



# ENVIRONMENTAL MANAGEMENT GROUP

## Technical report

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## Recreational Water Quality in Hawke's Bay

Review of the 2010-2011  
Recreational Water  
Quality Monitoring  
Programme

June 2011  
EMT 11/01  
HBRC Plan Number 4257



## **Environmental Management Group Technical Report**

**Environmental Science**

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# **Recreational Water Quality in Hawke's Bay: A Review of the 2010-2011 Recreational Water Quality Monitoring Programme**

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Prepared by: SARAH ALEXANDER,  
TECHNICIAN WATER QUALITY

Reviewed by: ANNA MADARASZ-SMITH,  
SCIENTIST, COASTAL QUALITY

Approved by: GRAHAM SEVICKE-JONES,  
MANAGER, ENVIRONMENTAL SCIENCE

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## EXECUTIVE SUMMARY

Thirty two sites were monitored as part of the 2010/11 Recreational Water Quality Monitoring Programme undertaken by Hawke's Bay Regional Council. The sites were sampled and analysed on a weekly basis for faecal indicator bacteria counts. This annual summer programme enables Council to assess the microbiological water quality of popular bathing areas, and elucidate trends in water quality throughout the region. The selected sites include both marine and freshwater popular bathing locations – including one lake, and in addition five sites were monitored to determine the suitability of areas for shellfish gathering.

The sites can be distinguished as follows:

- fourteen marine sites (Enterococci bacteria)
- six freshwater rivers (*Escherichia coli* bacteria)
- twelve estuarine/lagoon/tidal freshwater sites (Enterococci /*Escherichia coli* bacteria)
- one freshwater lake (*Escherichia coli* bacteria)
- six marine sites for shellfish gathering (Faecal coliforms)

The sites were monitored on a weekly basis (except for Clive River and Puhokio Stream which were monitored fortnightly) to assess their suitability for contact recreation and shellfish gathering. Results were compared with the Ministry for the Environment and Ministry of Health Microbiological Water Quality Guidelines (2003).

Twelve of the fourteen sites sampled achieved 100% compliance with the *two-consecutive* exceedance guideline, with Te Awanga Coastal and Waipatki Beach achieving 95% compliance during the 2010/11 season. These results indicate that while rainfall and undetermined contamination can affect water quality at marine sites, exceedances are short lived and these areas generally have high water quality suitable of contact recreation.

Of the six freshwater (including one lake) sites sampled, three (Ngaruroro River, Tukituki River at Walker road and Tutaekuri River) achieved 100% compliance with Ministry guidelines, while the remaining sites achieved 90-95% compliance with Ministry guidelines.

This season twelve estuarine and/or freshwater sites (where a tidal influence may render them brackish) were sampled, eight of these sites were also tested for Enterococci levels. This was undertaken to ensure the parameter tested was giving a true indication of the state of that particular site. Of the twelve (freshwater or brackish water sites) four sites achieved 95% compliance with the guidelines. Six of the twelve sites achieved 80-90% compliance and the remaining two sites Waipuka Stream at Ocean Beach and Puhokio Stream at Waimarama achieved less than 75% compliance. Puhokio Stream achieved just 53% compliance, further investigation into this site has been recommended. With regard to the Enterococci results this season, four sites are recorded and tested for both parameters, based on conductivity results. All four sites achieved between 80-90% compliance with both Enterococci /*Escherichia coli* bacteria guidelines.

In addition to the recreational water quality sites, six sites were monitored to assess the quality of waters at shellfish gathering sites. One (Kairakau Lagoon) out of the six of the shellfish gathering sites monitored in Hawke's Bay were 100% compliant with Ministry guidelines for microbiological water quality, in 2009/10 two of five sites were 100% compliant and in 2008/09 all five sites were 100% compliant, It has been recommended to carry out shellfish testing at Te Awanga, due to exceeding guidelines two years in a row. Ahuriri Estuary and Te Mahia have also been identified for further investigation due to high results over the season.

The lower levels of compliance with Ministry guidelines compared to previous seasons reflect the extensive wet weather experienced through January.



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## LIST OF ABBREVIATIONS

|      |                                  |
|------|----------------------------------|
| HBRC | Hawke's Bay Regional Council     |
| MfE  | Ministry for the Environment     |
| MoH  | Ministry of Health               |
| PHU  | The Public Health Unit           |
| RMA  | Resource Management Act          |
| SFRG | Suitability for Recreation Grade |

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## 1.0 INTRODUCTION

Hawke's Bays coastal waters, freshwater lakes and rivers are frequently used for a range of recreational activities. However, the suitability of these areas for contact recreation can be compromised through contamination by human and animal faecal matter, which may carry harmful, illness causing pathogens<sup>1</sup>.

In order to monitor the risk associated with contact recreation, Hawke's Bay Regional Council (HBRC) undertake an annual Recreational Water Quality Monitoring Programme in collaboration with Territorial Local Authorities (TLA's) and the Public Health Unit of the Hawke's Bay District Health Board (PHU). Monitoring is carried out at a number of sites throughout the region to assess the bacteriological water quality of areas commonly used for contact recreation. The results are then compared to Ministry for the Environment (MfE) and Ministry of Health (MoH) guidelines (2003).

The aims of the programme are to:

- Determine the suitability of the coastal, estuarine and freshwater sites for recreational use;
- Assist in safeguarding public health and the environment;
- Compare the current water quality with that of previous studies;
- Provide a baseline for future studies; and
- Identify any problems and target investigations to those areas requiring mitigation, remediation or further study.

### 1.1 Legislative Responsibility

Two main sources of legislation define the monitoring required to assess the water quality of areas used for contact recreation - the Resource Management Act (1991) and the Health Act (1956). Responsibility for overseeing these Acts is shared between Regional Councils (the RMA), Territorial Local Authorities (RMA and Health Act), and the District Health Boards (the Health Act). The 'Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas' (MoH and MfE, 2003) have outlined various approaches to the delegation of duties between the involved agencies.

The approach currently used in Hawke's Bay is similar to that outlined in the guidelines. Hawke's Bay Regional Council has taken responsibility as the lead agency for this monitoring, and undertakes all routine monitoring and the facilitation of follow-up sampling when necessary. The territorial local authorities have responsibility for erecting warning signs and undertaking sanitary surveys when required. The Public Health Unit, through its health protection officers and Medical Officer of Health, have responsibility for informing the public (usually through a press release and/or location signage) when an exceedance of the guidelines has occurred. Updated results are also available from the B4U Swim line, and the HBRC website.

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<sup>1</sup> These can include gastro-enteritis, respiratory illnesses, Hepatitis A, giardiasis, cryptosporidium, campylobacteriosis, and salmonellosis (from MfE and MoH, 2003).

## 1.2 2009/2010 Recommendations

1. That Hawke's Bay Regional Council continue to monitor freshwater, estuarine and marine bathing and shellfish gathering sites in accordance with the Ministry for the Environment and Ministry for Health guidelines; **Monitoring continued in 2010/11 season.**
2. That follow-up exceedance sampling for sites only be undertaken where the cause of the exceedance cannot be attributed to rainfall. Compliance of marine sites will need to be assessed under the more stringent single-sample exceedance if follow-up sampling of rainfall related exceedances is not proposed for these areas; **Actioned in 2010/11 season.**
3. That follow-up sampling after an exceedance event at Puhokio Stream not be undertaken, unless there is reasonable cause to believe that the exceedance is extraordinary. Permanent signage is currently in place warning swimmers of the risk associated with this site; **Actioned in 2010/11 season.**
4. That monitoring of shellfish gathering waters in accordance with MfE and MoH guidelines be continued for the 2010/11 season; **Continued in 2010/11 season with the additional site Te Mahia.**
5. That the monthly report visually showing the percentage compliance for freshwater, estuarine and marine sites continues to be produced, circulated internally and made available to the public via the regional councils website; **Was completed for 1 month on request, recommended for 2011-12.**
6. That sampling at Clive River and Puhokio Stream be undertaken fortnightly as these sites are fully graded, have a 'Very Poor' grade, and are permanently sign-posted. Ocean, Pourerere, Westshore and Porangahau Beaches could also be considered for reduced monitoring as these sites are fully graded as 'Very Good' and have retained this grade over the past four years. **Clive River was sampled weekly from December to February due results continuing to be in alert mode. Ocean, Pourerere, Westshore and Porangahau Beaches remained to be sampled weekly for reporting preposes.**
7. That Kairakau Lagoon, Maungawhio Lagoon and Porangahau River are monitored for Enterococci and *E. coli* as these sites have been shown to be sufficiently saline/brackish to warrant the use of additional indicators; along with continuing to be monitored for conductivity to assess the appropriateness of *E. coli* or *Enterococci* as the most appropriate indicator for each site at the time of sampling. **Actioned in 2010/11 season.**
8. Clive River, Waipuka Stream and Wairoa River sampled and reported for *E. coli* results, in sampling procedure for these three sites include a conductivity value and if value exceeds 10,000 uS/cm request that lab conducts Enterococci results in addition with *E. coli*. **Actioned in 2010/11 season.**
9. Pandora Pond monitored for Enterococci only, as the last two consecutive years of conductivity results have indicated saline waters. **Actioned in 2010/11 season.**

## 2.0 METHODOLOGY

### 2.1 Site Selection Criteria

The sites that are monitored as part of the recreational water quality programme are selected according to a number of criteria. Each site is either:

- A popular recreational site;
- An area classified as 'Contact Recreation' under the Regional Coastal Environmental Plan (HBRC,2008);
- A site that will assist in determining the state of the environment;
- A site that will identify trends in coastal, estuarine and fresh water quality; and/or
- A site selected in co-operation with TLA's and the Hawke's Bay District Health Board.

### 2.2 Sampling and Notification

The programme for the 2010/2011 summer consisted of 32 sites between Mahanga and Porangahau Beaches. These sites are commonly used for recreational purposes (i.e. swimming, water skiing, rowing etc.) and include freshwater, estuarine/tidal and marine sites throughout the region (see appendix 1).

Sampling was undertaken in accordance with MoH & MfE guidelines (2003), and sampling was undertaken on a weekly basis, with the exception of two sites, Clive River and Puhokio Stream. Samples were collected at these sites every two weeks due to the fact that they have permanent signs erected and have attained full grading of 'Very Poor' under the MoH & MfE Suitability for Recreation grading system. Sampling was scheduled for Monday of each week for a 20-week period over the summer season (November– March). Samples were collected in accordance with the sampling procedures outlined in sections D2 and E2 of the guidelines (MoH & MfE, 2003) and kept chilled until laboratory analysis. Associated environmental information was collected for each site at the time of sampling, including temperature, turbidity, conductivity at selected sites and the number of users at each site.

Samples were analysed for the indicator bacteria Enterococci in marine waters, *Escherichia coli* and/or Enterococci in brackish or freshwater (with a tidal influence), *E. coli* in freshwater and faecal coliforms in shellfish gathering waters. The dual testing of indicator bacteria for brackish or freshwater (with a tidal influence) was undertaken to ensure the tested parameter was giving a true and clear indication of the state of that site. Enterococci survival rate is higher than *E. coli* in saline waters and therefore may give a better indication of actual bacterial levels in brackish environments. Where conductivity readings taken at the time of sampling indicated a freshwater environment ( $<10 \text{ mS/cm}^{-1}$ ) then the lab analysis was conducted for *E. coli* only.

Rainfall measurements were collected from localised rain gauges to determine whether significant rainfall had preceded sampling. Significant rainfall was determined to be 8-10mm recorded at any catchment rainfall station(s) for that site in the three days preceding sampling. If sample results exceeded guideline values, the rainfall data was then reviewed to assist in identifying whether exceedances were related to high rainfall episodes. If it could be shown that rainfall coincided with an exceedance then those rainfall related exceedances occurring in fresh and brackish water systems were not re-sampled as a previous study has shown bacteria levels to reach guideline values within three days under these conditions (Stansfield, 2002). Follow-up sampling was conducted for all exceedances (including rainfall related) in marine waters in order to determine the level of compliance against MfE & MoH guidelines.

In the event of a non-rainfall related **alert** level exceedance, follow-up sampling was conducted daily until results were within guideline values (see section 2.4 Guidelines). For non-rainfall related **action** level exceedances, daily follow-up sampling was undertaken, signs erected, and warnings against swimming were issued by PHU press releases. Results were also available from the PHU 'B4U Swim' (safeswim) telephone line and B4U Swim from the HBRC website.

### 2.3 Indicator Bacteria

The Recreational Water Quality Programme aims to assess the suitability of areas for contact recreation (see Section 1). To achieve these objectives it is necessary to determine whether sites have been subject to contamination from human or animal faecal matter that may compromise the health and safety of people using the area. As it is not feasible to analyse water samples for the range of pathogenic organisms that can cause illness, bacteria that are specific to the gut of warm-blooded animals are used to indicate whether faecal material is present in the water. The levels of this indicator can be used to provide an assessment of the relative risk of illness.

The most common illness from swimming in contaminated water is gastroenteritis, but recent evidence indicates that respiratory illness and skin infections are also common. These illnesses can be caused by a wide range of pathogenic organisms including viruses, bacteria and protozoa (such as salmonella, campylobacter, cryptosporidium, and giardia) (MfE & MoH, 2003).

### 2.4 Guidelines

All sampling and evaluation of results was undertaken in accordance with the 'Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas' (MoH and MfE, 2003; Table 1).

**Table 1: Water quality guidelines for marine and freshwater recreational areas (from MoH/MfE, 2003)**

| Response Level    | Marine Water<br>Enterococci cfu/100mL<br>Single Sample | Freshwater<br>E. coli cfu/100mL<br>Single sample | Shellfish gathering Waters<br>Faecal coliforms/100mL<br>(over season)         |
|-------------------|--|--|---|
| Surveillance Mode | <140   | <260   |   |
| Alert/Amber Mode  | 140 - 280  | 260 - 550  |   |
| Action/Red Mode   | >280*  | >550   |   |
| Season Results    |  |  | 10% of samples not exceeding 43/100mL and Median level not exceeding 14/100mL |

\* Two consecutive samples taken within 24hrs exceeding 280-Enterococci/100 mL is required before the Action Mode is initiated

When water quality falls within the limits of the 'surveillance mode', this indicates that the risks of illness from bathing are acceptable. If the water quality falls into the 'alert' categories, this indicates an increased risk of illness from bathing, but still within the acceptable range. This signals agencies to conduct follow-up sampling of the site in order to monitor whether contamination levels increase to the 'action' level.

If the water quality should enter the 'action' category (for marine sites, this involves two consecutive samples exceeding the upper limit), then the water poses an unacceptable health risk from bathing. At this point, signs are erected at the bathing site, and the public informed that it is unsafe to swim at that site.

The recreational shellfish-gathering bacteriological guideline values were also obtained from the 'Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas' (MoH and MfE, 2003; Section F). These state that the median level of faecal coliform content should not exceed a Most Probable Number (MPN) of 14/100ml and that no more than 10% of samples should exceed a MPN 43/100ml for the season.

## **2.5 Annapolis Protocol / Beach Grading**

The MfE and MoH (2003) guidelines move away from simple reactive monitoring to a risk based management approach for recreational waters. This is done by combining an assessment of the potential inputs of contaminated water to a site with an assessment of the historical monitoring from the site to generate a 'Suitability For Recreation Grade' (SFRG), which can be used to advise the public of the most suitable sites for swimming, and other recreation activities. For a full description of the grades see appendix 2.

## **2.6 Data Analysis**

Monitoring information from the last ten seasons was analysed to determine whether any significant trends were detectable in the microbiological water quality of sites associated with the Recreational Water Quality Monitoring programme. While data could not be corrected for flow, nor was it possible to remove the effect of variable weather which can impact on bacterial levels, it was considered that the long-term nature of the data set might be of sufficient length as to buffer the data from these effects.

Data from the previous 10 seasons was collated and any follow-up samples removed from the data set. Temporal trend analysis was carried out using NIWA's water quality trends software. All statistical tests involving pairwise comparisons were reconfirmed using the False Discovery Rate test recommended in McBride (2005).

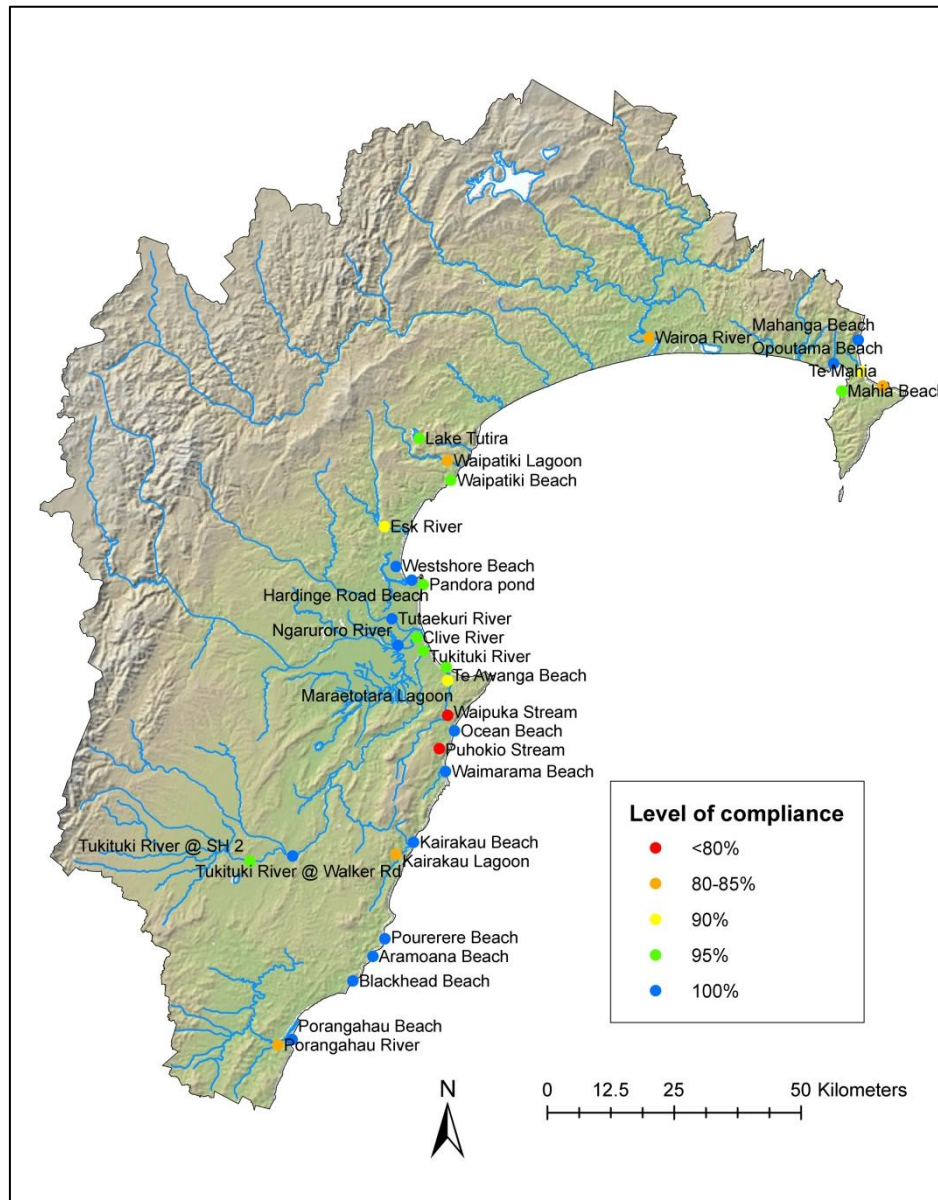
Results were identified as significant if they met the following criteria:

- 1) It was significant at 95%;
- 2) The slope equated to a change of >1% per year in the variable concerned; and
- 3) The overall change for the time period concerned exceeded current laboratory detection limits.

Individual site results and false discovery results for the P-values can be found in appendix 3.

### 3.0 SAMPLING SITES

Thirty two sites were sampled between Mahanga and Porangahau Beaches (Figure 1) (see appendix 1 for site descriptions). A number of these sites have peak usage over a 2-4 week period (around Christmas and New Year). Additionally, as many of these sites are remote from large population centres, the size of their communities can increase by several orders of magnitude for the Christmas and New Year period. Much of the accommodation in these areas is in campgrounds and baches, and most often the predominant wastewater treatment system is individual septic tanks.



**Figure 1: Map of sites included in the 2010/11 Recreational Water Quality Monitoring Programme including level of compliance with MfE & MoH action level guidelines (Marine action mode compliance based on a two consecutive sample exceedance).**

## 4.0 RESULTS

### 4.1 Monitoring Results

A summary of the sampling results for each site is shown in the tables below. Detailed results can be found in table and graph form in appendices 4 and 5 respectively.

#### 4.1.1 Marine Recreational Sites

Marine waters within Hawke's Bay have water quality suitable for contact recreation. Twelve of the fourteen sites sampled achieved 100% compliance with the *two-consecutive* exceedance guideline, with Te Awanga Coastal and Waipatki Beach achieving 95% compliance (Table 2).

**Table 2: Range of *Enterococci* results at the marine sites and compliance with guidelines 2010/11**

| Site              | Minimum | Maximum | <i>Enterococci</i> % compliance with: |                                    |  |
|-------------------|---------|---------|---------------------------------------|------------------------------------|--|
|                   |         |         | Alert Mode                            | Action Mode Single Sample          | Action Mode Two-Consecutive Exceedance Guideline |
|                   |         |         | 140 cfu <i>Enterococci</i> / 100ml    | 280 cfu <i>Enterococci</i> / 100ml | 280 cfu <i>Enterococci</i> / 100ml               |
| Aromoana Beach    | <1      | 33      | 100                                   | 100                                | 100  |
| Blackhead Beach   | <1      | 80      | 100                                   | 100                                | 100  |
| Hardinge Rd Beach | <1      | 82      | 100                                   | 100                                | 100  |
| Kairakau Beach    | <1      | 24      | 100                                   | 100                                | 100  |
| Mahanga Beach     | <1      | 1600    | 95                                    | 95                                 | 100  |
| Mahia Beach       | <1      | 870     | 95                                    | 95                                 | 100  |
| Ocean Beach       | <1      | 130     | 100                                   | 100                                | 100  |
| Opoutama Beach    | <1      | 1700    | 80                                    | 85                                 | 100  |
| Porangahau Beach  | <1      | 56      | 100                                   | 100                                | 100  |
| Pourerere Beach   | <1      | 55      | 100                                   | 100                                | 100  |
| Te Awanga Coastal | <1      | 410     | 85                                    | 90                                 | 95   |
| Waimarama Beach   | <1      | 30      | 100                                   | 100                                | 100  |
| Waipatiki Beach   | <1      | 550     | 95                                    | 95                                 | 95   |
| Westshore Beach   | <1      | 330     | 95                                    | 95                                 | 100  |

Both the **action** mode two-consecutive exceedances discussed above have been included in the *Two-consecutive Exceedance Guideline* as, no re-samples were taken to verify waters were within guideline levels within 24 hours. The sites were not re-sampled due to staff restrictions.

Opoutama Beach achieved 85% compliance with **action** Mode *single sample exceedance* levels, these three exceedances where rainfall related and re-samples for all where within guidelines.

Of the nine exceedances for the 10/11 season, five exceedances could be attributed to rainfall. Three of the remaining four exceedances for the season at marine sites occurred within a two week period when the weather was warmer and dryer (14th to the 21st February). Due to warmer weather at this time recreational beach use may have increased with corresponding pressure on septic tanks and waste water disposal systems.

These results indicate that exceedance events in marine waters in Hawke's Bay tend to be short-lived, and that even results of non-rainfall related events return to below guideline values before the two-consecutive sample action level as defined by MfE and MoH (2003) are reached. Heavy and sustained rainfall can affect water quality at coastal sites, however at other times water quality is high.

#### 4.1.2 Freshwater Recreational Sites

Freshwater recreational areas in Hawke's Bay had generally good water quality throughout the bathing season (Table 3). Of the six sites sampled, three sites; Tutaekuri River at Pakowhai Bridge, Ngaruroro River at Chesterhope and Tukituki at Walker Road achieved 100% compliance with Ministry guidelines for *E. coli*. Lake Tutira and Tukituki at SH2 Waipukurau achieved 95% compliance. Esk River at Eskdale Park achieved 90% compliance with Ministry guidelines for *E. coli*

**Table 3: Range of *E.coli* results at Freshwater sites and compliance with guidelines 2010/11**

| Site                              | Minimum                    | Maximum                    | Alert Mode                     | Action Mode                    |
|-----------------------------------|----------------------------|----------------------------|--------------------------------|--------------------------------|
|                                   | cfu <i>E. coli</i> / 100ml | cfu <i>E. coli</i> / 100ml | 260 cfu <i>E. coli</i> / 100ml | 550 cfu <i>E. coli</i> / 100ml |
| Esk River @ Eskdale Park          | 13                         | 2300                       | 80                             | 90                             |
| Lake Tutira @ Camping Ground      | 14                         | 1000                       | 85                             | 95                             |
| Ngaruroro River @ Chesterhope     | 27                         | 370                        | 95                             | 100                            |
| Tukituki River @ Walker Rd        | <1                         | 260                        | 95                             | 100                            |
| Tukituki River @ SH2 Waipukurau   | 3                          | 730                        | 80                             | 95                             |
| Tutaekuri River @ Pakowhai Bridge | 2                          | 430                        | 90                             | 100                            |

For the **alert** mode level of 260 cfu/100ml, just two sites, Ngaruroro River and Tukituki at Walker Road had 95% compliance for the 10/11 season. The remaining four sites had between 80% to 90% compliance (Table 3). However, it should be noted that the high *E. coli* results recorded where a result of a very wet January (see rainfall maps in appendix 6). A high number of these **alert** mode exceedances where rainfall related. (See appendix 4)

There were fifteen exceedances of the alert water quality guidelines reported from routine sampling of freshwater sites in 10/11 season for *E. coli* (see appendix 4 and 5). Of the fifteen alert exceedances, four of these also exceeded action mode and two of the four where recorded as rainfall related exceedances. Eleven of the fifteen alert exceedances were rainfall related, indicating the adverse effect that heavy rainfall can have on the microbiological water quality of Hawke's Bays rivers. Of the remaining four Alert Mode exceedances *not* related to rainfall, three were re-sampled and had returned to background levels by the second sample, indicating short-lived sporadic events.

