# Interim Report on the Microbial Quality of Recreational Waters in the Swan and Canning Rivers

## Grading their Suitability for Recreational Use

**Environmental Health Directorate** **November 2006**

## Acknowledgments

The Environmental Health Directorate would like to acknowledge a number of agencies and individuals for their time and effort in helping provide information and expertise to complete this report.

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# 1.0 Executive Summary

The purpose of this report is to provisionally grade popular recreational water sites along the Swan and Canning Rivers routinely monitored for bacteria by the Environmental Health Directorate (EHD) in accordance with the National Health and Medical Research Council (NHMRC) *Guidelines for Managing Risks in Recreational Waters* (2005).

The Guidelines combine historical enterococci (faecal indicator) data with faecal pollutant sources potentially impacting on the water in order to assign an overall classification or beach grade to a water body. Beach grades represent the different levels of health risk the water may pose to a water user, and are considered to be the most effective way of providing the public with sufficient information about the general state of the water. This information assists the public in making a more informed decision about where and when they want to go swimming.

The Environmental Health Directorate has graded twenty six sites along the Swan River and two sites along the Canning Rivers using enterococci data recorded from 2001 to 2006 in combination with sanitary survey information collected for each sampling location. The grades are provisional and dependent on annual review as additional information becomes available and until data from 100 samples over five years is obtained.

Overall the results were generally good. Nineteen sites were graded as 'Good' and nine sites 'Poor' as per table 1 below.

**Table 1: Provisional Beach Grades for Sampling Sites Located Within The Swan And Canning Rivers**

| Site Description | Microbial Assessment Category (provisional) | Sanitary Inspection Category (provisional) | Overall Beach Grades (provisional) | Traffic Light Classification |
|---|---|---|---|---|
| Middle Swan Reserve | D | Moderate | Poor | Red |
| Ray Marshall Park (First Ave) | D | Moderate | Poor | Red |
| Success Hill Reserve | C | Moderate | Poor | Red |
| Kings Meadow Reserve (Helena River) | C | Moderate | Poor | Red |
| Sandy Beach Reserve (Kenny-Reid Sts) | C | Moderate | Poor | Red |
| Garvey Park (Fauntleroy Ave) | C | Moderate | Poor | Red |
| Hinds Res (Garrett Road-Jetty-Milne St) | C | Moderate | Poor | Red |
| Cracknell Park (Riversdale Rd) | B | Moderate | Good | Green |
| Belmont Park (end Beach-Goodwood) | B | Moderate | Good | Green |
| East Street Maylands Yacht Club | C | Moderate | Poor | Red |
| Coode Street South Perth | B | Moderate | Good | Green |
| Narrows Bridge | B | Moderate | Good | Green |
| Hackett Drive, Crawley (Kiosk, Jetties) | B | Moderate | Good | Green |
| Hackett Drive, Crawley (Tree) | B | Moderate | Good | Green |
| Como Beach North | B | Moderate | Good | Green |
| Como Beach South | B | Moderate | Good | Green |
| Como Beach Jetty | B | Moderate | Good | Green |
| Abrahams Reserve Beach | B | Moderate | Good | Green |
| Deep Water Point Beach (Near Jetty) | B | Moderate | Good | Green |
| Shelly Beach (Near Drain) | D | Moderate | Poor | Red |
| Waylen Bay (Scout Hall) | B | Low | Good | Green |
| Cunningham Street (Applecross) | A | Moderate | Good | Green |
| Point Walter (Kiosk) | B | Moderate | Good | Green |
| Point Walter (Boat Ramps) | B | Moderate | Good | Green |
| Keane Street Beach (50m S Irvine St) | B | Moderate | Good | Green |
| Johnston Street-Hill Tce Beach | B | Moderate | Good | Green |
| Bicton Baths | B | Moderate | Good | Green |
| Preston Point – John Tonkin Park | B | Moderate | Good | Green |

When reviewing the 2001-2006 beach grades it is important to note that there has been a marked improvement in microbial assessment categories (MAC) for a number of sampling locations along the rivers compared to the 2000-2005 microbial assessment categories. However, this may not be reflected in the overall beach grades. The 2000-2005 interim assessment of the Swan and Canning Rivers was based solely on enterococci data and did not take into consideration the faecal pollutant sources potentially impacting on the water as per the NHMRC Guidelines (Laidlaw, 2005).

