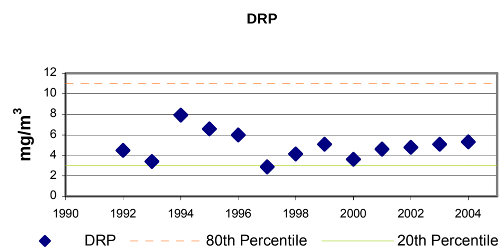
One possible reason for the lower phosphorus levels is due to phytoplankton productivity as shown by the higher Chla levels found in the South Basin. A decease in both Chla and TP also strengthens this relationship indicating phosphorus to be a limiting factor in the estuary.

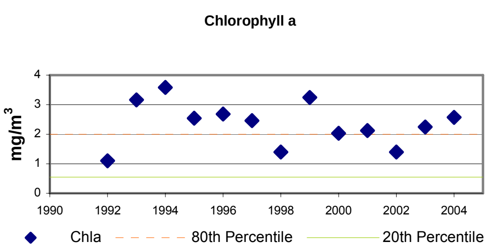
There are no trends shown for ammonium nitrogen or oxides of nitrogen with both parameters having levels typical of Bay of Plenty estuaries (Figure 88).

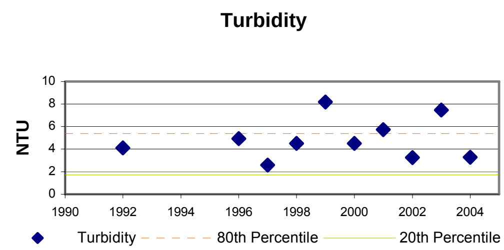
Concentrations for both *E.coli* and enterococci are below the red alert level as defined by the microbiological water quality guidelines (2003). Environmental conditions (wind and wave suspension) may be responsible an increasing trend as is the case for suspended solids at some locations.

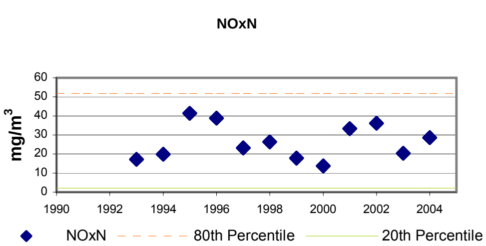
Dissolved oxygen and temperature also show increasing trends over the long term data, but in the shorter term dissolved oxygen is increasing while temperature is decreasing. Dissolved oxygen levels have on occasion been below RECP standards.

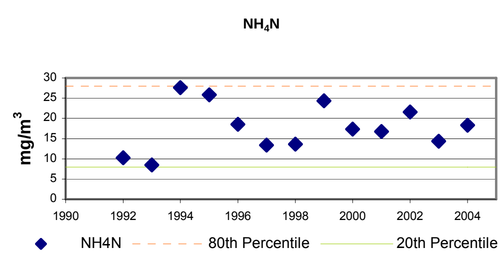












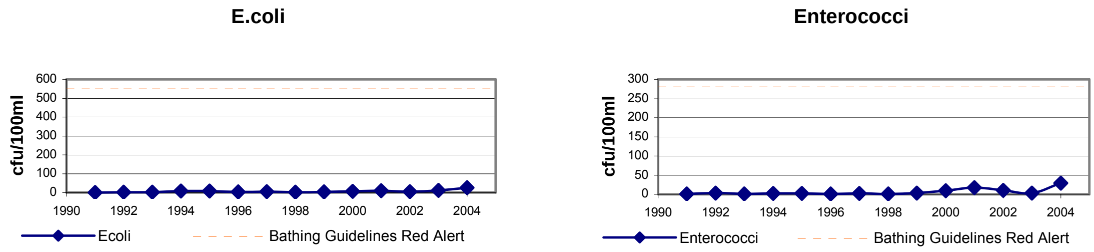


Figure 88 Average yearly concentrations and BOP Estuary 80th & 20th percentiles and guidelines, South Basin, Tauranga Harbour.

3.9.29 North Basin

There have been eight sites monitored in the North Basin with Bowentown Boat ramp, Tanners Point jetty, and Kauri Point Jetty being the current monitoring stations. Other sites were monitored until 1998 when monitoring was changed to shore based in areas where good channel access is available.

In analysis of trends in the monitoring data not only are individual sites examined (Table 8), but the North Basin is analysed based on five high-mid tide monitoring sites covering the period 1991 to 2005. The fives sites used include: Mid Harbour; Kauri Point Jetty; Matakana; Tanners Point; and Bowentown Boat Ramp. These sites provide the best representation of the available data over this time period for the North Basin.

Table 8 Water quality trends, North Basin, Tauranga Harbour.

Site	Analysis Period	Chla	Turb	SS	TP	NH_4N	NOxN	E.coli	Ent
Mid Harbour	91 - 98	ND	-	-	-	-	-	-	-
Kauri Point Jetty	98 - 05	-	-	↑ (p=0.001)	↑ (p=0.02)	-	-	-	-
Ongare Point Low tide	91 - 05	ND	↓ (p=0.04)	-	↓ (p=0.001)	-	↓ (p=0.001)	ND	ND
Matakana	91 - 98	-	-	-	-	-	↑ (p=0.04)	-	-
Tanners Point	98 - 05	-	-	↑ (p<0.001)	-	-	-	-	-
Bowentown Boat Ramp	91 - 05	↓ (p<0.001)	-	↑ (p<0.001)	-	↑ (p<0.001)	-	↑ (p=0.02)	↑ (p=0.001)
Bowentown Pios	91 - 98	-	ND	-	↓ (p=0.03)	-	-	-	-

ND= no or limited data, ↑=increasing trend, ↓= decreasing trend, "-" = no trend, p = probability.

3.9.30 Chlorophyll a

Chlorophyll *a* concentrations display a significant deceasing trend in the North Basin over the period 1992 to 2004. Only the Bowentown Boat Ramp site shows this trend due to higher levels of chlorophyll *a* occurring at this site over the 1994 to 1996 period. Since this time concentrations have been relatively stable.

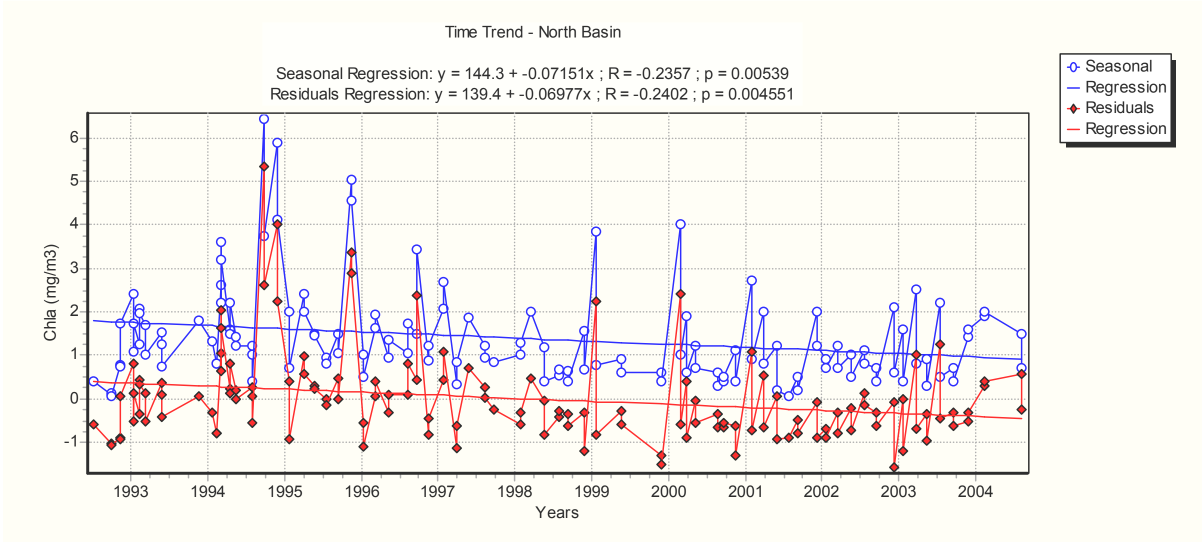


Figure 89 Chlorophyll a concentrations, North Basin, Tauranga Harbour.

3.9.31 Turbidity and Suspended Solids

Figure 90 displays turbidity and SS concentrations for the North Basin over the analysis period 1991 to 2005. Turbidity shows no significant trend over this analysis period but SS has a significantly increasing trend over the analysis period. These two variables have no correlation in the North Basin or for individual sites.

SS concentrations appear to be less wind affected than southern sites, possibly due to the depth of samples and differing hydrodynamics on the channels on the incoming and outgoing tides.

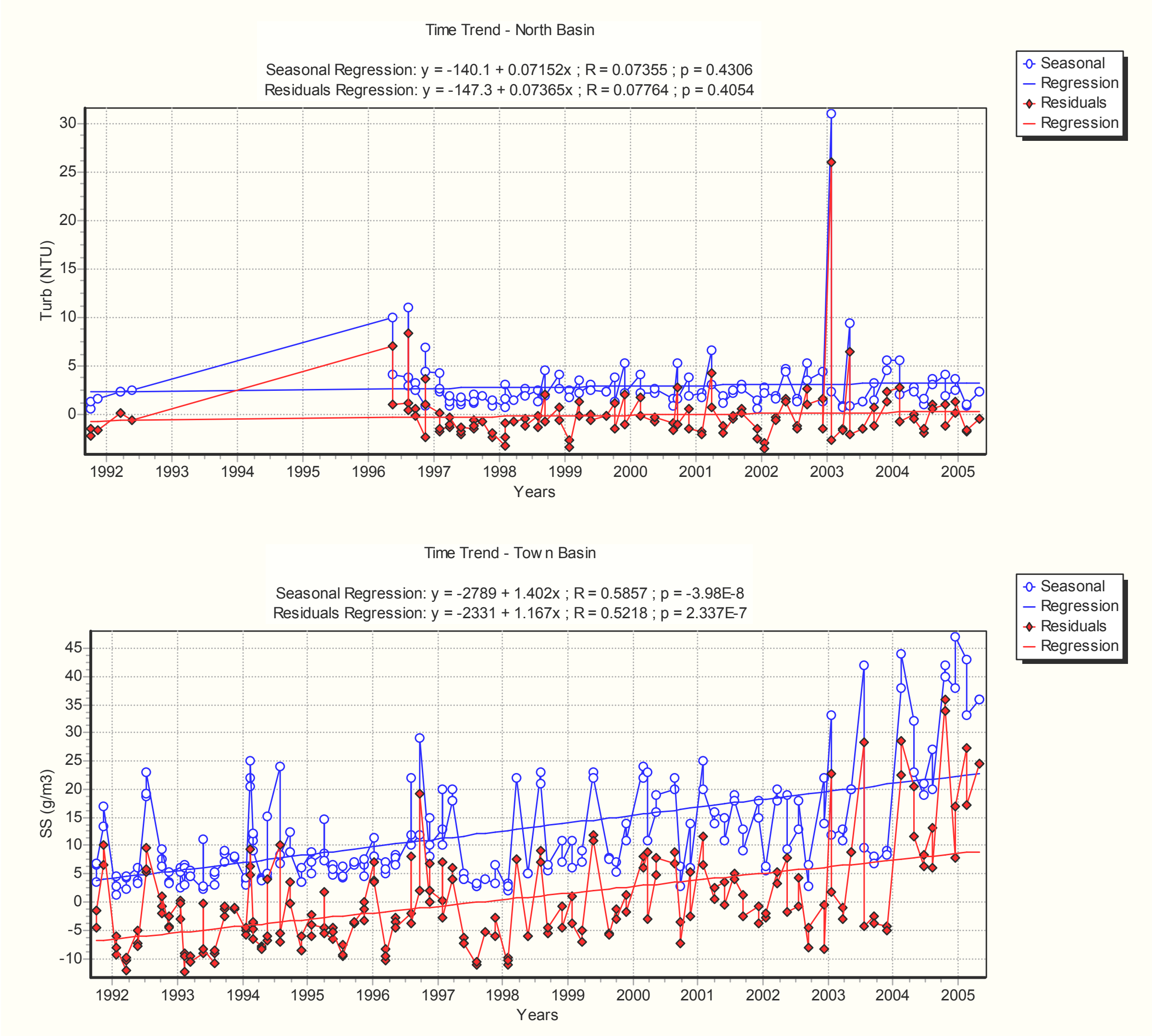


Figure 90 Turbidity and SS concentrations, North Basin, Tauranga Harbour.

3.9.32 **Total Phosphorus**

No significant trend in TP concentrations is observed over the 1991 to 2005 analysis period for the North Basin. However, a significant deceasing trend in TP is observed at Bowentown Pios and the low tide site at Ongare Point, while an increasing trend is found over the later analysis period at Kauri Point Jetty (Table 8).

Ongare point is the only site to show a correlation between TP and SS (Pearson r=0.828, p<0.001, n=85). This again highlights the different dynamics occurring between the tides as fine sediment containing organic material is entrained in the channel currents demonstrated by the higher turbidities during low tide.

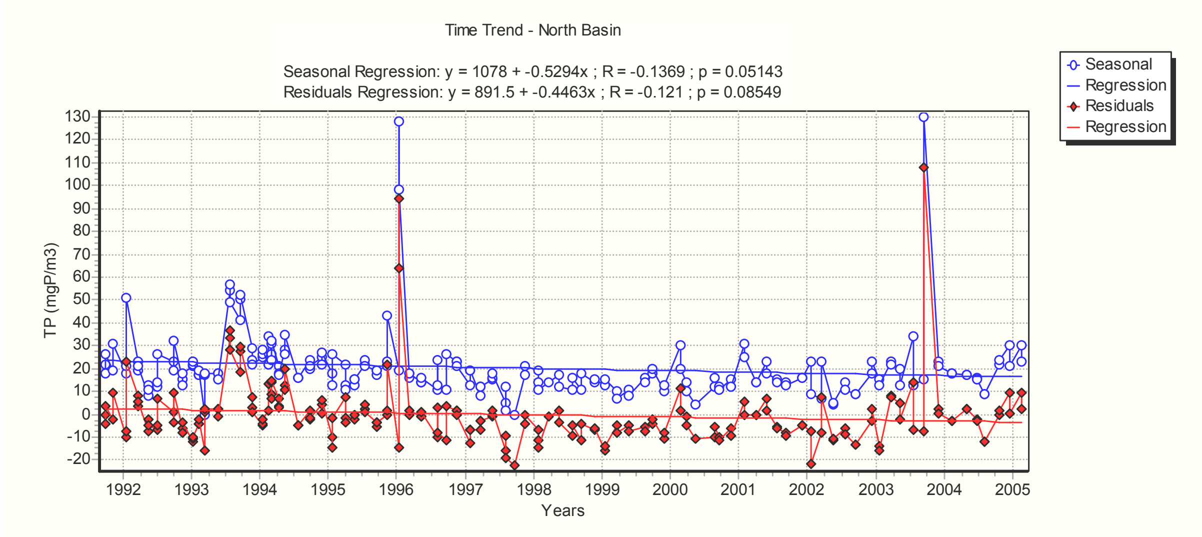


Figure 91 TP concentrations, North Basin, Tauranga Harbour.

3.9.33 Ammonium nitrogen

A range of ammonium nitrogen fluctuations are shown over the analysis period but with the net result of a significantly increasing trend (Figure 92). After a downward trend from the end of 1994 to 1997, concentrations rose till the year 2000, after which they fell.

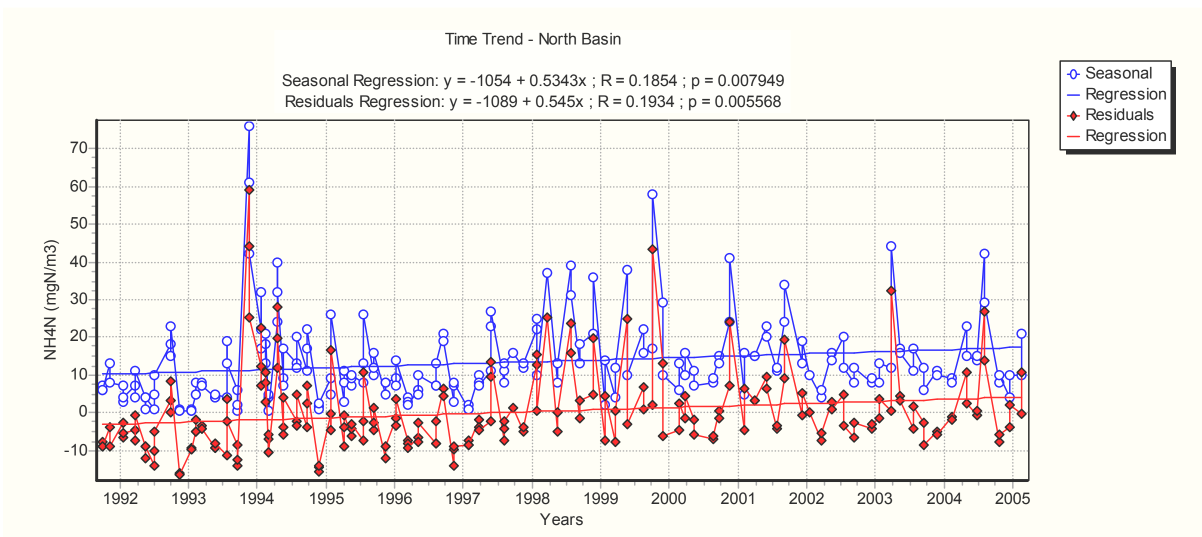


Figure 92 NH_4N concentrations, North Basin, Tauranga Harbour.

3.9.34 Oxides of nitrogen

Figure 93 displays the NOxN concentrations in the North Basin over the analysis period 1993 to 2005. No significant trend is shown by analysis of the residuals. Maximum levels as is usual occur generally in winter.

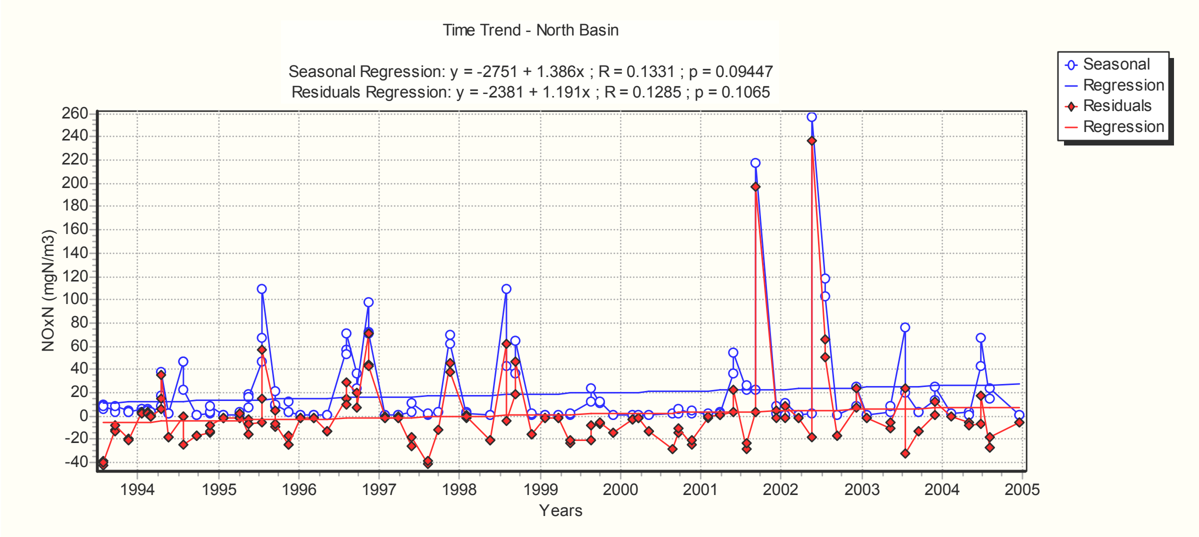


Figure 93 NOxN concentrations, North Basin, Tauranga Harbour.

3.9.35 Indicator Bacteria

Both indicator bacteria species show significantly increasing trends over the analysis periods. Even with an increasing trend, *E.coli* and enterococci concentrations are on average at a low level (i.e. well below the red alert level as defined by the microbiological water quality guidelines) indicating minimal risk to users of the water for recreational purposes.

There is a weak correlation between *E.coli* and enterococci (Pearson r=0.445, p<0.001, n=158) highlighting the potential of either species in gauging bacterial water quality.

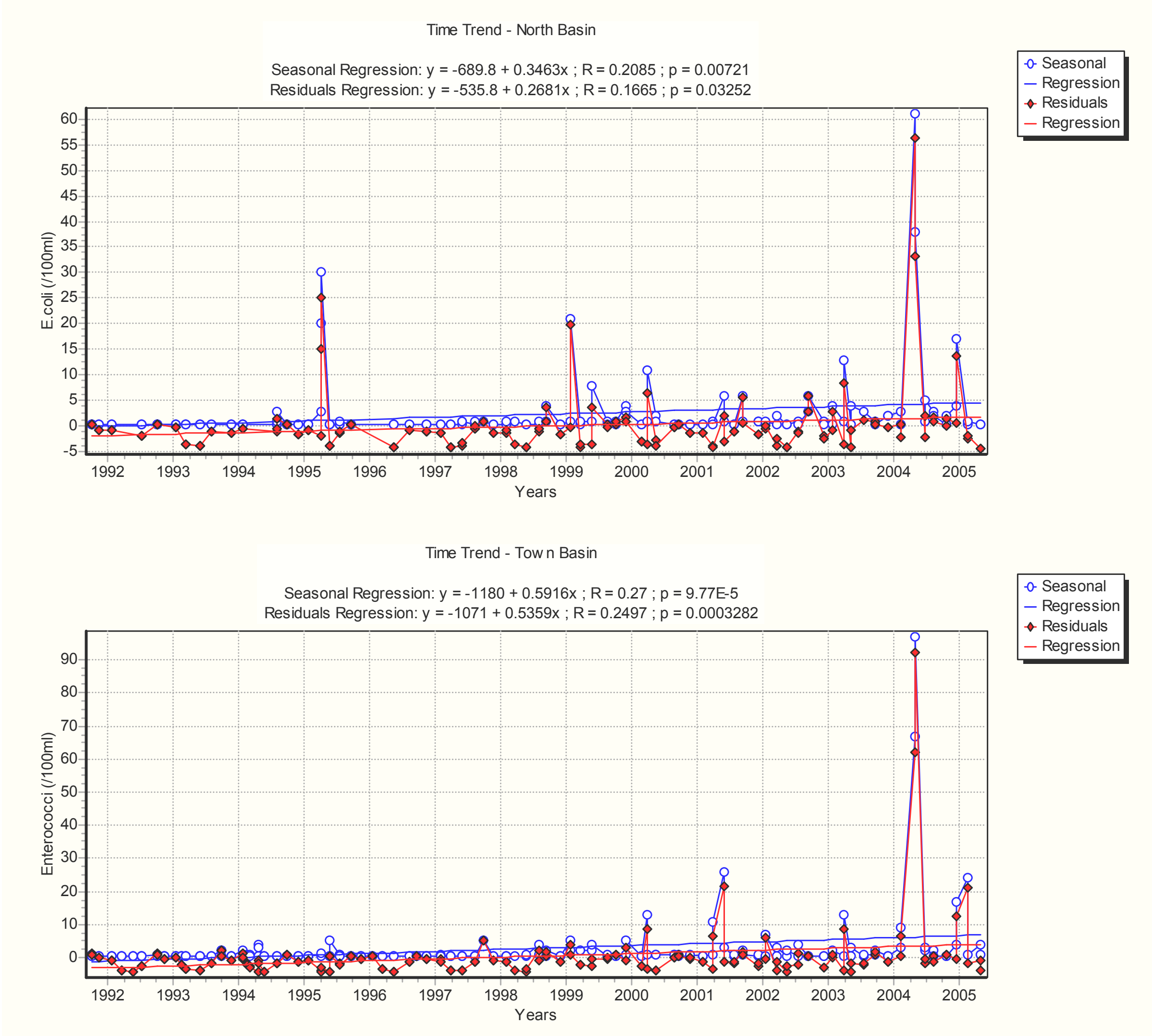


Figure 94 E.coli and enterococci concentrations, North Basin, Tauranga Harbour.

3.9.36 Dissolved Oxygen and Temperature

No significant trend is displayed for DO concentrations over the 1991 to 2005 analysis period. There is a slight but significant increasing trend in temperature (0.07°C/yr, p=0.005). The Kauri Point and Tanners Point sites both show significant trends for increasing levels of DO and decreasing temperature for the 1998 to 2005 period. These trends are not reflected in the low tide site. DO concentrations were not at or above 80% saturation levels for 2.3% of sampling events over the 1991 to 2005 period.