### 4.1.3 Estuarine and Freshwater (with a tidal influence) Recreational Sites

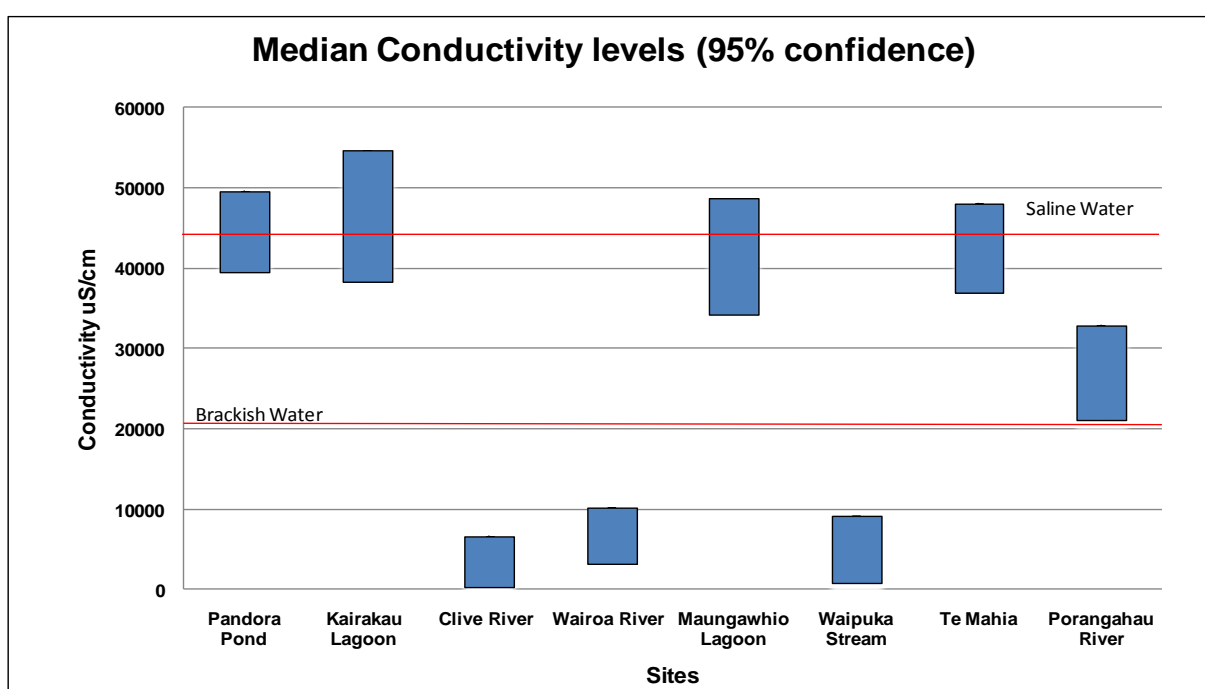
This season sampling for both indicators in brackish waters was undertaken to provide the most appropriate indicator based on conductivity results. Three of the eleven estuarine and freshwater sites in the 09/10 season were recommended to be sampled for both indicators based on the seasons conductivity results and at a further three sites conductivity values taken to best determine the most appropriate indicator at the time of sampling. The three sites sampled for both indicators included Kairakau Lagoon, Maungawhio lagoon, Porangahau River and new site Te Mahia at boatramp.

**Table 4: Conductivity results from 2010/11**

| Site              | Min Conductivity uS/cm | Max Conductivity uS/cm | Median |
|-------------------|------------------------|------------------------|--------|
| Pandora Pond      | 13900                  | 52500                  | 44600  |
| Kairakau Lagoon   | 5000                   | 54600                  | 46500  |
| Clive River       | 270                    | 39300                  | 2940   |
| Wairoa River      | 170                    | 36000                  | 6675   |
| Maungawhio lagoon | 2240                   | 55200                  | 41500  |
| Waipuka Stream    | 780                    | 46800                  | 4520   |
| Te Mahia          | 13400                  | 53900                  | 42500  |
| Porangahau River  | 1800                   | 48100                  | 27000  |

Conductivity results (Table 4), show that Clive River, Wairoa River and Wapuka Stream are predominately freshwater with *E. coli* being the most appropriate indicator. Kairakau Lagoon, Maungawhio Lagoon and Porangahau River show both fresh and saline water characteristics, both *E. coli* and Enterococci have been reported as indicators for these sites. Pandora Ponds conductivity results show this site is saline water and is reported for Enterococci only. Te Mahia's conductivity results show this site is saline water, due to been a new site this season we have reported on both *E. coli* and Enterococci. Compliance levels for Te Mahia are taken from Enterococci results, as these are most representative of risk to Public health.

**Figure 2: The electrical conductivity median for each site over 20010/11 season**



**Table 5: *E. coli* and Enterococci results at Freshwater (with a tidal influence) and Estuarine sites for 2010/11**

| Site                          | <i>E. coli</i> % compliance with: |                               | Enterococci % compliance with: |  |
|-------------------------------|-----------------------------------|-------------------------------|--------------------------------|--|
|                               | Alert Mode                        | Action Mode                   | Alert Mode                     | Action Mode Two-Consecutive Exceedance Guideline |
|                               | 260 cfu <i>E. coli</i> /100ml     | 550 cfu <i>E. coli</i> /100ml | 140 cfu Enterococci /100ml     | 280 cfu Enterococci /100ml                       |
| Clive River @ SH2 Bridge      | 50                                | 95                            |                                |  |
| Maraetotara Lagoon            | 60                                | 90                            |                                |  |
| Puhokio Stream @ Waimarama    | 8                                 | 53                            |                                |  |
| Tukituki River @ Black Bridge | 90                                | 95                            |                                |  |
| Waipatiki Lagoon              | 65                                | 85                            |                                |  |
| Waipuka Stream @ Ocean Beach  | 65                                | 75                            |                                |  |
| Wairoa River @ Ski Club       | 65                                | 85                            |                                |  |
| Kairakau Lagoon               | 85                                | 85                            | 75                             | 80   |
| Maungawhio Lagoon             | 95                                | 95                            | 90                             | 90   |
| Porangahau River              | 75                                | 80                            | 75                             | 85   |
| Te Mahia @ Boatramp           | 93                                | 93                            | 82                             | 82   |
| Pandora Pond                  |                                   |                               | 85                             | 95   |

Table 5 shows the results most representative of risk to public health for Freshwater (with a tidal influence) and Estuarine sites, where *E. coli* and Enterococci results are shown. This indicates that at any given sampling time these sites could be calculated as either saline or freshwater. At ten sites of the twelve sites *E. coli* results are used for indicating water quality. Four sites achieved 90-95% compliance with *E. coli* action mode. Four sites including Waipatiki Lagoon, Wairoa River, Kairakau Lagoon and Maungawhio Lagoon achieved 85% compliance; with Porangahau River and Waipuka Stream achieving 75-80%, Puhokio Stream achieved just 53% compliance with action mode (Puhokio Stream is sampled on a fortnightly basis).

Three sites, Kairakau Lagoon, Maungawhio Lagoon and Porangahau River are reported for both *E. coli* and Enterococci. (Table 5). Kairakau Lagoon and Maungawhio Lagoon show higher levels of compliance by 5% when *E. coli* is used as the indicator, compared to Enterococci results, while Porangahau River shows higher level of compliance by 5% when Enterococci is used as the indicator, compared to *E. coli* results. At these three sites single sample results are acted on in respect to sampled conductivity results to achieve most appropriate indicator for assessing the risk to public health.

The results for conductivity and previous recommendations for Te Mahia and Pandora Pond sites indicate that Enterococci should be used to indicate water quality. Te Mahia at the boatramp exceeded action mode on two different occasions both rainfall related, follow up samples also exceeded or in one case follow up sampling was not undertaken. Pandora Pond exceeded action mode twice, follow up sampling was not undertaken on one occurrence due to rainfall event that meant it was unsafe to undertake resampling.

A high number of alert exceedances were recorded over the season with Puhokio Stream and Clive River achieving 8 and 50% compliance with *E.coli* alert mode. This high level of alert for both *E. coli* and Enterococci, some of these can be correlated with a very wet January with maximum results due to heavy rainfall. Overall the 2010/11 season was a normal summer with rainfall been only five percent higher than normal for the Hawke's Bay area, but it was variable across the catchments and variable through the summer, being a combination of three drier than normal months (November, December and February), one near normal month (March) and one very wet month (January) see appendix 6.

All alert and action exceedances were either re-sampled or attributed to rainfall events. In all cases Enterococci counts had returned to background levels by the following sample. Samples were not re-sampled if conductivity results indicated that *E. coli* was a better indicator, in this case if *E. coli* did not exceed the alert mode re-sampling would not take place.

Comparison at the three sites where both indicators where tested, of the compliance rates of the two indicator parameters reveals that testing for a single indicator does not necessarily give a true assessment of overall suitability for recreation at that particular site. For example, testing of *E.coli* only at the Porangahau River at Bridge can be misleading as it indicates 85% compliance with all Ministry guidelines for recreation; but if the indicator sampled for is Enterococci then this rises to 95% compliance for two consecutive exceedances (Table 5).

**Table 6: The preferred indicator for 2011/2012 season based on results from 2010/11**

| Site                          | Preferred Indicator  |
|-------------------------------|--|
| Clive River @ SH2 Bridge      | <i>E. coli</i> , take conductivity value if above 10,000 uS/cm request both <i>E. coli</i> and Enterococci |
| Kairakau Lagoon               | Both / with conductivity values to determine the most appropriate  |
| Maraetotara Lagoon            | <i>E. coli</i>   |
| Maungawhio Lagoon             | Both / with conductivity values to determine the most appropriate  |
| Pandora Pond                  | Enterococci  |
| Porangahau River              | Both / with conductivity values to determine the most appropriate  |
| Puhokio Stream @ Waimarama    | <i>E. coli</i>   |
| Tukituki River @ Black Bridge | <i>E. coli</i>   |
| Waipatiki Lagoon              | <i>E. coli</i>   |
| Te Mahia @ Boatramp           | Enterococci, Fecal Coliforms and take conductivity for additional information                              |
| Waipuka Stream @ Ocean Beach  | <i>E. coli</i> , take conductivity value if above 10,000 uS/cm request both <i>E. coli</i> and Enterococci |
| Wairoa River @ Ski Club       | <i>E. coli</i> , take conductivity value if above 10,000 uS/cm request both <i>E. coli</i> and Enterococci |

Table 6 shows the recommended indicators for the 2011/12 Recreation Water Quality season. Clive River, Waipuka Stream at Ocean Beach and Wairoa River have been identified as predominantly freshwater sites, due to the occasional saline conductivity result, it is recommended for managing public health, to take conductivity values at the time of sampling and if results are above 10,000 uS/cm request that the lab conduct test for Enterococci in addition to *E. coli*. For reporting purposes it is recommended that Maraetotara Lagoon, Puhokio Stream, Tukituki River at Black bridge and Waipatiki Lagoon are reported as freshwater sites. Pandora Pond is recommended to be treated as a marine site for both managing public health and reporting. Te Mahia at boatramp is recommended to be tested for Enterococci, Fecal Coliforms and values recorded for conductivity at the time of sampling. Te Mahia at boatramp is a marine site but due to site been new this season it is important establishing a good conductivity record for managing public health at this site.

#### 4.1.4 Shellfish Gathering Sites

In addition to the recreational bathing water sampling, six sites were monitored to assess their suitability for shellfish gathering (Figure 3). The sites were chosen from areas identified as having significant shellfish populations based upon information from discussions with TLA's and the Hawke's Bay District Health Board.

One only of the six sites sampled was within end of season guideline values. The guidelines stipulate that no more than 10% of samples can exceed a faecal coliform MPN (Most Probable Number) value of 43/100ml, and have a median level of 14 Faecal coliforms/100mL or below. The results showed all sites (except Kairakau Beach) exceeded the guidelines based on faecal coliform MPN of 43/100ml at least once over the 2010/11 recreational season. Mahia Beach and Waipatiki beach had 20% of samples exceeding a MPN of 43/100ml and median values of 1 and 5 Faecal coliforms/ 100mL within guidelines, while Ahuriri Estuary, Te Awanga Beach and Te Mahia had 40, 30 and 59% of samples exceeded a faecal coliform MPN value of 43/100ml. Median values for these three sites were also above guidelines at 38.5 Faecal coliforms /100mL, 17 Faecal coliforms /100mL and 84 Faecal coliforms /100mL respectively. Te Mahia achieved 59% of weekly samples above the exceedance faecal coliform MPN value of 43/100ml and median value of 84 Faecal coliforms /100mL. This is a decrease on the previous season where two of the five sampled sites achieved compliance with Ministry guidelines. This could be a reflection of the generally above average rainfall in January in Hawke's Bay for the 2010/11 season.

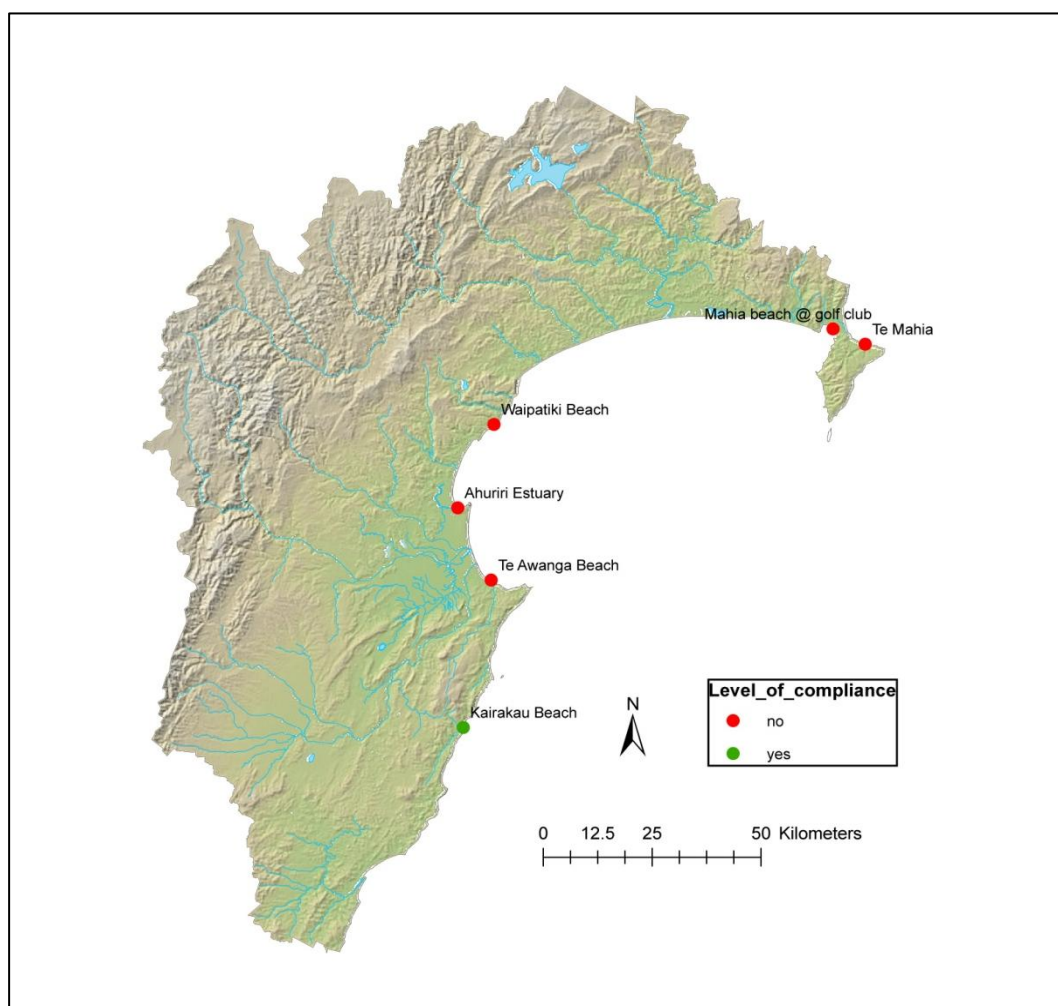


Figure 3: Compliance with MfE & MoH shellfish gathering water guidelines for the season 2010/11 season.

## 4.2 Long-term trends

Comparison of the current seasons results with that of previous years, to detect changes and trends in the microbial water quality of Hawke's Bays waters, is hindered by changing guideline values, sampling techniques (e.g. depth of sampling within the water column), and variable weather which can all impact on bacterial levels. However, it was considered that statistical analysis of water quality trends could be viable using data from the previous ten seasons due to the consistent sampling methodology over this timeframe. While the data cannot be corrected for flow, and it is not possible to remove the effect of variable weather which can impact on bacterial levels, it was considered that the duration of the data set may be sufficient to buffer these effects.

### 4.2.1 Trend Detection

There has been no significant trend in the results over time for marine sites suggesting that microbiological water quality in marine waters is stable (Table 7).

**Table 7: Trend analysis for sites between 2001 and 2011 (decreasing trends correspond to decreases in the level of bacteria and thus increases in water quality).**

| Site Name                              | Trend    | Slope                    | Significant | N   |
|--|----------|--------------------------|-------------|-----|
| Blackhead Beach                        | No Trend |                          |             | 209 |
| Clive River @ SH2 Bridge               | No Trend |                          |             | 181 |
| Esk River @ Eskdale Park               | No Trend |                          |             | 218 |
| Hardinge Road Beach                    | No Trend |                          |             | 208 |
| Kairakau Beach                         | No Trend |                          |             | 208 |
| Kairakau Lagoon                        | Decrease | -1.53 E.coli (cfu/100ml) | Yes         | 218 |
| Lake Tutira @ Camping Ground           | Increase | 1.83 E.coli (cfu/100ml)  | Yes         | 219 |
| Mahanga Beach                          | No Trend |                          |             | 149 |
| Mahia Beach                            | No Trend |                          |             | 219 |
| Maraetotara Lagoon                     | No Trend |                          |             | 219 |
| Maungawhio Lagoon                      | No Trend |                          |             | 179 |
| Ngaruroro River @ Chesterhope          | No Trend |                          |             | 218 |
| Ocean Beach                            | No Trend |                          |             | 209 |
| Opoutama Beach                         | No Trend |                          |             | 209 |
| Porangahau Beach                       | No Trend |                          |             | 199 |
| Pourerere Beach                        | No Trend |                          |             | 169 |
| Puhokio                                | No Trend |                          |             | 177 |
| Tukituki River @ Black Bridge          | No Trend |                          |             | 199 |
| Tukituki River @ SH2 Waipukurau        | No Trend |                          |             | 200 |
| Tutaekuri River @ Pakowhai Road Bridge | No Trend |                          |             | 220 |
| Waimarama Beach                        | No Trend |                          |             | 210 |
| Waipatiki Lagoon                       | No Trend |                          |             | 220 |
| Wairoa River                           | No Trend |                          |             | 219 |
| Waipatiki Beach                        | No Trend |                          |             | 209 |
| Waipuka Stream @ Ocean Beach           | No Trend |                          |             | 219 |
| Westshore Beach                        | No Trend |                          |             | 209 |
| Te Awanga Beach                        | No Trend |                          |             | 125 |
| Porangahau River                       | Increase | 5.13 E.coli (cfu/100ml)  | Yes         | 119 |
| Aramoana Beach                         | No Trend |                          |             | 69  |

Pandora Pond not included as insufficient Enterococci sample numbers

Te Mahia and Tukituki @ Walker Rd not included as new sites, insufficient sample numbers

One of the freshwater and estuarine sites Kairakau Lagoon showed a decrease in bacterial numbers (based on *E. coli*) (Table 7). An increase was seen at Lake Tutira and Porangahau River, although Lake Tutira was relatively small (<2 *E. coli* /100mL) more data is required to assess its significance.

Ongoing land management and increased awareness of preventing stock access in streams may be starting to have observable effects in water quality. However further investigation into the increase at Porangahau River should be investigated.

These results are the second from a proposed new sampling regime, so it is not possible to draw definitive conclusions from that but clearly the indicator selected as the parameter to measure waterway health (particularly those with a brackish environment) can influence the resulting picture. As the sample number grows for each site we can see long term trends, with less effect of one off events.

#### 4.2.2 Suitability for Recreation Grades

Suitability for Recreation Grades (SFRG's) were assessed using data from the previous five years for all sites. Overall grades for the SFRG for the past five years were reviewed with the inclusion of the 2010/11 data and are presented in Table 8. For a full description of the grades see appendix 2.

**Table 8: Comparison of SFRG's for 2010/11**

| Site Name                  | SFRG 2011                | SFRG 2010                | SFRG 2009 | SFRG 2008 | SFRG 2007 | Comments  |
|----------------------------|--------------------------|--------------------------|-----------|-----------|-----------|---|
| Aramoana Beach             | Very good                | Very good                | Very good | Ungraded  | Ungraded  | Unchanged   |
| Blackhead Beach            | Very good                | Very good                | Very good | Very Good | Very Good | Unchanged   |
| Clive River                | Very poor                | Very poor                | Very poor | Very Poor | Very Poor | Unchanged   |
| Esk River                  | Fair                     | Fair                     | Fair      | Fair      | Fair      | Unchanged   |
| Hardinge Road Beach        | Good                     | Good                     | Good      | Good      | Good      | Unchanged   |
| Kairakau Beach             | Good                     | Good                     | Very good | Good      | Good      | Unchanged   |
| Kairakau Lagoon            | Poor                     | Poor                     | Poor      | Poor      | Poor      | Unchanged   |
| Lake Tutira                | Very poor                | Very poor                | Very Poor | Very Poor | Very Poor | Unchanged   |
| Mahanga Beach              | Follow up                | Follow up                | Very Good | Very Good | Very Good | Skewed results do a few high rainfall and non rainfall related exceedance.                                  |
| Mahia Beach                | Good                     | Good                     | Good      | Good      | Very Good | Manually altered from Very Good to Good due to some issues with septic tanks particularly after heavy rain. |
| Maraetotara Lagoon         | Poor                     | Poor                     | Poor      | Poor      | Poor      | Unchanged   |
| Maungawhio Lagoon          | Fair                     | Fair                     | Good      | Poor      | Fair      | Unchanged   |
| Ngaruroro River            | Fair                     | Fair                     | Fair      | Fair      | Fair      | Unchanged   |
| Ocean Beach                | Very good                | Very good                | Very Good | Very Good | Very Good | Unchanged   |
| Opoutama Beach             | Fair                     | Good                     | Good      | Fair      | Poor      | Decreased - Change in MAC from B-C, 95% ile from 165 to 395   |
| Pandora Pond               | Ungraded for Enterococci | Ungraded for Enterococci | Good      | Good      | Good      | Changed indicator to Enterococci, insufficient data   |
| Porangahau Beach           | Very good                | Very good                | Very Good | Very Good | Very Good | Unchanged   |
| Porangahau River           | Poor                     | Fair                     | Ungraded  | Ungraded  | Ungraded  | Decreased - Change in MAC from B-D, 95% ile from 248 to 669   |
| Pourerere Beach            | Very good                | Very good                | Very Good | Very Good | Very Good | Unchanged   |
| Puhokio Stream             | Very poor                | Very poor                | Very Poor | Very Poor | Very Poor | Unchanged   |
| Te Awanga                  | Fair                     | Fair                     | Ungraded  | Ungraded  | Ungraded  | Unchanged   |
| Tukituki River_Blackbridge | Fair                     | Fair                     | Fair      | Fair      | Fair      | Unchanged   |
| Tukituki River_Waipukurau  | Fair                     | Fair                     | Fair      | Fair      | Fair      | Unchanged   |
| Tutaekuri River            | Fair                     | Fair                     | Fair      | Fair      | Good      | Unchanged   |
| Waimarama Beach            | Good                     | Good                     | Good      | Fair      | Good      | Unchanged   |
| Waipatiki Beach            | Good                     | Good                     | Good      | Good      | Good      | Unchanged   |
| Waipatiki Lagoon           | Very poor                | Very poor                | Very Poor | Very Poor | Very Poor | Unchanged   |
| Waipuka Stream             | Poor                     | Poor                     | Poor      | Poor      | Poor      | Unchanged   |
| Wairoa River               | Poor                     | Fair                     | Fair      | Poor      | Poor      | Decreased - Change in MAC from C-D, 95% ile from 400 to 620   |
| Westshore Beach            | Very good                | Very Good                | Very Good | Very Good | Very Good | Unchanged   |
| Te Mahia                   | Ungraded                 |                          |           |           |           | New site 2010-11, insufficient data   |
| Tukituki River @ Walker Rd | Ungraded                 |                          |           |           |           | New site 2010-11, insufficient data   |

Three sites, Opoutama Beach, Porangahau River and Wairoa River showed a decrease in grade related to a shift in the Microbiological Assessment Category (MAC). The MAC category is based on the 95%ile of indicator counts, so changes to this category can reflect a decrease in water quality within the past 5 years (i.e. including data from 2005 onwards).