For easier interpretation by the public the beach grades have been placed into a traffic light system of green, amber or red. Green represents the safer areas to swim and red represents the recreational areas of higher risk. Therefore there are nineteen 'green' sites and nine 'red' sites. Each classification is categorised into one of the three colours and is defined below:

| | |
|---|---|
|  | **Very Good:** Water is considered safe for swimming at all times. Consistently very good water quality tests and very few potential contamination sources indicate that water quality at this location should be of a high standard.<br>**Good:** Conditions are safe for swimming most of the time. Water quality tests are generally good on nearly all occasions and there are few potential faecal pollution sources identified. Standard advisories should be followed such as avoiding swimming 3 days after heavy rainfall in river and estuarine waters. |
|  | **Fair:** Conditions are generally okay for swimming, although water quality tests may show times of elevated bacteria mostly due to animal pollutant sources (e.g. bird faeces) and rainfall. Swimming should be avoided during periods of high rainfall events, and if the water is discoloured. |
|  | **Poor:** Conditions are generally not okay for swimming, as indicated by historical sampling results. There may be a higher risk of illness if you ingest the water, particularly by the very young, the very old and those with compromised immunity. Swimming or putting your head under the water should be avoided. Activities such as wading, canoeing, boating and fishing are still suitable. High bird life, narrow rivers, low dilution, low salinity and stormwater pollution may help pathogens survive longer in these waters, particularly after rainfall events.<br>**Very Poor:** Avoid swimming at these locations, as there are direct discharges of faecal material. Permanent signage may be erected at the beach stating that swimming is not recommended. |

The assessment of faecal pollutant sources impacting on the rivers did not identify any human faecal sources regularly discharging into the rivers, though some limited and intermittent discharge cannot be ruled out completely. Sources of human faecal pollution represent a greater risk to public health when compared to animal faecal sources. Although animal sources do present some degree of risk, the range of pathogenic organisms from animal excreta is much narrower than that from human excreta, thus representing a lowered risk to public health.

Accordingly, those sites assigned as 'red' classification are considered to represent less of a risk to public health than might otherwise be expected, except during and after rainfall events. Fortunately, the majority of the red sites are located in the Upper Swan were participation in whole-of-body contact activities such as swimming is minimal. The Upper Swan is generally used for secondary contact activities such as canoeing, boating and fishing. Natural hazards including high turbidity and submerged trees and rocks can make swimming in these parts of the river relatively unsafe.

Rainfall data indicates that rainfall events, which wash animal excreta into the water and potentially human excreta from illegal cross connections into the stormwater system, are associated with elevated bacterial levels in a number of locations along the Swan and Canning Rivers. Ideally, consideration is needed to implement stormwater management to control or redirect stormwater from discharging directly into river systems to help increase the overall bacterial quality of the water. This would reduce the public health risks to recreational water users, particularly during and after summer rainfall events.

Notwithstanding this, it is important to increase public awareness on healthy swimming practices and communicate the general risks present in the Swan and Canning Rivers, particularly following rainfall events. The Healthy Swimming website (www.healthyswimming.health.wa.gov.au) is one effective channel to communicate such water quality information to the public.

## 2.0 Introduction

The Environmental Health Directorate (EHD) of the Western Australian Department of Health coordinates microbiological water monitoring of recreational areas along the Swan and Canning Rivers, in order to assess compliance of the water with the 2005 National Health and Medical Research Council (NHMRC) *Guidelines for Managing Risks in Recreational Waters.*

The Swan and Canning Rivers are an important Western Australian icon and a natural playground for WA residents and tourists alike. The river systems are used extensively for activities such as swimming, boating, canoeing, and skiing. For this reason it is important for the public to be aware of the potential health risks involved when partaking in whole-of-body contact activities such as swimming.

There are a number of impacts on the river systems that can influence the microbial quality of the water including malfunctioning sewage pumping stations, stormwater drains, septic tanks, ablution blocks, animals, boats, and commercial and farming activities. Other factors such as heavy rainfall and bather density are also known to influence water quality.

Pathogens (disease causing organisms) in recreational waters can pose a risk to human health. Water contaminated by sewage and excreta may contain a diverse range of pathogenic micro-organisms such as viruses, bacteria and protozoa. These organisms may pose a health hazard when the water is used for whole-of-body contact activities, and it is desirable for water to be largely free of pathogens that may cause human illness.

The EHD monitoring program was established to monitor the microbial quality of recreational waters. The program has been ongoing for many years. Since this time there has been a major revision of previous recreational guidelines and the current aims of the monitoring program have been changed to reflect this. The current program aims to:

- Classify water bodies to assist the public in making a more informed decision about where they want to swim.
- Issue warnings during pollution events.
- Identify microbial pollution sources.
- Look for long-term microbial trends in water quality.
- Assist in identifying and promoting effective management interventions.