3.9.37 Discussion

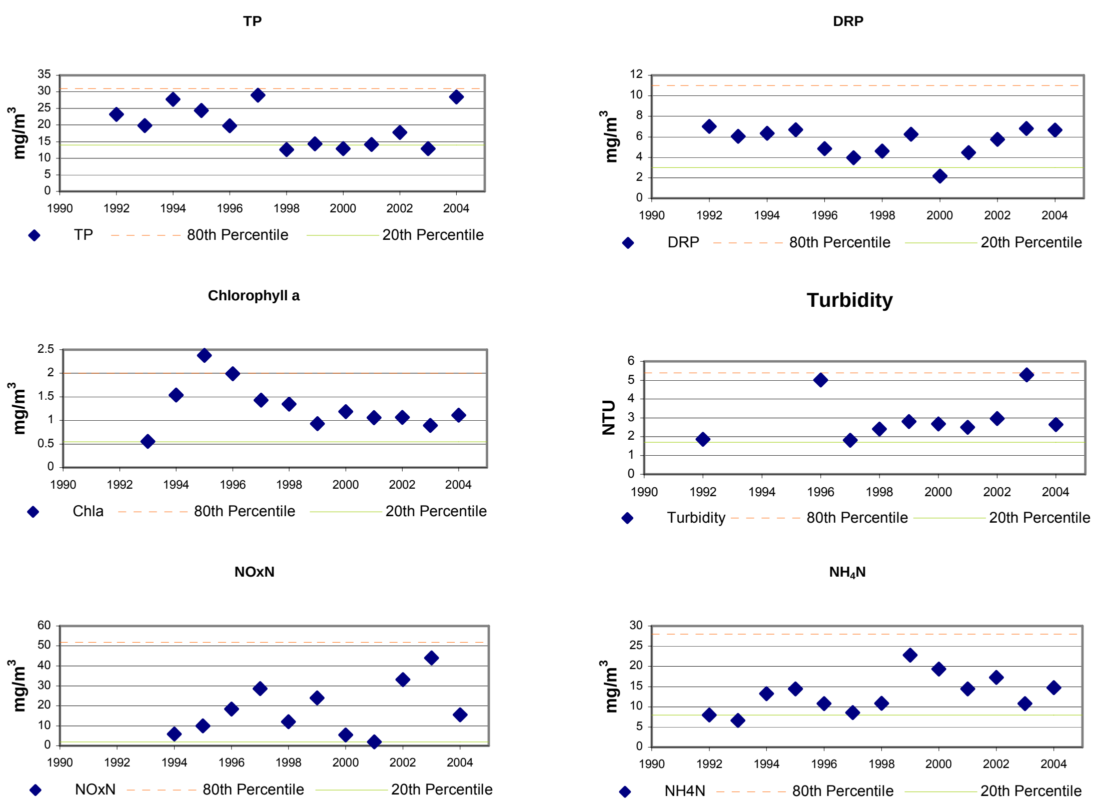
The North Basin displays good water quality for most determinands. At present almost all deteminands are well under the 80th percentile for Bay of Plenty estuaries (Figure 95).

The level of phosphorus has generally decreased in the North Basin, however since around the year 2000 both DRP and TP levels have shown an increase at some sites. TP concentrations are presently around the 80th percentile for Bay of Plenty estuaries.

Chlorophyll *a* concentrations have been elevated but now remain well below the 80th percentile for Bay of Plenty estuaries. Elevated levels may have been caused by outbreaks of sea lettuce although such levels have not been experienced with more recent outbreaks. This may be related to available phosphorus in the systems as at two sites chlorophyll *a* concentrations have a relationship with TP (Bowentown Boat Ramp: r=0.455, p=0.005, n=83; Matakana: r=0.644, p=0.002, n=34).

Suspended solids and turbidity have shown a similar relationship to the other Tauranga Harbour basins, that is that these parameters do not correlate for high tide sites. It is, however, less evident in the North Basin that wind is the factor increasing the levels of suspended solids. Tidal direction and strength also play a part in the suspension of material and may be important contributing factors to the increasing trend. Turbidity is generally good, indicative of clear water conditions. This is also reflected in secchi disk measurements with the disk often visible throughout the entire water column.

Oxides of nitrogen concentrations are for the most part stable with maximum concentrations occurring over winter. Ammonium nitrogen concentrations show some distinct rises and falls with the major trend over the last fourteen years of monitoring being an increasing one. However, the recent trend is a decreasing one. Ammonium nitrogen concentrations are on average under the 80th percentile for Bay of Plenty estuaries (Figure 95).



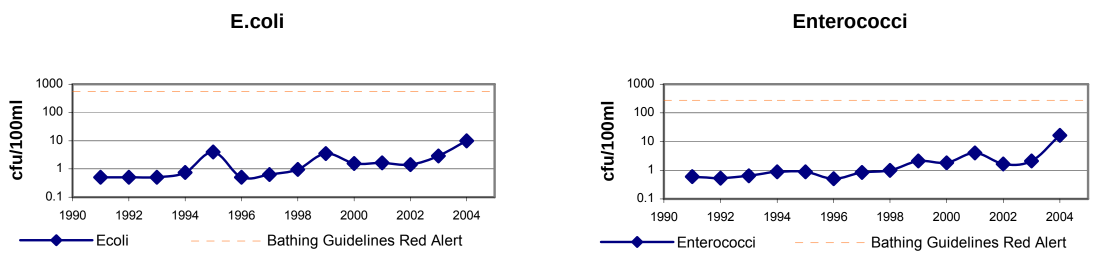


Figure 95 Average yearly concentrations and BOP Estuary 80th & 20th percentiles and guidelines, North Basin, Tauranga Harbour.

E.coli and enterococci concentrations have been increasing (Figure 95). Levels of both these indicator bacteria remain below the red alert level for the microbiological water quality guidelines.

Chapter 4: Summary

Water quality classifications and standards are set out in the RCEP and the PRWLP. For harbours and estuaries these classifications protect bathing standards (red alert level), aquatic organisms, as well as the temperature, and oxygen saturation. This report has examined classifications and standards for oxygen saturation, bathing water standards and water clarity and these are summarised below.

Examination of trends in water quality is also integral in safeguarding the life-supporting capacity of estuaries and estuarine ecosystems as well as maintaining and enhancing water quality. Trends in water quality have been examined for several water quality parameters in the major estuaries and river estuaries of the Bay of Plenty. Over time, trends can change for any given parameter and over the fourteen years of monitoring some estuaries display several different trends within this period. As the monitoring programme for Bay of Plenty estuaries has only been in place since the early 1990s, the focus of this report has been on long term trends. Examining trends from the beginning of monitoring (in the early 1990s) to present helps to ascertain if water quality is deteriorating or improving. A summary of these trends where significant is presented in Tables 9 and 10.

Estuarine water quality is dependant upon fluvial and oceanic water dynamics and environmental conditions within the estuary. Due to the complex interactions of these variables it is not always possible to ascertain what are the contributing factors to any change in water quality, although the behaviour of other parameters in the estuary can help to establish the cause of a trend. Correlation statistics help determine the relationship between parameters and potentially the relationship with the wider environment.

Comments on trends, observations, and correlations are summarised below for each estuary. Comments on classifications are based on the last three years of data.

4.1 Estuaries

Table 9 Water quality trends, Bay of Plenty Estuaries

Site	Analysis Period	Chla	Turb	SS	TP	NH_4N	NOxN	E.coli	Ent
Ohiwa Harbour	90 - 05	↓ (p=0.03, 92-04)	-	↑ (p<0.001)	-	-	-	-	↑ (p=0.002)
Little Waihi	90 - 05	-	-	↑ (p=0.006)	↑ (p=0.01)	-	-	-	-
Maketu	91 - 05	-	-	↑ (p=0.004)	-	-	-	-	-
Tauranga Harbour									
Town Basin	91 - 05	↓ (p=0.02, 92-04)	↓ (p=0.04)	-	↓ (p<0.001)	-	-	-	-
Otumoetai Channel	98 - 05	-	-	-	↓ (p=0.03)	-	↓ (p=0.04)	↑ (p=0.03)	-
South Basin	91 - 05	-	-	↑ (p<0.001)	↓ (p=0.05)	-	-	↑ (p=0.01)	↑ (p<0.001)
North Basin	91 - 05	↓ (p=0.005, 92-04)	-	↑ (p<0.001)	-	↑ (p=0.0 06)	-	↑ (p=0.03)	↑ (p<0.001)

ND= no or limited data, ↑=increasing trend, ↓= decreasing trend, "-" = no trend, p = probability (95-05 = time trend)

4.1.1 Ohiwa Estuary

- Ohiwa Harbour water quality is good and stable.
- Water quality classifications have been met.
- Chlorophyll a concentrations have been declining slightly and are at levels consistent of oligotrophic waters.
- Turbidity has been poor in comparison with other estuaries. Suspended solids correlates with turbidity, but only suspended solids displays a significant increasing trend. Potential cause of increasing suspended solids is due to strong winds during sampling over the past few years.
- Enterococci levels have been increasing and this may be related to increasing suspended solids.

4.1.2 Little Waihi Estuary

- Water quality is generally good.
- Water quality classification has been exceeded for bathing standards on one occasion in the last three years, otherwise classifications have been met.
- Elevated DRP levels, likely source is terrestrial.
- Increasing trends in suspended solids and total phosphorus.

4.1.3 Maketu Estuary

- Maketu water quality is stable but poorer than other Bay of Plenty estuaries.
- Water quality classification has been exceeded for bathing standards on one occasion in the last three years, otherwise classifications have been met.

- Nutrient levels are elevated with respect to other Bay of Plenty estuaries but have improved since the estuaries monitoring programme was established.

- A trend in increasing suspended solids primarily due to high winds and flood flows.

4.1.4 Tauranga Harbour – Town Basin

- Shows improvement in water quality with water quality being good.

- Water quality classifications have been met.

- Nutrient levels were high but have reduced to levels that on average are under the 80th percentile for Bay of Plenty estuaries.

- Turbidity has shown some improvement. Suspended solids at two sites within the Town Basin display increasing trends due to strong wind conditions during sampling.

- Microbiological water quality is good with enteroccoci and E.coli likely to come from the same source.

4.1.5 Tauranga Harbour – Otumoetai Channel

- Water quality is good with some improvements in nutrient levels, but deteriorating microbiological water quality.

- Water quality classification for oxygen saturation was not met on one occasion otherwise classifications have been met.

- Fluctuations in water clarity are likely to be wind induced.

- *E.coli* concentrations display an increasing trend but are still well within recommended contact recreation guidelines.

4.1.6 Tauranga Harbour – South Basin

- Water quality is good but microbiological water quality is showing some deterioration.

- Water quality classification for oxygen saturation was not met on one occasion otherwise classifications have been met.

- TP levels have decreased and DRP levels are low compared to other estuaries.

- There are increased chlorophyll *a* concentrations in this basin compared to other estuaries. Increases in phytoplankton are likely to have utilised DRP explaining why DRP concentrations are lower but not TP.

- E.coli and enterococci concentrations display an increasing trend but are still within recommended contact recreation guidelines. Increases may be due to increased wind strength re-suspending sediments during recent sampling events.

- Recent trends show dissolved oxygen content increasing as temperature decreases. This may be due to environmental conditions.

4.1.7 Tauranga Harbour – North Basin

- Water quality of the North Basin is generally good but some parameters are declining.
- Water quality classifications have been met.
- Ammonium nitrogen concentrations have increased in the last fourteen years but more recently concentrations are declining.
- Suspended solids levels are increasing, although water clarity is good as indicated by turbidity.
- E.coli and enterococci concentrations are increasing but are still within recommended contact recreation guidelines.

4.2 River Estuaries

Table 10 Water quality trends, Bay of Plenty River Estuaries

Site	Analysis Period	Chla	Turb	SS	TP	NH_4N	NOxN	E.coli	Ent
Opotiki	91 - 05	-	-	-	↑ (p=0.04)	↑ (p=0.02, 95-05)	-	-	-
Whakatane	91 - 05	-	-	-	-	↓ (p=0.03)	↓ (p=0.002)	↑ (p=0.04)	-
Rangitaiki	95 - 05	↑ (p=0.04)	-	-	-	-	-	↑ (p=0.05)	-
Tarawera	95 - 05	↓ (p<0.001, 96-05)	-	↓ (p<0.001)	-	-	↑ (p=0.02)	-	-
Kaituna	95 - 05	-	-	-	↑ (p=0.007)	-	↑ (p=0.004)	-	↑ (p<0.001)
Matata Lagoon	01 - 05	↓ (p=0.02)	↓ (p=0.03)	↓ (p=0.03)	-	-	-	-	-

ND= no or limited data, ↑=increasing trend, ↓= decreasing trend, "-" = no trend, p = Bonferroni probability (95-05 = time trend)

4.2.1 Opotiki Estuary

- Water quality is fair in comparison to other Bay of Plenty River estuaries.
- Water quality classification has been exceeded for bathing standards on two occasions. Water quality classifications for oxygen saturation was not met on two occasions otherwise classifications have been met.
- Ammonium nitrogen concentration in the estuary have improved, although the short term recent trend is one of increasing concentrations.
- TP, turbidity and NOxN concentrations are strongly influenced by river flows and have maximums in winter when groundwater levels are high and surface runoff is greater. TP displays an increasing trend influenced in part by flood flow events.

4.2.2 Whakatane Estuary

- Water quality is fair but stable, with decreasing dissolved inorganic nitrogen levels and poor water clarity.

- Water quality classification has been exceeded for bathing standards on three occasions. Water quality classification for oxygen saturation was not met on one occasions otherwise classifications have been met.

- Both ammonium nitrogen and oxides of nitrogen displayed decreasing trends in the estuary.

- Dissolved oxygen shows a correlation with ammonium nitrogen indicating that DO is consumed on reaction with ammonium nitrogen.

- The estuary has poor water clarity compared to other Bay of Plenty River estuaries due to its high suspended solids load from the river.

- E.coli concentrations have increased. Bacterial levels have on occasion exceeded recommended water quality guidelines.

4.2.3 Rangitaiki Estuary

- Rangitaiki Estuary water quality is fair but, stable with elevated phosphorus levels and increasing bacterial levels.

- Water quality classification has been exceeded for bathing standards on one occasion, otherwise classifications have been met.

- Elevated chlorophyll *a* concentrations are symptomatic of high phosphorus concentrations in this freshwater dominated estuary.

- *E.coli* concentrations display an increasing trend and both *E.coli* and enterococci have at times exceeded recreational water quality guidelines. Enterococci have relationship with ammonium nitrogen indicating that contamination may be from organic wastes.

- Water clarity is at times elevated usually due to flood flows.

4.2.4 Tarawera Estuary

- Water quality in the Tarawera Estuary is poor compared to other Bay of Plenty River estuaries but is improving.

- Water quality classification has been exceeded for bathing standards on five occasions in the past three years. Water quality classification for oxygen saturation has not been met on all but two occasions in the past three years, otherwise classifications have been met.

- Suspended solids and colour have been improving significantly as a result of improved discharges from the Tasman Industrial complex.

- Nutrient levels are generally at or above the 80th percentile for Bay of Plenty River estuaries.

- Despite high nutrient levels phytoplankton concentrations are relatively low. This may be due to the loss of light due to the high colour content of the river.
- *E.coli* and enterococci have at times exceeded recreational water quality guidelines.
- Ten years of temperature data displays a decrease of 0.1°C per year.

4.2.5 **Kaituna Estuary**

- The Kaituna Estuary has good water quality in comparison to other river estuaries but displays signs of decreasing water quality. This may be partially a function of sampling at times of increased flow in recent times.
- Water quality classification has been exceeded for bathing standards on one occasion in the last three years. Water quality classification for oxygen saturation was not met on five occasions, otherwise classifications have been met.
- Both TP and DRP display significantly increasing trends and come from terrestrial sources. Phosphorus levels are low compared to other river estuaries in the Bay of Plenty.
- NOxN is increasing in concentration and correlates with TP. Correlation of these two parameters indicates a similar source.
- Enterococci levels in the estuary have been increasing and more recently so have *E.coli*. *E.coli* has a relationship with turbidity potentially indicating that these bacteria are flushed into the estuary with sediment.

4.2.6 **Matata Lagoon**

- Water quality of the Matata Lagoon is poor.
- Matata Lagoon was partially infilled in 2005 by a large debris flows. Water quality for the South-east lagoon is summarised here and in Table 7.
- Water quality classification has been exceeded for bathing standards on six occasions in the last three years. Water quality classification for oxygen saturation was not met on eleven occasions in the last three years, otherwise classifications have been met.
- Turbidity and chlorophyll *a* concentrations both show short term decreasing trends.
- Oxygen levels are on occasion severely depleted to levels detrimental to some aquatic organisms.
- Indicator bacteria regularly exceed recreational water quality guidelines due to large water fowl populations and streams and drains contributing to the bacterial load.

4.3 Conclusions and Recommendations

The estuaries of the Bay of Plenty are generally of good water quality. Classification for estuarine water quality as per the Regional Coastal Environmental Plan and the Proposed Regional Water and Land Plan have on occasion being breached. Breaches include the bathing water quality standards being exceeded and oxygen saturation levels above 80 percent not being met.

Increasing bacterial contamination remains one of the major issues in Bay of Plenty Estuaries, predominantly affecting the river estuaries (Figure 97). Increases have been detected in non-riverine estuaries, but this is primarily due to local environmental conditions such as wind re-suspension of bacteria in estuarine sediments, rather than any detectable increase in contamination levels. If pathogens are lasting in the estuarine sediments for longer periods then there may be consequences for achieving contact recreation standards. Sediment monitoring could help determine if this is occurring.

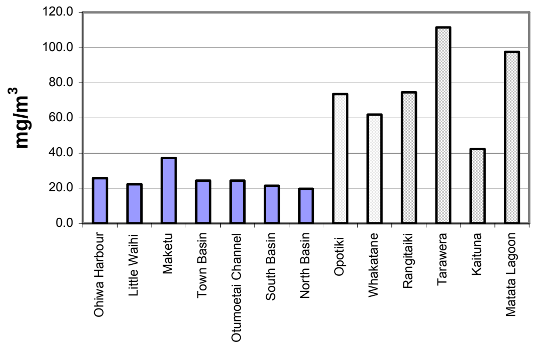
Phytoplankton productivity is relatively low in most estuaries, although dissolved inorganic nitrogen levels are generally greater than recommended trigger levels. Phytoplankton in some estuaries show signs of phosphorus limitation. However, no estuary exhibits signs of eutrophication and it is recognised that supply of nutrients to estuaries usually well in excess of phytoplankton requirements (Schindler, 1981).

Oxides of nitrogen show a seasonal pattern with winter highs and summer lows at many sites. This is in part due to high groundwater and lack of uptake of nitrate nitrogen by plants during winter resulting in mobile nitrate nitrogen being flushed into waterways and estuaries. It is also due to phytoplankton reducing in numbers in the estuarine environment over the winter months and consequently not utilising nitrate nitrogen. Ammonium nitrogen has winter maximums for similar reasons to oxides of nitrogen. Microbial activity is reduced in winter and the conversion of ammonium nitrogen to other forms of nitrogen is reduced. Ammonium nitrogen is not mobile in groundwater, so likely increases of ammonium nitrogen in waterways come from such practices such spraying effluent onto pastures in winter when the infiltration capacity of the ground is low and runoff is high elevating levels in drains and streams.

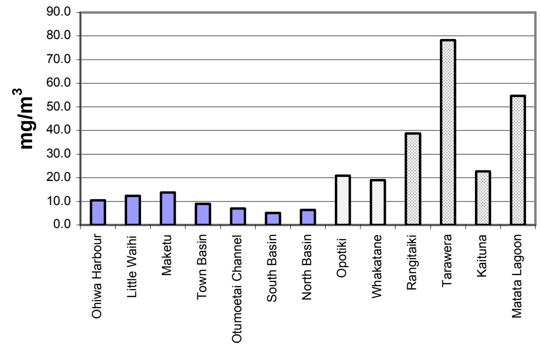
Suspended solids concentrations have displayed increasing trends in many of the non-riverine estuaries. The reasons for this may be due to environmental conditions such as wind and currents causing material to suspended. Park (2003) showed that sediment supply has decreased in the Kopurererua River and that muddy sediments deposited in the Aongatete Estuary may be a result of historical deposits. He also shows that sediment supply to Ohiwa Harbour via the Nukuhou River has been stable over the last decade (Park, 2005). Further analysis of other freshwater inflows to these estuarine systems will help reveal if sediment supply to estuaries is an issue.

On very few occasions the dissolved oxygen content of some estuaries has been under 80 percent saturation level with the exception of the Tarawera Estuary. The Tarawera Estuary rarely complies with the oxygen saturation classification in the RCEP.

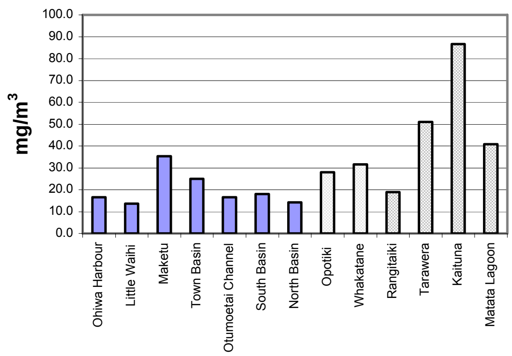
TP



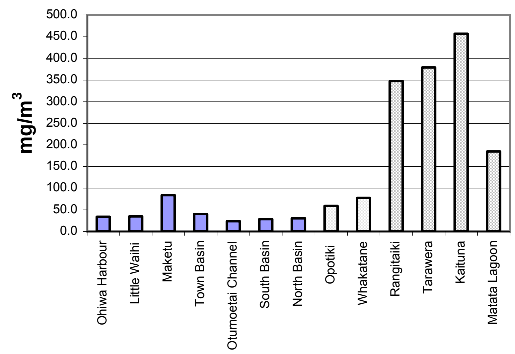
DRP



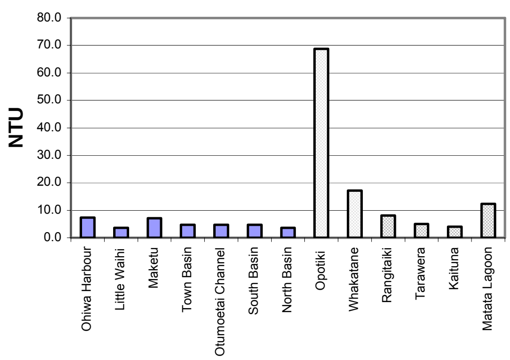
NH4N



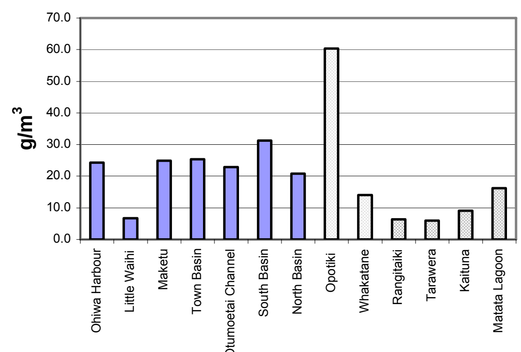
NOxN



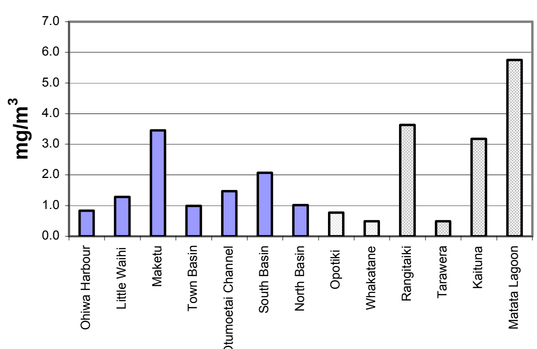
Turbidity

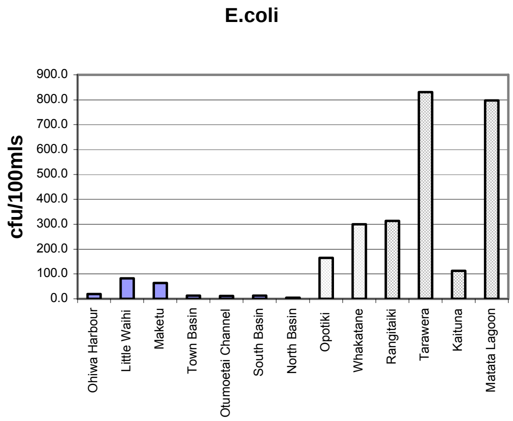


SS



Chla





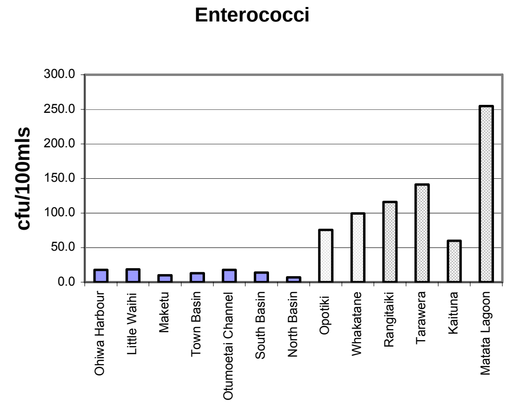


Figure 96 Comparison of data averaged over 3 years, 2002-2004, for Estuary parameters (yellow/cross-hatched columns are River Estuaries).