Mahanga Beach site has been allocated a follow up status due to one rainfall related exceedances over the season, and two the previous season. If we run the trend test excluding the 7<sup>th</sup> March 2011 and 1<sup>st</sup> of February 2010 result, Mahanga remains in Very Good condition. Pandora Pond's conductivity results indicate Enterococci is the best indicator, with only three years of results an SFRG is not able to be calculated. Te Mahia at boat ramp and Tukituki River at Walker road are both new sites this season, with insufficient data to calculate an SFRG.

Mahia Beach site was manually placed into the Good category from the Very Good grade based on known potential concerns with individual septic tank systems, which can at times pose a risk. This change is reflected in the Sanitary Inspection Category of the assessment rather than the MAC, which improved from a 95%ile of 148 to 130.

Overall the changes in grades reflect the sensitivity of the software to changes in the 95%ile which can affect the MAC grade category and subsequently the Suitability for Recreation Grade. Whether these represent general improvements or declines in the environmental quality relies on a subjective assessment of the rate and magnitude of any change. For a comparison of *all* years, for *all* sites regarding compliance percentages with alert and action modes see Table 9 and 10.

**Table 9: Comparison of seasons 2006-2011 for freshwater and estuarine sites**

| Site                            | % Compliance with Alert Mode<br>(260 E. coli/100ml) |      |      |      |      |      | % Compliance with Action Mode<br>(550 E. coli/100ml) |      |      |      |      |      |
|---------------------------------|---|------|------|------|------|------|--|------|------|------|------|------|
|                                 | 2006  | 2007 | 2008 | 2009 | 2010 | 2011 | 2006   | 2007 | 2008 | 2009 | 2010 | 2011 |
| Clive River @ SH2 Bridge*       | 90  | 100  | 90   | 95   | 85   | 50   | 95   | 100  | 90   | 100  | 90   | 95   |
| Esk River @ Eskdale Park        | 90  | 90   | 90   | 90   | 95   | 80   | 95   | 100  | 100  | 90   | 95   | 90   |
| Kairakau Lagoon                 | 90  | 100  | 85   | 100  | 85   | 85   | 95   | 100  | 90   | 100  | 90   | 85   |
| Lake Tutira @ Camping Ground    | 95  | 95   | 80   | 100  | 80   | 85   | 95   | 95   | 85   | 100  | 90   | 95   |
| Maraetotara Lagoon              | 95  | 85   | 80   | 95   | 80   | 60   | 95   | 90   | 95   | 95   | 85   | 90   |
| Maungawhio Lagoon               | 95  | 100  | 85   | 100  | 95   | 95   | 95   | 100  | 90   | 100  | 95   | 95   |
| Ngaruroro River @ Chesterhope   | 95  | 80   | 90   | 95   | 85   | 95   | 95   | 100  | 100  | 100  | 95   | 100  |
| Porangahau River                | 95  | 100  | 100  | 100  | 70   | 75   | 100  | 100  | 100  | 100  | 85   | 80   |
| Puhokio Stream @ Waimarama*     | 90  | 50   | 60   | 75   | 80   | 8    | 95   | 67   | 80   | 85   | 95   | 53   |
| Tukituki River @ Black Bridge   | 90  | 85   | 95   | 95   | 90   | 95   | 90   | 100  | 100  | 95   | 95   | 100  |
| Tukituki River @ SH2 Waipukurau | 90  | 100  | 85   | 95   | 85   | 95   | 95   | 100  | 100  | 100  | 95   | 100  |
| Tukituki River @ Walker Rd      | n/s   | n/s  | n/s  | n/s  | n/s  | 80   | n/s  | n/s  | n/s  | n/s  | n/s  | 95   |
| Tutaekuri River @ Pakowhai Rd   | 90  | 100  | 95   | 95   | 90   | 90   | 95   | 100  | 100  | 100  | 90   | 100  |
| Waipatiki Lagoon                | 85  | 75   | 60   | 100  | 70   | 65   | 95   | 95   | 75   | 100  | 90   | 85   |
| Waipuka Stream @ Ocean Beach    | 90  | 85   | 80   | 95   | 75   | 65   | 90   | 100  | 90   | 95   | 95   | 75   |
| Wairoa River @ Ski Club         | 95  | 85   | 90   | 100  | 75   | 65   | 95   | 100  | 95   | 100  | 90   | 85   |

N/S = Not Sampled

\* These sites were sampled fortnightly.

**Table 10: Comparison of seasons 2006- 2011 for marine sites**

| Site                | % Compliance with Alert Mode<br>(140 <i>Enterococci</i> /100ml) |      |      |      |      |      | % Compliance with Action Mode<br>(550 <i>E. coli</i> /100ml) |      |      |      |      |      |
|---------------------|---|------|------|------|------|------|--|------|------|------|------|------|
|                     | 2006  | 2007 | 2008 | 2009 | 2010 | 2011 | 2006   | 2007 | 2008 | 2009 | 2010 | 2011 |
| Aramoana Beach      | 100   | 100  | 95   | 100  | 95   | 100  | 100  | 100  | 95   | 100  | 95   | 100  |
| Blackhead Beach     | 100   | 100  | 90   | 100  | 90   | 100  | 100  | 100  | 95   | 100  | 90   | 100  |
| Hardinge Road Beach | 95  | 100  | 100  | 95   | 95   | 100  | 95   | 100  | 100  | 100  | 95   | 100  |
| Kairakau Beach      | 100   | 100  | 95   | 100  | 95   | 100  | 100  | 100  | 100  | 100  | 95   | 100  |
| Mahanga Beach       | 90  | 100  | 90   | 95   | 90   | 95   | 95   | 100  | 95   | 95   | 90   | 95   |
| Mahia Beach         | 90  | 100  | 95   | 100  | 95   | 95   | 100  | 100  | 100  | 100  | 95   | 95   |
| Ocean Beach         | 95  | 100  | 100  | 95   | 90   | 100  | 95   | 100  | 100  | 100  | 95   | 100  |
| Opoutama Beach      | 95  | 100  | 100  | 95   | 85   | 80   | 95   | 100  | 100  | 95   | 90   | 85   |
| Pandora Pond        | n/s   | n/s  | n/s  | n/s  | 95   | 85   | n/s  | n/s  | n/s  | n/s  | 95   | 90   |
| Porangahau Beach    | 100   | 95   | 95   | 100  | 90   | 100  | 100  | 95   | 95   | 100  | 95   | 100  |
| Pourerere Beach     | 100   | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| Te Mahia @ Boatramp | n/s   | n/s  | n/s  | n/s  | n/s  | 82   | n/s  | n/s  | n/s  | n/s  | n/s  | 82   |
| Te Awanga Coastal   | 100   | 90   | 100  | 100  | 80   | 85   | 100  | 95   | 100  | 100  | 85   | 90   |
| Waimarama Beach     | 100   | 100  | 95   | 100  | 95   | 100  | 100  | 100  | 95   | 100  | 95   | 100  |
| Waipatiki Beach     | 95  | 100  | 100  | 95   | 95   | 95   | 95   | 100  | 100  | 100  | 95   | 95   |
| Westshore Beach     | 100   | 100  | 95   | 100  | 90   | 95   | 100  | 100  | 95   | 100  | 90   | 95   |

N/S = Not Sampled

NB. 2004 onwards Action Mode Compliance assessed using single-sample exceedance

## 5.0 DISCUSSION

### Marine water

As with last year, marine sites in Hawke's Bay have shown a reasonable level of compliance with recreational water quality guidelines - supporting their use as a contact recreation resource. While high bacterial numbers can occasionally occur in quantities that could pose a significant health risk, follow-up sampling has shown these events to be short-lived and often directly related to heavy rainfall. Results tend to be back to surveillance mode prior to reaching the two consecutive sample action level as set out in the Microbiological guidelines (MfE and MoH, 2003). Of the elevated counts over the 2010/2011 recreational season, majority of the results can be seen as rainfall related, as very high rainfall fell through January and February.

All exceedances showed a quick return to background levels with the exception of Te Mahia and Clive River at the end of the season. The elevated counts occurred mainly around the end of January to start of February, where high rainfall events were prevalent.

The marine sites sampled under the current programme did not highlight any significant water quality issues. Hawke's Bay marine water quality continues to support contact recreation activities most of the time, except for periods of heavy and sustained rainfall.

### Estuary and Freshwater

Microbiological water quality in the freshwater and estuarine sites shows higher variability, and water quality appears to be compromised at a number of sites. A few sites have maintained a high level of water quality, however some persistent problem areas are repeatedly highlighted each season, such as Puhokio stream. As with the marine sites, a number of exceedances occurred with the high rainfall at the end of January, Rivers lagoons and estuaries showed very high results over this time. In general freshwater and brackish water quality is shown to be affected by rainfall.

The exceedances observed in the freshwater and estuarine areas during the 2010/11 programme are reasonably evenly divided between being rainfall related events and events not attributed to rainfall. The remaining forty three action mode exceedances are split with twenty three related to rainfall events and twenty unrelated to a high rainfall event, and occurring in periods of dry weather and in the absence of any obvious external sources.

Therefore it can be seen that rainfall events do have an impact on the water quality of Hawke's Bay. A higher number of exceedances were observed this season compared to previous seasons. (43 action mode exceedances in freshwater and estuarine areas were recorded this season, 31 exceedances were recorded in the 10/11 season and 11 exceedances were recorded in the 08/09 season). This can be explained by the influx of surface run-off, carrying bacteria sourced from the excreta of land based animals during rain events. As for the non-rainfall related events, a possible explanation is that in areas where fine sediments dominate, sediment resuspension occurring through disturbance by swimmers or wave action may increase bacteria numbers in the overlying waters. Given the potential for sediments to harbour, and subsequently release bacteria, it may be possible that high bacteria levels at a given sampling time, may not originate from a discharge or by direct runoff, but from the resuspension of sediments by bathers.

At some sites Clive River, Porangahau River and Puhokio Stream further investigations are recommended to assist in identifying the sources of bacteria as to target management.

The results for the shellfish gathering waters reveal that one of the five sites sampled complied with shellfish gathering guidelines based on seasonal medians and percentage of samples above 43 Faecal coliforms/100mL. This is a decrease on last year when two of the five achieved full compliance. Follow up sampling is required at Te Awanga Beach; shellfish flesh sampling will take place as results show two consecutive years of non compliance.

In general rainfall in the Hawke's Bay Region for the season come out pretty much normal at 105%, but it was variable across the catchments. The monitoring period was also variable through there being a combination of three drier than normal onths (November, December and February), on near normal month (March) and one very wet month (January). This undoubtedly, was a factor in the high results obtained over the season form recreational areas seen throughout the region.

The following recommendations are made;

#### 4 RECOMMENDATIONS

- 1) That Hawke's Bay Regional Council continue to monitor freshwater, estuarine and marine bathing and shellfish gathering sites in accordance with the Ministry for the Environment and Ministry for Health guidelines;
- 2) That follow-up exceedance sampling for freshwater sites only be undertaken where the cause of the exceedance cannot be attributed to rainfall.
- 3) That follow-up sampling after an exceedance event at Puhokio Stream not be undertaken, unless there is reasonable cause to believe that the exceedance is extraordinary. Permanent signage is currently in place warning swimmers of the risk associated with this site;
- 4) That follow-up samples be obtained within 24 hours where possible, even in the case on high rainfall on re-sampling day.
- 5) That monitoring of shellfish gathering waters in accordance with MfE and MoH guidelines be continued for the 2011/12 season;
- 6) Shellfish testing be undertaken on Ahuriri Estuary, Te Awanga Coastal and recommended also Te Mahia, dependent on available funding.
- 7) That the monthly report visually showing the percentage compliance for freshwater, estuarine and marine sites continues to be produced, circulated internally and made available to the public via the regional councils website;
- 8) That sampling at Clive River and Puhokio Stream be undertaken fortnightly as these sites are fully graded, have a 'Very Poor' grade, and are permanently sign-posted. Between the months of December to February these sites will be sampled weekly to correspond with recommendation 9. Ocean, Pourerere, Westshore and Porangahau Beaches could also be considered for reduced monitoring as these sites are fully graded as 'Very Good' and have retained this grade over the past four years.
- 9) Investigation into Puhokio Stream, Porangahau River and Clive River, Faecal source tracking, dependent on available funding.
- 10) That Kairakau Lagoon, Maungawhio Lagoon and Porangahau River continue to be monitored for both Enterococci and *E. coli* as these sites have been shown to be sufficiently saline/brackish to warrant the use of additional indicators; along with continuing to be monitored for conductivity to assess the appropriateness of *E. coli* or Enterococci as the most appropriate indicator for each site at the time of sampling.
- 11) Clive River, Waipuka Stream and Wairoa River to be monitored as freshwater sites for reporting purposes. For managing public health sample these three sites for conductivity and if value exceeds 10,000 uS/cm request that lab conducts Enterococci results in addition with *E. coli*.
- 12) Pandora Pond to be monitored as a marine site.

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## 6 REFERENCES

Hawke's Bay Regional Council, (2008). Regional Coastal Environmental Plan. ISBN 1-877174-16-5.

McBride G.B, (2005). Using statistical methods for water quality management. Issues, Problems and Solutions. pp313, Wiley Interscience Publication ISBN0-471-47016-3

Ministry for the Environment & Ministry of Health (2003). Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. MoH & MfE, Wellington.

Stansfield, B. (2002). Effects of Rainfall on the Bacteriological Water Quality of Hawke's Bay Bathing Sites. Hawke's Bay Regional Council Internal Report: EMI 02/07.

**Appendix 1**  
**Site Descriptions**

## **Marine Sites**

### Aramoana

Aramoana is a recent addition to the monitoring programme due to the development of a coastal subdivision and its associated expected increase in recreational water users. It stands at the northern boundary of the Te Angiangi marine reserve that receives increasing numbers of users each year.

### Blackhead Beach

Blackhead Beach is the main access point to the Te Angiangi Marine Reserve, and is a popular swimming and recreation spot. There is a small settlement with holiday baches and two camping grounds.

### Hardinge Rd. Beach

The beach at Hardinge Road is close to a number of recreational facilities, including a children's playground, beachfront walkway and ice cream parlour in close proximity to the sampling site. The beach is adjacent to the entrance to the inner harbour and the Port of Napier.

### Kairakau Beach

Kairakau Beach is a popular spot for fishing, boating, surfing and diving. There is a small settlement with holiday baches, a camping ground and a few permanent residents. Over recent years, some erosion has occurred at this beach, making access to the beach difficult. The Kairakau Lagoon discharges at the southern end of the beach.

### Mahanga Beach

On the northern side of the Mahia Peninsula, Mahanga Beach has a small resident population and a number of holiday baches. This area is currently expanding, with subdivision occurring inland toward the Mahia road. At present, the settlement is serviced solely by septic tanks.

### Mahia Beach

Mahia Beach is a small settlement on the southern side of the Mahia Peninsula. The population of this settlement increases markedly in summer months due to the influx of holidaymakers using the baches and camping ground in the area. The settlement is serviced solely by septic tanks, and there is a stormwater drain out into the marine area near the boat ramp. Subdivision is occurring rapidly in this location with several new developments underway throughout the sampling season, and pressure on camping space has increased with the closure of the nearby Opoutama campsite.

### Ocean Beach

Ocean Beach is a popular surf and swimming beach due to its close proximity to Napier and Hastings and the presence of a surf lifesaving patrol. The Waipuka Stream (mentioned below) discharges into the south-eastern end of the beach. Samples at this site are taken in the main swimming area, immediately in front of the surf lifesaving tower.

### Opoutama Beach

Opoutama Beach is located on the south side of the Mahia Peninsula. The only resident population includes a few lifestyle blocks. Subdivision of the former campsite is continuing. The Opoutama Stream runs into the western side of the beach, after draining a small agricultural catchment. The beach is commonly used for swimming and other recreational activities in the summer months.

### Porangahau Beach

Porangahau Beach, located approximately 40km south east of Waipukurau is used for swimming, fishing and other recreational activities. There are no direct discharges in the vicinity of the beach, although the Porangahau River discharges approximately 10km north of the beach. The Porangahau Township is serviced by a community sewage treatment system.

### Pourerere Beach

Pourerere Beach, in southern Hawke's Bay, is a popular holiday destination. The township is comprised of a number of holiday homes, as well as some permanent residents. The community is serviced solely by individual septic tank systems.

### Te Awanga

The Te Awanga site is adjacent to the Maraetotara Lagoon sampling site and has been included in the sampling programme to reflect the high number of users at this site. It has a recognised surf break that at times attracts large numbers of surfers. The site has a reef environment as well as being the discharge point for the Maraetotara River.

### Waimarama Beach

Due to its close proximity to Napier and Hastings, and the presence of a surf lifesaving patrol, Waimarama Beach remains a popular swimming beach. The beach has both a large resident population as well as numerous visitors over the summer season. The Puhokio Stream (see below) discharges into the northern end of the beach.

### Waipatiki Beach

Waipatiki is a small settlement located approximately 20km north of Napier and consisting of a number of baches, a campground, and a small resident population. The area at the rear of the back dunes and on the headland is currently under development, and a community sewage treatment system was installed in 2006. Its close proximity to Napier and Hastings makes it popular for day excursions. There is a small stream/lagoon, which drains into the beach (see Waipatiki Lagoon below).

### Westshore Beach

Westshore Beach is located to the north of Napier city, and is popular with both locals and holidaymakers. A patrolled surf lifesaving club adds to the appeal of the beach. There are a number of stormwater discharges into the marine area near the beach, but these do not seem to affect the water quality at this beach.

## **Freshwater and Estuarine Sites**

### Clive River at State Highway 2 Bridge (Boat Ramp)

The Clive River catchment passes through pastoral, horticultural, viticultural, industrial and urban areas, as well as receiving all the stormwater from Hastings City. The river is used extensively for recreational use, particularly rowing, water skiing and jet skiing.

### Esk River

The Esk River drains a moderately sized, rural catchment. It does not pass through or near any urban centres prior to discharging into the Bay between Whirinaki and Bayview. The sampling site is at Eskdale Park, which is a popular area for families.

### Kairakau Lagoon

The Kairakau Lagoon is formed at the mouth of the Mangakuri River, which passes through a predominantly pastoral catchment before discharging into the ocean at Kairakau. The lagoon is situated close to the camping ground and is frequently used for fishing, boating and swimming, particularly by children.

### Lake Tutira

Lake Tutira is one of the largest lakes in Hawke's Bay and is located approximately 50km north of Napier. It is a common camping/holiday site over the summer period, and is regularly used for canoeing, swimming, fishing and boating. In addition, this site is a country park, with significant birdlife. The sampling site is located at the boat ramp opposite the main campground.

### Maraetotara Lagoon

The Maraetotara River enters the coast via the Maraetotara Lagoon at Te Awanga, after passing through predominantly pastoral land. Due to the low flow in the river, and sea swells at the beach, the mouth of the river is closed through much of the summer period. The Te Awanga camping ground is situated beside the northern embankment of the lower Maraetotara River, and the sample site is directly south of the main car park. Te Awanga is popular due to its good surf break and its close proximity to Cape Kidnappers and the gannet colony.

#### Maungawhio Lagoon

The Maungawhio Lagoon is located on the northern side of the Mahia Peninsula, and is formed by the Kupuawhara Stream. The lagoon has been identified as a Significant Area in Hawke's Bays Regional Coastal Plan (HBRC, 1999), and is both an important fish spawning area, breeding and roosting area for variety of water birds. The lagoon is regularly used for swimming, fishing and shellfish gathering.

#### Ngaruroro River at Chesterhope Bridge

The site at Chesterhope Bridge is a popular bathing spot during the summer for locals from Napier and Hastings. The Ngaruroro River drains a catchment that is predominantly agricultural in the upper reaches, and used for intensive horticulture in the lower reaches. The Hawke's Bay Regional Council maintains this area for easy public access to the river.

#### Pandora Pond

Pandora Pond is a small, sheltered area of Ahuriri Estuary, separated from the main estuary by a spit, and located close to Napier. It is frequently used for water based recreational activities including swimming, kayaking, rowing and sailing. There has been a shift toward apartment style living in the vicinity of the sampling site so user numbers are expected to increase now the development is completed. The majority of Napier's stormwater discharges into the Ahuriri Estuary upstream of the site, and the Pandora Pond area itself is adjacent to a number of industries.

#### Puhokio Stream at Waimarama Beach

The Puhokio Stream drains a small, steep, agricultural catchment before passing through the settlement of Waimarama and discharging at the northern end of the beach. The warm temperatures and slow flowing lagoon type nature of the stream makes it particularly popular with children. In the past, the stream has repeatedly shown high levels of faecal contamination, predominantly sourced from agriculture, but also influenced by on-site wastewater treatment systems.

#### Porangahau River

The sample location is directly down-stream of wastewater plant's discharge and is a boat launch ramp.

#### Te Mahia at Boat Ramp

The sample site is in the coastal waters adjacent to the boat ramp at Whangawehi Stream. This area is regularly used by the local community for recreational activities as well as being the downstream receiving environment of a large catchment area, which includes the forested area proposed to take the Mahia community wastewater via land application. This is a new site in 2010/11.

#### Tukituki River at Black Bridge

The Tukituki River drains the Ruataniwha Plains area, before passing through agricultural land on its way to Hawke Bay just south of Clive. The sampling site at Black Bridge is in the tidal part of the river, and is regularly used for swimming and other recreational activities.

#### Tukituki River at SH2, Waipukurau

The Tukituki River drains the Ruataniwha Plains area, before flowing through Waipukurau on its way to the coast at Haumoana. The river, in the vicinity of the SH2 bridge, is a popular swimming spot in the summer.

#### Tukituki River at Walker Rd

The Tukituki River drains the Ruataniwha Plains area, before flowing through Waipukurau. This site is at the Walker Road access point east of Waipawa below the confluence of the Tukituki and Waipawa Rivers. The sampling site was identified for recreational purposes through the Recreational Usage Survey and due to its close proximity and upstream nature means that it can provide a proxy for the Tamumu Bridge, Shag Rock and Patangata sites. This is a new site in 2010/11.

#### Tutaekuri River at Pakowhai Rd. Bridge

The Tutaekuri River drains a predominantly agricultural and forested catchment, with some intensive horticultural activities in the lower reaches. The recreational site at the Pakowhai Rd Bridge is a popular bathing spot, which can be accessed from the end of Guppy Rd in Taradale. The Hawke's Bay Regional Council has endeavoured to make this area more accessible to the public for recreational activities.

#### Waipatiki Lagoon

The Waipatiki Lagoon is formed by the Waipatiki Stream which drains a small, predominantly agricultural and forestry hill catchment, before flowing through the settlement of Waipatiki. This site frequently exceeds the Alert and Action guideline levels. In the past, evidence has suggested that the contamination of the stream is primarily faecal material from malfunctioning septic tanks in the settlement. In 2006 the area upgraded to a community sewage treatment system with the majority of baches and houses connected.

#### Waipuka Stream at Ocean Beach

The Waipuka Stream flows through a small, steep, agricultural catchment before discharging into Hawke Bay at the eastern side of Ocean Beach. The stream also passes by baches at the small community, and often forms a lagoon, which is popular with small children.

#### Wairoa River (Boat ramp)

The Wairoa River is one of the largest rivers in Hawke's Bay, and consequently has a large catchment in which the predominant land use is sheep and beef farming, with some dairying also occurring. The sampling site is at the Water Ski Club in the Wairoa township, and the river is tidal at this point. There are a number of discharges (in addition to the agricultural land use), which may affect the water quality at this site. Frasertown Meats is located upstream of the sampling site, and downstream discharges include Affco Wairoa and the municipal sewage discharge from Wairoa township. Additionally, there are a number of stormwater drains which flow into the river, and both active and closed landfills near the mouth of the river.

### **Shellfish Gathering Waters**

#### Ahuriri Lagoon

This site is located on the true left bank of the Estuary approximately 40m upstream of the Pandora road bridge. It receives considerable fishing pressure throughout the year for cockles.

#### Kairakau Beach

The Kairakau Beach site is the same as for the recreational water quality monitoring site. The Kairakau Lagoon discharges at the southern end of the beach.