## 3.0 NHMRC *Guidelines for Managing Risks in Recreational Waters*

The NHMRC Guidelines are based on the 2003 World Health Organisation (WHO) *'Guidelines for Safe Recreational Water Environments. Volume 1 – Coastal and Fresh Waters'*. These guidelines are a major revision of previous recreational water guidelines, and provide a mechanism for communicating substantiated information to the public on bacterial risks in popular recreational water environments.

Under the guidelines, a risk-management framework is used to grade a recreational water body as 'very good', 'good', 'fair', 'poor' or 'very poor' with the aim of providing generic statements on the level of public health risk a particular water body may pose to a water user, rather then relying on the traditional percentage compliance of faecal indicators. Beach grades are considered to be the most effective way of providing the public with information about the general state of a beach to allow them to make a more informed decision about the risk of recreational contact.

The guidelines are deliberately conservative and categorise a beach by taking into account its highest ranked risk source. This is achieved by combining:

a) Microbial water quality assessment categories (counts of historical faecal indicator bacteria) and
b) Sanitary inspection category (determined through assessment of the degree of influence of faecal material).

For most healthy people water conforming to the guideline value will pose only a minimal increase in daily risk. However, water conforming to the guidelines may still pose a potential health risk to high-risk user groups such as the very young, the elderly and those with impaired immune systems (NHMRC, 2005, pg 75).

# 4.0 Overview of Environmental Health Directorate Sampling Program

## 4.1 Sampling sites

Water samples are collected from twenty-eight sites in the Swan (26) and Canning (2) Rivers by sampling officers from the Environmental Health Directorate or Local Government. Sites have been chosen based on their popularity for whole-of-body contact recreational areas where people generally go swimming and are potentially at a greater risk of illness if they ingest the water. Figure 1 details the current sampling locations.

## 4.2 Frequency of sampling

During the bathing season, recognised in Western Australia as November to late April, samples are collected from each site on a weekly to fortnightly basis to try to achieve at least twenty samples per site. Samples are only collected during the bathing season to reflect the times when most people are using the water for whole-of-body contact activities.

## 4.3 Sampling methodology

Samples are collected in accordance with the Department of Health 'Standard Microbiological Water Sampling Techniques (Environmental Waters)' guidelines. In general samples will be collected by hand grab. The sampler will wade into the water until the depth is approximately at waist level. A grab sample is then collected at a depth of approximately 30cm below the surface of the water, in 250ml sterilised polyethylene containers. Samples are collected from the same location during all sampling events.

Where wading into the water may stir up sediments or the water is only accessed via a jetty, a sampling pole of approximately 1.5m in length is used.

## 4.4 Site Observations

At each site, the location, time of sample collection, condition of the water body, weather conditions and the presence of wild or domestic animals is noted. These field notes assist in determining faecal influencing factors on non-compliant results.

## 4.5 Sample storage and transportation

Samples are stored on ice in an insulated container or in a car refrigerator at 1°C to 4°C. Samples are transported to the NATA accredited (Accreditation No. 2858) PathWest Water Examination Laboratory by the field officer collecting them, and must be analysed within 24 hours of collection, but 6 hours is preferable.

## 4.6 Sampling Parameters

Samples are analysed for a bacteria called enterococci. Enterococci has been advocated by the WHO and NHMRC as the single preferred faecal indicator organisms. They are normally found in the intestinal tract of warm blooded animals (humans and animals). Although they are generally not harmful themselves, they indicate the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoa that also live in human and animal digestive systems. Therefore, their presence in water bodies suggests that pathogenic microorganisms might also be present and that swimming might be a health risk.

## 4.7 Laboratory Technique

The standard laboratory analysis technique for enterococci has been outlined by PathWest Waters Examination Laboratory:

**Enterococci**
A test portion of sample is aliquoted, and the Enterolert reagent powder is added. Once dissolved the contents are added to a Quanti tray. This is placed through a sealer, which seals all the liquid in the 49 large and 48 small wells. The Quanti - Tray is then incubated at 41°C for 24 hours. Following incubation the Quanti - Tray is removed from the incubator and examined under ultra-violet light. The number of fluorescent wells is counted and compared to the Quanti - Tray Most Probable Number charts and a final result obtained on the number of Enterococci present in the sample per 100mL. The Enterolert method uses 4-methylumbelliferyl-β-D-glucoside (MUG) as the defined substrate nutrient indicator. This compound, when hydrolysed by Enterococcal-β-glucosidase, releases 4-methylumbelliferone which exhibits fluorescence under a $UV_{365}$ lamp.