Industrial discharges are having some impacts on estuarine water quality, but in some cases it is difficult to discern between the impacts of non-point source contamination (e.g. agriculture and urban run-off) and industrial or point source contamination. The Tarawera Estuary is one estuary showing improvements in water quality with industry having greatly reduced the biochemical oxygen demand, suspended solids, and colour loads to the river. The Kaituna Estuary is an example of an estuary displaying some increasing trends in nutrients and bacterial levels for which industry shoulders some of the responsibility. Industry on this river is moving towards improving treatment systems. As the effects of these improvements are seen, examination of other sources of nutrients and bacteria inputs to the river will be needed if increasing trends continue.

Recent estuarine monitoring data is summarised in Figure 96 displaying water quality data averages over the last three years (2002 to 2004). This graphic not only shows recent water quality results but highlights the differences between river estuaries and oceanic estuaries. River estuaries generally have greater nutrient and bacteria concentrations and are also more turbid. Although, suspended solids levels have been greater in oceanic estuaries.

The differences in water quality between river estuaries and oceanic estuaries is due to the ameliorating impact of greater volumes of saline waters compared to freshwater as well as tidal flushing. Oceanic estuaries, while dominated by saline waters, are also affected by estuarine waters returning on the incoming tide and changes in oceanic currents as represented by the southern oscillation index (SOI).

The effect of oceanic waters in the estuarine environment can be seen in the relationship between sea lettuce abundance within Tauranga Harbour and the SOI. When deep oceanic nutrient rich waters are able to mix with surface waters under El Nino conditions (a positive SOI), these nutrient laden waters enter the harbour allowing sea lettuce to proliferate. Several estuaries also show nutrient concentrations similar to near shore oceanic nutrient concentrations adjacent to estuary mouths, indicating the dominance of oceanic waters in estuaries. However, smaller estuaries such as Little Waihi do exhibit influences of freshwater inputs on nutrient concentrations.

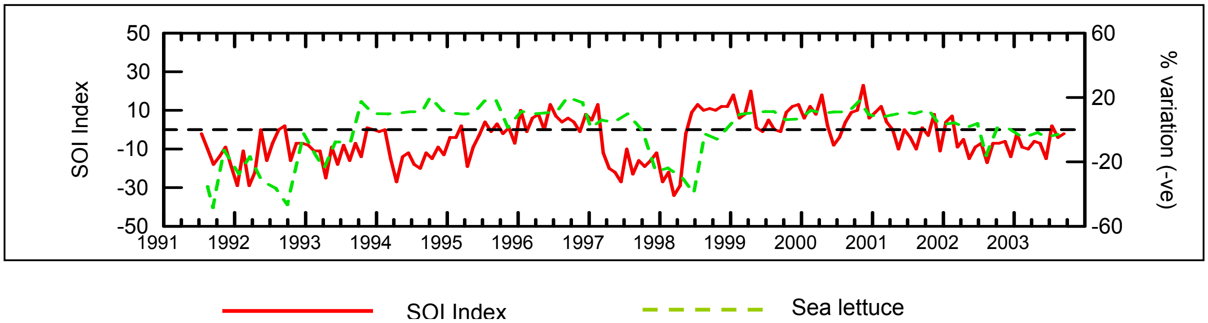


Figure 97 Southern Oscillation Index and seasonal sea lettuce variation.

Rivers in flood pump nutrients and suspended solids into the upper reaches of estuaries saturating these zones for short periods. In Tauranga Harbour studies have shown that flushing from the upper reaches of the sub-estuaries is poor (Park, 1991). River water may oscillate with estuarine waters for four or more tidal cycles before being integrated with oceanic dominated waters. This is likely to be the case in other estuaries. As noted above there is a complex mix of factors that operate to alter the nutrient status of an estuary over time. Trend monitoring will continue to see if degradation is occurring in Bay of Plenty Estuaries or if trends are results of natural permutations.

Some parameters regularly exceed recommended trigger levels for the protection of aquatic biota in south-east Australian estuaries and low land rivers. Trigger levels are based on quite different ecosystems than found in the Bay of Plenty and so may not be entirely appropriate for Bay of Plenty estuaries. Trend analysis, comparison with classification standards and comparison similar aquatic systems are more useful indicators for detecting changes in water quality in Bay of Plenty Estuaries until such a time that specific trigger levels for Bay of Plenty are developed.

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Appendices

Appendix 1 – Laboratory Methods

Appendix II – Water Quality Classifications

Appendix III – Analytical Results

Appendix 1 – Laboratory Methods

Chlorophyll *a*	Spectrofluorophotometer
Conductivity	APHA Method 2510
Dissolved oxygen	APHA Method 4500-0G YSI Temp & DO meter
Dissolved reactive phosphorus molybdate	NWASCO Misc Pub No 38 (1982) Antimony, phosphate
E coli	APHA Method 9213D
Enterococci	APHA Method 9230C
Faecal coliform	APHA 9222D
Ammonium nitrogen	NWASCO Misc Pub No 38 (1982) Phenolhypochlorite
colorimetry	
Nitrate nitrogen 4500	Total oxidised nitrogen. Flow injection analyser, APHA
pH	APHA Method 4500
Salinity	YSI SCT
Suspended solids	APHA Method 2540D
Temperature	YSI Temp & DO Meter
Total phosphorus	NWASCO Misc Pub No 38 (1982) Acid per sulphate digestion.
Turbidity	APHA Method 2130B – Hach 2100 N

Appendix 2 – Water Quality Classifications

Coastal Water Quality Classification – Regional Coastal Environmental Plan (S13.2)

S13.2.1 No discharge shall cause:

- the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials; and
- any conspicuous change in the colour or visual clarity; and
- any emission of objectionable odour; and
- any significant adverse effects on aquatic life;

in coastal waters, foreshore and seabed within the coastal marine area.

S13.2.2 Within all harbours and estuaries, and into the open coast out to a distance of 400 m from the line of mean high water springs:

- the visual clarity of the water shall not be so low as to be unsuitable for bathing; and
- the water shall not be rendered unsuitable for bathing by the presence of contaminants; and
- there shall be no undesirable biological growths as a result of any discharge of a contaminant into the water; and
- the natural temperature of the water shall not be changed by more than 3 degrees C; and
- the concentration of dissolved oxygen shall exceed 80% of saturation concentration; and
- aquatic organisms shall not be rendered unsuitable for human consumption by the presence of contaminants.

Contact Recreation Water Quality Classification – Schedule 10 of the Proposed Regional Water and Land Plan

Any discharge of contaminants or water to water in a river or stream classified, as Contact Recreation in the Water Quality Classification Map shall not alter the quality of the water beyond the following standards after reasonable mixing of the discharge with the receiving water:

(a) The discharge shall not cause the visual clarity of the water to fall below 1.6m of a horizontal sighting distances of a 200mm black disc (from Water Quality Guidelines Number 2, Ministry for the Environment, June 1994).
(b) The discharge shall not cause the *E. coli* level to exceed 126/100ml as measured by a single sample.
(c) The water shall not be rendered unsuitable for bathing by the presence of contaminants as a result of the discharge at levels exceeding those specified in the Recreational Water Quality Guidelines, Ministry of Health/Ministry for the Environment, November 1999.
(d) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water.
(e) The discharge of contaminants (either by itself or in combination with the same, similar, or other contaminants) or water to water shall not cause:
(i) The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials.
(ii) Any conspicuous change in the colour or visual clarity, subject to (a).
(iii) Any emission of objectionable odour (refer to the Operative Bay of Plenty Regional Air Plan).
(iv) The rendering of fresh water unsuitable for consumption by farm animals (refer to ANZECC Guidelines for Fresh and Marine Water Quality, 2000).

(v) Any significant adverse effects on aquatic life (refer to ANZECC Guidelines for Fresh and Marine Water Quality, 2000).

Explanation/Intent of Classification

To ensure that the contact recreation values of rivers and streams classified as Contact Recreation are protected from the adverse effects of discharges. The standards are based on the CR (contact recreation) water quality class of the Third Schedule and section 70 of the Resource Management Act 1991, and relevant national standards. The *E. coli* limit is set to allow for bathing suitability.

Appendix 3 – Analytical Results

Estuary: Opotiki **Station:** Opotiki Wharf

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conduvtivity (ms/m)	SS (g/m3)	TKN (mgN/m3)	E.coli cfu/100ml	Enterococci cfu/100ml	Faecals cfu/100ml	Salinity o/oo
20/07/95	61	336	0.02	201	16.5	37		7	10.3	21.4		100	43		2.5
12/09/95	43	63	0	0	15	27		7.4	130	17.5		49	11	45	2.5
13/11/95	34		0	71	15	16		7.4	109	7.2			50		2.5
22/01/96	37		0	48	21	29		7.3	406	4.4			34	240	2.5
25/03/96	42	339	0.08	74	20	29		7.2	113	6.6			175	155	1.55
21/05/96	40	159	0.02	84	15	28		7.4	83	3.2		51	30	70	2.5
24/07/96	154		0	152	10	30	124	7.5	8.5	131		79	6	76	2.5
17/09/96	55		0	120	14	31	21	7.2	9.7	21			4.25	86	2.5
15/11/96	29		0.17	24	5	17	3.4	7.4	662	5		260	69	610	2.5
29/01/97	23		0.05	2	7	18	1.9	7.3	600	2		470	230	610	2.5
01/04/97	32		0.08	51	33	24	2.4	7.2	381	3		110	19	240	2.5
29/05/97	27		0.17	15	27	13	2.1	7.4	770	2		310	15	330	4.3
08/07/97	38		0.09	216	23	29	5.1	7.1	45.8	3		29	7	30	0.3
08/09/97	14		0.37	43	26	15	2	7.3	378	3		11	3	30	2.4
04/11/97	27		0.11	69	43	22	3.4	7.2	529	4.5					3.2
29/01/98	28		1.29	5	14	16	2.3	7.4	825	3		2200	320	3000	4.7
18/03/98	38		0.13		16	35	6.7	7.2	34	6.7		210	180	350	0.2
19/05/98	34		0.09	71	24	26	2.7	7.3	435	4.4		62	110	170	2.4
28/07/98	72		0.05	200	25	35	45	7.3	10.1	44		97	15	230	0.1
24/09/98	36		0.05	154	27	28	6.5	7	31.3	5.4		19	3	68	0.2
23/11/98	21		0.22	7	17	11	2	7.4	471	2.6	172.5	77	34	100	2.5
19/01/99	34	120	0.2	11	32	26	2.3	7.4	430	2.6	109	220	73	260	3
23/03/99	24	87		12	32	15	3.4	7.3	335	3.4	75	210	110	120	2
20/05/99	54			113	19	36	24	7.5	26.1	25	33	160	90	190	0.1
05/07/99	83			161	16	31	76	7.1	10.8	75		140	21	210	0.1
30/09/99	29			67	38	12	2.9	7.2	282	4.4		180	240	280	2.8
16/11/99	64		0.05	113	14	26	26	7.8	12.6	28		83	19	67	0.1
10/01/00	36		0.2	14	11	29		7	120.7	2.5	104	87	58	200	0.7
09/03/00	115		0.7	118	45	58	36	6.9	156.9	34	320	2000	570	1400	1.1
23/05/00	40		0.05	151	13	33	4.2	7	114.9	5.2		37	7	41	0.6
05/07/00	76	349	0.8	141	13	17	62	7.2	65.1	67	208	300	110	540	0.3
19/09/00	35		0.7	91	21	26	3.7	6.8	72.7	3.6		27	19	80	0.4
14/11/00	32		0.05	28	28	20	3.2	7.4	428	3.4		220	210	240	2.3
15/01/01	18		0.3	0.5	14	11	2.7	7.41	1095	2		63	57	83	5.6
14/03/01	29		0.05	18	38	13	2.8	6.8	326	5.2		83	120	140	1.7
28/05/01	29		0.05	100			2	7.1	261	2.1		100	12	100	1.4
10/07/01	18		0.05	16	16	8	1.6	7.1	237	1		6	1	12	1.3
10/09/01	31		0.2	96	24	20	2.2	7.2	52.6	2.6		24	10	110	0.1
05/11/01	46		0.05	74	20	36	8.8	7.2	13.6	10		230	51	140	0.1
18/01/02	41		0.05	70	11	35	8.6	7.3	13.2	7.6		130	83	180	0.1
20/03/02	32		0.2	14	70	29	2.1	7.76	663	4.6		36	100	83	3.8
17/06/02	29		0.2	116	10	32	7.8	7.2	46.3	9.6		190	55	160	0.2

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conduvtivity (ms/m)	SS (g/m3)	TKN (mgN/m3)	E.coli cfu/100ml	Enterococci cfu/100ml	Faecals cfu/100ml	Salinity o/oo
17/07/02	38		0.05	142	16	34	5.8	7.13	59.3	5		30	17	47	0.3
10/09/02	31		0.2	19	22	17		7.26	543	3.3		22	90	59	3.4
07/11/02	31		1.5	38	24	29	1.5	7.32	475	2.5		22	15	64	2.6
21/01/03	62		0.6	7	25	25	32	7.3	821	29		1700	140	1600	4.7
06/03/03	313		0.3	35	31	20	1.6	7.3	5680	4.2		480	160	540	3.3
08/05/03	20		0.1	34	27	20	1.1	7.2	203	1.6		80	70	120	0.9
21/07/03	28		0.05	141	33	0.5	2.4	7.1	268	2.2		23	20	40	1.2
01/09/03	17		0.6	12	16	5	1.8	7.3	206	1.4		200	800	290	1
10/11/03	27		0.1		37	22	3.1	7.2	211	3		36	9	76	1
10/02/04	42		0.05	54	16	31	4.2	7.2	137	5		97	120	100	9
27/04/04	36			8	30	11	3.3	7.4	1256	8.2		230	38	240	7.1
21/06/04	720			123	17	40	1700	7.2	8	1280		410	43	590	
04/08/04	49		0.2	312	74	13	15	7.1	460	17		47	17	80	0.3
04/10/04	50			23	49	40	2.4	7.1	239	3.6		410	40	1100	0.3
30/11/04	29			31	14	24	2.5		148	3.2		61	40	79	0.8
01/02/05	31				16	20	2	7.5	2110	17		46	24	69	11.6
26/04/05							1.7	7.4	1026	5		43	51	100	

Estuary: Opotiki Estuary **Station:** Kukumoa

Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NOx (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (ntu)**	**pH**	**SS (g/m3)**	**TKN (mgN/m3)**	**E.coli /100ml**	**Enterococci /100ml**	**Faecal coliform /100ml**	**Salinity o/oo**
15/02/91	29				68	11			3		260	67		2.8
04/03/91	26				80	15		7.5	4.3		11	173	1200	7.3
01/07/91	24				48	17		7.3	2.7		150	34	520	2.8
29/08/91	50				60	14		7.4	8.7		80	47	220	4.2
07/11/91	82				32	12	2.3	7.2	30.8		300	37	420	1.3
13/02/92	33				30	9	2.8	7.5	2		0.5	1	100	0.8
19/03/92	29				15	14		7.9	6.7		830	100	710	8.1
20/05/92	44				27	15	1.7	7.8	2.6		710	180	1500	3
20/07/92	40		0.42		28	18		7.2	13.2		28	0.5	210	2
29/09/92	22		0.05		84	12		7.5	4.1		54	28	150	6.5
19/11/92	24		0.05		55	19		7.5	5.5		1	0.5	33	2.5
11/01/93	28		1.75		28	17		6.3	2.6		0.5	26	180	2.2
16/03/93	29		0.75		29	21		7.2	1.6		10	3	72	4
10/05/93	53		0.45		191	22		7.6	3.1		46	39	450	7.3
26/07/93	24	146		19	41	13		7.6	6.3		0.5	39	30	6.8
24/09/93	30	159		16	35	14		7.7	6.4		37	4	60	5.6
17/11/93	23		0.2	23		20		7.4	3.3		38	11	260	6.1
17/01/94	24	23	0.6	4	33	12		8.2	4.1		62	6	1600	24.3
16/03/94	29	130	0.4	29	39	22		7.5	3.2					2.45
16/05/94	26	55	0.2	24	31	16		7.8	3.4			32	240	11.2
12/07/94	42	180	0.2	98	26	15		7.4	2.8		190	32	230	4.6
27/10/94	16	55	0.48	8	13	10		7.5	4.8		190	21	210	3.7
22/11/94	38.5	122	0.8	21	50.5	19		7.3	13.4		730	83	1100	3.3
24/01/95	28	61	0.23	0.5	14	16		7.6	6		22	2	150	13.5
18/04/95	24	123	0.24	55	24	19		7.4	5.3		210	90	350	5.6
24/05/95	26	164	0.12	31	85	18		7	1.4		41	16.5	63	1.1
20/07/95	51.5	350	0.12	232	31.5	34.5		7.2	11.2		40	37	170	2.5
12/09/95	35	82	0.04		15	13		7.2	16.5		53	5	68	2.5
13/11/95	23	86	0.02	30	19	15		7.6	3.4		14	3	24	2.5
22/01/96	23	53	0	12	9	11		7.6	4			40	170	7.2
25/03/96	31	111	0.04	42	17	18		7.4	3.2			18	260	2.7
21/05/96	21	137	0.15	72	12	15		7.4	3.3		37	9	93	2.5
24/07/96	86		0.46	172	10	25	60	7.4	55		74	5	46	2.5
17/09/96	42		0.16	121		23	11	7.3	17			7	28	2.5
15/11/96	27		0.12	29	5	13	5.1	7.5	6		65	25	440	5.9
29/01/97	19		0.32	1	2	12	3.9	7.9	6		6	15	32	14
01/04/97	23		0.07	31	27	15	2.4	7.5	4		14	10	43	5.6
29/05/97	22		0.2	18	20	13	2	7.6	2		11	8	27	6.8
08/07/97	28		0.12	214	20	16	5.7	7.2	5		13	3	36	1.9
08/09/97	14		0.59	26	16	6	3.1	7.5	3.8		6	1	11	7.6
04/11/97	25			34	25	15	2.7	7.4	5.4		170	65	1100	5.7
29/01/98	26		0.56		16	17	2.2	7.7	3.1		83	90	240	7.7
18/03/98	25		0.12	55	17	25	3.5	7.3	4.3		690	90	1300	0.5
19/05/98	25		0.4	59	21	15	3.9	7.7	6.2		20	27	58	8.9

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NOx (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (ntu)	pH	SS (g/m3)	TKN (mgN/m3)	E.coli /100ml	Enterococci /100ml	Faecal coliform /100ml	Salinity o/oo
28/07/98	285		0.05	283	116	20	320	7.1	330	362	65	30	140	0.6
24/09/98	27		0.11	116	21	14	10	7.4	10.4		16	5	33	3.3
23/11/98	14		0.28	9	12	8	2	7.5	1.4		44	25	83	6.3
19/01/99	22		0.2	8	24	13	2.7	7.7	2.9		87	16	150	9.5
23/03/99	28			18	18	13	3.8	7.5	4.2	188	97	73	160	5.1
20/05/99	42			117	12	20	18	7.6	19	87	100	61	120	0.8
05/07/99	183			33	28	27	155	7.2	160	190	130	28	280	0.1
30/09/99	24			63	38	9	2.8	7.3	5.2		67	2	140	5
16/11/99	65		0.1	133	15	18	27	7.4	59		51	11	220	0.4
10/01/00	23		0.2	3	12	15		7.5	4.2		210	48	330	7.1
09/03/00	82	375	0.4	96	50	42	14	7	15	279	1100	500	1200	3.8
23/05/00	28		0.05	142	24	19	3.8	7.2	3.8		26	13	43	2.4
05/07/00	75	376	0.6	180	22	14	55	7.3	60	196	250	73	600	1.7
19/09/00	23		0.3	65	21	16	3	7.1	2.6		17	0.5	44	1.4
14/11/00	27		0.2		19	12	5	7.6	5.8		160	55	280	8.5
15/01/01	17		0.2	1	11	9	3.5	7.78	5.2		10	0.5	28	16
14/03/01	25		0.05	14	31	11	2.3	6.9	3		51	21	74	4.2
28/05/01	21		0.05	76			2.8	7.5	4.2		160	14	460	7.2
10/07/01	12		0.3	14	12	8	2.2	7.3	5		8	2	19	3.3
10/09/01	34		0.2	76	41	17	4.3	7.2	9.5		43	19	140	1.9
05/11/01	39		0.3	70	26	23	14	7.4	15		180	17	270	1
18/01/02	46		0.4	17	22	20	6.3	7.3	6.4		110	90	120	0.8
20/03/02	29		0.7	16	48	12	3.6	7.69	15		30	90	230	4.9
17/06/02	29		0.1	124	11	22	8.5	7.3	8.4		97	40	110	1.2
17/07/02	36		0.05	210	9	22	16	7.44	16		37	8	60	3.1
10/09/02	29		0.2	17	17	13		7.51	21		5	6	32	5.5
07/11/02	24		9.1	21	39	29	15	7.53	52		4	18	27	6.7
21/01/03	38		0.8	1	16	17	12	7.9	23		180	24	290	21.8
06/03/03	35		0.2	31	24	15	2.6	7.8	7.8		190	77	290	12.5
08/05/03	34		0.7	18	49	15	7.3	7.7	14		360	140	420	6.5
21/07/03	21		0.05	141	34	20	2	7.4	2.4		0.5	3	10	2.8
01/09/03	22		0.7	11	20	5	3.1	7.8	6.4		7	35	110	7.3
10/11/03	32		0.2	7	36	14	3	7.5	6.6		65	33	81	5.9
10/02/04	39		0.7	18	16	22	8.2	7.5	16		31	90	80	3
27/04/04	30			15	33	18	6	7.6	11		97	12	120	8.2
21/06/04	526			153	11	25	560	7.4	540		430	140	770	
04/08/04	24		2.6	63	16	13	3.3	8.07	15		10	41	12	11.2
04/10/04	30			10	22	17	3.9	7.5	15		29	8	100	1.6
30/11/04	29			29	63	24	2.4		2.8		41	11	63	0.7
01/02/05	29				14	20	2.3	7.6	19		43	0.5	56	10.4
26/04/05							2.8	7.8	7		54	56	110	

Lake: Whakatane Harbour **Station:** Yacht Club

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	TKN (mgN/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
06/12/85	141	302		77	20	39			11.4	48	205				
17/02/86	51	313		77	35	10			500	6	201				
18/04/86	21	325		185	34	2			1070	11	106				
12/08/86	62	373		222	19	25			12.2	19	132				
01/12/86	63	470		148	56	5			137.1	21	266				
02/02/87	42			223		17			1230	15					
16/02/87	51	359		165	51	20			1456	6	143				
31/03/87		457		125	116				780	19	216				
24/06/87	43	456		260	68				670	7	128				
19/07/90	54	669		350	63	29	9.5	7.2	53	10.4	256	92	200	360	
12/10/90	48	517		225	47	32	5.3	7.3	133	26	245	42	20	250	
18/01/91	31	265		132	10	8	3	7.5	2000	6.6	123	63	18	123	13
06/08/91	54	745		300	139	17	6.8	7.4	349	15.5	306	116	10	112	
14/10/91	58	421		200	58	21	7.3	7.5	526	13.1	163	33	40	170	
14/01/92	56	384		100	61	9	9.7	7.7	967	17.7	223	68	186	320	
21/04/92	28	284		206	5	9	3.3	7.7	1944	4.3	73	3	12	140	
06/08/92	39	685		313	141	17	3.5	7.4	340	6.1	231	28	11	40	
21/10/92	34	378		121	55	19	5.4	7.5	69.8	10.1	202	160	49	147	0.5
14/01/93	23				10	15		7.7	5230	6.3	29	0.5	27	15	
08/04/93	37			257	12	10	2.6	7.8	2600	7.8		110	58	210	
17/05/93	114	721		177	163	39	32	7.1	178	139					
21/07/93	40	818		200	210	12	2.8	7.6	1122	13	408	23	20	77	6
13/10/93	78	650		115		24	6.4	7.7	123	17.2	535	100	18	120	
24/01/94	143	1012		247	208	19	14.8	7.1	977	17.9	557		300		
08/04/94	66	550		3	225	15	5.3	7.5	1180	8	322		47	3000	
11/07/94	44	402		230	34	25	5	7.2	111.2	16	138	950	180	1200	
17/10/94	33	301		160	25	24	9.5	7.6	25.2	22.4	116	1300	800		0
13/01/95	60	202		3	21	21	8	7.3	1026	21	178	160	22	770	
08/06/95	40	481		236	86	26	4.3	7.2	70.2	8.7	159	130	31	200	0.3