#### Mahia Beach at the Golf Club

This site falls between the Mahia Beach and Opoutama Beach recreational water quality sites. It is located adjacent to a well known pipi bed that receives considerable fishing pressure during the summer months. The site is accessed via the walkway that departs directly opposite the entrance to the Mahia Beach golf Club.

#### Te Awanga Coastal

The Te Awanga site is sampled at the same location as the Te Awanga recreational water quality site. The site has a reef environment historically known to harbour mussels.

#### Waipatiki Beach

Waipatiki's close proximity to Napier and Hastings makes it popular for day excursions and for the collection of shellfish. Sampling is carried approximately 100m south of the Bathing beach site, near the start of the rocky reef system. There is a small stream/lagoon, which drains into the beach adjacent to the sampling site.

**Appendix 2**  
**Suitability for Recreation Grade (SFRG)**  
**Accompanying Information**

## Definitions for Suitability for Recreation Grades

NB: Different definitions exist for marine and freshwater gradings, however there is essentially little difference and therefore only the marine gradings have been described here to give an idea of the meaning of each grade. From MfE & MoH , 2003.

### Very Good

Water quality tests and assessment of potential contamination sources indicate beaches within this category are considered to have very good water quality. There may be some runoff from low-intensity agriculture/urban/rural catchments, but there are likely to be no significant sources of faecal contamination.

Recommendation: Considered satisfactory for swimming at all times, and therefore may not require monitoring on a regular basis.

### Good

Water quality tests and assessment of potential contamination sources indicate that beaches within this category are considered to have generally good water quality. On occasions (such as after high rainfall) there may be increased risk of contamination from run-off. Such sites receive run-off from one or more of the following sources and may contain animal or faecal material:

- River discharges impacted by tertiary treated wastewater, combined sewer overflows, intensive agriculture/rural catchments, feral bird/animal populations;
- River discharges impacted by run-off from low-intensity agricultural/urban/rural catchment;
- Stormwater not contaminated by sewage.

Recommendation: Satisfactory for swimming most of the time. Exceptions may include following rainfall. Such beaches are monitored regularly throughout the summer season and warning signs will be erected if water quality deteriorates.

### Fair

Water quality tests and assessment of potential contamination sources indicate that beaches within this category are considered to have generally fair water quality. Events such as high rainfall increase the risk of contamination levels from run-off. Such sites receive run-off from one or more of the following sources of faecal material:

- River discharges impacted by tertiary treated wastewater, combined sewer overflows, intensive agriculture/rural catchments, feral bird/animal populations;
- River discharges impacted by run-off from low-intensity agricultural/urban/rural catchment;
- Stormwater not contaminated by sewage.

Recommendation: Generally satisfactory for swimming, through there are many potential sources of faecal material. Caution should be taken during periods of high rainfall, and swimming avoided if water is discoloured. Sites are monitored weekly and warning signs erected if water quality deteriorates.

### Poor

Water quality tests and assessment of potential contamination sources indicate that beaches within this category are considered to have generally poor water quality. These sites receive run-off from one or more of the following sources and may contain animal or human faecal material:

- Tertiary treated wastewater;
- Urban stormwater, marinas or moorings, intensive agriculture;
- River discharges containing untreated /primary/secondary treated wastewater or on-site waste treatment systems.

Recommendation: Generally not okay for swimming, as indicated by historical results. Swimming should be avoided, particularly by the very young, very old and those with compromised immunity. Permanent warning signs may be erected at these sites, although councils may monitor these sites weekly and post temporary warnings.

## Very Poor

Water quality tests and assessment of potential contamination sources indicate that beaches within this category are considered to have generally very poor water quality. These sites receive run-off from one or more of the following sources and may contain animal or human faecal material:

- Untreated/primary/secondary treated wastewater;
- Tertiary treated wastewater;
- Urban stormwater, marinas or moorings, intensive agriculture;
- River discharges containing untreated /primary/secondary treated wastewater or on-site waste treatment systems.

Recommendation: Avoid swimming as there are direct discharges of faecal material. Permanent signage will be erected at the beach stating that swimming is not recommended.

| Suitability for Recreation Grade   |           |   |   |  |  |                                  |
|------------------------------------|-----------|---|---|--|--|----------------------------------|
| Susceptibility to faecal influence |           | Microbiological Assessment Category (MAC) |   |  |  | Exceptional Circumstances<br>*** |
|                                    |           | Indicator counts (as percentiles)         |   |  |  |                                  |
|                                    |           | (per 100ml)<br>≤ 40 Ent.<br>≤ 130 E. coli | (per 100ml)<br>41-200 Ent.<br>131-260 E. coli | (per 100ml)<br>201-500 Ent.<br>261-550 | (per 100ml)<br>>500 Ent.<br>>550 E. coli |                                  |
| Sanitary Inspection Category       | Very Low  | Very Good                                 | Very Good                                     | Follow-up**                            | Follow-up**                              |                                  |
|                                    | Low       | Very Good                                 | Good  | Fair                                   | Follow-up**                              |                                  |
|                                    | Moderate  | Follow-up*                                | Good  | Fair                                   | Poor                                     |                                  |
|                                    | High      | Follow-up*                                | Follow-up*                                    | Poor                                   | Very Poor                                |                                  |
|                                    | Very High | Follow-up*                                | Follow-up*                                    | Follow-up*                             | Very Poor                                |                                  |
| Exceptional Circumstances          |           |   |   |  |  |                                  |

### Notes

- \* Indicates unexpected results requiring investigation (reassess SIC and MAC). If after reassessment the SFRG is still follow-up, then assign a conservative grade (i.e. the first grade to the right of the follow-up in the same SIC row).
- \*\* Implies non-sewage sources of indicators, and this should be verified. If after verification the SFRG is still follow-up, then assign a conservative grade (i.e. the first grade after follow-up in the same MAC column).
- \*\*\* Exceptional circumstances: relate to known periods of higher risk for a graded beach, such as during a sewer rupture or an outbreak of a potentially waterborne pathogen in the community of the recreational area catchment. Under such circumstances a grading would not apply until the episode has abated.

**Appendix 3**  
**2009/10 Season –**  
**Mann-Kendall Trend Test Result**

**Aramoana Beach****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 4 years and 1 months from 2007 to 2011

69 observations from 12/03/07 to 21/03/11 with 42 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|----------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 2.00         | -284.00           | 34670.00 | -1.52 | 0.13 | 0.00                    | -2.28               | 0.00                 |

**Blackhead Beach****Mann-Kendall test for Ent (c/100ml)**

Starting month = November

Period analysed 8 years and 5 months from 2002 to 2011

209 observations from 12/11/02 to 21/03/11 with 169 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 1.00         | 91.00             | 975029.00 | 0.09 | 0.93 | 0.00                    | 0.00                | 0.00                 |

**Clive River****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 10 years and 5 months from 2000 to 2011

181 observations from 24/11/00 to 14/03/11 with 67 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 110.00       | -598.00           | 664131.33 | -0.73 | 0.46 | -1.95                   | -6.59               | 2.56                 |

**Esk River****Mann-Kendall test for Ecoli (cfu/100ml)**

Starting month = November

Period analysed 10 years and 5 months from 2000 to 2011

218 observations from 23/11/00 to 21/03/11 with 108 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 45.50        | 1649.00           | 1158689.00 | 1.53 | 0.13 | 1.50                    | 0.00                | 3.16                 |

**Harding Road Beach****Mann-Kendall test for Ent (cfu/100ml)**

Starting month = November

Period analysed 10 years and 4 months from 2000 to 2011

208 observations from 18/12/00 to 21/03/11 with 152 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 4.00         | -466.00           | 998496.67 | -0.47 | 0.64 | 0.00                    | -0.17               | 0.00                 |

**Kairakau Lagoon****Mann-Kendall test for Ecoli (cfu/100ml)**

Starting month = November

Period analysed 10 years and 5 months from 2000 to 2011

218 observations from 24/11/00 to 21/03/11 with 117 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 22.50        | -3134.00          | 1158023.33 | -2.91 | 0.00 | -1.53                   | -2.76               | -0.57                |

**Kairakau Beach****Mann-Kendall test for Ent (c/100ml)**

Starting month = November

Period analysed 10 years and 4 months from 2000 to 2011

208 observations from 19/12/00 to 21/03/11 with 176 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 1.00         | 1207.00           | 940335.00 | 1.24 | 0.21 | 0.00                    | 0.00                | 0.00                 |

**Tutira Lake****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 9 years and 5 months from 2001 to 2011

219 observations from 11/11/01 to 21/03/11 with 122 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 22.00        | 3126.00           | 1174083.33 | 2.88 | 0.00 | 1.83                    | 0.72                | 3.03                 |

**Wairoa River****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 10 years and 5 months from 2000 to 2011

219 observations from 23/11/00 to 21/03/11 with 98 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 61.00        | -1459.00          | 1174673.67 | -1.35 | 0.18 | -2.01                   | -4.78               | 0.32                 |

**Westshore Beach****Mann-Kendall test for Ent (c/100ml)**

Starting month = November

Period analysed 10 years and 4 months from 2000 to 2011

209 observations from 18/12/00 to 21/03/11 with 156 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 5.00         | -491.00           | 1015132.33 | -0.49 | 0.63 | 0.00                    | -0.22               | 0.00                 |

**Mahanga Beach****Mann-Kendall test for Ent (c/100ml)**

Starting month = November

Period analysed 10 years and 4 months from 2000 to 2011

149 observations from 18/12/00 to 21/03/11 with 113 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 1.00         | 1601.00           | 350788.33 | 2.70 | 0.01 | 0.00                    | 0.00                | 0.10                 |

**Mahia Beach****Mann-Kendall test for Ent (c/100ml)**

Starting month = November

Period analysed 10 years and 4 months from 2000 to 2011

219 observations from 18/12/00 to 21/03/11 with 153 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 7.00         | -1300.00          | 1171318.00 | -1.20 | 0.23 | -0.20                   | -0.60               | 0.00                 |

**Maratotara Lagoon****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 10 years and 5 months from 2000 to 2011

219 observations from 24/11/00 to 21/03/11 with 93 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 76.00        | -256.00           | 1174726.00 | -0.24 | 0.81 | -0.24                   | -3.29               | 2.59                 |

**Mungawhio Lagoon****Mann-Kendall test for Ecoli (cfu/100ml)**

Starting month = November

Period analysed 8 years and 5 months from 2002 to 2011

179 observations from 11/11/02 to 21/03/11 with 113 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 6.00         | 1601.00           | 635516.33 | 2.01 | 0.04 | 0.18                    | 0.00                | 0.67                 |

**Ngaururoro River****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 10 years and 5 months from 2000 to 2011

218 observations from 24/11/00 to 21/03/11 with 103 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 53.00        | 1599.00           | 1158717.00 | 1.48 | 0.14 | 1.57                    | 0.00                | 3.24                 |

**Opoutama Beach****Mann-Kendall test for ENT (c/100ml)**

Starting month = November

Period analysed 10 years and 4 months from 2000 to 2011

209 observations from 18/12/00 to 21/03/11 with 151 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 4.00         | 1534.00           | 1012771.33 | 1.52 | 0.13 | 0.06                    | 0.00                | 0.31                 |

**Ocean Beach****Mann-Kendall test for ENT (c/100ml)**

Starting month = November

Period analysed 10 years and 4 months from 2000 to 2011

209 observations from 19/12/00 to 21/03/11 with 161 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 1.00         | 2445.00           | 981848.33 | 2.47 | 0.01 | 0.00                    | 0.00                | 0.08                 |

**Pandora Pond****Mann-Kendall test for Ent (c/100ml)**

Starting month = November

Period analysed 1 years and 5 months from 2009 to 2011

40 observations from 2/11/09 to 21/03/11 with 12 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 13.50        | 242.00            | 7348.00  | 2.81 | 0.00 | 13.81                   | 5.37                | 32.03                |

**Puhokio Stream****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 10 years and 3 months from 2000 to 2011

177 observations from 24/11/00 to 31/01/11 with 52 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 230.00       | -525.00           | 621195.00 | -0.66 | 0.51 | -3.36                   | -13.78              | 6.15                 |

**Pourerere Beach****Mann-Kendall test for ENT(c/100ml)**

Starting month = November

Period analysed 10 years and 4 months from 2000 to 2011

169 observations from 19/12/00 to 21/03/11 with 139 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 1.00         | 1346.00           | 512951.33 | 1.88 | 0.06 | 0.00                    | 0.00                | 0.00                 |

**Porangahau Estuary****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 5 years and 5 months from 2005 to 2011

119 observations from 8/11/05 to 14/03/11 with 57 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 11.00        | 2550.00           | 189084.00 | 5.86 | 0.00 | 5.13                    | 3.30                | 8.03                 |

**Porangahau Beach****Mann-Kendall test for ENT(c/100ml)**

Starting month = November

Period analysed 9 years and 5 months from 2001 to 2011

199 observations from 12/11/01 to 21/03/11 with 156 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 1.00         | 1771.00           | 840512.33 | 1.93 | 0.05 | 0.00                    | 0.00                | 0.06                 |

**Tukituki River at Black Bridge****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 10 years and 5 months from 2000 to 2011

199 observations from 29/11/00 to 21/03/11 with 102 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 33.00        | -1977.00          | 881856.33 | -2.10 | 0.04 | -1.66                   | -2.90               | -0.35                |

**Tukituki River at Waipukurau****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 9 years and 5 months from 2001 to 2011

200 observations from 11/11/01 to 21/03/11 with 117 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 21.00        | 2126.00           | 894798.67 | 2.25 | 0.02 | 1.40                    | 0.31                | 2.50                 |

**Tutaekuri River****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 10 years and 5 months from 2000 to 2011

220 observations from 24/11/00 to 21/03/11 with 121 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 37.00        | -1114.00          | 1190574.67 | -1.02 | 0.31 | -0.66                   | -1.93               | 0.40                 |

**Waimarama Beach****Mann-Kendall test for ENT (c/100ml)**

Starting month = November

Period analysed 10 years and 4 months from 2000 to 2011

210 observations from 19/12/00 to 21/03/11 with 158 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 2.00         | 605.00            | 1006569.00 | 0.60 | 0.55 | 0.00                    | 0.00                | 0.00                 |

**Waipatiki Beach****Mann-Kendall test for ENT (c/100ml)**

Starting month = November

Period analysed 10 years and 4 months from 2000 to 2011

209 observations from 23/12/00 to 21/03/11 with 166 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 2.00         | 1099.00           | 985417.67 | 1.11 | 0.27 | 0.00                    | 0.00                | 0.00                 |

**Waipatiki Lagoon****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 10 years and 5 months from 2000 to 2011

220 observations from 23/11/00 to 21/03/11 with 84 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z     | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|-------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 120.00       | -1351.00          | 1190871.67 | -1.24 | 0.22 | -3.10                   | -7.31               | 0.95                 |

**Te Awanga Beach****Mann-Kendall test for ENT (c/100ml)**

Starting month = November

Period analysed 5 years and 5 months from 2005 to 2011

125 observations from 8/11/05 to 21/03/11 with 72 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance  | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|-----------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 6.00         | 680.00            | 218765.33 | 1.45 | 0.15 | 0.50                    | 0.00                | 1.54                 |

**Waipuka Stream****Mann-Kendall test for Ecoli (c/100ml)**

Starting month = November

Period analysed 10 years and 5 months from 2000 to 2011

219 observations from 24/11/00 to 21/03/11 with 96 ties

Sample size greater than 10 and normal approximation used to determine P value

|            | Median value | Kendall statistic | Variance   | Z    | P    | Sen slope median annual | 5% confidence limit | 95% confidence limit |
|------------|--------------|-------------------|------------|------|------|-------------------------|---------------------|----------------------|
| Unadjusted | 40.00        | 401.00            | 1174701.67 | 0.37 | 0.71 | 0.30                    | -1.18               | 1.98                 |

**E.coli**

False Discovery Rate results for P-value

Samples with a probability level of 0.02000000 or less are significant at P = 0.05

There are 7 significant correlations

| Row                            | Probability | Critical value | Adjusted P-value |
|--------------------------------|-------------|----------------|------------------|
| Kairakau Lagoon                | 0.000000    | 0.006667       | 0.000000         |
| Lake Tutira                    | 0.000000    | 0.010000       | 0.000000         |
| Porangahau Estuary             | 0.000000    | 0.003333       | 0.000000         |
| Tukituki River at Waipukarau   | 0.020000    | 0.013333       | 0.075000         |
| Mungawhio Lagoon               | 0.040000    | 0.016667       | 0.100000         |
| Tukituki River at Black Bridge | 0.040000    | 0.020000       | 0.100000         |
| Esk River                      | 0.130000    | 0.023333       | 0.262500         |
| Ngaururoro River               | 0.140000    | 0.026667       | 0.262500         |
| Wiaroa River                   | 0.180000    | 0.030000       | 0.300000         |
| Waipatiki Lagoon               | 0.220000    | 0.033333       | 0.330000         |
| Tutaekuri River                | 0.310000    | 0.036667       | 0.422727         |
| Clive River                    | 0.460000    | 0.040000       | 0.575000         |
| Puhokio Stream                 | 0.510000    | 0.043333       | 0.588462         |
| Waipuka Stream                 | 0.710000    | 0.046667       | 0.760714         |
| Maratotara Lagoon              | 0.810000    | 0.050000       | 0.810000         |

## Enterococci

False Discovery Rate results for P-value

Samples with a probability level of 0.02000000 or less are significant at P = 0.05

There are 7 significant correlations

| Row                | Probability | Critical value | Adjusted P-value |
|--------------------|-------------|----------------|------------------|
| Pandora Pond       | 0.000000    | 0.003333       | 0.000000         |
| Mahanga Beach      | 0.010000    | 0.006667       | 0.050000         |
| Ocean Beach        | 0.010000    | 0.010000       | 0.050000         |
| Porangahau Beach   | 0.050000    | 0.013333       | 0.180000         |
| Pourerere Beach    | 0.060000    | 0.016667       | 0.180000         |
| Aramoana Beach     | 0.130000    | 0.023333       | 0.278571         |
| Oputama Beach      | 0.130000    | 0.020000       | 0.278571         |
| Te Awanga Beach    | 0.150000    | 0.026667       | 0.281250         |
| Kirakau Beach      | 0.210000    | 0.030000       | 0.345000         |
| Mahia Beach        | 0.230000    | 0.033333       | 0.345000         |
| Waipatiki Beach    | 0.270000    | 0.036667       | 0.368182         |
| Harding Road Beach | 0.640000    | 0.046667       | 0.685714         |
| Westshore Beach    | 0.630000    | 0.043333       | 0.685714         |
| Waimarama Beach    | 0.550000    | 0.040000       | 0.687500         |
| Blackhead Beach    | 0.930000    | 0.050000       | 0.930000         |

**Appendix 4**  
**Tables of Results**

### Marine Sites – *Enterococci* Indicator

| Date Sampled | Mahanga Beach | Mahia Beach | Oputama Beach | Waipatiki beach | Westshore Beach | Hardinge Road Beach | Date Sampled | Te Awanga Coastal | Ocean Beach | Waimarama beach | Kairakau Beach | Pourerere Beach | Aramoana Beach | Blackhead Beach | Porangahau Beach |
|--------------|---------------|-------------|---------------|-----------------|-----------------|---------------------|--------------|-------------------|-------------|-----------------|----------------|-----------------|----------------|-----------------|------------------|
| 01-Nov-10    | 1             | 1           | 1             | 2               | 2               | 2                   | 01-Nov-10    | 2                 | 4           | 1               | 1              | 1               | 1              | 1               | 2                |
| 08-Nov-10    | 1             | 1           | 2             | 1               | 4               | 13                  | 08-Nov-10    | 4                 | 1           | 1               | 1              | 1               | 1              | 1               | 1                |
| 15-Nov-10    | 1             | 12          | 72            | 16              | 4               | 1                   | 15-Nov-10    | 9                 | 1           | 1               | 1              | 1               | 1              | 4               | 1                |
| 22-Nov-10    | 12            | 3           | 35            | 8               | 13              | 2                   | 22-Nov-10    | 3                 | 1           | 1               | 1              | 1               | 1              | 1               | 1                |
| 29-Nov-10    | 16            | 1           | 3             | 130             | 2               | 9                   | 29-Nov-10    | 32                | 1           | 1               | 1              | 1               | 1              | 10              | 2                |
| 06-Dec-10    | 3             | 24          | 1             | 1               | 10              | 5                   | 06-Dec-10    | 6                 | 1           | 3               | 1              | 1               | 1              | 1               | 1                |
| 13-Dec-10    | 1             | 1           | 1             | 7               | 4               | 82                  | 13-Dec-10    | 4                 | 25          | 1               | 1              | 1               | 10             | 1               | 10               |
| 20-Dec-10    | 50            | 3           | 22            | 2               | 9               | 3                   | 20-Dec-10    | 85                | 20          | 11              | 1              | 1               | 2              | 2               | 22               |
| 28-Dec-10    | 68            | 100         | 140           | 32              | 250             | 8                   | 28-Dec-10    | 410               | 26          | 30              | 13             | 55              | 33             | 80              | 56               |
| 05-Jan-11    | 1             | 7           | 5             | 1               | 3               | 7                   | 05-Jan-11    | 100               | 1           | 1               | 1              | 1               | 1              | 1               | 1                |
| 10-Jan-11    | 1             | 70          | 3             | 3               | 1               | 1                   | 10-Jan-11    | 2                 | 1           | 1               | 1              | 1               | 1              | 1               | 1                |
| 17-Jan-11    | 5             | 2           | 1             | 1               | 15              | 1                   | 17-Jan-11    | 1                 | 1           | 1               | 1              | 2               | 1              | 1               | 1                |
| 24-Jan-11    | n/s           | n/s         | n/s           | n/s             | n/s             | n/s                 | 24-Jan-11    | n/s               | n/s         | n/s             | n/s            | n/s             | n/s            | n/s             | n/s              |
| 31-Jan-11    | 50            | 40          | 600*          | 10              | 30              | 20                  | 31-Jan-11    | 90                | 30          | 10              | 10             | 10              | 20             | 70              | 40               |
| 07-Feb-11    | 1             | 15          | 12            | 40              | 3               | 22                  | 07-Feb-11    | 24                | 1           | 5               | 1              | 1               | 1              | 2               | 1                |
| 14-Feb-11    | 170           | 26          | 34            | 77              | 330             | 28                  | 14-Feb-11    | 300               | 14          | 9               | 1              | 1               | 1              | 2               | 3                |
| 21-Feb-11    | 18            | 22          | 83            | 550             | 4               | 23                  | 21-Feb-11    | 270               | 130         | 24              | 6              | 1               | 30             | 9               | 1                |
| 28-Feb-11    | 110           | 97          | 1300*         | 1               | 67              | 2                   | 28-Feb-11    | 5                 | 5           | 1               | 1              | 1               | 1              | 1               | 1                |
| 07-Mar-11    | 1600*         | 870*        | 1700*         | 9               | 2               | 19                  | 07-Mar-11    | 54                | 55          | 4               | 24             | 6               | 1              | 6               | 4                |
| 14-Mar-11    | 1             | 1           | 3             | 4               | 14              | 1                   | 14-Mar-11    | 2                 | 6           | 3               | 2              | 15              | 1              | 1               | 1                |
| 21-Mar-11    | 3             | 11          | 7             | 18              | 5               | 1                   | 21-Mar-11    | 23                | 16          | 13              | 2              | 1               | 1              | 1               | 1                |

Exceeded Alert Level (140 cfu *Enterococci* / 100ml)

Exceeded Action Level (280 cfu *Enterococci* / 100ml)

\_\_\_\_ = Site re-sampled \* = Rainfall related (in Marine sites rainfall related samples are re-sampled)

### Freshwater Sites – *E.coli* Indicator

| Date Sampled | Esk River @ Eskdale Park | Lake Tutira @ Camping ground | Ngaruroro River @ Chesterhope Bridge | Tukituki River @ SH2 Waipukarau | Tuaekuri River @ Pakawhai Rd Bridge | Tukituki River @ Walker Rd |
|--------------|--------------------------|------------------------------|--------------------------------------|---------------------------------|-------------------------------------|----------------------------|
| 01-Nov-10    | <u>500*</u>              | 23                           | 37                                   | 14                              | 39                                  | 8                          |
| 08-Nov-10    | 20                       | 27                           | 37                                   | 3                               | 18                                  | 23                         |
| 15-Nov-10    | 52                       | 48                           | 42                                   | 110                             | 37                                  | 3                          |
| 22-Nov-10    | 180                      | 190                          | 210                                  | 19                              | 140                                 | 11                         |
| 29-Nov-10    | 2300                     | 13                           | 77                                   | 160                             | 69                                  | 12                         |
| 06-Dec-10    | 150                      | 150                          | 100                                  | 55                              | 36                                  | 6                          |
| 13-Dec-10    | 140                      | 41                           | 130                                  | 27                              | 75                                  | 3                          |
| 20-Dec-10    | 250                      | <u>530*</u>                  | 170                                  | 730*                            | 84                                  | <u>260*</u>                |
| 28-Dec-10    | 24                       | 46                           | 56                                   | 34                              | 46                                  | 39                         |
| 05-Jan-11    | 68                       | 100                          | 64                                   | 9                               | 63                                  | 6                          |
| 10-Jan-11    | 13                       | 60                           | 52                                   | 27                              | 2                                   | 3                          |
| 17-Jan-11    | 200                      | 40                           | 140                                  | 19                              | 21                                  | 8                          |
| 31-Jan-11    | <u>530*</u>              | 160                          | 210                                  | 400*                            | 430*                                | 210                        |
| 07-Feb-11    | 13                       | <u>470</u>                   | 27                                   | 390                             | 31                                  | 16                         |
| 14-Feb-11    | 52                       | 14                           | 51                                   | 57                              | 31                                  | 1                          |
| 21-Feb-11    | 100                      | 23                           | 110                                  | 12                              | 23                                  | 1                          |
| 28-Feb-11    | 17                       | 120                          | 73                                   | 30                              | 33                                  | 12                         |
| 07-Mar-11    | <u>390*</u>              | 60                           | <u>370*</u>                          | <u>420*</u>                     | <u>390*</u>                         | 130                        |
| 14-Mar-11    | 77                       | <u>1000</u>                  | 100                                  | 24                              | 40                                  | 2                          |
| 21-Mar-11    | 120                      | 31                           | 120                                  | 71                              | 140                                 | 59                         |