Lake:	Whakatane Harbour		**Station:**	Quay Street - Steps to River											
Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**Conductivity (ms/m)**	**SS (g/m3)**	**TKN (mgN/m3)**	**E.coli (/100ml)**	**Enterococci (/100ml)**	**Faecal coliform (/100ml)**	**Salinity o/oo**
07/08/95	56	613		315	43	27	7.1	7.1	35.7	19.1	255	1400	160	1400	
17/11/95	37	241		52	35	22	3.6	7.4	505	7	154	130	21	110	
27/02/96	24	181			46	22	3.9	7.5	595	5.3	135		66	300	3.1
20/05/96	45	287		134	25	22	6.8	7.5	263	16.6	128	100	23	120	2.5
12/08/96	36	398		218	28	22	6.3	7.1	246	10	152		5	67	1.2
23/09/96								7.1	26	14					
05/11/96	29	183		34	11	7	2.1	7.8	1122	4	138		11	1200	6.5
18/02/97	37	146.5		0.5	8	18	2.7	7.4	1370	4	138	73	20		8.8
05/05/97	23	97.5		0.5	13	8	2.9	7.7	1670	5	84	30	9	80	
01/09/97	22	157.5		0.5	33	14	3.4	7.3	500	5.4	124	7	0.5	47	2.8
13/11/97	35	174		5	39	14	4.5	7.6	1337	8.2	130	140	15	150	8.1
27/02/98	52	251.5		0.5	37	23	9	7.6	1341	16	214	470	300	790	
05/05/98	24	129.5		0.5	25	12	2.5	7.7	1428	3.5	104	250	37	300	7.3
31/08/98	48	437		212	28	27	24	7.1	29.3	25	197	140	21	170	
04/11/98														17000	
06/11/98														600	
11/11/98														135	
16/11/98	22	171		12	37	8					122	160	7	240	
15/02/99	27	133.5		0.5	21	12	3.4	7.6	1682	4.5	112	220	32	400	
13/05/99	27	154.75		16.75	32	12		7.6	1700	5	106	27	23	57	11
24/05/99												22	24	42	
17/03/00	29	155		1	22	8	2.3	7.4	2067	6.7	132	24	21	150	9
16/06/00	44	410		238	38	20	8.7	7	10.3	7.2	134	14	9	37	
07/12/00	34	188		21	11	16	2.4	7.3	771	3	156	69	14	97	4.3
12/12/01	216	447		134	17	34	203	6.82	13.6	324	296	330	330	330	
24/04/02	17			16	13	15	16	7.7	2720	46		310	43	330	
26/02/03	31	123.5		0.5	23	8	3.2	7.8	310	5.8	100	900	37	900	19.5
15/12/03	51			58	33	27	11	7.5		13		1100	47	1700	
07/07/04	49				23	27	15	7.1	310	19		120	38	180	
08/09/04	129			457	218	18	12	7.5	620	19		100	270	130	
17/03/05	22						1.5	7.6	2240			460	320	520	
08/06/05							5.2	7.3	855			17	7	38	

Estuary: Rangitaiki River **Station:** Jetty at Boat Ramp

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	TKN (mgN/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
21/07/95	53	440	0.04	397	18	29		7.8	8.5	16.5		14	20	40	2.5
12/09/95	107	581	0.13	339	22	45		7	37.8	22.6	242		210	3300	2.5
14/11/95	57	468	1.32	360	17	31		6.8	14.8	3.9		90	49	1500	2.5
23/01/96	37	279	4.68	233	8	25		7.1	334	5.7			110	690	2.5
26/03/96	45	376	6.9	236	8	15		7.6	109	6.6			83	74	0.5
27/05/96	76	498	0.28	337	18	32	43	7.2	7.9	40.4		340	130		2.5
24/07/96	89		0.02	414	45	24	49	7.4	9.9	64		160	63	100	2.5
17/09/96	79		0.27	369	18	25	26	7.2	8.1	32			27	250	2.5
15/11/96	54		0.48	369	13	29	7.6	7.2	259	13		40	72	100	2.5
30/01/97	42		0.41	233	6	32	2.9	7.2	263	5		0.5	8	8	2.5
01/04/97	51		0.74	257	20	32	3	7.4	280	5		24	10	34	2.5
29/05/97	55		0.51	368	36	35	4.5	7.3	71	4		0.5	30	3500	0.3
07/07/97	53		0.5	436	19	38	9.3	7.3	9.1	10			31	52	0
08/09/97	55		0.74		0		5.1	7.2	24.2	3.1	128	16	66	28	0.2
04/11/97	41		0.4	355	28	36	3.3	7.4	28.2	3.6		58	110	110	24.8
30/01/98	41		1.24	105	43	36	2.1	7.4	482	2.4		280	580	770	2.7
18/03/98	117		0.41	104	17	119	4	7.4	35	4.6		150	400	200	0.2
19/05/98	39		0.32	292	20	29	2	7.4	41.2	2.8		26	15	42	0.2
30/07/98	69		0.13	448	36	38	18	7.3	9	30		76	7	160	0
25/09/98	70		0.38	10	24	55	12	7.2	11.7	12		120	24	100	0.1
23/11/98	65	580	5.13	304	11	56	3.9	7.1	11.7	6	276	138	38	210	
19/01/99	66		13.4	148	49	15	4.8	7.2	15.6	10		930	310	1400	4.1
22/03/99	40	318		125	28	21	2.3	7.3	3260	4	193	100	31	150	1.4
21/05/99	38		0.6	367	19	28	4.3	7.5	106.9	9.4		66	160	320	0.5
06/07/99	52	583		432	18	39	9.3	7.2	13.8	9.2	151	72	42	160	0.1
01/10/99	72	494		379	18	54	3.1	7	176.9	4.1	115	54	1	120	0.8
15/11/99	107	590	0.3	300	23	45	66	6.8	9.8	59	290	360	57	820	0.1
13/01/00	90	465	7.3	131	9	38	2.4	7.1	25.1	4.7	334	3	70	90	0.2
09/03/00	52	294	6.9	42	4	20	2.2	7.2	240.1	6.1	252	140	140	200	1.3
08/05/00	53		3.5	317	81	33	3.2	7.2	533	4	217	230	420	640	2.3
06/07/00	49	539	0.4	444	26	30	3.5	7	128	3	95	160	93	220	0.7
18/09/00	54		0.4	374	27	68	3.9	7	46.7	4.8		340	13	730	0.2
16/11/00	61			159	18	35	1.9	7.2	233	4.2		47	9	93	1.2
16/01/01	48		7.8	123	26	23	2.6	7.21	336	5.4		90	150	230	1.8
13/03/01	51		8.7	158	10	16	2.8	6.8	75.8	5.2		110	80	150	0.4
29/05/01	35		0.3	393	20	28	4.7	7.1	10.6	7.2		87	70	100	0.6
11/07/01	30		0.2	396	27	25	2.6	7	77	1.8		27	5	18	0.5
11/09/01	84		0.2	384	34	68	3.4	7.1	15.2	3.2		23	17	37	0.1
05/11/01	86		3.5	233	15	65	2.9	7.2	39.5	4.6		90	19	130	0.2
16/01/02	113		0.7	339	4	105	5.4	6.6	15.8	6.2		390	42	740	0.1

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	TKN (mgN/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
21/03/02	65		12.3	156	8	22	2.4	7.5	47	5		163	11	410	0.3
18/06/02	45		0.5	407	15	40	3	7.3	20.5	5.4		130	56	320	0.1
17/07/02	45		0.2	411	18	31	11	7.02	24.5	12		16	26	31	0.1
12/09/02	59			395	21	49		7.25	645	4.5		410	150	750	3.8
06/11/02	59		0.05		14	24	3.6	7.18	579	5		230	73	590	3.6
22/01/03	105		7.6	115	24	5	2.4	7.2	655	28		160	50	530	3.2
05/03/03	59		10	79	9	15	2.5	7.3	214	5.5	109	130	110	230	1.2
07/05/03	41		1.2	286	38	29	2	7.2	260	3.2		430	120	610	1.5
22/07/03	51			418	19	39	4.2	7.2	26.8	5.6		57	14	240	0.1
02/09/03	85		1	332	34	2	2.9	7.7	284	3.6		220	180	520	1.4
11/11/03	56		2.9	1	8	48	2.7	7.2	34.2	3.6		70	110	330	0.2
11/02/04	52		6.9	341	11	32	4.2	6.8	22.7	5.2		240	90	510	0.1
29/04/04	82			436	44	42	3	7.2	35	6.8		1700	600	2900	0.2
22/06/04	152			404	30	38	61	7.1	7.7	84		900	350	700	0
03/08/04	61		0.3	655	23	24	22	6.88	49.6	29		110	47	380	0.2
05/10/04	130			647	13	109	5.3	7.4	10.3	10		140	47	170	0.2
02/12/04	81				7	43	2.9	7.1	48.5	4.4		150	15	720	0.2
02/02/05	51				13	25	10	7.1	13.18	25		14	200	42	0.1
27/04/05							2.3	7.2	413	7.2		53	120	77	2

Estuary: Tarawera River **Station:** 50m d/s of Matata/Thornton Rd

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	TKN (mgN/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
21/07/95	103	727	0.18	410	100	50		7.5	36.6	18.4		40	12	80	2.5
12/09/95	82	963	0.4	451	71	57		7.4	38.4	27	512	130	26	170	2.5
14/11/95	130	535	0.38	312	41	67		7.2	39.4	17		300	55	54	2.5
23/01/96	101	471	0.71	245	16	76		7.3	39	16.7			1700	1900	2.5
26/03/96	102	621	0.91	338	32	56		7.4	36.8	15			250	120	0.2
27/05/96	102	620	0.6	281	47	52	9.9	7.2	38	19.3		1800	59	2600	2.5
24/07/96	110		0	405	87	50	12	7.3	36.8	29		220	49	460	2.5
17/09/96	103		0	348	46	44	10	7.3	33	36			170	830	2.5
15/11/96	100		1	338	51	50	6.6	7.4	35.5	19		670	210	900	2.5
30/01/97	106		0.74	288	39	72	5.1	7.3	43.2	10		350	220	750	2.5
01/04/97	131		1.19	331	99	69	6.3	7.3	41.1	10		430	43	830	2.5
29/05/97	143		0.77	336	52	81	7.6	7.4	42	15		540	93	1000	0.2
07/07/97	133		0.71	450	105	71	10	7.2	41.5	18		230	37	380	0.2
08/09/97	133		0.97	369	56	102	7.4	7.2	42	12		370	58	830	0.2
04/11/97	151			306	53	125	7.1	7.4	41.1	11		400	100	830	0.2
30/01/98	156		0.91	268	31	107	4.3	7.5	40.7	6.8		610	280	1100	0.2
18/03/98	154		1.08	228	44	118	4.8	7.4	43.7	4.7		730	210	830	0.2
19/05/98	177		0.18	321	61	141	3.4	7.4	44.9	5.2		330	62	530	0.2
30/07/98	120		0.44	448	87	87	9.6	7.3	35.2	22		800	80	1100	0.2
25/09/98	151		0.9	360	60	109	9.6	7.3	36.2	33		1800	130	930	0.1
23/11/98	132	651	0.56	285	36	101	6	7.4	39	9.6	366	867	107	1567	
19/01/99	133		0.83	261	11	88	7.9	7.2	39.2	16		440	150	530	3.1
22/03/99	132			309	27	108	4	7.4	40.6	5.6		1000	150	2200	0.2
21/05/99	112		0.5	348	26	81	5.2	7.4	38.4	10		430	70	700	0.2
06/07/99	108	779		357	40	65	5.8	7.5	37.9	10	422	630	73	1930	0.2
01/10/99	115	783		407	44	80	5.7	7.2	36	21	376		1	59	0.2
15/11/99	91		0.5		50	59	9.1	6.9	31.4	19	453	710	49	2400	0.2
13/01/00	125		0.7	330	27	82	5.1	7.2	38.3	15		570	90	1600	0.2
09/03/00	115	804	1.2	316	42	85	3.6	7.5	38.5	3.5	488	730	190	1500	0.2
08/05/00	118	757	0.7	388	58	92	5.3	7.3	38.7	9.4	369	720	390	1100	0.5
06/07/00	138		0.8		53	87	6.3	7.2	38.3	16	460	230	63	470	0.2
18/09/00	121		0.4	361	23	41	8.6	7.2	35.7	12	338	370	40	1000	0.2
16/11/00	108			319	46	92	2.7	7.3	35.5	4.8		570	50	900	0.15
16/01/01	111		1.4	226	38	73	4	7.3	41.4	6.4		380	110	400	0.1
13/03/01	107		1.9	272	40	75	3.7	7	39.6	7.5		460	110	2100	0.2
29/05/01	105		0.05	405	30	56	7.1	7.1	34.9	18		1500	220	1800	0.2
11/07/01	85		0.3	348	16	57	4.7	7.2	36.6	7.3			190	1300	0.2
11/09/01	104	809	0.3	355	78	62	4.8	7.3	37.6	9.8	454	90	20	130	0.2
05/11/01	98		0.3	273	42	70	3.8	7.3	38.5	6.4		360	100	1000	0.2
16/01/02	108		0.9	284	39	71	4	6.8	34.7	6.7		370	38	830	0.2

Estuary: Tarawera River **Station:** 50m d/s of Matata/Thornton Rd

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	TKN (mgN/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
21/03/02	99		0.6	363	37	83	2.8	7.5	38.4	4.8		270	87	360	0.2
18/06/02	90		0.3	388	39	69	3.3	7.4	36.6	4.6		190	120	240	0.2
17/07/02	105		0.3	393	48	71	4.7	7.24	36.7	6.7		310	19	360	0.2
12/09/02	118			389	60	93		7.33	36.5	7.3		4000	50	4000	0.2
06/11/02	117		1		71	99	2.8	7.36	65.7	4.5		160	63	2400	0.4
22/01/03	136		0.5	366			3	7.5	40.8	3.7		440	150	540	0.2
05/03/03	134		0.5	454	34	115	2.4	7.3	36.9	6.8		970	240	1200	0.2
07/05/03	119		0.3	375	10	83	3.2	7.2	38.4	6.2		490	180	630	0.2
22/07/03	111			403	38	70	4.7	7.3	36.7	9.4		47	63	73	0.2
02/09/03	122		0.6	419	75	86	4.4	7.4	419	6.2		470	300	400	0.2
11/11/03	92		0.3	289	38	63	3.5	7.3	39.2	5.3		630	93	1000	0.2
11/02/04	103		0.5	270	30	82	2.9	6.9	40.1	4.2		800	100	1200	0.2
29/04/04	159			530	124	112	7.3	7	30.1	9		3700	740	2400	0.1
22/06/04	106			433	61	54	6.2	7.2	34.2	13		1300	170	2400	0.2
03/08/04	84		0.4	441	53	35	24	7.11	31.5	18		360	10	610	0.2
05/10/04	98			383	67	60	7.3	7.2	32.5	3.3		540	140	770	0.2
02/12/04	100				55	72	3.7	7.3	35.5	6.8			190	470	0.2
02/02/05	92				52	74	3.1	7.2	36	5.7		23	340	29	0.2
27/04/05							3	7.4	38.2	7.5		240	140	260	0.2

Estuary: Matata Lagoon **Station:** Control Structure

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	TKN (mgN/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
29/05/01	100		2.8	320	53	57	7.7	7.3	54.2	8.7		800	140	1000	0
11/07/01	128		17	7	55	22	21	7.5	162	28		110	80	190	0.8
11/09/01	71	464	9.4	3	75	15	19	7.4	208	26	461	140	73	240	1.1
05/11/01	115		3.9	175	49	64	19	7.3	47.8	23		610	97	1200	0.2
16/01/02	64		17.1	24	53	52	21	6.6	115.7	22		260	48	570	0.6
21/03/02	79	379	10.3	13	18	23	20	8.4	73.7	32	366	116	200	470	0.4
18/06/02	96		11.1	154	38	40	19	7.3	42.1	17		1500	730	2300	0.2
17/07/02	67		7.2	77	17	22	22	7.17	46.8	25		130	21	130	0.2
12/09/02	117			398	55	89		7.31	34.2	5.9		610	280	700	0.2
06/11/02	98		2.8		40	64	8.4	7.55	58.5	11		270	220	310	0.3
22/01/03	138		1.2	356	41	126	6.6	7.4	47.5	15		320	240	610	0.2
05/03/03	90		5	96	20	38	1.2	7.3	297	18		570	270	830	1.7
07/05/03	109		3.4	252	44	63	10	7.3	80.9	13		670	400	800	0.4
22/07/03	66			14	7	18	17	7.9	182	20		10	17	43	0.5
02/09/03	118		2.1	384	64	73	8.5	7.4	63.4	13		370	140	48	0.3
11/11/03	105		1	232	42	60	8.1	7.3	48	11		140	27	360	0.2
11/02/04	113		7.2	105	61	62	13	7.1	175.5	19		630	140	2000	0.9
29/04/04	99			155	30	54	5.5	7	320	7		3600	840	7700	1.7
22/06/04	86			19	6	25	16	7.1	72	17		1100	350	840	0.3
03/08/04	81		0.6	476	59	37	6.8	7.13	32.7	11		200	80	430	0.2
05/10/04	121			202	90	62	23	7.2	60.7	29		3300	490	3700	0.3
02/12/04	108				50	77	4.1	7.4	42.4	6.4		560	90	630	0.2
02/02/05	172				38	134	2.3	7	42.1	6		9	490	14	0.1
27/04/05							3.3	7.3	49.9	5.5		220	180	440	0.2

Estuary: Little Waihi Estuary **Station:** 50m offshore from Domain

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
28/08/90	16				9	12				19.2	5	5	19	29.3
19/11/90	48				32	33		7.7	3820	6	82	58	344	24.5
25/02/91	95				61	67	4	7.9	1480	13.1		15		9.5
24/05/91	146				59	54	4.5	7.8	1620	11.3	5	28	37	9.3
28/06/91	21				32	11		8	4510	3.6	12	17	17	29
29/08/91	36				23	17		7.9	5060	37.5	8	3	8	25.5
08/11/91	23				4	6	2.1	8.1	4560	11.8	1	56	20	25.1
14/02/92	41				11	11	2.8	8	2960	9.3	0.5	3	7	18.9
20/03/92	33				7	19		6	4840	5.8	42	12	84	10.2
05/05/92	11				9	0.5	0.7	8	3130	4.3	16	91	35	
06/07/92	87				64	61		7.6	2030	16.1	23	58	124	10
30/09/92	26		0.05		13	11		8	5300	5.5	0.5	0.5	0.5	
26/11/92	40		0.18		5	9	1.7	8	4750	10.5		1	2	33.1
15/01/93	20		0.79		1	7		7.8	4930	4.1	0.5	3	1	31.65
11/03/93	24		1.14		5	6		8.2	3700	18.4	4	2	4	33.8
11/05/93	20		0.94		6	14		8.1	5260		0.5	1	0.5	32.5
28/07/93	44	172		18	9	9		8		5.9	0.5	0.5	0.5	29.7
23/09/93	63	223		6	7	8		8.4	5140	39.6	4		1	34.45
19/11/93	32	99	1.6	16	31	13		8.1	5310	8.7	0.5	1	3	34.6
18/01/94	27	67	1.6	10	26	13		8.3	5280	8.2	1	4	1	29.65
15/03/94	33	151	2.2	13	19	15		8.2	5360	20.2		16		28.05
17/05/94	33	42	1.4	19	13	6		8.1	5370	17.4		0.5	1	34.9
28/07/94	31	230	0.8	66	11	11		8	5200	13.9	5	22		34.5
28/09/94	32	107	0.78	0.5	24	8		8.1	5230	30	1	2	1	34
24/11/94	29.5	162	3.54	16	10.5	10.5		8	5380	4.6	0.5	0.5	0.5	34.8
23/01/95	17	72	1	0.5	17	7		8	4590	10.6	1	1	1	29.7
18/04/95	18	86	1	0.5	17	7		8.1	5100	5.3	2	2	2	33.3
23/05/95	66	74	1.04	17	12	7		8	5220	6.2	10	4	12	34.3
21/07/95	62.5	137	1.34	88	14.5	16.5		8	5220	31.1	8	4	11	34
12/09/95	28	97	0.34	39	14	8		8	5260	5.4	0.5	0.5	2	35
14/11/95	34	159	2.92	35	33	13		8	4900	4.9	3	0.5	1	32
23/01/96	14	142	3.22	6	4	5		8.1	4820	33.8		14	16	32.3
26/03/96	16	91	0.86	0.5	7	4		8.1	5270	3.1		0.5	2	34.6
27/05/96	25	127	0.92	20	9	8	3.6	8.1	5320	14.9	6	3	6	35
24/07/96	28		0.93	85	13	10	5.2	8.1	5290	15	6	1	13	35
17/09/96	7		2.86	5	7	0.5	2	8.1	5230	8		0.5	1	34.2
15/11/96	31		1.04	64	17	13	5.2	8	5330	17	0.5	0.5	1	34.9
30/01/97	23		1.07	3	13	7	7.8	8.1	5260	22	0.5	2	0.5	34
01/04/97	9		0.24	4	13	4	0.9	8.1	5250	5	0.5	0.5	0.5	35.2
29/05/97	16		0.7	5	17	5	0.8	8	5180	4	0.5	0.5	0.5	34.2

Estuary: Little Waihi Estuary **Station:** 50m offshore from Domain

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
07/07/97	15		2.01				1	8	5140	1	0.5	0.5	0.5	34.6
08/09/97	14		2.85	26	15	8	9	7.9	5090	31	28	44	24	34.9
04/11/97	12			4	10	8	1.4	8	5280	16	0.5	0.5	10	35.7
30/01/98	16		2.1	1	16	4	1.7	8	4800	6.7	3	2	6	35.7
18/03/98	13		0.66	10	27	6	1.4	8.1	5320	6.4	10	3	10	34.3
19/05/98	30		0.41	146	45	22	2.2	8.1	4810	9.9	2	2	6	19.6
30/07/98	25		0.71	72	13	9	12	7.9	5040	27	0.5	2	5	28.3
25/09/98	16		0.55	44	30	12	1.4	8	5320	6	2	0.5	1	33.9
23/11/98	9		0.92	3	15	3	2.6	8.6	5170	7.6	0.5	1	3	
19/01/99	16		0.88	0.5	33	3	2.4	8.1	5130	32	1	4	1	31
22/03/99	18			33	9	8	4.1	8.1	5150	12	5	1	35	26.6
21/05/99	9		1.2	6	4	3	2	8	5270	29	0.5	0.5	0.5	24.6
06/07/99	13			18	10	7	3.4	8	5330	15	0.5	0.5	1	34.4
01/10/99	25			7	10	3	2.4	8	5390	20	1	0.5	10	26.7
15/11/99	18		1	4	19	0.5	2.6	7	5090	13	1	0.5	4	26.6
13/01/00	18		0.7	0.5	10	2	3.2	8.1	5230	9.5	0.5	0.5	1	32.4
09/03/00	19		0.5	1	13	4	2.4	8	5090	20	5	25	6	35.2
08/05/00	47		1	26	15	8	15	8	5370	58	2	4	3	32.9
06/07/00	54		0.9	83	15	14	23	7.9	5220	51	16	33	26	32.6
18/09/00	12		0.7	2	15	3	0.9	8.1	5280	5.2	2	1	0.5	27.4
16/11/00	18			24	19	10	2.6	8	5280	8.8	0.5	1	2	34.9
16/01/01	14		0.05	3	8	7	4.2	7.96	5270	22	0.5	3	3	34.8
13/03/01	16		0.2	3	11	2	1.8	8	5240	12	0.5	4	1	35.7
29/05/01	27		0.05	121	17	17	1.3	8	5300	4.6	1	1	3	36.7
11/07/01	25		7.9	36	19	9	8	7.9	5240	16	0.5	0.5	0.5	33.2
11/09/01	28		0.6	73	72	16	3.1	8.1	4740	11	4	3	9	30.2
05/11/01	20		1.4	20	18	9	2	8	5400	15	2	2	4	36.5
16/01/02	27		1.5	4	11	10	6.5	7.7	5350	23	2	0.5	3	31.2
21/03/02	13		0.5	6	9	8	0.44	8.2	5.4	9.6	0.5	0.5	0.5	36.6
18/06/02	22		1.6	69	12	16	5.9	8	5290	30	1	7	3	28.9
17/07/02	23		0.4	98	7	18	2.4	8.03	5350	9.6	0.5	0.5	0.5	31.4
12/09/02	14			2	10	11		8.13	5340	11	4	3	8	33.6
06/11/02	18		1.3		9	17	2.8	7.98	5380	16	240	5	11	34.5
22/01/03	28		1.1	34	13	15	5.8	7.9	5380	28	1	100	5	28.8
05/03/03	20		1.1	24	5	12	5	8.1	5370	26	1	5	5	36.6
07/05/03	20		2.2	7	8	2	3.7	8.1	5300	22	4	160	11	33.4
22/07/03	18			34	10	9	2.2	8.1	5390	3.8	0.5	1	0.5	31.9
02/09/03	22		3.6	25	9	14	6.4	8.1	5340	31	3	14	5	25.1
11/11/03	19		0.8	45	16	14	0.81	8	5390	4.2	3	3	2	34.2
11/02/04	18		0.7	3	14	8	0.91	8	5230	17	1000	3	47	27
29/04/04	237			458	154	125	26	8	873	47	630	2800	1000	5.1
22/06/04	32			70	17	14	7.2	8	5230	33	2	3	4	34.2