Exceeded Alert Level (260 cfu *E. Coli* / 100ml)

Exceeded Action Level (550 cfu *E. Coli* / 100ml)

\_\_\_\_\_ = Site re-sampled \* = Rainfall related

### Estuarine and Freshwater (with a tidal influence) Sites – *E.coli* / *Enterococci* Indicator

| Date Sampled | Maungawhio lagoon          | Pandora Pond | Waipatiki lagoon | Wairoa River @ Sk Club | Te Mahia @ Boatramp        | Date Sampled | Clive River @ SH2 Bridge  | Kairakau Lagoon            | Maratotara lagoon | Porangahau River          | Phhokio Stream @ Waimarama Beach | Waipuka Stream @ Ocean Beach | Tukituki River @ Balck Bridge |
|--------------|----------------------------|--------------|------------------|------------------------|----------------------------|--------------|---------------------------|----------------------------|-------------------|---------------------------|----------------------------------|------------------------------|-------------------------------|
| 01-Nov-10    | 2 / 6                      | 10           | 320*             | 48 / n/t               | n/s                        | 01-Nov-10    | <u>340</u> / <u>340</u>   | 24 / 80                    | 54                | 6 / 39                    | 330                              | 69 / n/t                     | 25                            |
| 08-Nov-10    | 2 / n/t                    | 33           | 48               | 8/8                    | n/s                        | 08-Nov-10    | 84 / n/t                  | 9 / 74                     | <u>410</u>        | 10 / 54                   | 270                              | 87 / n/t                     | 30                            |
| 15-Nov-10    | 9 / 67                     | 16           | 1                | 54 / n/t               | n/s                        | 15-Nov-10    | n/s                       | 39 / 84                    | 120               | <u>730</u> / <u>1900</u>  | n/s                              | 190 / n/t                    | 14                            |
| 22-Nov-10    | 18 / 46                    | 13           | 190              | 640* / n/t             | 28 / 97                    | 22-Nov-10    | <u>460</u> / n/t          | 19 / 1                     | 53                | 40 / 95                   | 370                              | 91 / n/t                     | 45                            |
| 29-Nov-10    | 1 / 1                      | <u>340</u>   | 5800             | 120 / 43               | 4 / 1                      | 29-Nov-10    | n/s                       | 12 / n/t                   | <u>340</u>        | 9 / 8                     | n/s                              | <u>940</u> / n/t             | 20                            |
| 06-Dec-10    | 2 / 4                      | 110          | 120              | 54 / 13                | 1 / 14                     | 06-Dec-10    | <u>660</u> / <u>750</u>   | 13 / 8                     | 96                | 11 / 59                   | 2600                             | 22 / 9                       | 55                            |
| 13-Dec-10    | 1 / 1                      | 23           | 130              | 120 / 20               | 49 / 1                     | 13-Dec-10    | <u>400</u> / <u>110</u>   | 4 / 1                      | 36                | 11 / 11                   | n/s                              | 13 / 14                      | 10                            |
| 20-Dec-10    | 60 / 230                   | 11           | 330*             | 300* / n/t             | 10 / 10                    | 20-Dec-10    | <u>550</u> / <u>1200*</u> | <u>320</u> / <u>630*</u>   | 67                | <u>280</u> / <u>570*</u>  | 1100                             | 310 / n/t                    | 500*                          |
| 28-Dec-10    | 24 / 8                     | 47           | 4                | 30 / 43                | 16 / 4                     | 28-Dec-10    | 160 / 160                 | 42 / 30                    | 610               | 130 / 120                 | 720                              | 90 / 74                      | 33                            |
| 05-Jan-11    | 3 / n/t                    | 4            | 170              | 20 / 10                | 25/n/t                     | 05-Jan-11    | <u>360</u> / <u>630</u>   | 16 / 13                    | 100               | 1 / 1                     | 5                                | 18 / n/t                     | 36                            |
| 10-Jan-11    | 2 / 2                      | 6            | 160              | 32 / 79                | 2 / 6                      | 10-Jan-11    | 31 / 53                   | 44 / n/t                   | 4                 | 16 / 16                   | n/s                              | 92 / 82                      | 1                             |
| 17-Jan-11    | 8 / 14                     | 100          | 210              | 34 / 12                | 6 / 6                      | 17-Jan-11    | <u>290</u> / <u>210</u>   | 69 / n/t                   | 64                | 65 / n/t                  | 380                              | 120 / n/t                    | 26                            |
| 24-Jan-11    | n/s                        | n/s          | n/s              | n/s                    | n/s                        | 24-Jan-11    | n/s                       | n/s                        | n/s               | n/s                       | n/s                              | n/s                          | n/s                           |
| 31-Jan-11    | 300* / n/t                 | 160*         | 1100*            | 1200* / n/t            | 1300* / n/t                | 31-Jan-11    | <u>540</u> / <u>590*</u>  | <u>510</u> / <u>590*</u>   | 1500*             | <u>730</u> / <u>790*</u>  | n/s                              | <u>2300</u> / <u>2700*</u>   | 110                           |
| 07-Feb-11    | 30 / 23                    | 29           | 180              | <u>350</u> / 81        | 25 / 170                   | 07-Feb-11    | 220 / n/t                 | 87 / 19                    | <u>420</u>        | 53 / 200                  | 470                              | <u>460</u> / n/t             | 33                            |
| 14-Feb-11    | 70 / 4                     | 14           | 130              | <u>380</u> / n/t       | 12 / 6                     | 14-Feb-11    | 250 / 170                 | 27 / 4                     | <u>360</u>        | 11 / 24                   | 750                              | 190 / n/t                    | 44                            |
| 21-Feb-11    | 36 / 110                   | 110          | 120              | 48 / n/t               | 96 / 48                    | 21-Feb-11    | 40 / <u>790</u>           | 1100 / 230                 | 300               | <u>380</u> / <u>450</u>   | 2700                             | n/t / <u>870</u>             | 860*                          |
| 28-Feb-11    | 110 / 150                  | 16           | 450              | 67 / 12                | 52 / 100                   | 28-Feb-11    | <u>490</u> / n/t          | 140 / 3                    | 340               | 10 / 20                   | 730                              | <u>1400</u> / <u>630</u>     | 23                            |
| 07-Mar-11    | <u>2100</u> / <u>1500*</u> | <u>580*</u>  | 43               | 660* / n/t             | <u>2400*</u> / <u>2000</u> | 07-Mar-11    | 460* / n/t                | <u>1900</u> / <u>1700*</u> | 76                | <u>480</u> / <u>2000*</u> | 1500*                            | 860* / n/t                   | 90                            |
| 14-Mar-11    | 4 / 6                      | 11           | 1000             | 82 / 43                | 5 / 62                     | 14-Mar-11    | 210 / n/t                 | 24 / 10                    | 200               | 8 / 15                    | n/s                              | 56 / n/t                     | 12                            |
| 21-Mar-11    | 56 / 82                    | 43           | <u>520</u>       | 370 / <u>1300*</u>     | <u>1100</u> / 160          | 21-Mar-11    | 140 / <u>340</u>          | 57 / 51                    | 110               | 130 / 49                  | n/s                              | 150 / n/t                    | 56                            |
| Indicators   | Ent../ <i>E.coli</i>       | Ent          | <i>E.coli</i>    | <i>E.coli</i> / Ent..  | Ent../ <i>E.coli</i>       |              | <i>E.coli</i> / Ent..     | Ent../ <i>E.coli</i>       | <i>E.coli</i>     | Ent../ <i>E.coli</i>      | <i>E.coli</i>                    | <i>E.coli</i> / Ent..        | <i>E.coli</i>                 |

Exceeded surveillance Level (140 cfu *Enterococci* 100ml)

Exceeded Alert Level (280 cfu *Enterococci* / 100ml)

\* = Rainfall related exceedance therefore not re-sampled

\_\_\_\_ = Site re-sampled NB: Puhokio Stream not re-sampled

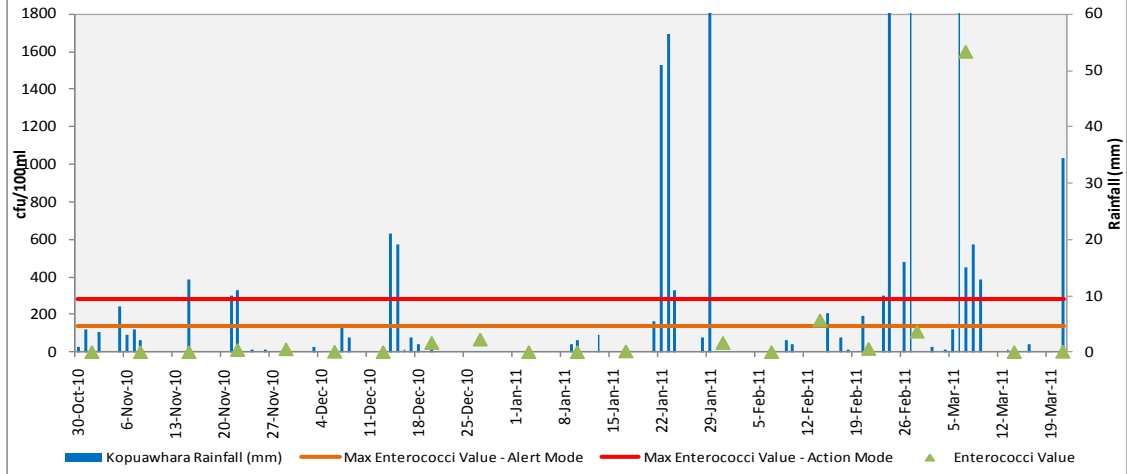
n/s = no sample, n/t= not tested

### Shellfish Gathering Sites – Faecal Coliform Count Indicator

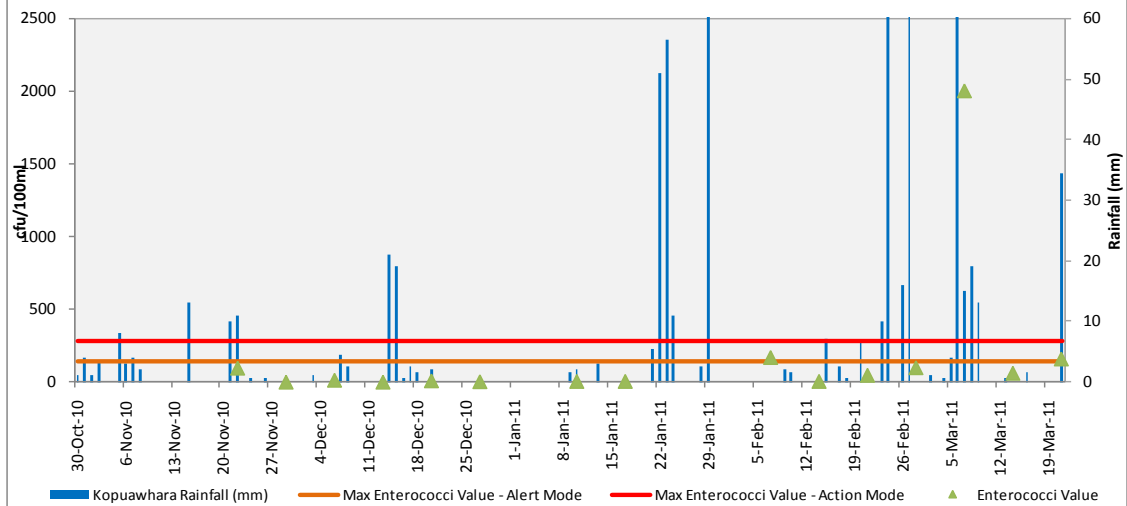
| Date Sampled           | Ahuriri Estuary faecal coliform count | Mahia @ Golf Club faecal coliform count | Waipatiki Beach faecal coliform count | Te Awanga faecal coliform count | Kairakau beach | Te Mahia @ Boatramp |
|------------------------|---------------------------------------|---|---------------------------------------|---------------------------------|----------------|---------------------|
| 01-Nov-10              | 52                                    | 1                                       | 15                                    | 6                               | 1              | n/s                 |
| 08-Nov-10              | 36                                    | 1                                       | 1                                     | 29                              | 17             | n/s                 |
| 15-Nov-10              | 25                                    | 1                                       | 3                                     | 110                             | 2              | n/s                 |
| 22-Nov-10              | 300                                   | 1                                       | 2200                                  | 4                               | 13             | 140                 |
| 29-Nov-10              | 29                                    | 1                                       | 19                                    | 17                              | 1              | 2                   |
| 06-Dec-10              | 2300                                  | 1                                       | 130                                   | 5                               | 1              | 38                  |
| 13-Dec-10              | 63                                    | 1                                       | 1                                     | 7                               | 1              | 1                   |
| 20-Dec-10              | 41                                    | 3                                       | 3                                     | 16                              | 8              | 10                  |
| 28-Dec-10              | 8                                     | 1800                                    | 3                                     | 590                             | 4              | 8                   |
| 05-Jan-11              | 12                                    | 1                                       | 9                                     | 50                              | 1              | 93                  |
| 10-Jan-11              | 18                                    | 4                                       | 23                                    | 5                               | 1              | 50                  |
| 17-Jan-11              | 17                                    | 5                                       | 3                                     | 9                               | 1              | 36                  |
| 31-Jan-11              | 30                                    | 30                                      | 670                                   | 100                             | 10             | 3400                |
| 07-Feb-11              | 63                                    | 55                                      | 16                                    | 22                              | 1              | 170                 |
| 14-Feb-11              | 31                                    | 1                                       | 7                                     | 390                             | 1              | 4                   |
| 21-Feb-11              | 62                                    | 1                                       | 1                                     | 220                             | 16             | 120                 |
| 28-Feb-11              | 11                                    | 1000                                    | 1                                     | 2                               | 1              | 84                  |
| 07-Mar-11              | 140                                   | 490                                     | 56                                    | 57                              | 22             | 7800                |
| 14-Mar-11              | 43                                    | 4                                       | 2                                     | 1                               | 1              | 110                 |
| 21-Mar-11              | 46                                    | 1                                       | 1                                     | 17                              | 3              | 1500                |
| No. of samples over 43 | 8                                     | 4                                       | 4                                     | 6                               | 0              | 10                  |
| % of samples over 43   | 40%                                   | 20%                                     | 20%                                   | 30%                             | 0%             | 59%                 |
| Median                 | 38.5                                  | 1                                       | 5                                     | 17                              | 1              | 84                  |

**Appendix 5**  
**Results Graph**

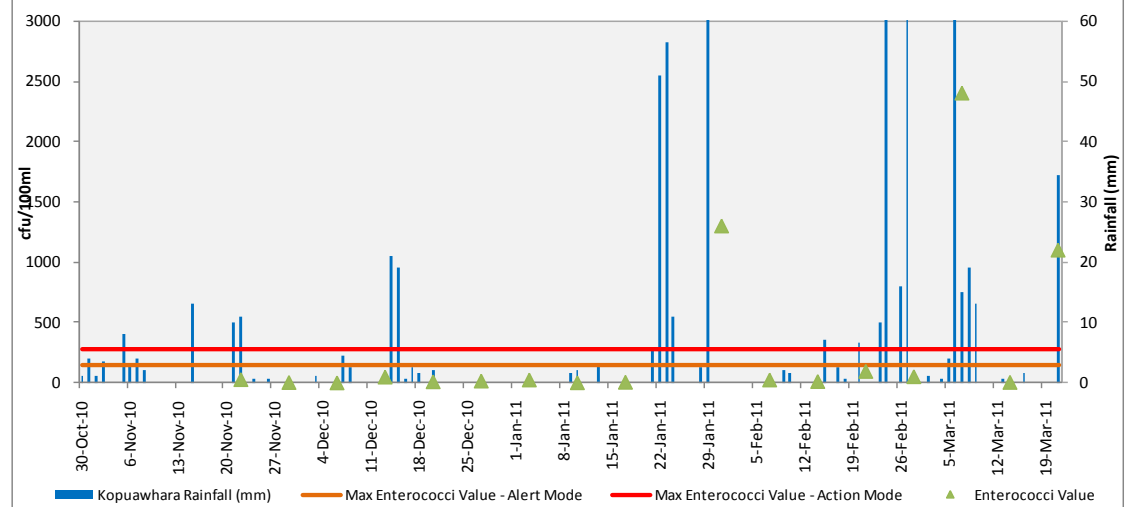
### Mahanga Beach

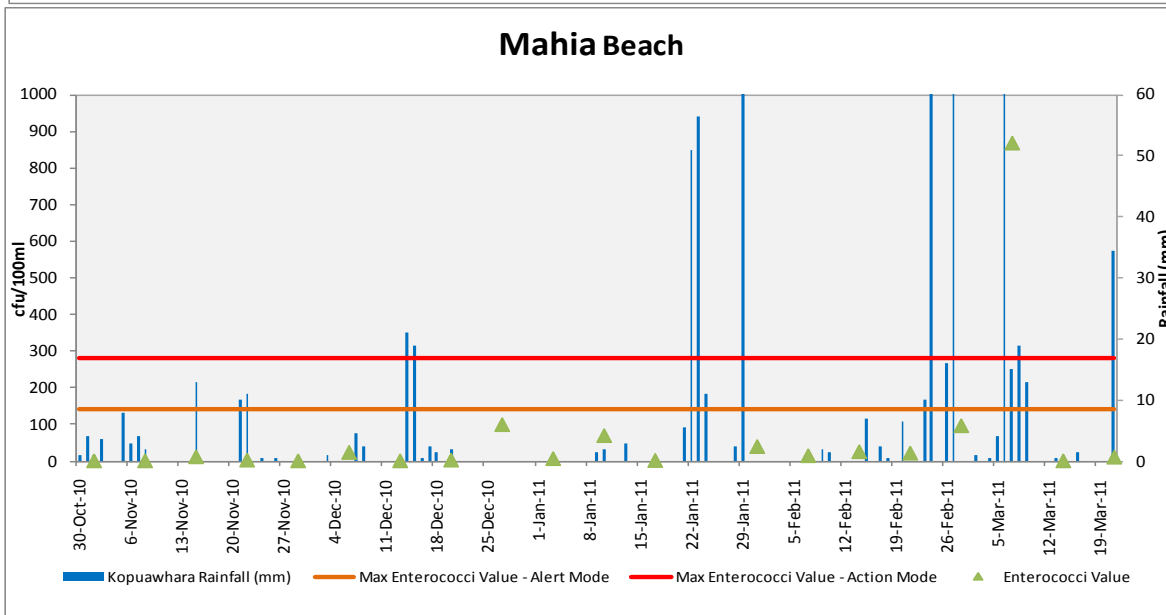
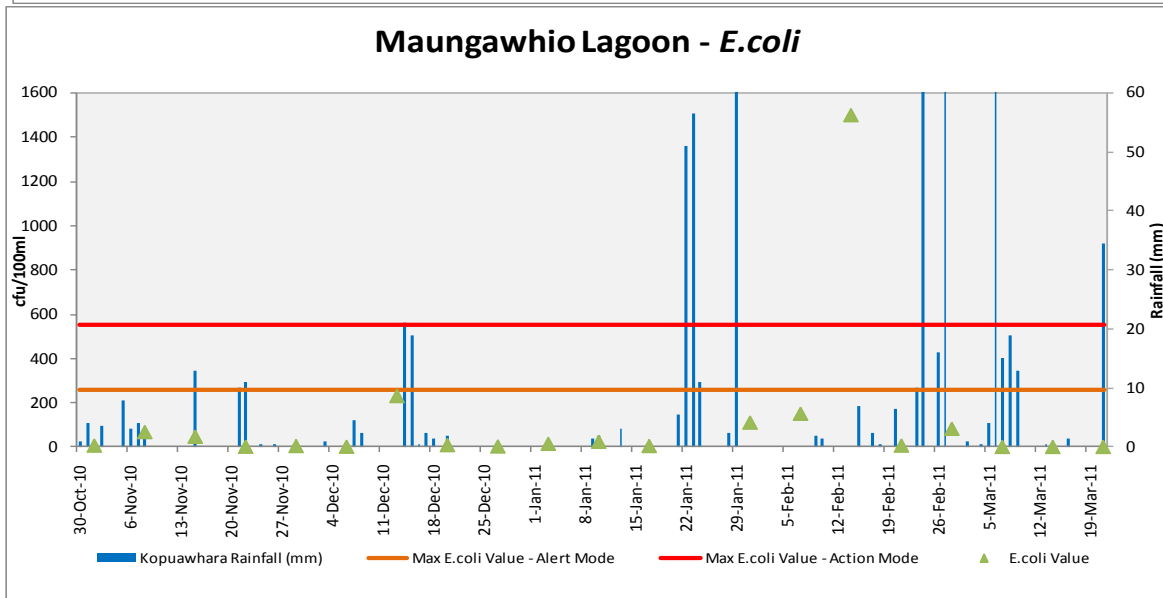
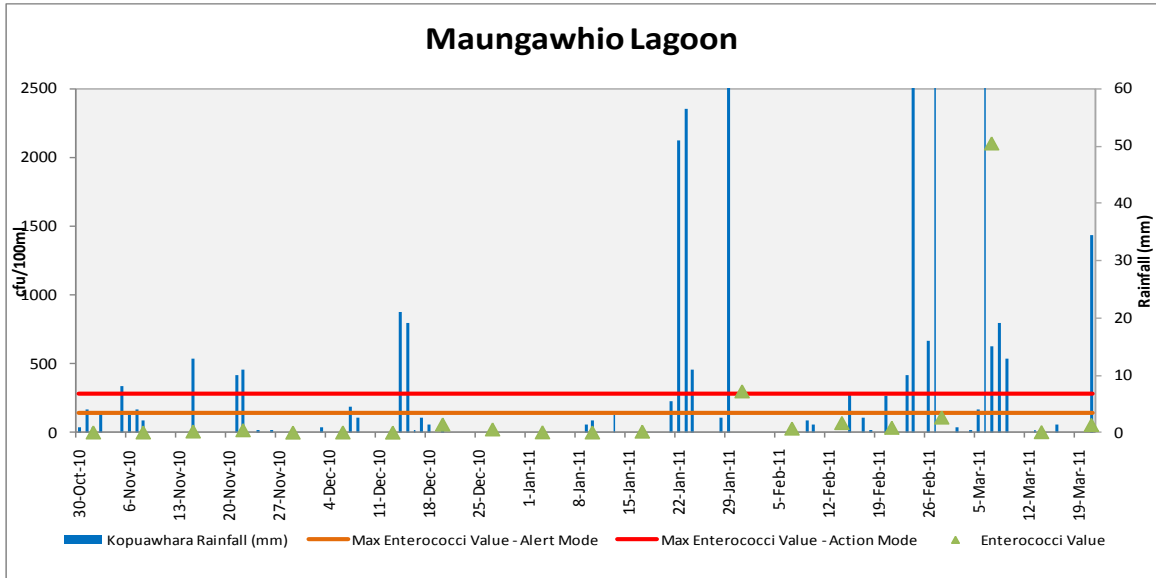