Estuary: Little Waihi Estuary **Station:** 50m offshore from Domain

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
03/08/04	22		1.4	63	21	7	1	8.09	4950	9.5	0.5	2	2	32.2
05/10/04	30			25	31	15	6.3	7.9	5170	41	9	16	39	33.5
02/12/04	29				22	19	1.4	8	5230	4.2	0.5	7	7	29.7
02/02/05	100				79	57	11	7.8	3690	48	2	16	11	24.4

Estuary: Maketu Estuary **Station:** Boat Ramp

Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**Conductivity (ms/m)**	**SS (g/m3)**	**E.coli (/100ml)**	**Enterococci (/100ml)**	**Faecal coliform (/100ml)**	**Salinity o/oo**
28/08/90	35				21	12				36	5	5	11	29.8
19/11/90	31				30	11		7.6	4210	14.5	5	5	13	27.1
25/02/91	30				31	18	2.7	7.7	3100	7.7		39		22.2
24/05/91	65				44	31	2.6	7.7	3830	4.6	0.5	33	8	28.2
28/06/91	21				59	11		8	4480	6.2	0.5	8	4	29
29/08/91	36				9	11		8	5050	25	5	0.5	7	25.7
08/11/91	49				0.5	6	9.9	8	4680	41.9	0.5	40	105	23.1
14/02/92	47				4	5	3.3	8.1	2800	8.9	0.5	4	5	14.4
20/03/92	51				13	15		8	4840	8.7	0.5	22	11	14
05/05/92	25				4	0.5	2.6	8	3140	16.8	5	7	10	
06/07/92	32		0.5		15	8		7.8	4550	16.3	4	26	39	17
30/09/92	29		0.05		10	7		8.1	5300	12.5	0.5	0.5	3	
26/11/92	22		3.16		0.5	9	4.6	7.9	4710	10.2		1	13	31.5
15/01/93	26		3.81		0.5	8		7.9	4970	8.7	0.5	3	2	32.1
11/03/93	22		1.93		12	7		8.1	3710	8.9	1	0.5	0.5	33.8
11/05/93	23		1.87		0.5	15		8.1	5230		0.5	1	0.5	32.7
28/07/93	51	337		14	7	9		8		6.9	0.5	0.5	1	30
23/09/93	65	255		12	11	10		8.3	5120	42.1			85	34.25
19/11/93	49	408	1	51	73	11		7.9	4860	13.4	1.5	18	21	31.5
18/01/94	53	186	2.8	83	27	31		8	5000	8.8	0.5	8	1	27.55
15/03/94	36	278	1.8	148	47	23		8.2	3940	7.6		10	30	20.5
17/05/94	36	47	1.8	10	7	5		8.1	5280	17.4		0.5	12	34.4
28/07/94	17	240	1.2	120	21	14		8	5040	25.6	32	31	29	33.1
28/09/94	29	126	1.32	24	19	12		8	5080	6.5	0.5	1	0.5	33.1
24/11/94	40	184	3.26	11	10	12.5		7.9	5090	5.2	1	1	2	32.7
23/01/95	35	169	3.6	19	19	18		8	5110	10.6	0.5	33	0.5	33.4
18/04/95	22	127	2.2	6	30	10		8.1	4960	7.6	25	8	27	32.2
23/05/95	28	142	3.46	17	25	8		8	5270	14.2	11	3	8	34.6
21/07/95	36.5	318	0.6	156	72	12.5		7.8	4250	7.7	24	2	37	27
12/09/95	20	185	1.04	55	34	9		7.9	4540	9.3	2	9	4	29
14/11/95	41	218	3.8	55	12	13		7.9	5070	12.9	7	5	50	33
23/01/96	27	140	2.34	4	6	7		8	4970	12.8		420	160	33.4
26/03/96	36	203	2.54	21	36	27		8	5190	6.9		3	1	33.9
27/05/96	42	193	1.45	30	28	14	6	8.1	5180	19.7	8	2	6	34
24/07/96	39		1.13	129	61	18	8.3	8	4820	15	13	1	8	31
17/09/96	18		1.52	36	14	6	3.3	8	5180	25		1	0.5	33.8
15/11/96	31		1.73	77	19	14	3.7	8	4980	12	1	5	10	32.2
30/01/97	34		1.48	33	31	18	4.6	8	5070	9	0.5	0.5	1	33
01/04/97	36		0.54	67	65	25	2.5	8	4750	7	0.5	0.5	1	31.5
29/05/97	24		1.14		29	12	2	8	5070	4	110	0.5	170	33.9

Estuary: Maketu Estuary **Station:** Boat Ramp

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
07/07/97	19		1.31				2.5	8	4990	6	2	6	4	33.5
08/09/97	27		2.79	14	9	6	8.4	7.9	5180	19	2	2	0.5	34.7
04/11/97	47			51	23	28	2.7	7.8	4980	21	1	1	1	35
30/01/98	81		4.78	86	161	35	4	7.7	4010	9.2	18	7	19	29.3
18/03/98	52		1.9	0	111	32	3.7	7.8	4850	17	70	6	76	30.8
19/05/98	16		0.71	26	18	7	1.7	8.1	5320	7.9	1	0.5	7	32.6
30/07/98	30		0.86	199	43	16	4.5	7.9	3640	12	0.5	0.5	7	21.2
25/09/98	39		2.42	47	28	11	9	7.9	5210	53	0.5	1	1	23.3
23/11/98	41		1.29	62	63	26	4.7	7.9	4850	9.2	5	0.5	10	
19/01/99	30		1.43	11	31	10	2.6	8	5120	8.6	10	7	11	32.4
22/03/99	16			24	20	5	2.7	8.1	5080	13	2	1	7	30
21/05/99	22		1.6	26	15	11	9.1	8	5270	47	3	10	2	26.4
06/07/99	35			39	40	13	5.4	8	5120	20	1	5	1	33.2
01/10/99	39			18	86	17	3.6	7.8	5000	22	1	0.5	13	30.2
15/11/99	55		1.5		51	16	8.4	6.9	3580	19	19	4	21	28.2
13/01/00	44		0.5	25	24	11	3.2	8	4850	8	0.5	0.5	0.5	30.8
09/03/00	31		0.8	4	14	8	5.3	8	5010	26	27	83	69	34.5
08/05/00	33		1	38	62	11	3.8	7.9	4880	11	20	15	69	29.5
06/07/00	59		0.2	94	14	14	24	7.9	5220	44	2	18	14	34
18/09/00	43		0.6	174	81	22	4.4	7.8	4260	11	2	0.5	5	33.45
16/11/00	30			12	30	10	5.2	8	5300	15	61	3	180	34.2
16/01/01	23		1.9	107	14	8	3.9	8.06	4220	12	0.5	4	2	27.2
13/03/01	37		1.6	11	18	10	5	8	5100	24	24	22	17	34.8
29/05/01	18		0.3	81	10	12	2.8	8	5340	16	1	5	4	36.8
11/07/01	30		0.7	59	34	11	5.5	7.9	5050	9.6	3	7	1	32.5
11/09/01	32		0.5	16	58	8	3.9	8.1	5140	9.6	17	16	29	33.2
05/11/01			1.5	28	28	20	2.7	8	5290	10	5	5	9	35.6
16/01/02	52		1.3	45	46	21	3.7	7.6	4530	7	24	3	22	28
21/03/02	31		1.2	46	36	17	3	8.1	5280	30	1	0.5	0.5	35.4
18/06/02	43		3.3	104	18	15	10.6	8.1	5050	44	14	24	27	29.1
17/07/02	27		1.3	101	10	16	8.4	8.04	5360	19	0.5	0.5	0.5	32.6
12/09/02	14			1	10	5		8.13	5360	5.4	12	18	17	35.9
06/11/02	18		16.9		6	11	2.2	8.08	5280	12	270	21	23	36.1
22/01/03	40		1.9	6	7	7	5.3	7.9	5450	32	0.5	1	2	35
05/03/03	28		1.6	19	5	10	9.4	8.1	5410	3.7	1	2	3	36.8
	28				5	10	9.4	8.1		3.7	1	2	3	36.8
07/05/03	28		4.1	4	7	31	7.9	8.1	5380	24	2	4	1	34.3
22/07/03	22			34	22	11	2.9	8.2	5380	8.2	0.5	0.5	0.5	33.3
02/09/03	54		5.3	22	8	9	26	8.1	5070	80	1	21	18	30.1
11/11/03	23		2.2	4	10	7	4	8.1	5340	15	4	5	6	34.6
11/02/04	20		2.9	2	7	3	2.8	8	5200	12	10	37	27	29.9
29/04/04	140			659	331	40	12	7.6	2060	30	770		900	12.6

Estuary: Maketu Estuary **Station:** Boat Ramp

Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**Conductivity (ms/m)**	**SS (g/m3)**	**E.coli (/100ml)**	**Enterococci (/100ml)**	**Faecal coliform (/100ml)**	**Salinity o/oo**
22/06/04	43			98	28	14	12	8.1	4970	56	19	4	17	32.7
03/08/04	18		2.2	89	41	7	2.3	8.06	4830	28	9	2	14	31.2
05/10/04	44			45	27	12	8	7.9	4940	55	14	21	24	31.8
02/12/04	29				20	14	1.6	8	5140	7.2	0.5	3	1	29.6
02/02/05	60				71	39	2.7	7.6	3960	28	0.5	9	0.5	26
27/04/05							1	8.2	5220	38	1	6	4	37.9

Estuary: Kaituna River Estuary **Station:** River Diversion Structure

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (ms/m)	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
14/11/95	43	587	1.62	368	70	22		7.1	158	4.7	460	32	900	2.5
23/01/96	34	362	14.9	60	11	7		8.1	3650	8.4		54	130	23.6
26/03/96	45	603	2.36	459	94	5		7.4	638	3.8		18	87	3.5
27/05/96	49	707	5.42	444	78	18	3.8	7.1	68	9.7	100	14	1180	2.5
24/07/96	42		1.9	359	131	13	7.1	6.9	154	13	420	13	440	2.5
17/09/96	26		16.47	102	82	0.5	4.1	7.8	4270	13		2	4	27.4
15/11/96	35		1.17	277	64	24	2.1	7.8	2630	3	66	9	160	14.8
30/01/97	45		5.03	431	58	22	3	7.6	1363	6	6	10	63	7
01/04/97	36		8.18	361	39	17	2.5	7.5	998	5	48	6	60	6.3
29/05/97	40		1.44	436	89	23	2.4	7.3	658	4	48	12	43	3.8
07/07/97	34		0.61				3.7	6.8	511	4	6	3	13	3
08/09/97	37		1.49	418	73	15	4.7	7.5	1853	13	73	12	130	11.5
04/11/97	41		1.2	482	73	22	2	7.2	594	5.4	10	6	71	5
30/01/98	27		3.68		48	8	2.4	8.1	3500	5.4	120	41	660	30.7
18/03/98	40		4.31	388			3.3	7.4	1044	7.1	220	40	180	5.5
19/05/98	32		1.51	121	51	11	1.9	8.1	4500	6.6	6	0.5	4	28.4
30/07/98	42		4.47	441	170	13	9.3	7.5	294	11	600	16	1600	2
25/09/98	35		4.05	432	79	21	3.9	7.5	391	6	510	44	2200	1.9
23/11/98	30		1.88	377	27	19	2.4	7.7	1628	5.4	51	13	71	
19/01/99	35		3.46	282	17	17	2.2	7.9	1938	8	93	83	230	18.6
22/03/99	17			24	14	5	2.8	8.2	5050	10	4	4	17	24.6
21/05/99	25		3.2	325	68	14	3.5	7.9	2160	17	17	7	47	12.7
06/07/99	36			443	66	17	3	7.4	929	5.5	27	8	80	5.9
01/10/99	36			206	85	14	2.2	7.9	3920	17	37	0.5	30	
15/11/99	41		1.3	354	91	13	5.8	7.3	137	8.5	64	6	110	0.4
13/01/00	38		2.5	371	46	17	2.2	7.6	1044	5.5	5	2	58	7.5
09/03/00	37		3.1	319	67	20	2.2	7.9	2811	16	29	170	140	18.1
08/05/00	35		1.8	290	48	13	3.1	7.9	3150	6.7	160	210	520	19.4
06/07/00	42		0.7	452	84	25	6.7		1730	12	57	43	250	13.2
18/09/00	33		1.2	478	66	13	3.3	7	840	4.4	73	7	77	4.6
16/11/00	29		17	188	41	17	2	7.9	3030	3.8	18	20	58	16.9
16/01/01	26		2.1	193	28	16	1.6	8.07	3690	4.2	30	21	47	23.4
13/03/01	34		1.3	239	38	10	2.3	8	3150	14	29	13	73	25.4
29/05/01	39		2.7	380	95	18	3.5	7.4	1440	6.4	88	15	410	0.8
11/07/01	39		1.4	483	95	22	5.7	7.4	1578	9.6	57	70	160	9.3
11/09/01	43		1.2	476	247	13	5.7	6.8	463	8	46	6	69	3.2
05/11/01	46		2	166	30	27	5.6	7.3	864	8	140	37	560	5.2
16/01/02	27		2.7	244	91	22	3.9	7.1	824	6.6	73	24	240	0.4
21/03/02	40		0.8	513	68	30	2.1	7.6	1180	5.7	13	14	57	7.1

Estuary:	Kaituna River Estuary		**Station:**	River Diversion Structure											
Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**Conductivity (ms/m)**	**SS (g/m3)**	**E.coli (/100ml)**	**Enterococci (/100ml)**	**Faecal coliform (/100ml)**	**Salinity o/oo**
18/06/02	45		1	389	95	32	2.4	7.4	1134	3.6	140	110	340	7.6
17/07/02	42		1.2	514	100	18	3.7	7.06	937	4.4	33	33	72	5.7
12/09/02	32			335	61	22		7.95	2830	10	190	77	330	22.2
06/11/02	28		0.4	298	32	18	1.6	8.01	3920	8.6	59	61	100	26.1
22/01/03	33		8.3	414	44	27	3.5	7.8	1823	11	110	57	170	11.3
05/03/03	59		2.2	501	114	40	3.1	7.1	365	5.2	220	87	790	1.6
07/05/03	56		3.5	462	114	17	2.8	7.8	2000	6.8	24	59	43	15.8
22/07/03	53	991		749	87	36	0.5	7.1	247	3.4	17	13	20	1.3
02/09/03	36		1.3	436	52	27	3.1	7.7	1649	8.2	70	120	120	9.1
11/11/03	41		1.8	504	48	21	2.9	7.3	5120	8	220	43	560	2.6
11/02/04	52		14.4	539	108	7	5.6	7	554	7	140	87	410	14.3
29/04/04				762			14	6.7	212	18	13000		13000	1.1
22/06/04	50			491	97	24	5.4	6.9	64.3	10	290	57	390	0.4
03/08/04	36		0.4	436	91	9	4.4	6.89	413	31	80	110	140	2.2
05/10/04	63			457	26	20	9	7	77.5	22	900	190	2200	0.3
02/12/04	45				58	28	1.9	7.3	787	3.8	130	24	160	3.9
02/02/05	49				56	34	1.7	7.2	283	7	1	140	7	1.3
27/04/05							1.7	7.6	1293	10	54	130	100	7.6

Estuary:	Tauranga Harbour		**Station:**	Maungatapu Bridge									
Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**SS (g/m3)**	**E.coli (/100ml)**	**Enterococci (/100ml)**	**Faecal coliform (/100ml)**	**Salinity o/oo**
10/09/90	52				39	5		8.2	8.5	5	5	5	23
01/10/91	32				23	11	1.3	8	12.1	2	2	11	
08/11/91	28				7	7		8.1	7	0.5	0.5	2	
22/01/92	46				22	9		7.7	15.1	2	85	1	16.3
18/03/92	49				11	6	6.4	8	24.9		22		
19/05/92	27				11	6		7.9	17.8		1	58	23.5
06/07/92	17				18	6		8	10.7	0.5	6	10	29.2
30/09/92	27		0.12		19	5		8.1	15.3	1	2	3	28
13/11/92	33		2.2		7	3		7.8	16.1		4	32	38.5
11/02/93	34				16	3		7.8	11.7		25		27.6
11/03/93	36				5	3		8	25.9	9	10		29
25/05/93	28		1.96		30	13		8	10.4	6	32	15	27.1
27/07/93	66	347		150	45	10		7.9	7.1	5	15	10	
21/09/93	51	303		45	37	11		8.2	15.4		7	25	29.9
18/11/93	34	284		19	174	6		8.1	12.5	0.5	4	7	29.9
14/02/94	4	172		15	28	11		8.1	24.8		4		31.9
16/05/94	45	0						8	19.6		18	18	31.5
28/07/94	36	570		39	161	14		7.8	14.2	87	26		18.7
26/09/94	26	227		63	51	10		8	13	9	1	9	27.1
25/11/94	28.5	270		14	17.5	3.5		7.9	8.7	4	2	2	28
23/01/95	31	237		20	33	8		8.1	8.2	5	0.5	6	34.2
05/04/95	41	295		55	70	19		8	9.8		89		23.2
19/05/95	44	246		49	40	7		8	36.4	8	4	17	31
18/07/95	41	662		348	85	19		7.8	11.1	29	48	16	20
14/09/95	37	272		141	36	7		8	10.5	3	0.5	4	25
13/11/95	30	305		54	34	6		7.9	8.7		2	6	24
10/01/96	25	206		15	20	3		8	14.4		2	6	26.4
08/03/96	31	188		11	13	5		8	12		1	3	32
08/05/96	27	227		49	43	7	5.9	8.1	10.4	18	9	26	29
05/08/96	33			385	57	9	3.7	7.8	12	39	20	58	19
19/09/96	24			108	17	5	68	8	13		1	1	31
14/11/96	182			25	2	2	2.4	7.9	205	2	3	8	30.6
28/01/97	15			11	17	5	7.8	8	8	0.5	0.5	0.5	35.5
26/03/97	31			32	6	4	4.5	7.8	22	2	0.5	4	30.3
27/05/97	29			129	76	12	1.5	7.7	15	32	16	39	25.7
07/08/97	12			215	35		4.2	8	9.5		2	2	32.1
22/09/97	21			91	32	5	5.9	7.92	9.7	25	6	33	27.9
18/11/97	30			65	42	12	4.7	7.9	24	15	3	8	28.8
29/01/98	23			4	26	8	3.8	8.1	14	9	2	7	
19/03/98	26			55	61	8	2.3	8	10	18	18	30	27.7

Estuary: Tauranga Harbour **Station:** Maungatapu Bridge

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
18/05/98	21		1.25	55	20	5	3.6	8.1	7.2	94	41	130	24.8
29/07/98	14		0.6	373	77	11	7.4	7.9	7.7	3	4	12	19.3
10/09/98	23		1.36	69	23	11	3.5	8	20	6	3	12	32.4
24/11/98	17		1.72	26	10	3	4	8	10	7	1	10	25.7
20/01/99	18		2.16	4	8	2	5.6	8	9.4	2	0.5	3	31.6
22/03/99	24			2	12	4	5	7.2	14	2	1	4	33.3
20/05/99	22			75	49	8	3.1	7.9	22	15	8	7	27.5
18/08/99	40			203	52	7	5.2	8	7.3	30	18	39	20
29/09/99	21			42	26	5	7.8	7.9	19	0.5	0.5	0.5	30.3
26/11/99	33		2.2	6	20	8	5.4	7.8	28	0.5	1	13	27.4
24/02/00	28		2.7	24	21	8	4.3	7.8	23	1	4	71	31.1
23/03/00	19		0.9	9	24	8		7.9	20	7	0.5	7	30.5
09/05/00	28		1	70	61	16	6.5	7.9	15	47	30	89	21.6
21/08/00	37			134	30	7	4.5	8	26	19	4	12	24.8
19/09/00	47		5.3	90	18	5	5.3	8	11	3	0.5	2	20
16/11/00	32		2	17	24	7	3.3	8	15	3	5	21	18.95
30/01/01	28		2.7	36	25	6	4.8	7.76	12	16	40	20	30.4
29/03/01	27		0.8	11	49	13	12.2	8	24	19	5	37	32.4
30/05/01	38		2.1	1450	57	8	2.6	7.8	43	26	49	37	24.9
24/07/01	15		0.1	55	23	7	5	7.8	19	2	8	3	29.5
06/09/01	31		0.8	71	49	12	4.8	7.9	14	1	6	4	27.4
05/12/01	7		2	265	56	9	3.7	7.48	12	64	25	71	13.4
17/01/02	20		1.6	47	35	7	6.6	8	22	2	0.5	3	26.6
18/03/02	28		2.2	14	11	4	3.5	7.99	20	0.5	16	5	30.9
17/05/02	11		1	43	104	29	3.5	8.06	15	0.5	2	3	23.5
17/07/02	26		3.2	305	35	11	1.6	7.97	8.8	2	3	9	19.9
11/09/02	14		0.8	7	9	0.5	4.2	8.06	5.8	72	14	92	34.3
09/12/02	22		0.9	16	29	8	4.6	7.9	13	24	10	77	26.6
21/01/03	22		1.5	12	25	6	1.2	8	26	9	10	11	26.8
25/03/03	20		0.8	13	24	6	2.4	8.2	17	4	7	11	32.5
09/05/03	21		0.8	35	27	5	3.5	8.2	21	2	5	9	27.6
17/07/03	22		0.8	34	22	9	2	8	16.4	0.5	5	3	27.6
15/09/03	11		0.4	12	60	7	3.3	8.2	9.6	17	0.5	34	27.7
27/11/03	31		0.8	34	15	10	12	8	12	14	1	24	30.5
12/02/04	42		4.3	13	29	3	5.4	7.9	55	14	21	34	25.4
15/02/04	32				29	3	2.4	8	38	1	7	3	32.5
28/04/04							3.7	8	30	120	120	160	30.1
23/06/04	18			197	56	8	2.5	8	11.4	8	8	18	30.9
05/08/04	18		0.9	28	28	5	2	8.1	26	16	4	47	28.1
19/10/04	19				28	12	6.9	8	37	2	14	1	33
16/12/04	43			22	15	14	3.3	7.7	49	7	44	12	34.5
28/04/05							1.9	8.1	32	0.5	2	2	33.2