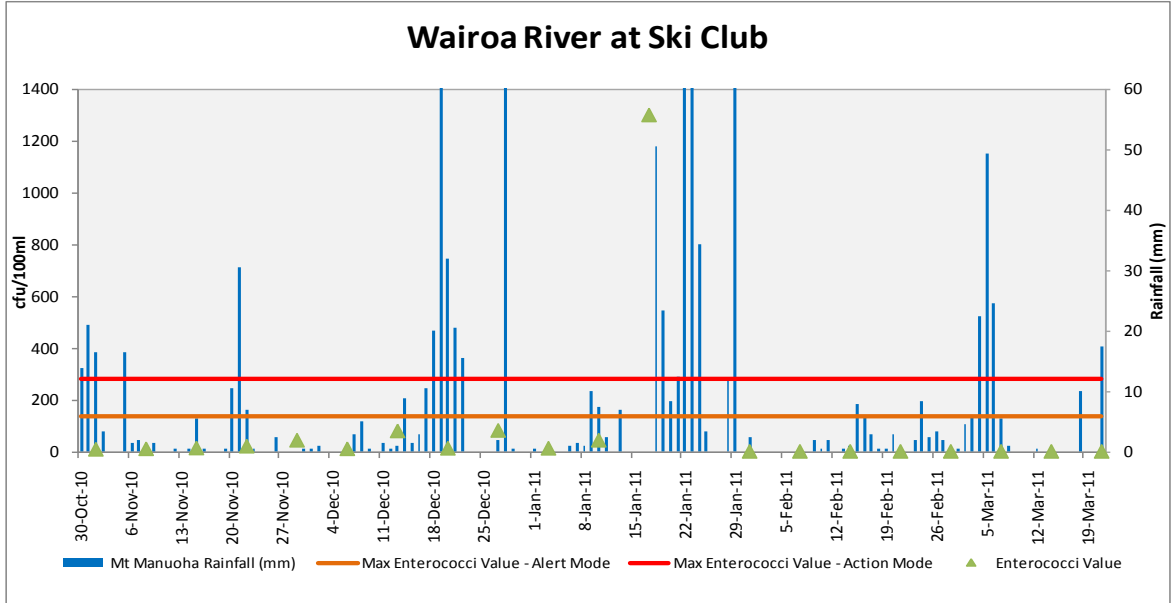
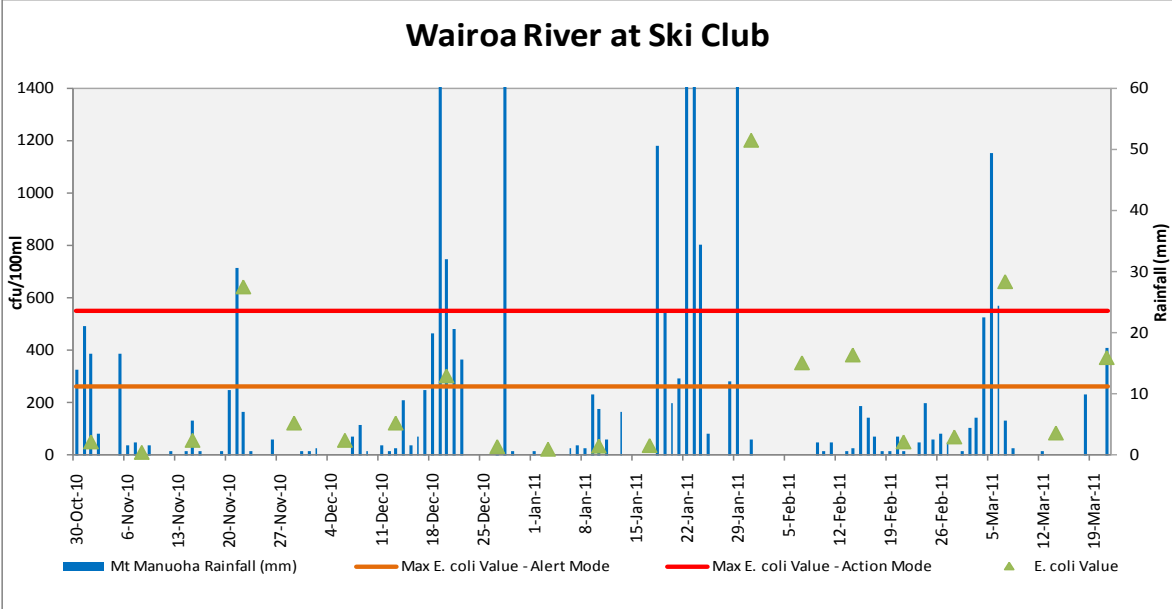
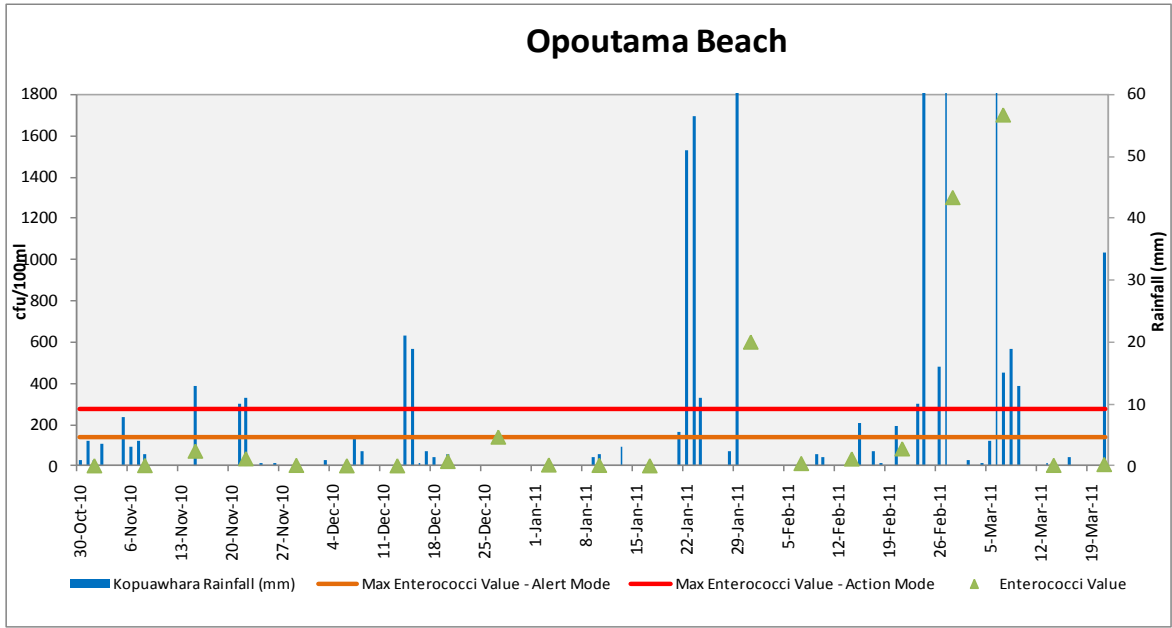
### Te Mahia E.coli

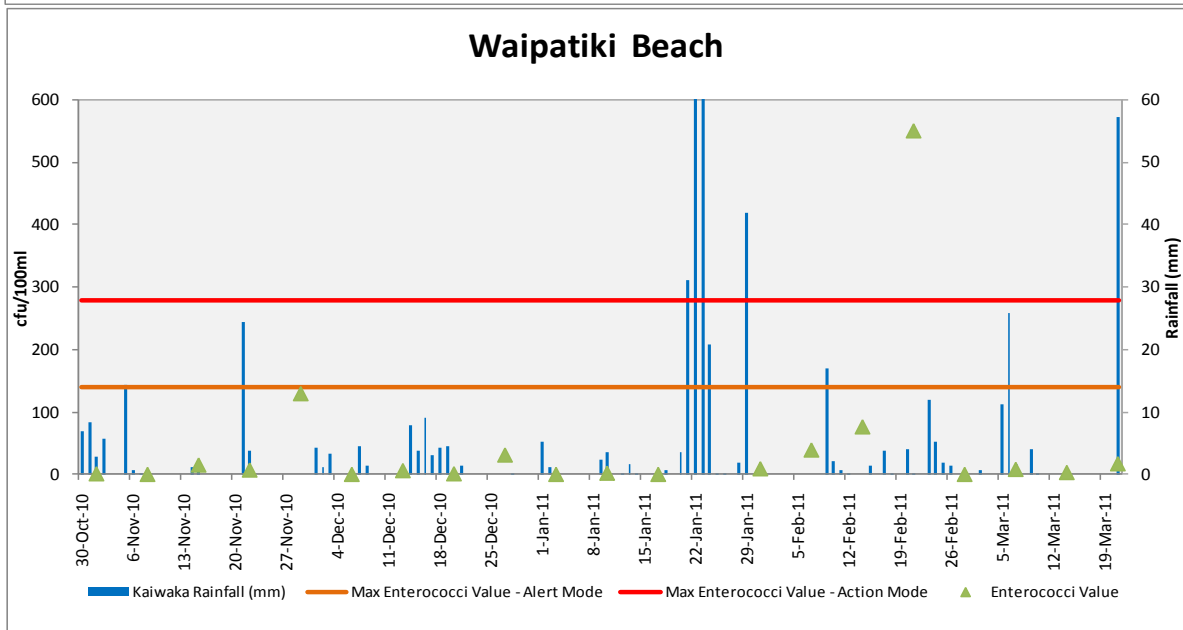
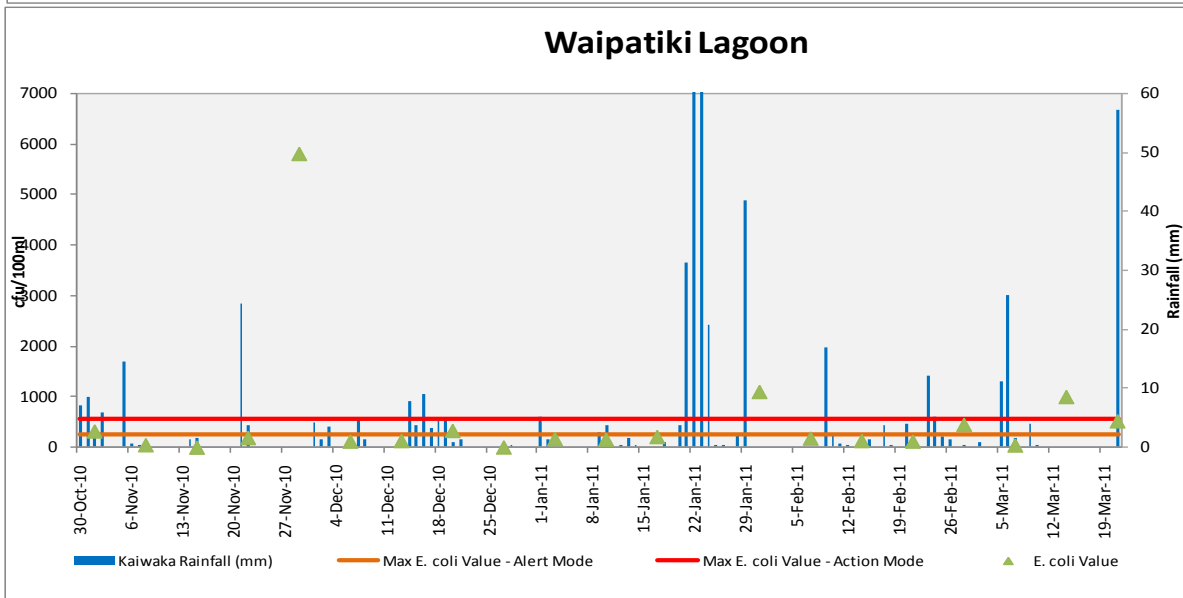
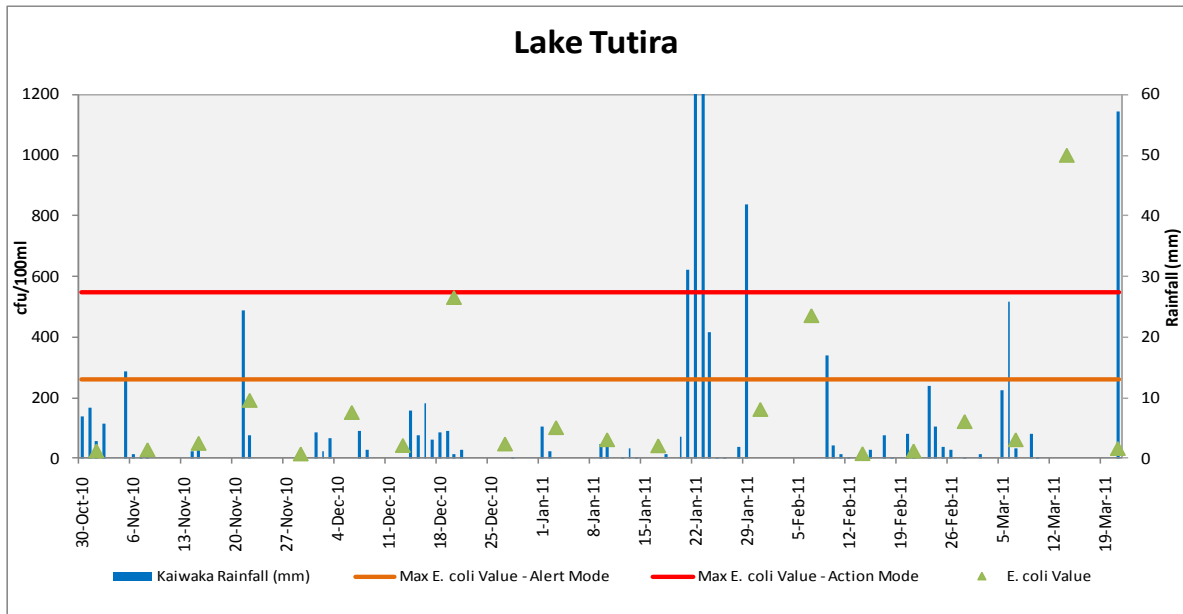


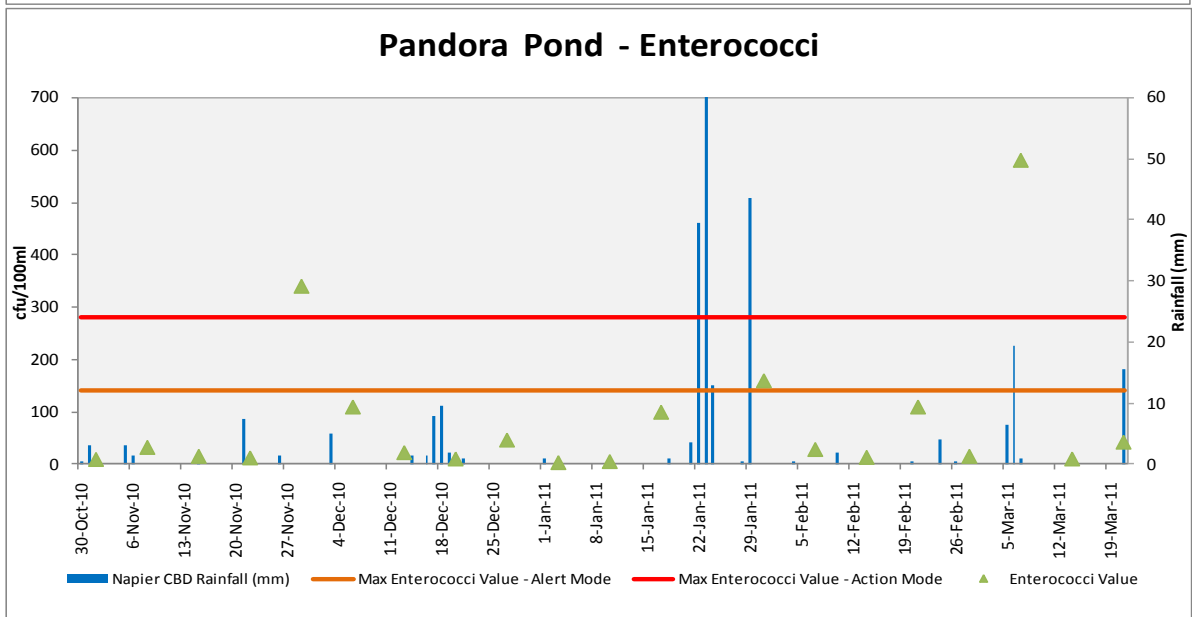
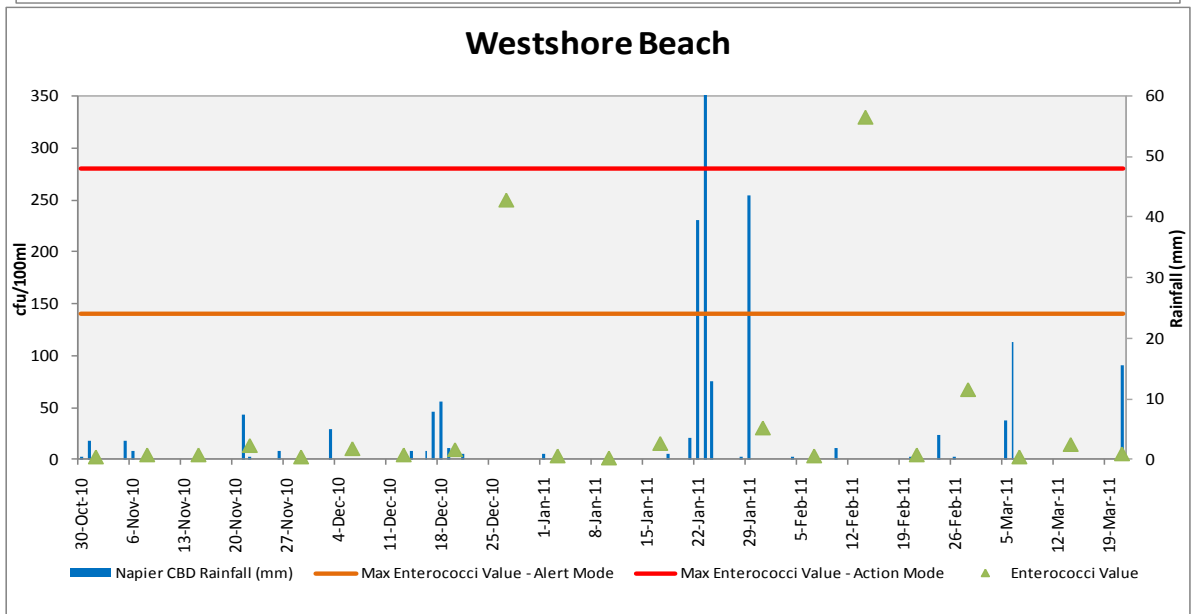
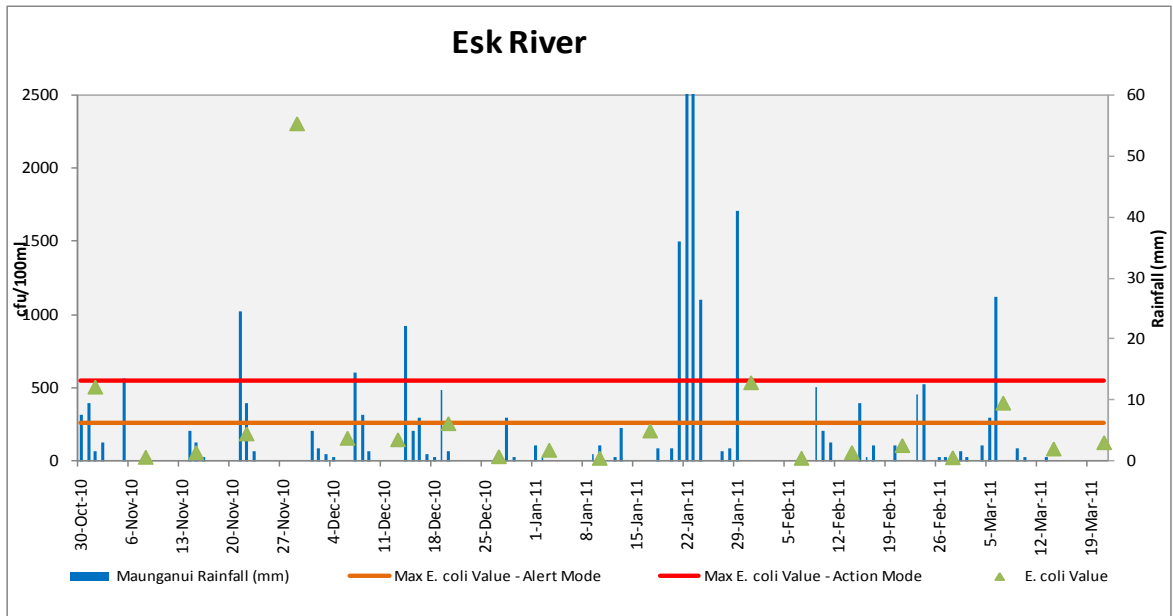
### Te Mahia Enterococci

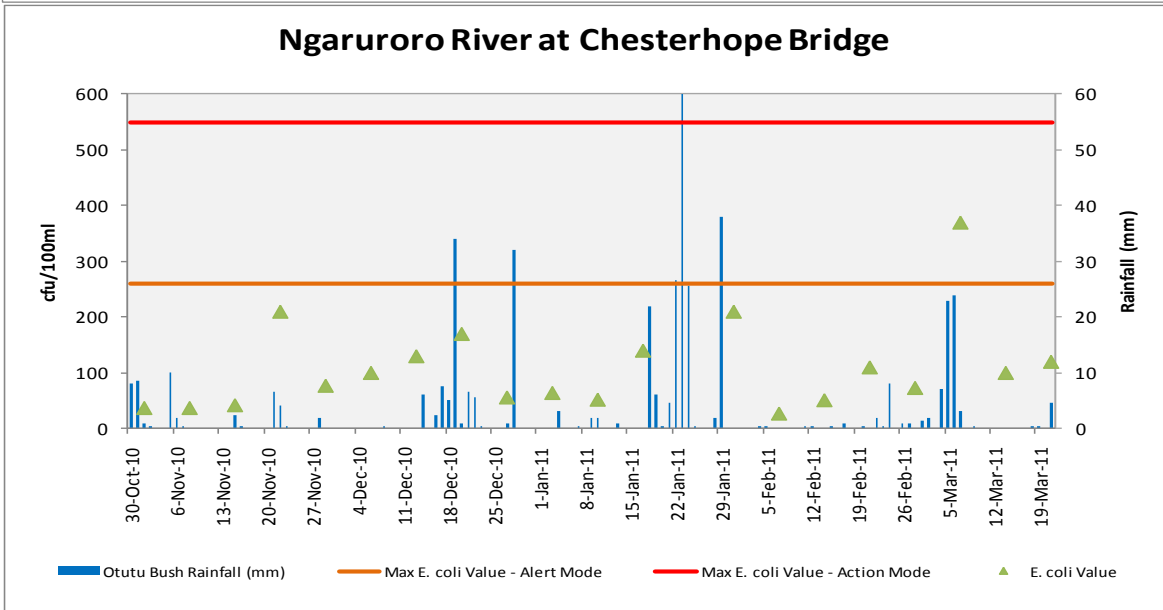
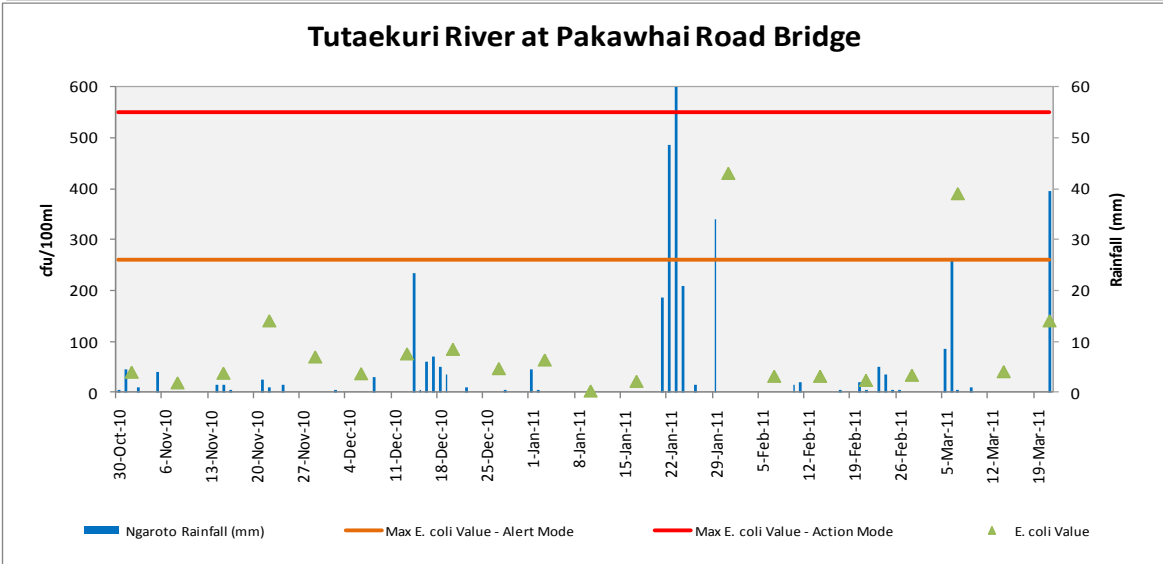
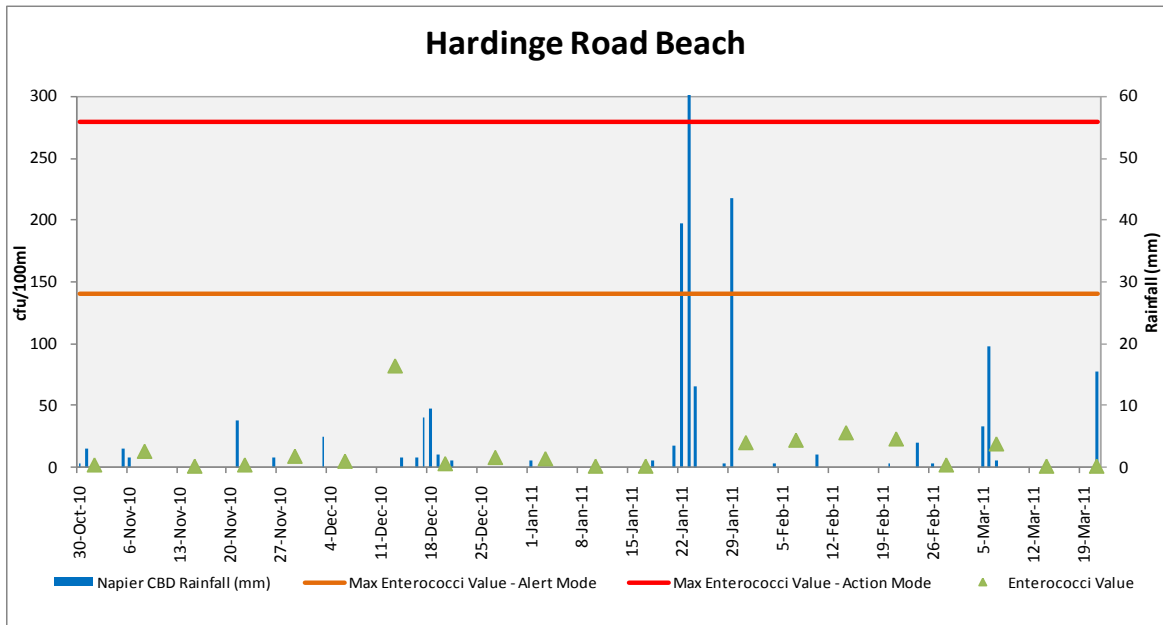


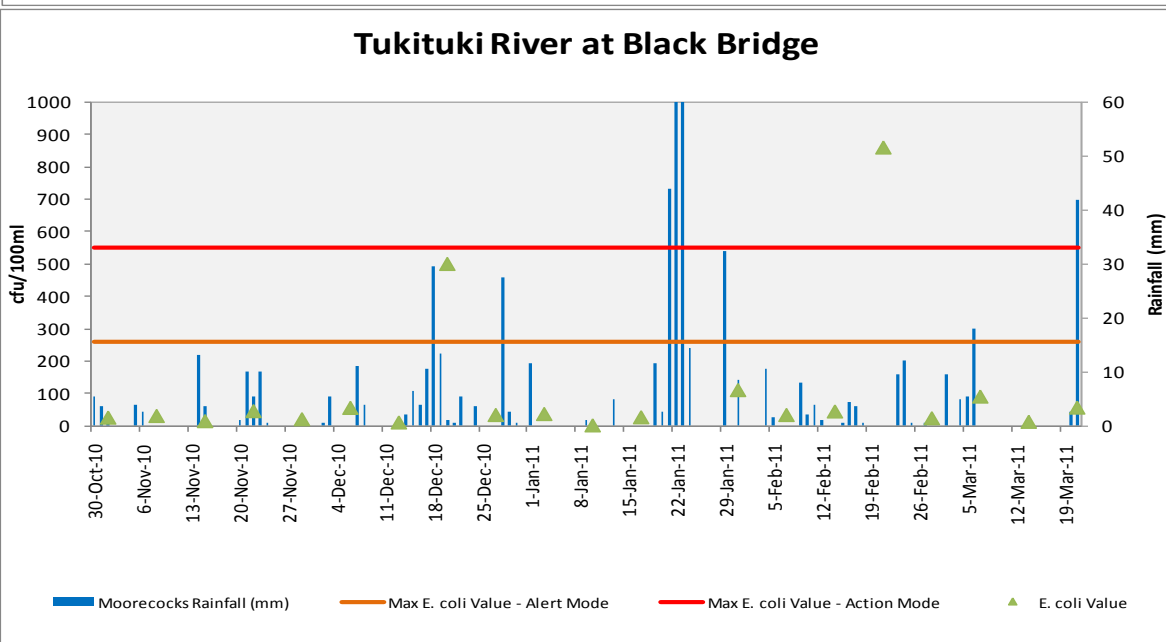
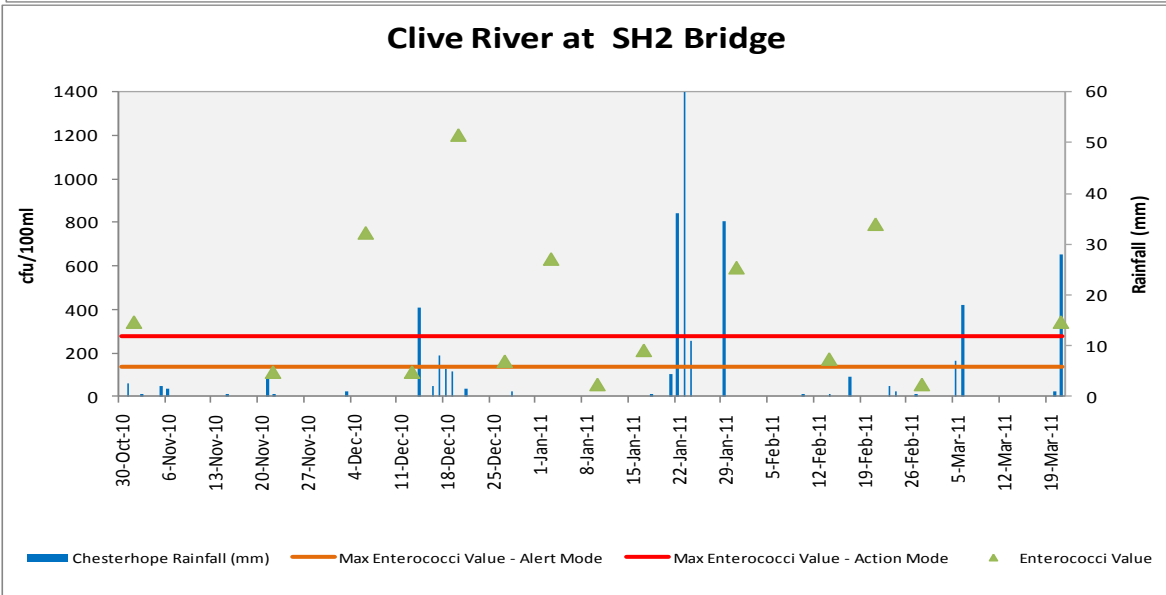
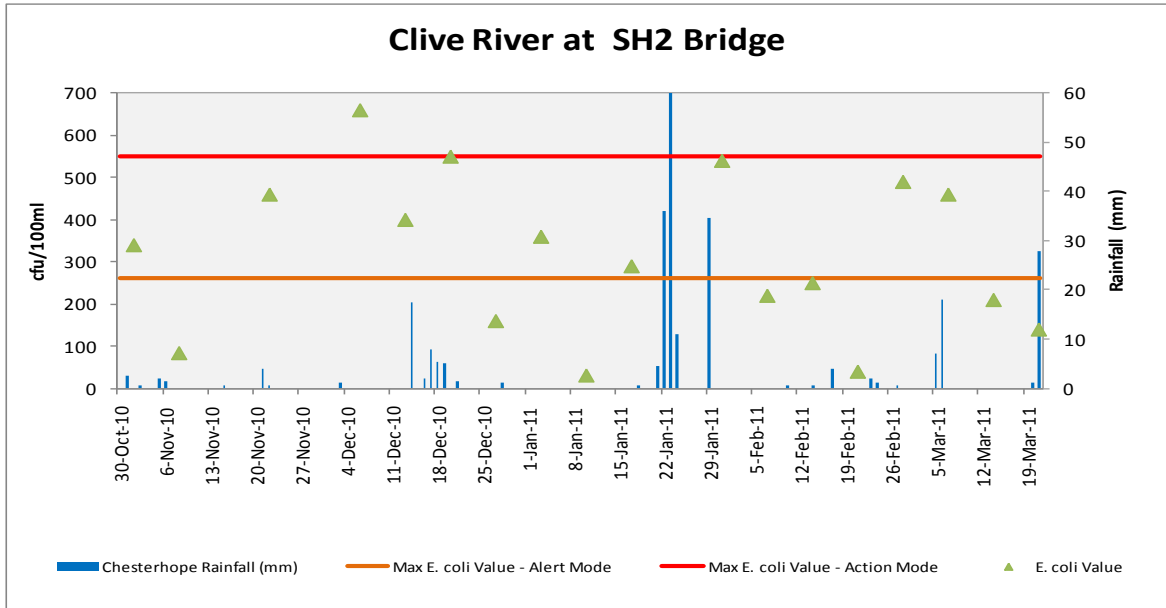




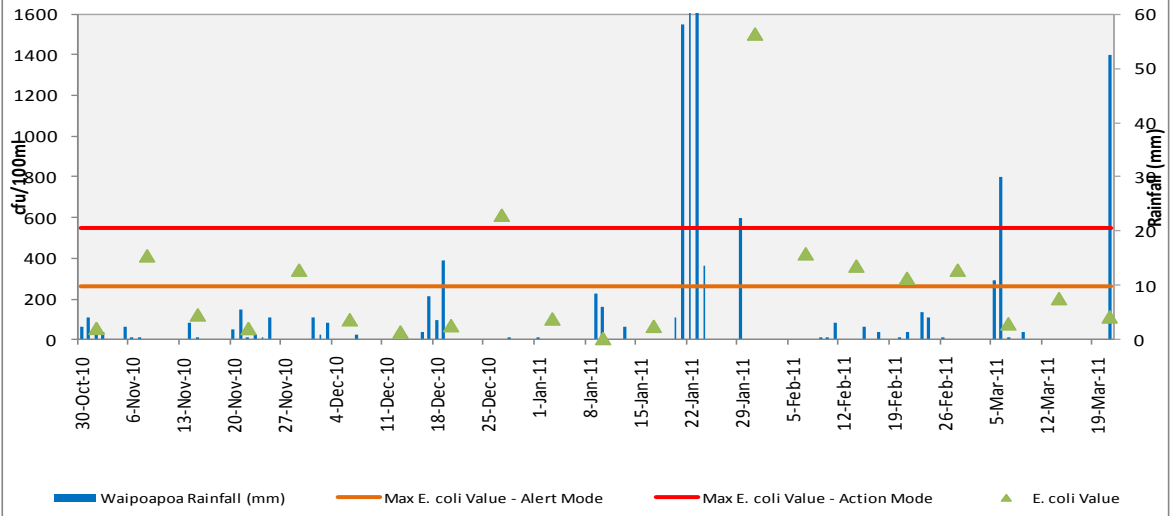




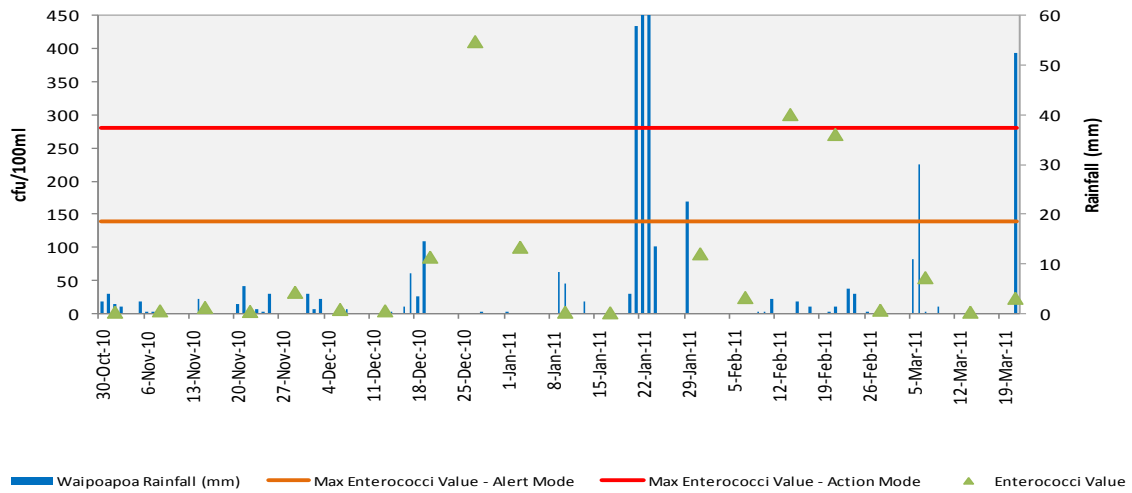




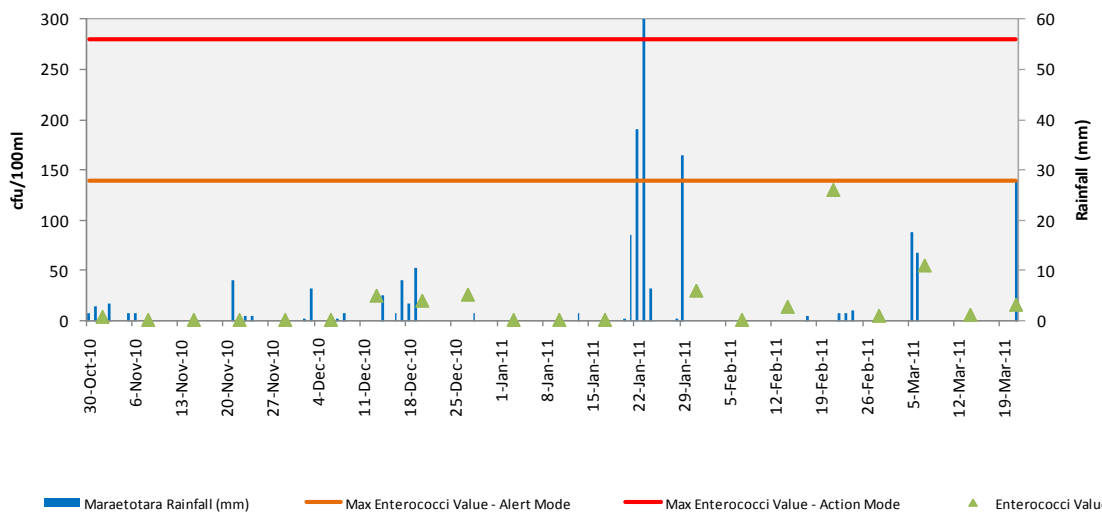
### Maraetotara Lagoon



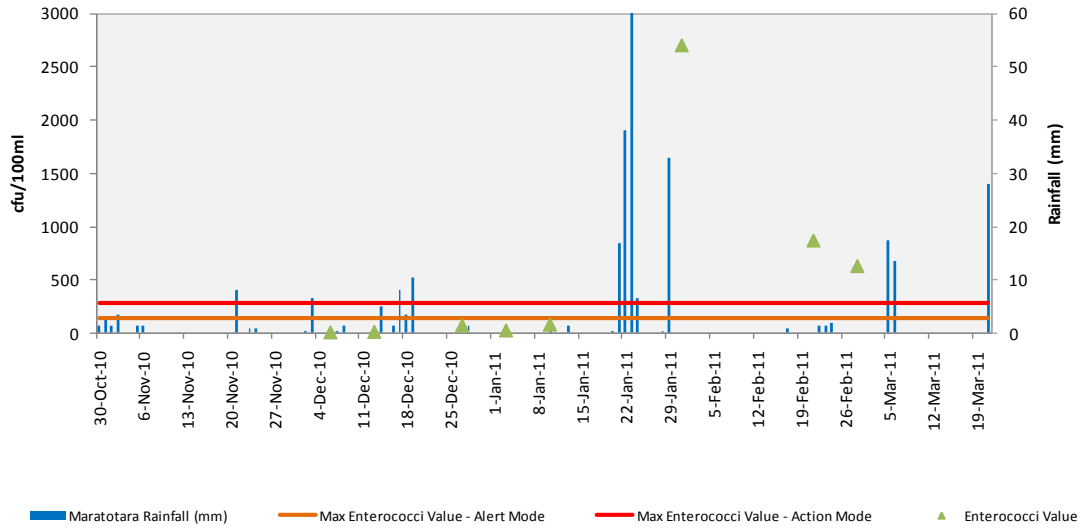
### Te Awanga at Camp Ground



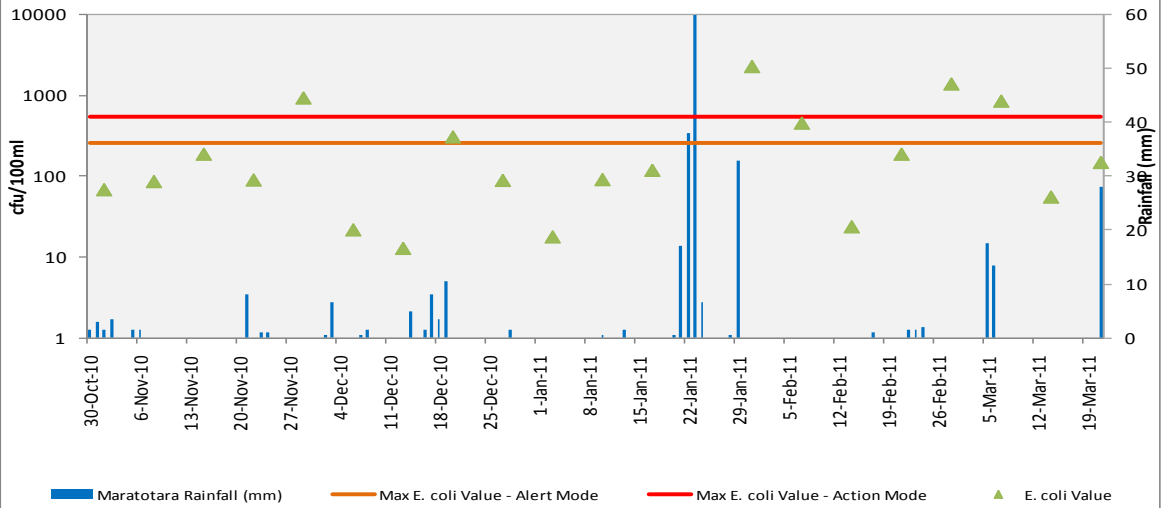
### Ocean Beach



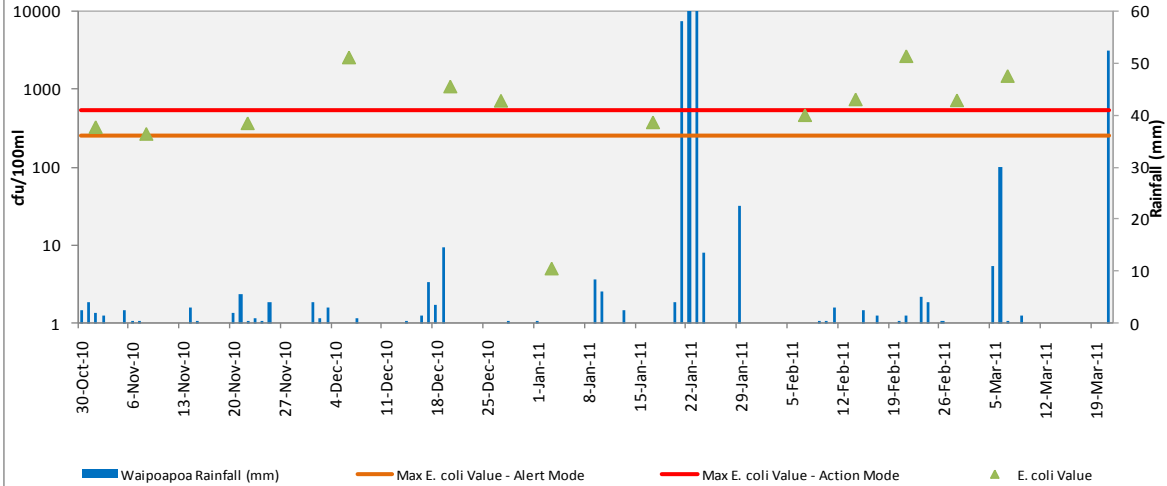
### Waipuka Stream at Ocean Beach

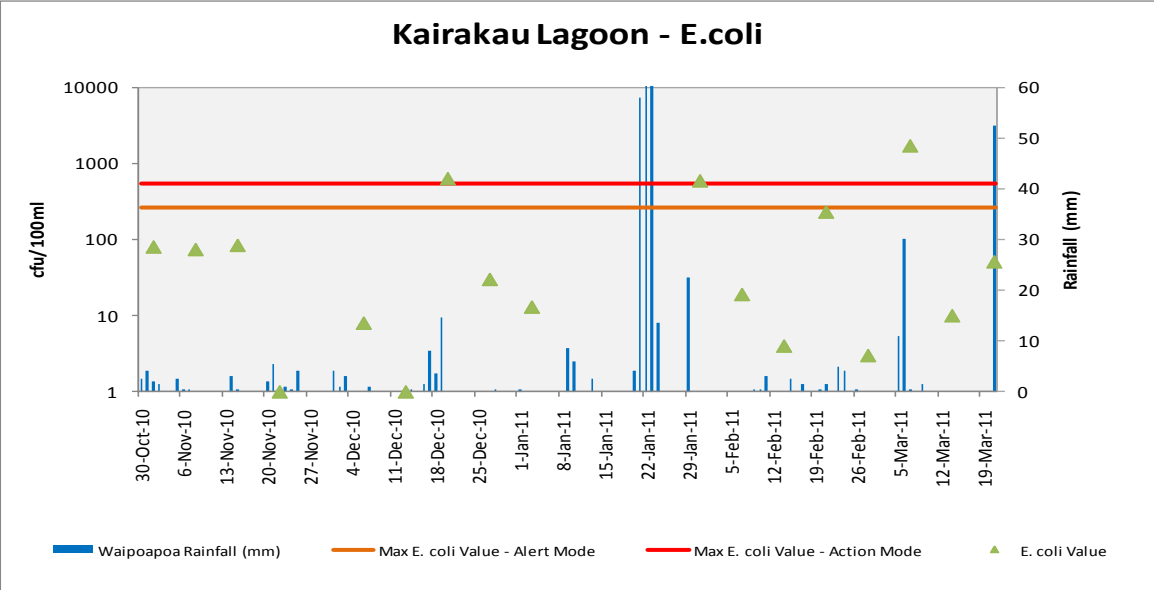
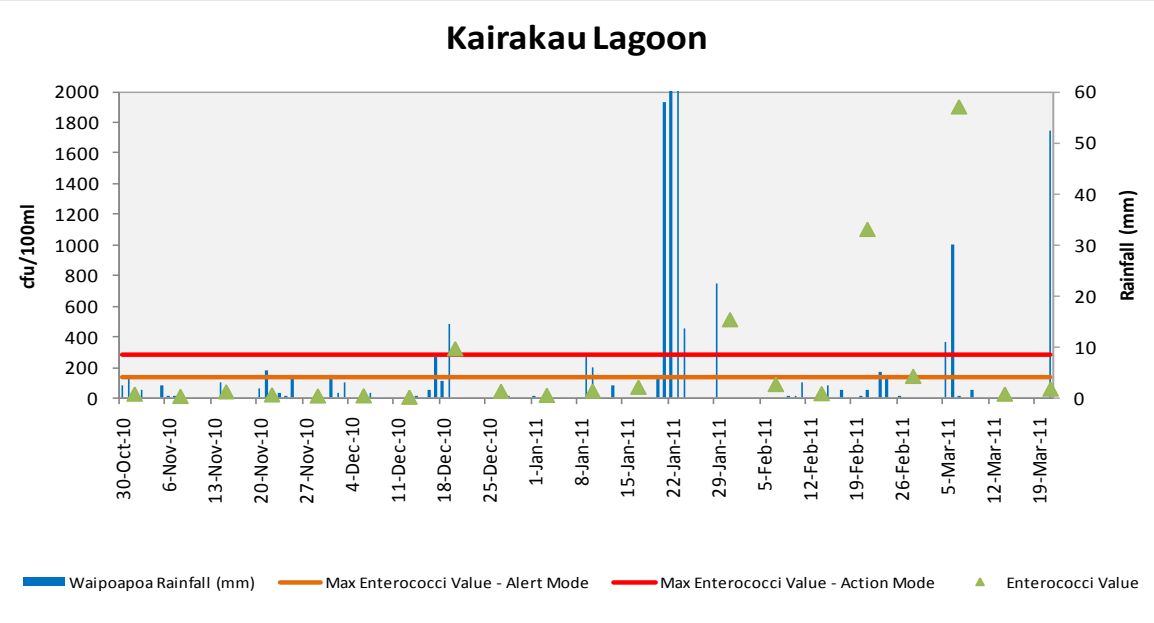
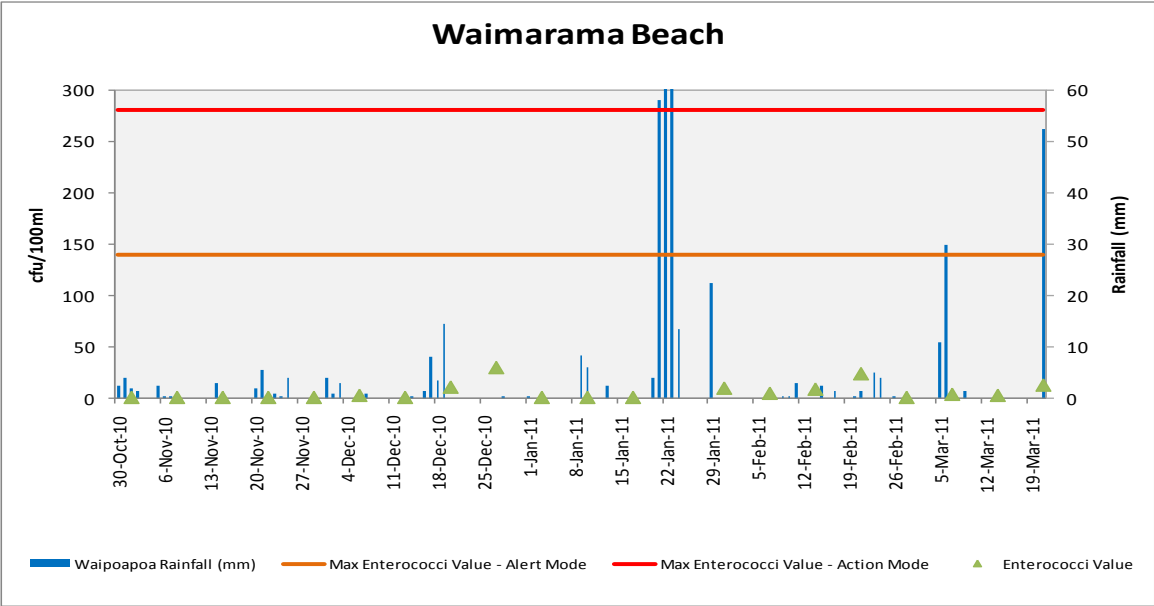