Estuary:	Tauranga Harbour		Station:	Grace Street					
Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**SS (g/m3)**
10/08/91	48			91	16	16		8.4	42.5
10/09/91	19			187	19	4			12.9
08/11/91	38			44	11	9			22.5
22/01/92	50			65	15	2			58.6
19/03/92	71			33	19	20		8.5	50
19/05/92	67			133	12	12	13	8.4	48.6
29/07/92	40			355	18	8		8.4	15.8
28/09/92	98			96	20	5		8.2	
28/10/92	55			187	30	9		8.2	40
22/12/92	90			94	20	5		8.3	47.1
23/02/93	36			66	22	9			29.3
06/04/93	43			79	27	22		8.2	19.7
03/06/93	28			180	18	16		8	10.3
18/08/93	39	361		125	30	7		8.2	27.8
14/10/93	78	248	1.6	45	38	11		8.3	20.5
14/12/93	80	339	4	5	31	12		8.4	47.7
01/03/94	62	325	2	11	44	10		9	30.4
12/04/94	69	580	3.4	45	79	4		8.2	70.4
22/06/94	62	470	2.4	367	48	17		8	14
23/08/94	15	300		7	14	4		8.6	11.6
05/10/94	32	352		75	53	9		8.4	10
06/12/94	57	309			1	0.5		8.1	39.4
01/02/95	137	384		0.5	30	9		8.2	93
29/03/95	61	220		6	43	9		8	33.8
16/05/95	33	456		53	92	9		8.1	14.7
11/07/95	26	538		213	47.5	10		8	8.6
07/09/95	35	420		176	39	7		8	12.3
07/11/95	54	244		52	52.5	14		8.1	39
16/01/96	62	372		67	50	12		8.1	26.8
01/04/96	31	214		21	18	5		8.1	19
14/05/96	29	251		52	47	11		8.2	7.5
16/07/96	46			326	62	14	16	8.2	31
10/09/96	18			504	58	8	3.3	7.9	6
26/11/96	44			68	16	2	7.5	8.1	18
09/01/97	29			97	7	1	6.7	8	16
05/03/97	62			48	48	10	16	8.1	51
05/05/97	33			82	28	7	5.1	8	13
17/07/97	13			339	28	5	2.8	8	10
18/08/97	11			95	26	5	2.1	8.2	7.2
01/10/97	25			72	54	12	4.8	8.3	14

Estuary: Tauranga Harbour **Station:** Grace Street

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)
10/12/97	33			13	8	2	8	8.1	46
09/02/98	45				30	12	23	8.1	71
23/04/98	50			20	37	2	17	8.4	22
23/06/98	37			230	32	9	9.5	8.3	24
19/08/98	83			210	25	6	37	8.1	72
19/10/98	25			54	49	10	3.1	8.3	8.8
03/12/98	38			94	30	5	15	8.1	46
15/02/99	49			12	22	3	17	8.1	41
15/04/99	30			14	32	5	10	8.3	42
28/06/99	90			42	221	9	33	8.3	71
10/08/99	52			187	21	3	23	8.1	52
07/10/99	99			6	18	5	39	8.2	79
20/12/99	45			0.5	11	8	5.3	8.4	23
17/02/00	52			5	28	14	8.2	8	43
17/04/00	36			16	32	8	7.6	8.2	41
15/06/00	20			207	35	11	2.7	8.2	7.6
28/08/00	20			63	37	8	3.1	8.3	7
25/10/00	30			746	17	0.5	8.4	8.1	27
11/12/00	243			0.5	18	3	111	8.2	355
07/02/01	74			33	20	7	29	8.09	81
06/04/01	30			58	56	12	7.8	8.2	23
19/06/01	9			183	46	11	1.1	8.1	4.4
02/08/01	28			18	28	7	5.2	8.2	14
15/10/01	31			137	44	12	4.5	8	13
12/12/01	81			106	22	7	9.6	8.25	113
25/02/02	30			41	42	5			
24/04/02	160			36	22	7	59	8.09	239
24/06/02	54			80	92	17	19	8.43	42
08/08/02	24			32	26	8	2.3	8.4	6.8
04/10/02	14			11	13	3		8.54	9.2
02/12/02	29			2	10	1	8.2	8.2	46
14/02/03	54			12	19	14		8.3	43
30/04/03	22			22	27	7	2.3	8.5	6.2
13/06/03	15			218	21	8	3	8.1	11
08/10/03	19			40	19	34	4	8.5	29
22/12/03	26			26	18	3	4.5	8.2	17
19/04/04	20			0.5	16	5	2.8	8.8	18
16/06/04	18			84	32	7	1.8	8.4	18
16/08/04	20			70	18	12	7.6	8.5	25.2
26/10/04	27			23	26	52	3.8	8.7	25
21/12/04	25			1	7	3	3.6	7.9	31
07/02/05	47				30	39	17	8	66

Estuary:	Tauranga Harbour		**Station:**	Grace Street					
Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**SS (g/m3)**
07/04/05	35						6.8	8.4	39

Estuary: Tauranga Harbour **Station:** Toll Bridge Marina

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
19/03/98	16		1.37	40	43	8	1.5	8	12	8	4	9	32.7
18/05/98	16		0.74	19	18	6	2.4	8.1	4.5	0.5	6	5	33.6
29/07/98	19		0.5	153	77	12	2.2	8	4.6	4	2	7	27.9
10/09/98	21		0.55	83	11	10	1.6	8	5.7	8	7	19	33.2
24/11/98	9		0.82	11	17	4	2.9	8.1	5.5	0.5	0.5	0.5	28.9
20/01/99	24		1.38	0.5	17	2	2.5	8.1	5.6	2	2	1	32.8
22/03/99	9			3	12	5	2.3	8	6.6	2	1	1	35.3
20/05/99	13			36	22	19	1.9	8	12	6	4	10	31.5
18/08/99	17			75	22	7	1.6	8.1	4.5	7	4	19	27.4
29/09/99	37			40	17	5	1.8	8	3.8	0.5	0.5	0.5	28.4
26/11/99	9		0.7	1	12	2	2.7	7.9	9.8	0.5	0.5	7	31.9
24/02/00	19		1.1	6	10	6	2.4	7.9	9.6	0.5	0.5	2	33.6
23/03/00	9		0.9	6	11	2		8	13	7	0.5	12	32.1
09/05/00	9		0.6	30	28	12	2.9	8	9.6	5	3	11	29.7
21/08/00	15		0.5	37	21	7	2.2	8.1	18	4	1	14	30.9
19/09/00	12		0.7	22	17	2	2.2	8.1	6	1	1	7	26.5
16/11/00	13		0.8	6	15	7	1.9	8.1	5.8	0.5	0.5	3	32.7
30/01/01	28		1.8	12	10	8	2	7.75	12	4	1	7	34.4
29/03/01	14		0.6	6	21	4	2.8	8.1	20	11	4	14	33.8
30/05/01	35		0.3	105	33	28	1.1	8	9.6	4	29	19	32.1
24/07/01	15		0.05	30	14	8	2.5	8	17	0.5	0.5	2	33.5
06/09/01	23		0.5	28	26	8	1.6	8	15	0.5	2	1	32.4
05/12/01	14		0.9	36	23	4	1.4	7.53	12	3	2	8	28.7
17/01/02	9		0.5	13	16	8	2.9	8.1	7.4	1	0.5	8	32.3
18/03/02	13		1	2	7	6	1.3	8.06	8.2	5	12	6	34.2
17/05/02	5		0.6	19	28	8	2.2	8.11	18	0.5	9	10	33.6
17/07/02	14		0.3	149	23	13	1.1	8.05	3.8	1	2	7	29.1
11/09/02	9		0.7	3	7	5	2.4	8.13	3.3	0.5	0.5	9	28.9
09/12/02	20		0.4	10	17	10	2.5	8	5.2	19	0.5	49	31.8
21/01/03	15		0.8	3	18	8	0.89	8.1	22	18	0.5	22	30.8
25/03/03	13		0.9	0.5	8	5	1.7	8.2	11	0.5	2	0.5	33.1
09/05/03	19		0.6	13	23	5	1.8	8.2	19	0.5	2	1	31.6
17/07/03	18		0.4	30	17	9	3.3	8.1	9.4	0.5	1	0.5	30.1
15/09/03	15		1	3	18	3	1.9	8.2	16	0.5	0.5	4	33.2
27/11/03	26		1.1	44	10	10	1.6	8.1	11	0.5	0.5	4	33.4
12/02/04	22		1.3	9	16	3	2	8.1	31	2	4	7	32
15/02/04	23				17	5	1.3	8	28	1	1	9	32
28/04/04	26			30	31	8	3.6	8.1	27	32	70	59	33.2
23/06/04	13			89	29	10	1.8	8.1	22	0.5	0.5	5	31.3
05/08/04	13		3.5	9	8	4	3.1	8.17	28	4	1	21	32.2

Estuary: Tauranga Harbour **Station:** Toll Bridge Marina

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
19/10/04	22				19	12	2.2	8	40	0.5	0.5	3	32
16/12/04	23			8	22	10	2.3	7.5	46	100	130	180	35
28/04/05							2.3	8.1	36	1	1	10	34.4

Estuary: Tauranga Harbour Site: Kulim Ave

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (mS/m)	SS (g/m3)
10/08/91	59			1456	53	44		9	980	29.9
10/09/91	29			95	6	0.5				9.5
08/11/91	19			19	6	3			4440	15.8
22/01/92	34			49	56	4			4460	18.4
19/03/92	36			45	11	7		9	4470	27.3
19/05/92	31			136	6	4	5.2	8.7		23.4
29/07/92	35			115	10	7		8.5	4170	7.3
28/09/92	43			134	10	5		8.9	4810	
28/10/92	19			46	2	0.5		8.7	4520	8.9
22/12/92	22				9	2		9	4730	4.9
23/02/93	33			35	44	4			4840	10.2
06/04/93	88			54	15	19		8.3	5240	8.7
03/06/93	25			102	23	16		8.3	4740	9.7
18/08/93	121	312		21	22	10		8.3	4910	55.4
14/10/93	91	369	2.1	10	48	15		8.4	5040	33
14/12/93	47	241	1.6	6	28	8		8.3	4850	13.3
01/03/94	45	211	0.8	8	43	19		9.3	5400	11.6
12/04/94	63	313	1.6	10	60	21		8.5	5110	40.8
22/06/94	11	130	0.8	44	30	11		8.2	5010	7.7
23/08/94	20	500		139	18	5		8.5	4620	8.2
05/10/94	26	278		65	33	9		8.4	4740	6.2
06/12/94	55	268		6	8	6		8.2	5140	17.6
01/02/95	41	170		0.5	15	10		8.4	5080	15.9
29/03/95	42	168		0.5	32	19		8.3	4460	15.9
16/05/95	51	185		30	22	10		8.2	4960	29.2
11/07/95	35	311		65	16	7		8	4590	16.2
07/09/95	280	765		65	5	3		8	3910	255
07/11/95	31	183		22	27	15		8.3	4930	5.2
16/01/96	75	209		0.5	8	6		8.1	5050	3.6
01/04/96	268	641		36	9	5		8.2	4840	272
14/05/96	27	150		0.5	26	11		8.3	5250	6.6
16/07/96	29			217	57	13	8	8.3	3670	17.5
10/09/96	11			653	28	4	3.4	8.3	3320	4
26/11/96	73			28	21	18	19	8.3	5240	54
09/01/97	21			29	14	5	4.8	8	4780	18
05/03/97	17			36	35	6	2.6	8	4470	8
05/05/97	22			1	14	5	1.7	8.6	4930	4
17/07/97	17	149		28	22	8	1.3	8.1	5120	4
18/08/97	33	230		18	19	6	9.3	8.4	4620	37
01/10/97	31	334		142	22	6	7.1	8.35	4370	29
10/12/97	25	181		2	17	6	2.5	8.4	4810	8

Estuary: Tauranga Harbour Site: Kulim Ave

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	Conductivity (mS/m)	SS (g/m3)
09/02/98	35	269		0.5	7	8	2	8.6	4910	11
23/04/98	18	143		0.5	8	3	1.6	8.6	4710	3.9
23/06/98	16			4	14	4	2	8.9	4857	5.4
19/08/98	67			29	10	3	33	8.4	4365	100
19/10/98	15			2	10	5	4.2	9.1	4755	13
03/12/98	17			4	29	10	4.2	8.5	4418	14
15/02/99	19			0.5	14	0.5	3	8.3	4980	5.6
15/04/99	138			37	28	5	72	8.4	4970	145
28/06/99	25			53	56	14	4.5	8.2	4710	22
10/08/99	20			56	17	5	2.8	8.2	4512	5.8
07/10/99	28			14	13	8	1.7	8.3	4570	7.4
20/12/99	12			0.5	12	8	3.3	8.3	5170	17
17/02/00	17			0.5	16	12	2.6	8.2	5110	18
17/04/00	22			10	25	10	2.5	8.5	4795	20
15/06/00	19			40	26	10	1.8	8.2	5080	8.6
28/08/00	41			190	30	9	17	8.1	4724	40
25/10/00	26			6	20	9	2.9	8.2	4877	16
11/12/00	44			1	10	5	13	8.3	4790	35
07/02/01	14			4	70	7	2.6	8.29	4800	10
06/04/01	22			10	45	14	3.7	8.4	4865	20
19/06/01	12			70	45	8	1.8	8.2	4540	6.6
02/08/01	22			11	35	8	2.5	8.2	4823	9.2
15/10/01	14			13	18	10	2	8	4530	6.8
12/12/01	74			8	12	9	32	8.53	4260	107
25/02/02	35			4		4			5100	
24/04/02	10			3	10	7	4.6	8.25	5040	20
24/06/02	23			37	14	10	6.9	8.72	4692	23
08/08/02	33			6	8	5	3.7	8.7	4770	7.2
04/10/02	12			2	14	6		8.47	4730	22
02/12/02	18			2	9	4	1.6	8.4	4945	7.2
14/02/03	18			11	11	5	1.5	8.5	5005	26
30/04/03	18			5	14	3	1.1	8.7	4840	5.6
13/06/03	13			9	13	8	1.5	8.6	5095	17
08/10/03	13			10	18	11	1.8	8.6	4091	8.6
22/12/03	32			17	8	5	6.4	8.2	4518	28
19/04/04	25			0.5	14	8	3.2	8.76	5200	11
16/06/04	16			18	25	10	1.6	8.5	4350	15
16/08/04	31			14	21	3	9.2	8.5	5010	25.4
26/10/04	22			32	30	3	1.8	8.4	4025	24
21/12/04	41			36	19	8	6.4	8	5100	32
07/02/05	41				19	7	2.6	8.6	5030	40
07/04/05	24					0	1.4	9.1	4729	25

Estuary: Tauranga Harbour **Station:** Otumoetai, Beach Rd.

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
01/10/91	21				11	6	0.6	8.2	5.8	1	1	4	
08/11/91	39				11	5		8.1	9.6	0.5	0.5	7	
22/01/92	27				19	9		7.8	1.7	0.5	13	0.5	22
18/03/92	36				3	6	3	8	21.5		360		
19/05/92	24				8	4		8.1	7.2		0.5	13	25
06/07/92	14				10	2		8	17.7	17	32	30	23.6
30/09/92	20		0.11		14	6		8.1	9.1	1	1	3	30
13/11/92	25		0.76		14	5		7.9	6.8		2	17	26.3
11/02/93	23		0.7		18	8		7.9	3.6		3		28.1
11/03/93	17		0.69		4	3		8.2	6.3	3	6	16	33.7
25/05/93	23		0.92		17	15		8	2.4	4	2	1	30.8
27/07/93	39	231		49	27	9		7.9	12.3	1	6		
21/09/93	53	287		19	42	14		8.3	6.7		1	5	31.8
18/11/93	35	134		8	143	10		8.1	6.5	0.5	0.5	3	32.6
18/01/94	29	122	1.2	9	79	11		8.2	2.5	0.5	0.5	3	31.4
14/02/94	32	110	1	9	59	17		8.2	19.2		0.5		34.8
16/05/94	69	232		18	25	5		8	45.7		31	33	31.4
28/07/94	17	230		74	27	6		8	9.3	31	7		28
26/09/94	21	87		15	39	9		8.1	8.6	1	0.5	1	31.1
25/11/94	26.5	136		15	5.5	7.5		8	2.9	0.5	1	0.5	32.7
23/01/95	28	148	4.6	0.5	59	14		8	6.2	0.5	0.5	1	32.4
05/04/95	20	162		16	44	10		8	4.9		10	50	29.2
19/05/95	21	155		59	28	11		8	6.1	2	6	3	32.9
18/07/95	26	262		129	31	17		8	3.9	7	1	13	30
14/09/95	11	144		52	23	9		8	5.1	1	0.5	1	32
13/11/95	53	299		14	15	9		8	3.4		0.5	1	32
10/01/96	16	141		0.5	23	5		8	7.2		1	1	30.9
08/03/96	18	130		5	13	3		8.1	4.6		0.5	2	33.5
08/05/96	18	132		9	23	6	2.8	8.1	6.6	1	3	7	33
05/08/96	16			149	24	5	1.5	8	6	5	2	8	28
19/09/96	15			92	27	6	2.8	8	6		0.5	4	30
14/11/96	15			22	16	5	1.1	8	11	1	0.5	2	32.8
28/01/97	13			7	20	5	1.1	8	4	0.5	0.5	1	34.6
26/03/97	12			13	17	5	1.8	7.9	15	1	0.5	6	34.4
27/05/97	20			61	34	8	0.5	7.8	6	8	5	37	31.1
07/08/97	19	134		30	19	5	1.5	8	1.9	0.5	1	2	34.3
22/09/97	21	131		15	23	6	2.6	8.03	3.4	4	3	3	33.2
18/11/97	28	201		57	20	10	1	8	7.1	27	7	26	32.1
29/01/98	33	184		4	46	13	1.4	8	2	30	15	29	

Estuary: Tauranga Harbour **Station:** Otumoetai, Beach Rd.

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
19/03/98	28	260		34	43	10	1.7	8	16	3	0.5	6	31.9
18/05/98	11		1.22	5	2	0.5	2.1	8.2	4.2	0.5	8	4	33.7
29/07/98	16		0.44	110	42	10	2	8	4.4	1	5	5	28.6
10/09/98	14		0.36	76	27	13	1.6	8.1	4	0.5	2	1	32
24/11/98	7		0.58	7	15	2	1.2	8.1	5.6	1	0.5	1	27.8
20/01/99	9		1.04	0.5	4	2	1.5	8.1	6	0.5	0.5	1	32.2
22/03/99	12			4	16	9	1.8	8.1	5.8	0.5	0.5	0.5	34.8
20/05/99	11			32	26	8	2.3	8.1	14	2	0.5	11	31.9
18/08/99	16			52	43	7	1.2	8.1	3.2	4	3	9	28
29/09/99	20			35	66	5	1.1	8	3.4	0.5	0.5	0.5	30
26/11/99	10		0.5	9	26	5	3.1	8	5.3	0.5	2	2	31.2
24/02/00	16		0.6	3	12	4	1.5	8	8.7	0.5	0.5	2	33.2
23/03/00	10		0.4	6	21	5		8	11	0.5	2	1	32.4
09/05/00	18		1.4	24	26	10	2.9	8	12	9	12	12	29.2
21/08/00	12		0.3	180	22	7	1.7	8.1	15	5	0.5	6	28
19/09/00	18		0.5	49	28	7	2.2	8.1	4.8	11	0.5	2	27.9
16/11/00	19		0.2	9	23	8	1.6	8	8	1	4	4	31.95
30/01/01	18		0.5	0.5	8	3	4.3	7.72	17	1	0.5	4	33.5
29/03/01	18		1.9	23	17	5	8.1	7.7	13	0.5	29	3	28.7
30/05/01	39		1.2	92	41	12	2.1	7.9	21	69	140	84	28.5
24/07/01	13		0.05	61	16	5	6.1	7.9	9.6	5	9	7	31
06/09/01	27		1.8	61	27	8	2	8	19	1	14	7	27.9
05/12/01	25		2	10	23	5	1.5	7.54	11	2	7	4	20.3
17/01/02	46		4	50	13	8	7.9	7.9	17	9	27	11	27.2
18/03/02	22		1.6	4	9	0.5	1.6	7.92	22	42	47	57	24.5
17/05/02	5		0.5	19	12	8	1.1	7.91	18	0.5	2	15	33
17/07/02	14		0.4	94	25	11	1.9	8.05	2.9	0.5	0.5	1	27.7
11/09/02	14		1.1	12	9	5	1.4	8.12	6.6	21	12	37	33.3
09/12/02	16		1.4	1	11	5	1.8	8	8.2	0.5	4	7	30.5
21/01/03	26		1.5	6	22	8	18	7.8	23	1	5	2	29.8
25/03/03	46		4.6		10	5	0.5	8.4	66	0.5	35	2	32.4
09/05/03	20		0.8	8	12	7	1.9	8.1	21	1	7	7	31.5
17/07/03	22		0.4	32	25	5	24	8.1	9.6	0.5	0.5	0.5	27.6
15/09/03	64		2	77	14	5	7.4	8.3	64	27	3	51	33.4
27/11/03	36		0.8	33	11	7	18	8.2	27	24	14	39	30.7
12/02/04	27		10.3	104	20	8	2	7.9	55	13	9	47	19.6
15/02/04	22				20	5	1.6	8.1	25	7	17	15	29.4
28/04/04	28			11	38	26	2.8	8.1	21	31	130	46	30.4
23/06/04	15			111	36	7	1	8.2	18	3	4	5	30.7
05/08/04	12		0.7	50	20	5	1.4	8.15	22	37	17	97	27.5
19/10/04	17				27	8	7.1	8.1	28	4	0.5	4	25

Estuary:	Tauranga Harbour		**Station:**	Otumoetai, Beach Rd.									
Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**SS (g/m3)**	**E.coli (/100ml)**	**Enterococci (/100ml)**	**Faecal coliform (/100ml)**	**Salinity o/oo**
16/12/04	39			8	9	8	1.3	7.6	56	2	14	9	30.5
28/04/05							1.8	8.1	35	16	8	17	32.4

Estuary: Tauranga Harbour **Station:** Tauranga Yacht and Boat Club

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
06/07/92	17		0.4		6	8		8	19.1	27	20	49	33.5
30/09/92	29				10	7		8.1	7.8				33.7
13/11/92	22		1.58		2	5		8	9.4		2	17	38.9
11/02/93	24		1.95		11	7		7.9	6.9		2		29.8
11/03/93	22		2.77		5	3		8.1	4.3	1	2	4	31.6
25/05/93	22		1.51		8	12		8.1	3.7	1	3	1	33.7
27/07/93	57	174		54	51	14		8	9.5	3	9	4	
21/09/93	61	153		4	5	7		8.3	16.6		5	8	34.4
18/11/93	34	234	1.6	12	79	6		8.1	12	0.5	1	0.5	34.1
18/01/94	28	97	3	12	34	12		8.2	4.4	0.5	1	11	34.3
14/02/94	32	96	1.9	16	25	12		8.2	25.8		5		34.8
01/03/94	26	70	2.2	4	4	8		8.9	9.2		5		34.9
14/04/94	21	101	0.9	14	25	12		8.2	7.7		42	89	34.7
16/05/94	46		1.4					8.1	10.7		11	7	34.2
28/07/94	19	210	1	37	17	6		8	12.4	34	2		31.6
26/09/94	25	86	1.75	5	37	10		8.1	12.8	4	1	8	34
25/11/94	34.5	196	6.31	23	9.5	9		8	7	0.5	0.5	3	33.7
23/01/95	26	96	1.9	0.5	15	6		8	12.8	1	0.5	1	33.7
05/04/95	44	142	1.8	8	41	21		8	8		17		31
19/05/95	24	94	1.26	9	12	4		8.1	15.5	0.5	1	2	35
18/07/95	34	285	0.65	139	37	20		8	9.6	3	1	4	32
14/09/95	14	125	0.91	32	12	7		8	5.4	0.5	1	3	34
13/11/95	27	168	1.17	19	16	5		8	4.2		0.5	5	34
10/01/96	3	148	1.08	0.5	10	2		8	8.4		2	32	32.6
08/03/96	18	131	1.43	0.5	3	2		8.1	9.2		0.5	0.5	34.8
08/05/96	18	146	0.54	0.5	12	3	6.6	8.1	10	5	1	4	34
05/08/96	26		0.87	117	22	11	3.8	8	18	4	4	15	30
19/09/96	16		2.37	78	13	7	2.6	8	14		0.5	0.5	34
14/11/96	17		1.79	45	9	9	2.7	8	12	0.5	3	3	35
28/01/97	15		0.9	9	21	7	1.6	8	8	0.5	2	0.5	35.1
26/03/97	8		0.9	8	4	3	2.5	7.9	10	2	2	8	36.3
27/05/97	18		2.13	23	16	7	0.8	7.8	8	0.5	17	15	33.7
07/08/97	12		2.78	0.5	3	6	2.3	8.1	2.6	0.5	0.5	0.5	35.7
22/09/97	11		2.18	15	13	5	2.7	8.02	5.4	1	0.5	3	35.4
18/11/97	26			86	30	15	1.7	7.9	8.1	9	2	17	33.8
29/01/98	14		1.58	5	11	5	1.7	8.1	4.6	1	1	1	

Estuary: Tauranga Harbour **Station:** Omokoroa, Wharf.

Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**SS (g/m3)**	**E.coli (/100ml)**	**Enterococci (/100ml)**	**Faecal coliform (/100ml)**	**Salinity o/oo**
01/10/91	25				17	6	1.8	8.1	11	0.5	2	2	
08/11/91	21				9	2		8	12	0.5	1	0.5	
22/01/92	24				17	4		7.8	5	0.5	10	0.5	21
19/03/92	25				10	2	3.5	8	11		5		
19/05/92	14				7	3		8.1	7.1		0.5	4	31.7
06/07/92	14		0.4		7	4		8	14.7	0.5	6	15	23.5
30/09/92	28		0.05		13	4		8.1	12.8	0.5	0.5	0.5	32
13/11/92	31		2.19		5	3		8	26.1		0.5	0.5	36.5
11/02/93	30		7.4		5	3		7.9	11.5		0.5		29.3
11/03/93	24		3.11		7	3		8.1	12.8	2	2	28	31.3
25/05/93	26		2.07		9	12		8	10.2	1	0.5	3	30.4
27/07/93	62	187		31	21	9		8	6.7	0.5	0.5	0.5	
21/09/93	64	186		4	0.5	4		8.3	16.2		0.5	1	33.1
18/11/93	34	132	1.5	8	87	9		8.1	22.4	0.5	1	0.5	33.3
18/01/94	37	237	6.6	5	61	7		8.3	15	0.5	0.5	32	33.1
14/02/94	35	130	5.5	5	28	7		8.2	32.4		0.5		33.8
01/03/94	49	191	7.7	4	1	7		8.8	14.6		5		32.6
14/04/94	27	230	2.4	43	54	12		8.1	8.1		16	135	29.2
16/05/94	28	96	1.3	15	22	6		8	9.3		1	3	33.1
28/07/94	19	310	1.8	52	25	3		8	18.1	22	1		25.8
26/09/94	24	99	1.46	16	36	4		8.1	16.4	10	3		31.9
25/11/94	32	204	1.9	8	4	5		7.9	14.4	0.5	0.5	0.5	33
23/01/95	35	165	4.58	0.5	4	1		8	20	0.5	0.5	2	32.2
05/04/95	37	197	3.2	34	36	6		8	9.4	61	9	62	26.7
19/05/95	21	140	1	33	17	7		8	10.5	0.5	0.5	2	33
18/07/95	32	313	1.03	137	35	11		8	18.6	3	2	1	30
14/09/95	17	137	2.28	14	5	2		8	17	0.5	0.5	1	32
13/11/95	25	157	3.15	0.5	4	2		8	12.2		0.5	2	33
10/01/96	121	172	6.32	0.5	2	0.5		8	27.6		1	0.5	31.2
08/03/96	23	163	2.54	1	5	2		8.1	7.9		0.5	0.5	32.8
08/05/96	23	153	1.48	6	13	5	7.7	8.1	14	0.5	0.5	0.5	33
05/08/96	20		1.6	145	30	4	14	8	19	4	3	12	27
19/09/96	31		2.21	73	21	2	8.1	8.1	49		0.5	24	31
14/11/96	23		1.94	6	4	2	6.7	8	26	0.5	1	2	33.5
28/01/97	23		3.73	0.5	0.5	2	2.8	8	18	0.5	1	1	34.2
26/03/97	12		2.12	0.5	2	2	4.6	7.9	22	0.5	0.5	4	33.7
27/05/97	26		1.18	66	42	10	6.2	7.8	12	10	6	43	29.3
07/08/97	5		1.07	11	10	3	1.7	8	5.3	0.5	0.5	0.5	33.7
22/09/97	21		2.13	14	13	5	6.7	8.02	16	3	0.5	4	33.3

Estuary:	Tauranga Harbour		**Station:**	Omokoroa, Wharf.									
Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**SS (g/m3)**	**E.coli (/100ml)**	**Enterococci (/100ml)**	**Faecal coliform (/100ml)**	**Salinity o/oo**
18/11/97	25			28	12	5	2.8	7.9	17	7	0.5	7	33.4
29/01/98	11		4.27	4	14	2	2.4	8	6.5	4	1	5	
19/03/98	14		1.81	31	45	5	2.1	8.1	18	1	1	4	30.1
18/05/98	16		1.07	10	10	3	4.1	8.1	6.6	0.5	0.5	0.5	33.7
29/07/98	16		0.96	84	43	10	3.5	8	19	0.5	0.5	4	28.7
10/09/98	21		0.84	40	13	5	4.7	8.1	9	0.5	0.5	2	30.9
24/11/98	16		2.16	2	7	0.5	6.8	8	15	0.5	0.5	1	29.3
20/01/99	27		5.48	0.5	3	0.5	3.5	8.2	17	1	0.5	1	31.4
22/03/99	13			0.5	12	0.5	4	8.1	9.4	0.5	1	2	34.8
20/05/99	15			22	20	8	3.4	8.1	27	2	2	8	32.5
18/08/99	20			44	59	3	4.6	8.1	12	0.5	0.5	7	28.9
29/09/99	25			26	32	0.5	3.8	8	11	0.5	0.5	0.5	29.2
26/11/99	12		1.7	8	7	3	5.9	8	12	7	13	12	30.7
24/02/00	28		3	0.5	8	3	3.5	8	33	0.5	1	0.5	33.5
23/03/00	12		0.8	3	13	2		8	18	0.5	0.5	1	32.5
09/05/00	28		1.4	11	28	8	4.7	8	26	10	6	10	30.8
21/08/00	15		1	22	10	5	3.8	8.1	33	0.5	0.5	0.5	31.1
19/09/00	20		2.2	22	21	5	5.2	8.1	11	0.5	0.5	1	28.1
16/11/00	28		1.2	0.5	8	4	3.7	8.1	17	0.5	0.5	1	32.6
30/01/01	22		1.1	0.5	8	2	2.2	7.96	24	0.5	0.5	1	34.4
29/03/01	15		1	3	15	3	22	8.1	6	1	5	1	32.8
30/05/01	63		1.9	72	23	7	2	8	70	20	40	31	30.9
24/07/01	11		0.05	21	13	5	3	7.9	18	0.5	0.5	0.5	32.8
06/09/01	11		0.5	26	32	5	5.4	8	16	4	10	11	29.5
05/12/01	26		2.3	15	8	0.5	2.8	7.58	28	6	0.5	5	22.8
17/01/02	15		2.2	0.5	8	2	2.3	8.1	30	0.5	1	0.5	31.6
18/03/02	13		1.4	0.5	11	3	3	8.01	9.4	0.5	0.5	2	33.1
17/05/02	9		0.9	14	18	5	3.2	8.09	21	0.5	1	3	33.1
17/07/02	14		0.7	139	20	9	2.7	8.03	9.8	0.5	0.5	1	29.1
11/09/02	11		0.6	5	10	6	5.8	8.13	6.5	0.5	2	0.5	34.5
09/12/02	26		2.4	0.5	1	2	3.3	8.1	19		0.5		32.8
21/01/03	13		3.4	0.5	5	3	2.9	8	28	0.5	2	0.5	30.8
25/03/03	22		2.4		9	0.5	0.95	8.2	11	1	4	1	30.7
09/05/03	17		1	17	23	5	2.6	8.1	22	1	2	3	32.1
17/07/03	14		0.8	21	18	5	3.4	8.1	10.4	1	2	1	30.2
15/09/03	15		1.1	2	7	3		8.2	17	0.5	0.5	0.5	33.4
27/11/03	31		1.1	52	6	10	2.4	8	9	0.5	0.5	1	33.9
12/02/04	18		3.4	5	7	0.5	4.7	8.1	26	0.5	2	7	29
15/02/04	27				7	2	2.4	8.2	38	0.5	27	14	33
28/04/04	26			13	34	14	3.9	8.1	28	80	100	80	30.5
23/06/04	13			84	28	8	2.1	8.1	21	7	1	4	29.8

Estuary: Tauranga Harbour **Station:** Omokoroa, Wharf.

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
05/08/04	13		2.3	20	16	5	3.2	8.13	24	2	2	7	31.4
19/10/04	22				16	7	2.6	8.1	41	0.5	1	1	32.3
16/12/04	27			4	16	6	3.2	7.5	33	90	110	180	34.1
28/04/05							0.6	8.1	38	0.5	0.5	0.5	33.4

Estuary: Tauranga Harbour **Station:** Te Puna Beach, Pitua Rd.

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
01/10/91	23				12	6	0.8	8.1	4.6	0.5	0.5	0.5	
08/11/91	18				3	4		8.1	9.3	0.5	0.5	0.5	
22/01/92	18				11	6		7.8	1.6	2	4	0.5	20.5
18/03/92	17				5	2	3.6	8.1	6.4		1		
19/05/92	17				8	1		8.1	6.8		2	0.5	31.5
06/07/92	15				8	6		8	20.6	8	3	10	32.5
30/09/92	7				10	3		8.1	7.4	0.5	0.5	0.5	32.2
13/11/92	27		1.78		1	3		7.9	10.8		1	20	35
11/02/93	19				12	7		7.9	2.5		2		29.8
11/03/93	18				9	4		8.1	3.6	4	3	10	32.9
25/05/93	20		1.74		9	13		8	3.4	1	0.5	0.5	30.7
27/07/93	49	141		35		10		8	3.8	0.5	0.5	0.5	
21/09/93	51	170		14	13	8		8.3	4.1		0.5	2	32.2
18/11/93	34	144		11	131	13		8.1	8.3	0.5	0.5	0.5	34.1
18/01/94	29	133		6	27	9		8.2	6.1	0.5	1	10	32.4
14/02/94	34	101		6	33	11		8.1	26		0.5		35.3
16/05/94	28					7		8	16		1	0.5	33.7
28/07/94	27	240		86	27	5		7.9	8.4	18	2		25.5
26/09/94	19	74		16	36	4		8.1	8.8	6	4	7	31.6
25/11/94	20.5	121		14	7.5	6.5		7.9	4.6	0.5	0.5	0.5	33.6
23/01/95	18	132		0.5	23	6		8	3.8	1	0.5	0.5	31.2
05/04/95	37	253		42	27	8		8	5.6		14		25.1
19/05/95	19	128		23	11	4		8	4.2	3	1	3	33.6
18/07/95	22	290		152	31	14		8	4.7	6	1	11	30
14/09/95	19	116		22	12	4		8	6.5	0.5	0.5	0.5	34
13/11/95	21	201		38	17	7		7.9	2.2		0.5	5	28
10/01/96	17	145		0.5	9	2		8	7.4		0.5	1	29.7
08/03/96	16	121		6	5	2		8.1	4.5		0.5	1	32.6
08/05/96	16	119		1	15	5	2.9	8.1	6	1	2	5	33
05/08/96	11			144	23	5	3.5	8	6	7	0.5	7	27
19/09/96	15			78	29	3	8.2	8.1	12		0.5	1	31
14/11/96	23			5	5	2	1.9	8	28	2	1	2	33.3
28/01/97	9			0.5	9	2	2.1	8	5	0.5	0.5	0.5	34.2
26/03/97	12			6	8	2	2.2	7.9	14	6	4	5	34
27/05/97	20			86	38	8	1.1	7.8	10	12	14	45	26.5
07/08/97	13				8	0.5	2	8.2	17	7	1	7	33.4
22/09/97	5			7	11	3	3	8.04	4.6	0.5	0.5	1	34
18/11/97	19			36	10	7	2.7	7.9	6.4	7	0.5	11	34.1
29/01/98	23			4	50	13	1.8	8	5.8	1	2	5	
19/03/98	17				30	4	2	8	19	1	1	1	33
18/05/98	16		1	6	15	3	1.8	8.1	6.7	0.5	0.5	0.5	34.2

29/07/98	18	0.82	65	37	10	1.8	8	4.9	6	2	17	26.4
10/09/98	11	0.57	49	21	10	1.3	8	5.1	0.5	0.5	0.5	31.2
24/11/98	18	1.18	9	17	3	2.6	8	5.5	3	0.5	5	28.9
20/01/99	8	3.56	0.5	3	0.5	1.5	8.1	6.4	2	4	2	30.5
22/03/99	13		6	9	2	4	8.1	3.4	0.5	1	1	34.7
20/05/99	11		39	12	5	1.8	8.1	20	9	2	17	30.9
18/08/99	17		43	28	13	2.2	8.1	3.6	2	2	7	29.4
29/09/99	18		32	12	8	1.2	8	4.6	0.5	0.5	0.5	29.4
26/11/99	15	1.2	4	13	6	2.2	8	4.4	1	2	6	30.9
24/02/00	25	1.6	0.5	22	8	2.1	7.9	16	0.5	0.5	0.5	34.1
23/03/00	9	0.7	6	16	2		8	12	0.5	0.5	0.5	32
09/05/00	23	1.9	14	22	8	3.1	8	15	8	11	13	29.7
21/08/00	16	0.5	70	21	5	2.3	8.1	49	7	0.5	34	27.9
19/09/00	56	13.2	12	15	7	1.2	8.1	5.4	1	2	4	29
16/11/00	13	0.6	1	18	8	3.1	8	15	0.5	2	0.5	33.4
30/01/01	26	0.9	1	22	7	6.1	7.75	18	0.5	0.5	0.5	34.1
29/03/01	26	1	5	27	8	2.8	7.8	15	0.5	7	11	33.7
30/05/01	12	1	91	35	10	2	8	70	71	71	63	30.7
24/07/01	20	0.1	85	21	6	6.6	8	13	4	14	7	31.3
06/09/01	31	2.1	52	38	8	1.7	7.9	17	6	9	2	28.3
05/12/01	18	9	17	28	4	1.2	7.48	19	1	37	2	24.4
17/01/02	24	0.6	14	21	10	14	7.9	13	2	0.5	2	31.1
18/03/02	42	3.6	3	22	6		7.9	44	2200	57	4300	32.7
22/03/02									4	17	4	
17/05/02	9	1.2	19	18	5	2.5	8.01	17	0.5	12	12	32.5
17/07/02	11	0.6	50	14	9	1.2	8.05	10.4	1	1	3	32.1
11/09/02	9	0.7	3	10	0.5	1	8.06	6.4	3	3	15	34.5
09/12/02	16	0.2	9	13	9	1.1	8	3.2	0.5	0.5	0.5	33
21/01/03	18	1.2	0.5	6	4	29	7.8	22	21	6	18	31.5
25/03/03	70	11.5		19	2	1.1	8.4	126	2	19	16	31.7
09/05/03	17	0.7	14	26	8	2.4	8.1	18	0.5	0.5	0.5	32.2
17/07/03	16	0.4	32	21	7	19	8.1	8	0.5	0.5	1	24.1
15/09/03	57	2.4	73	18	5	1.9	8.3	63	4	5	33	33.7
27/11/03	28	3.3	40	8	8	20	8.1	5	18	0.5	39	32.5
12/02/04	44	5.3	2	7	0.5	3.5	8	77	4	13	10	27.4
15/02/04	29			22	7	0.84	8.1	35	4	5	12	33.1
28/04/04	17		14	31	12	3.2	8.1	28	200	130	230	30.2
23/06/04	15		106	34	7	1.2	8	17	5	7	5	27.5
05/08/04	5	0.4	16	22	4	1.5	8.06	22	9	8	27	25.3
19/10/04	18			16	7	7.6	8.1	34	1	0.5	3	32.7
16/12/04	37		3	15	8	3.4	7.5	51	4	7	9	34.3
28/04/05						3.5	8.1	34	73	54	120	32.8
18/05/98	14	0.63	9	18	3	4.8	8.1	5.8	0.5	1	2	31.6
29/07/98	12	1.08	65	53	7	4.3	8	26	10	3	14	27.4
10/09/98	11	0.67	16	13	2	8.6	8.1	8.1	0.5	0.5	1	29.5
24/11/98	16	2.48	0.5	4	0.5	11	8	24	1	0.5	5	28.2

20/01/99	40	8.55	0.5	4	0.5	5	8.2	31	4	0.5	4	30.1
22/03/99	15		0.5	10	2	3.8	8	14	3	1	7	34
20/05/99	13	0.7	11	18	3	4.5	8	23	8	6	21	31
18/08/99	17		69	11	6	3.8	8.1	8.1	11	0.5	17	25.5
29/09/99	20		8	46	0.5	3.6	8	7.2	0.5	0.5	2	27.4
26/11/99	18	1.5	6	13	3	7.4	8	11	9	13	30	28.2
24/02/00	32	2.5	0.5	10	3	3.6	7.8	26	4	8	9	33.2
23/03/00	12	0.9	0.5	9	1		7.9	20	2	11	6	31.8
09/05/00	13	0.9	3	15	7	3.6	7.9	22	75	110	97	28.4
21/08/00	13	0.7	23	24	2	26	8.1	22	1	1	6	28.2
19/09/00	57	2.3	58	24	2	5.2	8.1	64	4	5	5	24.7
16/11/00	18	1.1	0.5	18	3	4.4	8	12	13	15	21	30.65
30/01/01	29	0.9	0.5	20	3	15	7.89	24	4	5	5	33.6
29/03/01	36	1.7	1	10	5	11	7.9	45	4	31	3	29.8
30/05/01	19	0.8	85	32	4	2.3	7.8	25	37	57	74	25.6
24/07/01	9	0.05	11	14	2	11	7.9	19	2	16	4	23.1
06/09/01	32	1	40	31	3	14	7.9	37	0.5	1	2	25.7
05/12/01	59	12.8	73	12	0.5	4.1	7.59	38	24	10	32	14.5
17/01/02	11	1.5	6	12	3	15	8	20	39	46	77	28.3
18/03/02	27	3.6	0.5	6	0.5	2.3	7.77	57	15	24	17	36
17/05/02	7	0.8	2	22	4	5.9	7.96	19	0.5	2	1	32.1
17/07/02	14	0.6	374	36	7	4.3	7.85	11	10	7	10	18.7
11/09/02	11	1.2	2	9	3	10.9	8.14	9	1	1	3	34.3
09/12/02	26	2.3	8	8	2	5.9	8	264	2	13	11	25.2
21/01/03	15	2.2	0.5	10	3	11	7.9	29	14	3	19	26.3
25/03/03	24	1.8	17	32	2	0.75	8.1	32	7	2	16	27
09/05/03	20	0.7	9	12	3	6.5	8.1	25	1	3	5	29
17/07/03	20	1.2	29	13	18		8	17	4	6	9	26.4
15/09/03	35	3.3	6	10	2	5.5	8.2	55	1	3	6	32.7
27/11/03	27	2	12	7	3	9	8	13	110	0.5	97	28.4
12/02/04	29	2.5	7	6	0.5	3.8	7.9	39	13	14	19	22.6
15/02/04	20			11	3	3.7	8.2	33	4	69	14	29.9
28/04/04	17		14	19	5	5.8	8	25	67	63	63	30.9
23/06/04	15		86	43	5	3.7	8	23	12	0.5	13	31.8
05/08/04	13	1.5	52	15	4	7.8	8.12	27	1	2	17	29.3
19/10/04	24			13	3	8.5	8.1	44	18	14	17	27.2
16/12/04	36		2	6	3	4	7.5	45	2	31	7	32.9
28/04/05						1.1	8	39	10	2	11	32.1

Estuary: Tauranga Harbour **Station:** Kauri Point Jetty

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
19/03/98	14		1.99		37	5	1.5	8.1	22	1	0.5	4	34.2
18/05/98	17		1.17	1	8	3	2.7	8.1	5.1	0.5	0.5	0.5	34.6
29/07/98	11		0.54	109	39	7	2.5	8	23	0.5	4	4	31.3
10/09/98	11		0.64	37	13	7	4.6	8.1	5.5	1	0.5	2	32.6
24/11/98	14		1.54	1	21	2	4.1	8.1	11	0.5	0.5	0.5	31
20/01/99	13		3.85	0.5	2	0.5	2.6	8.2	11	1	5	0.5	33.7
22/03/99	10			0.5	4	0.5	3.6	8.1	7.2	0.5	2	2	35.2
20/05/99	11		0.9	0.5	38	3	3.1	8.1	23	1	2	11	33.1
18/08/99	16			12	22	3	2.4	8.2	7.8	1	0.5	1	28.8
29/09/99	18			11	17	0.5	3.9	8	7.2	0.5	0.5		30.7
26/11/99	10		0.6	0.5	29	3	5.4	8	14	4	1	20	32.3
24/02/00	30		4	0.5	6	4	4.2	8	24	0.5	0.5	0.5	33.8
23/03/00	14		1.9	0.5	10	0.5		8	23	1	13	1	32.8
09/05/00	4		1.2	1	11	5	2.3	8	16	2	1	8	30
21/08/00	12		0.6		8	3	1.6	8.2	20	0.5	1	4	33.3
19/09/00	12		0.4	2	15	2	5.4	8.1	6.4	0.5	1	0.5	28.1
16/11/00	15		1.1	2	24	5	3.9	8.1	14	0.5	0.5	2	32.9
30/01/01	31		2.7	0.5	5	3	2.2	7.99	25	0.5	0.5	0.5	35.4
29/03/01	14		2	3	15	5	6.7	8.1	14	1	1	3	34.4
30/05/01	23		1.2	36	23	3	2	8	15	6	26	6	28.7
24/07/01	15			22	11	8	2.3	8	19	0.5	0.5	0.5	33.7
06/09/01	14		0.5	23	24	6	3.1	8	13	6	2	14	29.8
05/12/01	16		2	9	13	3	1.5	7.53	18	1	0.5	2	30
17/01/02	23		0.9	0.5	10	5	2.8	8.1	5.6	0.5	0.5	4	33.9
18/03/02	7		1.2	0.5	4	3	2	8.05	20	0.5	0.5	2	38.3
17/05/02	4		1	2	16	6	4.7	8.09	19	0.5	0.5	0.5	34.5
17/07/02	14		1.1	118	20	11	1.7	8.03	13	1	0.5	0.5	28.9
11/09/02	9		0.7	0.5	8	3	5.3	8.11	2.9	3	0.5	11	34.5
09/12/02	18		2.1	9	8	8	4.5	8.1	22	1	0.5	1	33.9
21/01/03	15		1.6	0.5	8	3	31	8	33	0.5	1	1	32.1
25/03/03	23		2.5		12	7	0.93	8.2	13	1	0.5	4	28.3
09/05/03	20		0.9	4	17	8	9.5	8.1	20	0.5	0.5	1	32.3
17/07/03	34		2.2	76	11	5	1.4	8.1	42		0.5		27.3
15/09/03	15		0.7	3	12	14	3.3	8.1	8	1	1	5	32.7
27/11/03	23		1.4	14	11	7	4.6	8	9	2	0.5	6	34.4
12/02/04	18		1.9	2	9	3	5.6	8	38	3	3	14	31.6
15/02/04	30				10	3	0.96	8.2	43	0.5	24	1	33.1
28/04/04	17			3	23	8	2.9	8	32	61	67	87	31.2
23/06/04	16			43	14	7	1.1	8.1	19	1	2	3	31.6
05/08/04	9		1.5	15	42	2	3.7	8.14	27	3	2	33	31.6

19/10/04	22		8	8	4.2	8	42	0.5	0.5	1	33.5
16/12/04	30	1	4	5	2.6	7.5	38	4	4	4	35.2

Estuary: Tauranga Harbour **Station:** Mid Harbour

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
28/04/05							2.4	8.1	36	0.5	4	1	34.7
01/10/91	26				6	9	1.4	8.1	6.8	0.5	0.5	0.5	21
08/11/91	31				8	3		8.1	16.9	0.5	0.5	0.5	
22/01/92	51				4	4		7.8	2.7	0.5	0.5	0.5	20
19/03/92	21				11	17	2.4	8	4.6		0.5		
19/05/92	11				4	2		8.1	3.4		0.5	1	32
06/07/92	26				10	11		8	22.9	0.5	0.5	0.5	32
30/09/92	32		0.05		23	6		8.1	9.4	0.5	0.5	0.5	31
13/11/92	18		1.71		0.5	3		7.9	5.3		0.5	0.5	38
12/01/93	23		1.72		0.5	10		7.8	5.3	0.5	0.5	0.5	33.1
11/02/93	19		1.95		5	5		8	6		0.5		30.2
11/03/93	18		1.01		7	4		8.2	4.5	0.5	0.5	0.5	33.6
25/05/93	15		0.74		5	7		8.1	2.9	0.5	0.5	0.5	30.3
27/07/93	49	167		9	13	6		8.1	5.3				
21/09/93	52	145		8	2	4		8.3	9		0.5	2	34.3
18/11/93	22	153		3	42	6		8.1	8.2	0.5	0.5	0.5	34
18/01/94	28	104		4	17	7		8.3	4.4	0.5	1	8	33.1
14/02/94	34	131	0.8	5	21	9		8.2	25		0.5		35
14/04/94	17	194	2.2	38	32	6		8.1	3.9		3	29	27.4
16/05/94	35	75		2	17	3		8.1	15.3		0.5	0.5	33.7
28/07/94	16	90	0.4	23	20	3		8	8.3	3	0.5	6	27.7
26/09/94	21	81		0.5	22	6		8.1	8.8	0.5	0.5	0.5	34.1
25/11/94	27	204		8	2.25	6		7.9	6.2	0.5	0.5	0.5	34
23/01/95	26	125		0.5	26	6		8	7	0.5	0.5	0.5	34.1
05/04/95	11	146		4	11	2		8	7.4	30	1.5	29	27.5
19/05/95	15	83		16	10	5		8.1	5.8	0.5	5	0.5	34.6
18/07/95	21	243		109	26	9		8	4.6	1	0.5	0.5	30
14/09/95	19	123		10	16	4		8	7.2	0.5	0.5	0.5	34
13/11/95	43	135		4	8	5		8	7.7		0.5	0.5	33
10/01/96	98	174		1	14	4		8	8		0.5	0.5	31.6
08/03/96	18	172		0.5	2	1		8.2	5.8		0.5	6	31.8
08/05/96	16	90		0.5	10	3	4.1	8.2	6.7	0.5	0.5	0.5	34
05/08/96	13			71	13	3	3	8	10				31
14/11/96	21			71	8	7	4.4	8	10	0.5	0.5	0.5	35.1
28/01/97	19			0.5	1	2	2.7	8	10	0.5	0.5	0.5	34.9
26/03/97	12			0.5	7	2	2	7.9	18	0.5	0.5	0.5	33.3
27/05/97	18				27	7	1.8	7.8	4	1	0.5	3	30
07/08/97	2			2	13	2	1.4	8.1	3.2	1	0.5	1	34.3
29/01/98	11			2	10	5	3.1	8.1	2.8	1	0.5	1	

Lake: Tauranga Harbour **Station:** Ongare Point.