### Waipuka Stream at Ocean Beach

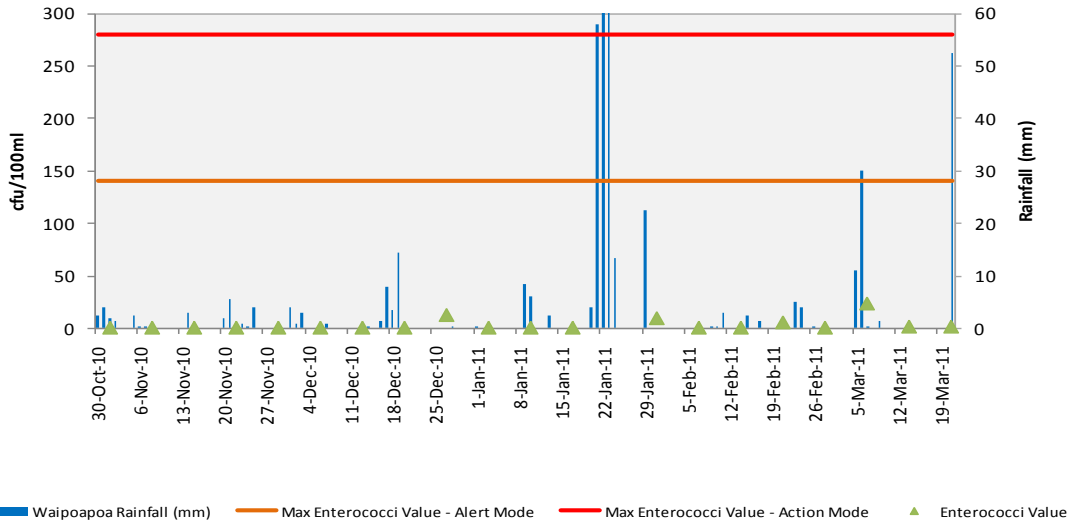


### Puhokio Stream

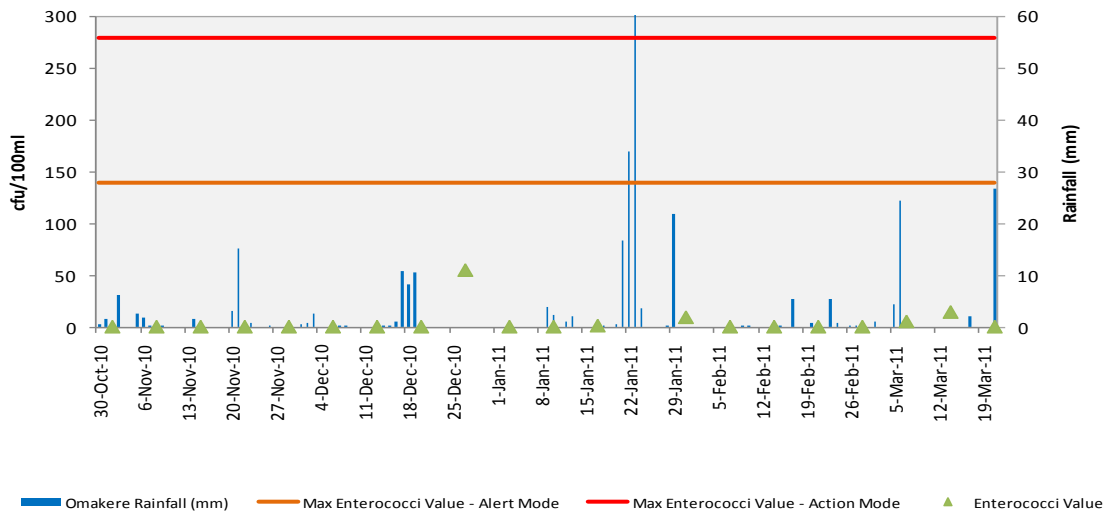




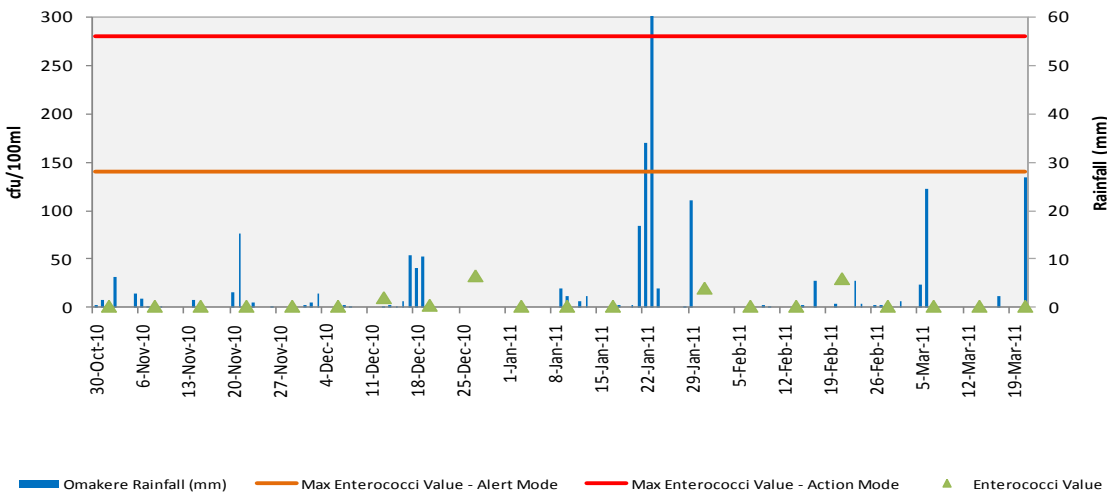
### Kairakau Beach

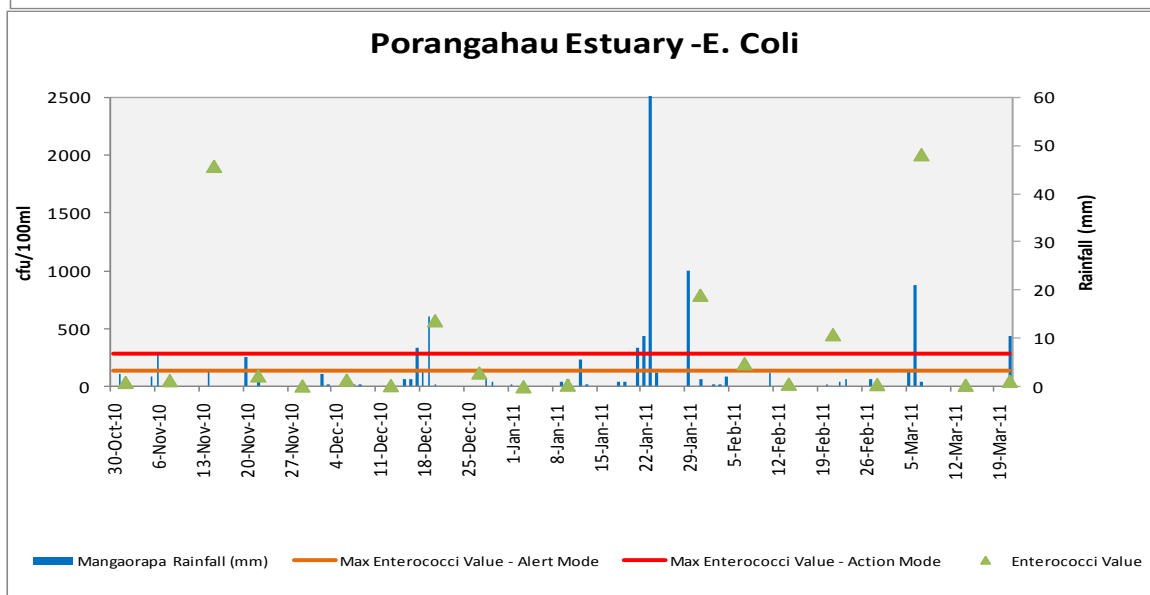
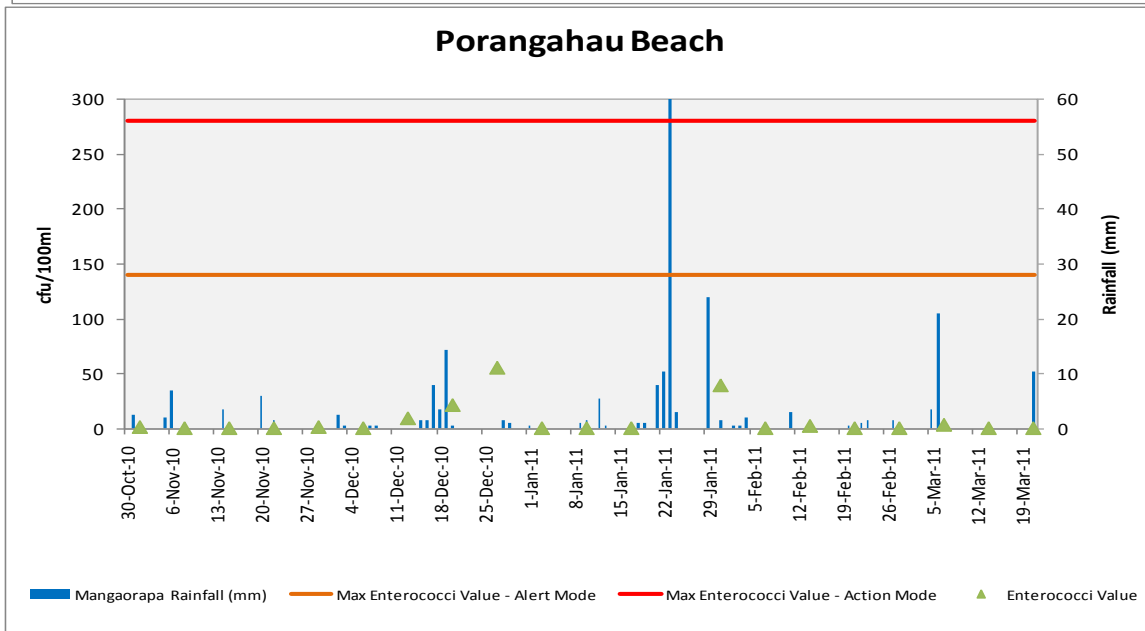
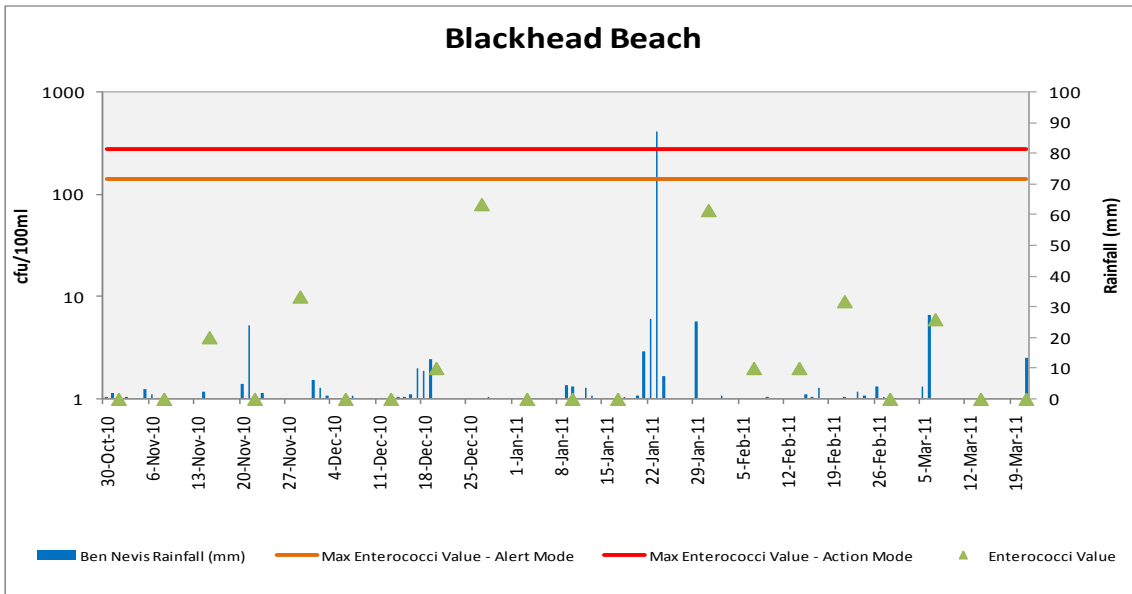


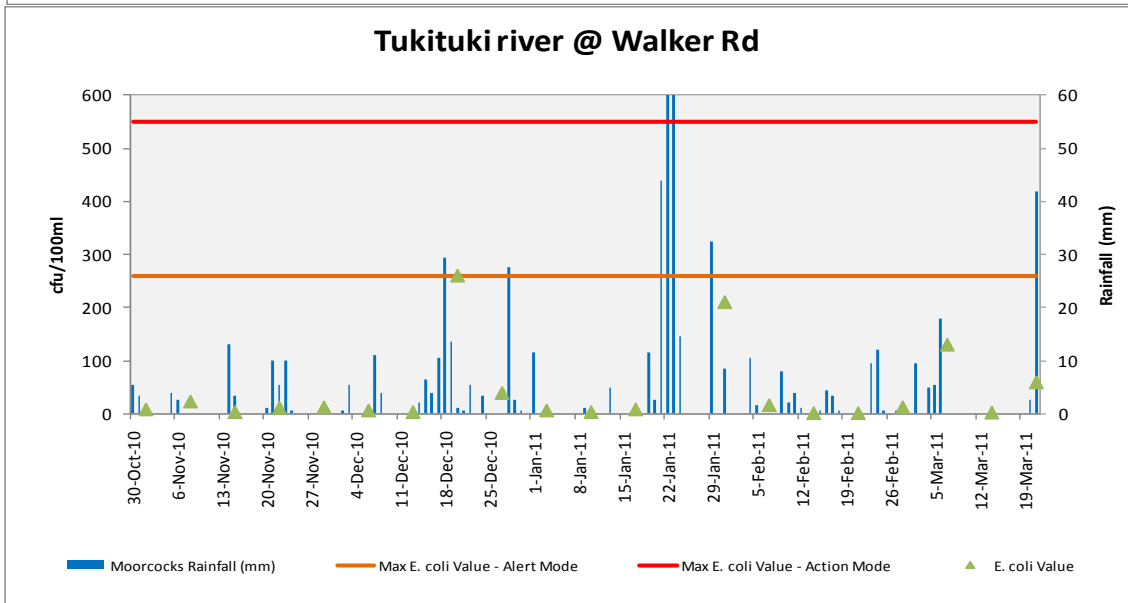
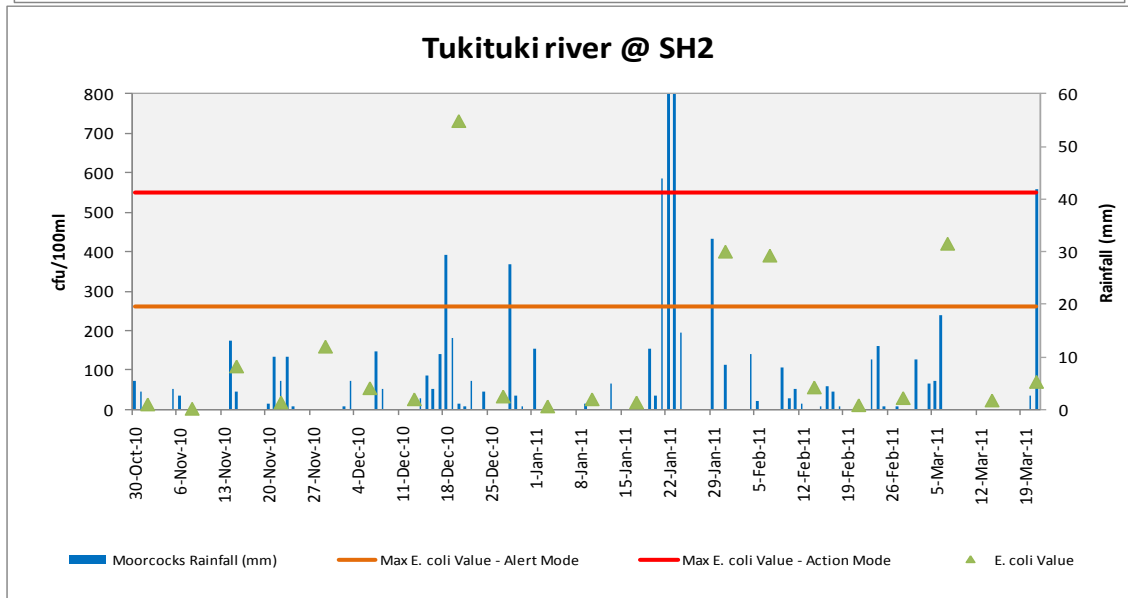
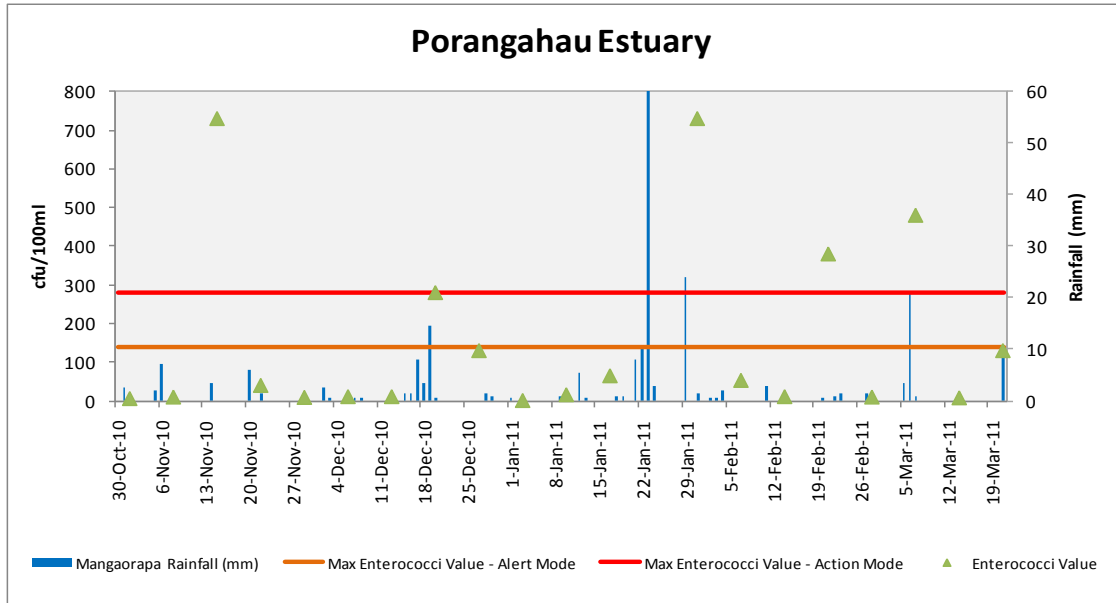
### Pourerere Beach



### Aramoana Beach



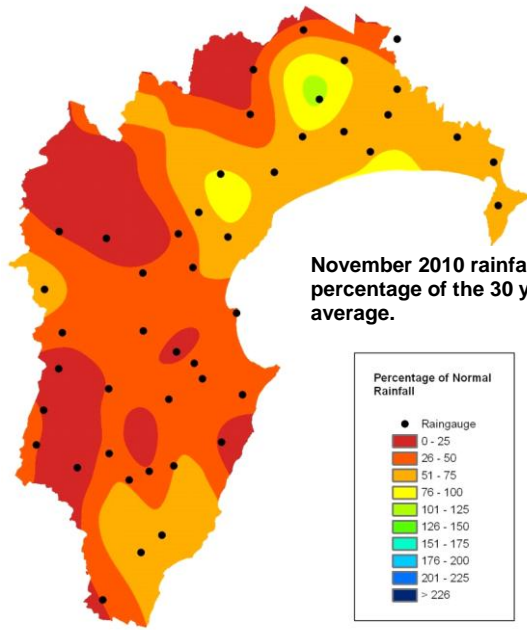




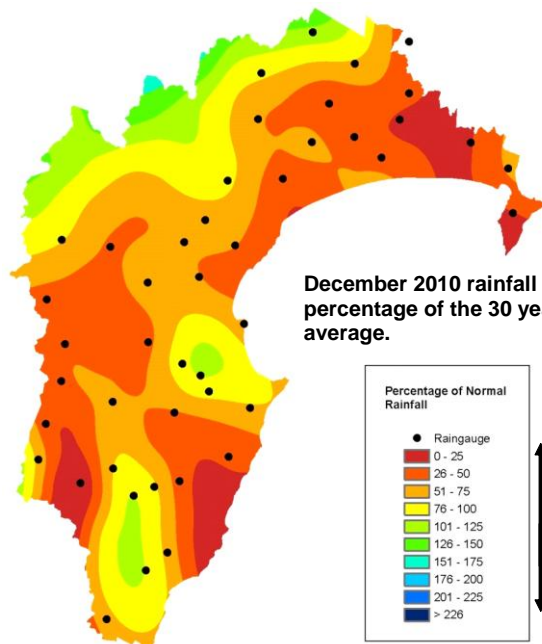
**Appendix 6**

**2010/11 Season –  
Percentage of Normal Rainfall by Month**

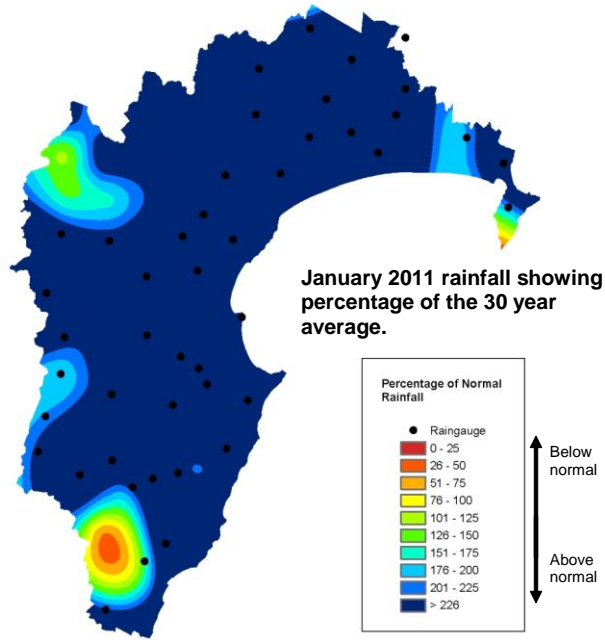
## Rainfall Report November 2010



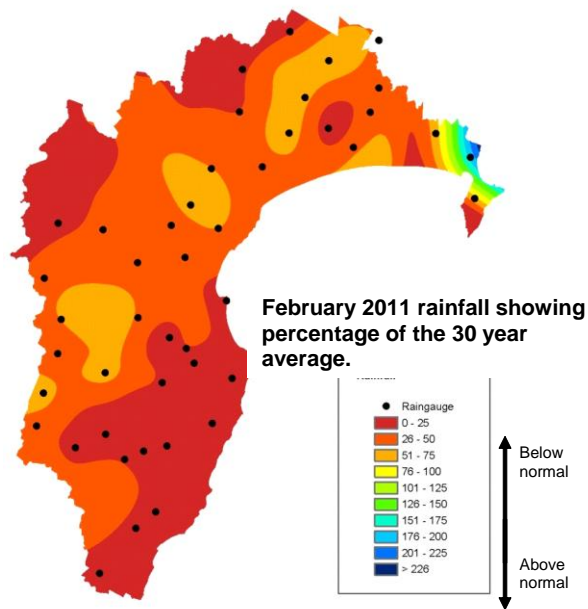
## Rainfall Report December 2010



# Rainfall Report January 2011



# Rainfall Report February 2011



# Rainfall Report March 2011