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)
10/08/91	60			1	10	13		8.2	55
10/09/91	45			92	7	0.5			22.9
08/11/91	41			28	5	4			20.1
22/01/92	58			72	31	0.5			120.9
19/03/92	29			37	4	5		8.6	5.1
19/05/92	24			131	6	0.5	2.5	8.5	19.8
29/07/92	24			178	16	3		8.1	13.4
28/09/92	37			234	16	4		8.2	
28/10/92	31			87	6	0.5		8.7	9.4
22/12/92	88				16	6		8.4	120.7
23/02/93	64			43	3	5			51.8
06/04/93	26			67	17	21		8.4	27.6
03/06/93	28			116	37	12		8.1	6.2
18/08/93	70	242			37	8		8.3	15.3
14/10/93	90	426	2	10	47	11		8.3	66.5
14/12/93	55	206	2	2	19	5		8.3	54.6
01/03/94	53	226	5.3	10	16	7		9	37.6
12/04/94	76	1262.5	2	693	231	23		8.1	34.3
22/06/94		430	1.8	131	39			8.1	8.8
23/08/94	4	190		18	21	5		8.2	14.4
05/10/94	32	182		27	39	9		8.1	20
06/12/94	128.5	720		84	4.75	5		8	80.2
01/02/95	50	205		0.5	19	6		8.1	32.6
29/03/95	41	167		0.5	40	8		8	36.9
16/05/95	51	189		36	6	7		8.1	39.8
11/07/95	41	269		45	24.5	10		8	23.1
07/09/95	49	261		36	23	8		8	62
07/11/95	29	214		0.5	29	15		8.2	5.8
16/01/96	99	256		0.5	17	9		8.2	7.8
01/04/96	56	262		0.5	26	7		8.2	35
14/05/96	27	166		0.5	52	11		8.1	6.5
16/07/96	16			84	33	8	4	8.1	7.6
10/09/96	16			46	38	6	5.3	8	15
26/11/96	131			1	15	7	44	8.2	147
08/01/97	15			36	21	3	2.3	8	12
05/03/97	224			2	2	5	91	8	215
05/05/97	33			17	52	12	3.5	7.8	13
17/07/97	15			30	22	5	1.6	8.2	7
18/08/97	41			0.5	16	5	22	8.1	55

Lake: Tauranga Harbour **Station:** Ongare Point.

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)
01/10/97	47			4	11	3	22	8.48	73
10/12/97	22			0.5	11	6	3.5	8.1	8.2
09/02/98	48			0.5	30	16	3	7.7	15
23/04/98	21			0.5	14	2	3.9	8	9.7
23/06/98	25			14	10	5	7.5	8.4	22
19/08/98	35			100	35	2	12	8	59
19/10/98	9			2	17	3	2.1	8.4	6.8
03/12/98	116			3	23	2	57	8.1	160
15/02/99	22			0.5	28	0.5	8.8	8	22
15/04/99	28			0.5	34	0.5	6.8	8.2	25
28/06/99	66			9	263	6	25	8	82
10/08/99	18			16	33	2	1.8	8	6.5
07/10/99	116			2	28	0.5	35	8	150
20/12/99	28			0.5	31	4	5.3	8.1	28
17/02/00	35			0.5	8	4	14	8	86
17/04/00	22			0.5	17	3	2.4	8.1	21
15/06/00	21			17	22	10	2.2	8.1	9.2
28/08/00	24			29	41	6	5.3	8	20
25/10/00	20			0.5	17	7	2.8	8.1	12
11/12/00	50			0.5	14	2	15	8.1	44
07/02/01	45			2	17	8	19	8.04	71
06/04/01	18			14	45	7	4.6	8	11
19/06/01	12			5	31	7	1.7	8.1	6
02/08/01	17			9	17	4	1.6	8.1	21
15/10/01	14			4	19	5	2.1	8	7.7
12/12/01	14			0.5	17	16	5.1	8	20
25/02/02	15			0.5	95	8	2.2	7.74	6.8
24/04/02	52			1	11	4	21	7.99	57
24/06/02	33			99	38	12	13	8.08	28
08/08/02	11			17	35	8	1.6	8.2	6.5
04/10/02	31			2	13	34		8.13	3.6
02/12/02	33			0.5	12	11	4.5	8.1	74
14/02/03	27			0.5	1	1	2.8	7.8	22
30/04/03	19			0.5	32	5	1.8	8.3	12
13/06/03	12			16	14	8	2.3	8	20
11/08/03	50			0.5	4	4	27	8.1	52
08/10/03	7			6	16	7	1.9	8.3	9.6
22/12/03	65			0.5	3	7	8.5	8.2	34
18/02/04	24			1	5	24	4.6	8.2	48
19/04/04	20			0.5	28	5	1.9	8.09	18
16/06/04	13			4	14	5	2.1	8.5	24

Lake: Tauranga Harbour **Station:** Ongare Point.

Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**SS (g/m3)**
16/08/04	9			14	7		1.6	8.4	9.4
26/10/04	23			2	22	6	4.8	8	23
21/12/04	101			0.5	4	3	27	8.2	126
07/02/05	36				34	8	6.2	8.1	72
07/04/05	18						1.9	8.4	30

Estuary: Tauranga Harbour **Station:** Tanners Point Jetty

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
18/05/98	12		0.39	0.5	13	3	1.9	8.2	5.2	0.5	1	3	35.8
29/07/98	16		0.65	43	31	10	1.4	8	21	1	1	0.5	30.8
10/09/98	18		0.38	65	18	11	1.9	8.1	6.5	4	2	21	33.6
24/11/98	15		0.67	2	36	3	2.7	8.1	7.1	0.5	0.5	1	31.6
20/01/99	15		0.77	0.5	14	2	1.8	8.1	6	21	2	35	32.7
22/03/99	7			0.5	12	0.5	2.2	8.1	9.2	1	2	3	35.6
20/05/99	8		0.6	2	10	3	2.6	8.1	22	8	4	17	34.3
18/08/99	14			24	16	3	2.4	8.2	7.6	0.5	1	5	30.5
29/09/99	20			12	58	3	1.3	8	5.4	1	0.5	1	31
26/11/99	13		0.4	0.5	10	4	2.3	8	11	3	5	12	33
24/02/00	20		1	0.5	13	4	2.3	8	22	0.5	0.5	0.5	34.4
23/03/00	10		0.6	0.5	16	4		8	11	11	1	6	33.4
09/05/00			0.7	1	7	8	2.7	8.1	19	1	1	1	32
21/08/00	16		0.3	2	9	5	0.9	8.2	22	0.5	1	0.5	34.4
19/09/00	11		0.5	6	13	4	1.6	8.1	2.7	0.5	0.5	0.5	31.2
16/11/00	12		0.4	5	41	9	1.9	8.1	6	0.5	1	2	34.5
30/01/01	25		0.9	2	16	7	1.8	7.97	20	0.5	0.5	0.5	35.5
29/03/01	14		0.8	2	15	5	3.2	8.1	16	0.5	11	0.5	34.8
30/05/01	18		0.2	55	20	8	1.2	8	11	1	3	2	32.5
24/07/01	14		0.05	27	12	7	2.6	8	18	0.5	1	0.5	34.3
06/09/01	13		0.2	217	34	7	2.7	7.8	9	1	1	3	30.2
05/12/01	16		1.2	2	19	7	0.59	7.51	15	1	1	3	33.1
17/01/02	9		0.7	11			2.2	8.1	6.4	1	7	2	34.3
18/03/02	23		0.7	0.5	6	3	1.7	7.96	18	2	3	2	39.1
17/05/02	5		0.5	257	14	5	4.4	8.13	9.4	0.5	2	2	34.5
17/07/02	11		0.8	103	12	9	1.3	8.03	18	0.5	4	1	30.7
11/09/02	9		0.4	0.5	12	5	3.6	8.13	6.5	6	0.5	14	36.6
09/12/02	23		0.6	25	9	17	1.4	8	14	0.5	0.5	0.5	34.5
21/01/03	13		0.4	0.5	13	6	2.4	8.1	12	4	2	1	33.7
25/03/03	22		0.8		44	3	0.8	8.1	11	13	13	19	26.8
09/05/03	13		0.3	9	16	7	1	8	20	4	3	5	32.9
17/07/03	13		0.5	20	17	5	1.4	8.1	9.6	3	1	4	27
15/09/03	130		0.4	4	6	5	1.5	8.1	6.8	0.5	2	0.5	33.1
27/11/03	21		1.6	25	10	10	5.6	8.1	8.4	2	0.5	7	34.4
12/02/04	18		2		8	4	2.1	8.1	44	0.5	9	3	31.5
15/02/04	23				21	2	1.1	8.2	33	1	1	1	33.5
28/04/04	17			0.5	15	5	2.4	8.1	23	38	97	31	32.7
23/06/04	15			67	15	8	1.6	8.1	21	5	3	3	32.5
05/08/04	9		0.7	24	29	5	3.2	8.13	20	2	0.5	11	31.2
19/10/04	24				10	8	1.9	8.1	40	2	0.5	1	35.2

16/12/04	21			0.5	10	6	3.7	7.6	47	17	17	27	35.2
28/04/05							2.4	8.2	36	0.5	1	4	34.9

Estuary:	Tauranga Harbour		**Station:**	Bowentown Boat Ramp									
Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**SS (g/m3)**	**E.coli (/100ml)**	**Enterococci (/100ml)**	**Faecal coliform (/100ml)**	**Salinity o/oo**
01/10/91	22				6	9	1.7	8.1	3.6	0.5	0.5	0.5	
08/11/91	19				13	5		8.1	13.3	0.5	0.5	0.5	
22/01/92	18				7	5		7.8	1.3	0.5	0.5	0.5	21
19/03/92	23				7	11	2.6	8	2.4		0.5		
19/05/92	8				4	2		8.1	6.1		0.5	0.5	32
06/07/92	12				1	8		8	18.7	0.5	0.5	0.5	33.5
30/09/92	23		0.1		18	7		8.1	7.7	0.5	1	0.5	33
13/11/92	15		0.78		0.5	5		8	3.5		0.5	2	40
12/01/93	21		2.39		0.5	10		7.8	6	0.5	0.5	0.5	32.8
11/02/93	17		1.25		5	5		8	3.1		0.5		30.3
11/03/93			1.67		7	2		8.2	4.5	0.5	0.5	11	33
25/05/93	18		1.52		4	11		8.1	2.2	0.5	0.5	0.5	33.8
27/07/93	54	120		6	4	5		8.1	3	0.5	0.5	0.5	
21/09/93	41	172		5	6	6		8.3	7.2		2	1	35
18/11/93	29	121	1.8	5	76	7		8.2	7.9	0.5	0.5	0.5	34.9
18/01/94	25	38	1.3	6	22	9		8.3	3.9	0.5	2	3	35.1
14/02/94	22	47	0.8	5	18	9		8.2	22		1		34.1
01/03/94	24	50	2.6	3	0.5	6		8.9	11		1		35.4
14/04/94	21	118	1.6	9	24	11		8.2	4.4		0.5	10	34.8
16/05/94	28	48	1.4	2	9	3		8.1	4.4		0.5	0.5	35.2
28/07/94	16	180	1.2	47	13	10		8	24.1	0.5	0.5	18	35.1
26/09/94	24	89	6.43	0.5	11	2		8.2	12.4	0.5	0.5	0.5	35.6
25/11/94	25	81	5.9	2	1.75	5.5		8	3.6	0.5	0.5	0.5	34.9
23/01/95	18	82	2	0.5	9	5		8	8.8	0.5	0.5	1	34.6
05/04/95	22	82	2.4	0.5	3	3		8.1	8.5	3	1	2	32.7
19/05/95	15	108	1.5	7	7	3		8	4.7	0.5	0.5	0.5	35
18/07/95	22	242	0.94	47	8	7		8	4.2	0.5	1	0.5	34
14/09/95	19	96	1.49	21	10	6		8	6.8	0.5	0.5	0.5	35
13/11/95	21	123	5.02	4	5	2		8	6.6		0.5	0.5	36
10/01/96	19	110	1.02	0.5	9	3		8	11.4		0.5	0.5	33.2
08/03/96	16	123	1.61	0.5	4	2		8.1	7		0.5	1	34.2
08/05/96	14	98	0.94	0.5	6	3	3.8	8.2	8.4	0.5	0.5	0.5	35
05/08/96	11		1.04	57	7	6	3.3	8	12	0.5	0.5	0.5	34
19/09/96	11		1.48	37	21	3	1	8.1	12		0.5	0.5	35
14/11/96	23		0.86	98	3	10	4.3	8	8	0.5	0.5	0.5	35.4
28/01/97	13		2.05	1	1	3	1	8	13	0.5	0.5	0.5	34.7
26/03/97	8		0.34	0.5	10	2	1.1	7.9	18	0.5	0.5	0.5	35.7
27/05/97	15		1.86	4	11	5	1.2	7.8	5	0.5	0.5	0.5	35
07/08/97	5		1.21	0.5	8	2	2	8	2.7	0.5	0.5	0.5	35.6

Estuary: Tauranga Harbour **Station:** Bowentown Boat Ramp

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
18/11/97	17			70	12	13	0.8	8	3.3	0.5	0.5	0.5	35.7
29/01/98	19		1.01	0.5	22	8		8	2	0.5	0.5	0.5	
19/03/98	11		1.59		24	3	0.4	8.1	11	7	4	5	34.2
18/05/98	12		0.3	2	15	3	1.7	8.2	4	0.5	1	0.5	35.7
29/07/98	10		0.3	85	23	12	5	8.1	22	0.5	1	1	31.8
10/09/98	14		0.66	48	18	10	1.3	8.2	12	10	17	6	32.7
24/11/98	10		0.4	3	32	5	2.3	8.1	3.6	0.5	1	3	31.1
20/01/99	24		0.5	0.5	28	2	0.8	8.2	3.2	0.5	0.5	0.5	33.7
22/03/99	5				12	0.5	1.2	8.2	4.4	0.5	2	1	35.4
20/05/99	6		0.3	0.5	12	8	1.6	8.2	10	0.5	2	2	34.4
18/08/99	16			23	13	11	4.6	8.2	5.2	0.5	0.5	1	30.2
29/09/99	22			6	20	0.5	1	8.1	14	0.5	0.5	2	29.7
26/11/99	7		0.2	0.5	23	5	1.5	8	8.9	9	11	22	33.1
24/02/00	16		0.9	0.5	11	3	1.4	8	9.2	0.5	3	2	34.5
23/03/00	7		0.3	0.5	14	0.5		8.1	4.8	0.5	1	0.5	33.3
09/05/00	13		0.5	0.5	27	4	1.9	8.1	8.6	0.5	1	6	31.8
21/08/00	15		0.2	0.5	8	8	2.4	8.2	23	0.5	0.5	3	34.9
19/09/00	15		0.5	2	13	3	1.6	8.2	7.3	0.5	0.5	0.5	30.5
16/11/00	12		0.4	6	44	8	1	8.1	5.8	9	13	18	34.7
30/01/01	21		0.9	3	10	7	4.8	7.94	9.2	0.5	2	0.5	35.4
29/03/01	23		0.6	4	15	3	1.6	8.2	24	1	3	0.5	33.1
30/05/01	22		0.4	58	16	9	1.4	8	6.4	18	19	22	32.7
24/07/01	15		0.05	17	15	3	1.7	8	17	0.5	3	1	33.4
06/09/01	14		0.1	14	30	7	2	8	11	0.5	6	2	32.3
05/12/01	15		0.8	2	16	5	1	7.52	15	0.5	1	1	34
17/01/02	9		0.5	4	17	8	3	8.1	4.6	0.5	1	1	33.5
18/03/02	9		0.7	0.5	10	4	1.4	8.05	19	4	4	15	38.8
17/05/02	4		0.5	10	16	5	1.4	8.14	3.6	0.5	0.5	1	34.6
17/07/02	13		0.6	88	6	11	1.1	8.05	7.7	1	2	1	33.1
11/09/02	5		0.3	0.5	26	3	2	8.17	4.8	3	3	5	36.4
09/12/02	24		0.5	20	13	13	1.4	8.1	7.6	2	7	2	34.3
21/01/03	13		0.3	0.5	19	5	2.1	8	19	2	2	2	32.8
25/03/03	13		0.9	28	14	8	2.21	8	9.7	11	17	24	
09/05/03	17		0.4	9	28	25	1.2	8.2	19	17	1	21	30.4
17/07/03	13		0.7	11	22	5	1.3	8.1	5.2	0.5	0.5	2	27.3
15/09/03	15		0.2	3	18	5	1.2	8.2	4.8	0.5	0.5	0.5	33.2
27/11/03	22		3.4	26	5	10	3.6	8	4	0.5	5	2	34
12/02/04	18		1.3	3	15	5	1.2	8	32	29	14	37	31.5
15/02/04	19				76	5	0.64	8.2	29	1	11	3	33.2
28/04/04	17			3	25	5	2.4	8.1	14	70	70	90	30.8
23/06/04	86			68	15	8	0.73	8.1	11.4	0.5	1	4	32.4

Estuary:	Tauranga Harbour		Station:	Bowentown Boat Ramp									
Date	**TP (mgP/m3)**	**TN (mg/m3)**	**Chla (mg/m3)**	**NO3 (mgN/m3)**	**NH4 (mgN/m3)**	**DRP (mgP/m3)**	**Turb (NTU)**	**pH**	**SS (g/m3)**	**E.coli (/100ml)**	**Enterococci (/100ml)**	**Faecal coliform (/100ml)**	**Salinity o/oo**
05/08/04	16		1.2	24	47	4	1	8.13	23	4	17	11	32.7
19/10/04	18				13	12	1.3	8.1	32	0.5	0.5	1	33.4
16/12/04	21			1	15	8	0.68	7.6	40	4	61	17	35
28/04/05							3.3	8.1	35	0.5	0.5	1	34.8

Estuary: Tauranga Harbour **Station:** Bowentown Pio

Date	TP (mgP/m3)	TN (mg/m3)	Chla (mg/m3)	NO3 (mgN/m3)	NH4 (mgN/m3)	DRP (mgP/m3)	Turb (NTU)	pH	SS (g/m3)	E.coli (/100ml)	Enterococci (/100ml)	Faecal coliform (/100ml)	Salinity o/oo
01/10/91	22				6	9	0.6	8.1	3.6	0.5	0.5	0.5	
08/11/91	19				13	5	1.7	8.1	13.3	0.5	0.5	0.5	
22/01/92	18				7	5		7.8	1.3	0.5	0.5	0.5	21
19/03/92	23				7	11		8	2.4		0.5		
19/05/92	8				4	2	2.6	8.1	6.1		0.5	0.5	32
06/07/92	12				1	8		8	18.7	0.5	0.5	0.5	33.5
30/09/92	23		0.1		18	7		8.1	7.7	0.5	1	0.5	33
13/11/92	15		0.78		0.5	5		8	3.5		0.5	2	40
12/01/93	21		2.39		0.5	10		7.8	6	0.5	0.5	0.5	32.8
11/02/93	17		1.25		5	5		8	3.1		0.5		30.3
11/03/93	0		1.67		7	2		8.2	4.5	0.5	0.5	11	33
25/05/93	18		1.52		4	11		8.1	2.2	0.5	0.5	0.5	33.8
27/07/93	54	120		6	4	5		8.1	3	0.5	0.5	0.5	
21/09/93	41	172		5	6	6		8.3	7.2		2	1	35
18/11/93	29	121	1.8	5	76	7		8.2	7.9	0.5	0.5	0.5	34.9
18/01/94	25	38	1.3	6	22	9		8.3	3.9	0.5	2	3	35.1
14/02/94	22	47	0.8	5	18	9		8.2	22		1		34.1
01/03/94	24	50	2.6	3	0.5	6		8.9	11		1		35.4
14/04/94	21	118	1.6	9	24	11		8.2	4.4		0.5	10	34.8
16/05/94	28	48	1.4	2	9	3		8.1	4.4		0.5	0.5	35.2
28/07/94	16	180	1.2	47	13	10		8	24.1	0.5	0.5	18	35.1
26/09/94	24	89	6.43	0.5	11	2		8.2	12.4	0.5	0.5	0.5	35.6
25/11/94	25	81	5.9	2	1.75	5.5		8	3.6	0.5	0.5	0.5	34.9
23/01/95	18	82	2	0.5	9	5		8	8.8	0.5	0.5	1	34.6
05/04/95	22	82	2.4	0.5	3	3		8.1	8.5	3	1	2	32.7
19/05/95	15	108	1.5	7	7	3		8	4.7	0.5	0.5	0.5	35
18/07/95	22	242	0.94	47	8	7		8	4.2	0.5	1	0.5	34
14/09/95	19	96	1.49	21	10	6		8	6.8	0.5	0.5	0.5	35
13/11/95	21	123	5.02	4	5	2		8	6.6		0.5	0.5	36
10/01/96	19	110	1.02	0.5	9	3		8	11.4		0.5	0.5	33.2
08/03/96	16	123	1.61	0.5	4	2		8.1	7		0.5	1	34.2
08/05/96	14	98	0.94	0.5	6	3		8.2	8.4	0.5	0.5	0.5	35
05/08/96	11		1.04	57	7	6	3.8	8	12	0.5	0.5	0.5	34
19/09/96	11		1.48	37	21	3	3.3	8.1	12		0.5	0.5	35
14/11/96	23		0.86	98	3	10	1	8	8	0.5	0.5	0.5	35.4
28/01/97	13		2.05	1	1	3	4.3	8	13	0.5	0.5	0.5	34.7
26/03/97	8		0.34	0.5	10	2	1	7.9	18	0.5	0.5	0.5	35.7
27/05/97	15		1.86	4	11	5	1.1	7.8	5	0.5	0.5	0.5	35
07/08/97	5		1.21	0.5	8	2	1.2	8	2.7	0.5	0.5	0.5	35.6
22/09/97	0		0.82	4	16	5	2	8.04	4.1	1	5	1	35

18/11/97	17		70	12	13	1	8	3.3	0.5	0.5	0.5	35.7
29/01/98	19	1.01	0.5	22	8	0.8	8	2	0.5	0.5	0.5	