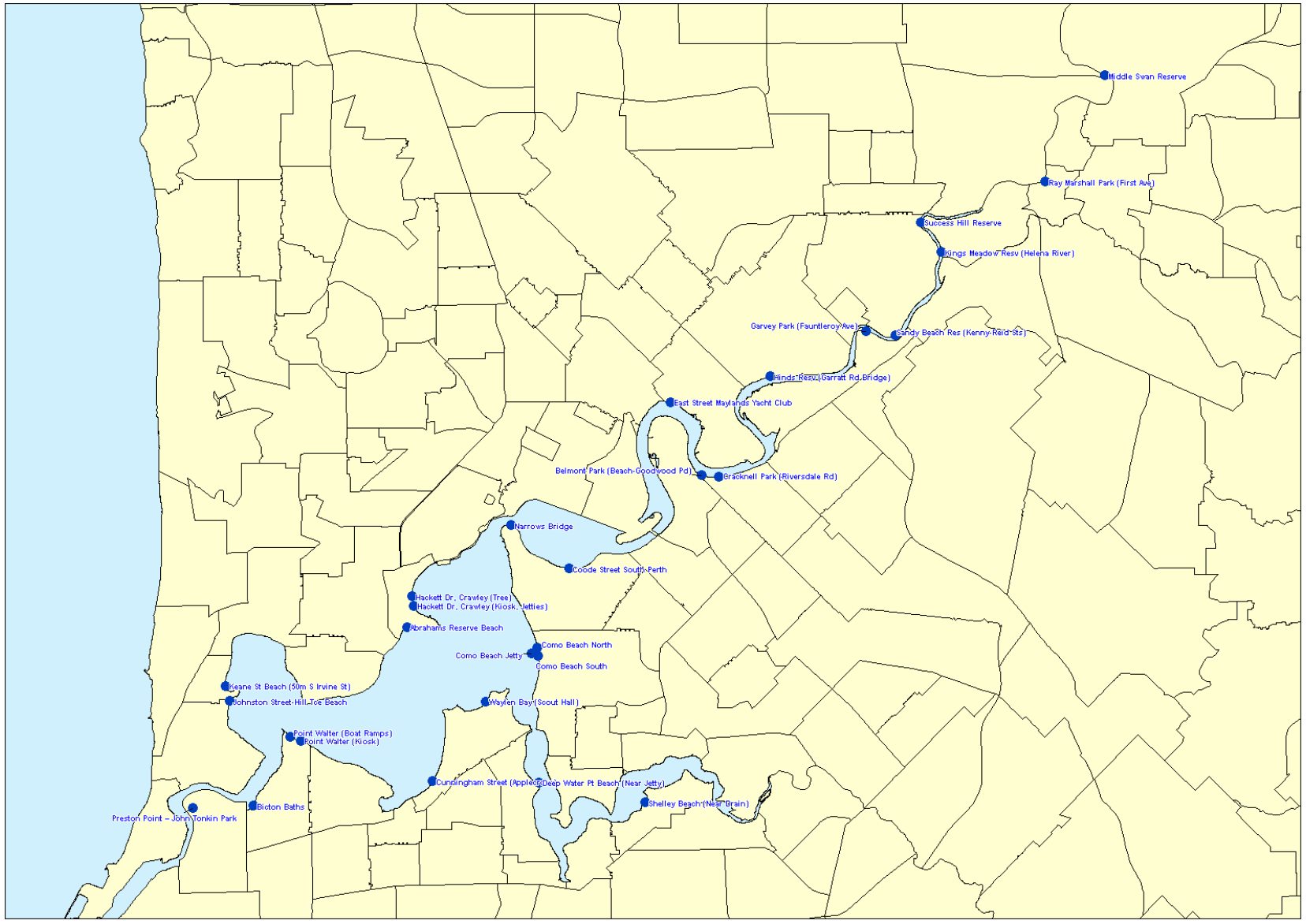



**Figure 1: Microbial Sampling Locations for the Swan and Canning Rivers**

## 5.0 Microbial Assessment Categories (MAC)

The first part to classifying a recreational water site is to assign a microbial assessment category (MAC) to each sampling location. The MAC are expressed in terms of the 95$^{th}$ percentile of numbers of enterococci per 100ml. Each microbial assessment category of A, B, C or D represent different levels of health risk to a water user based on the exposure conditions of key epidemiological studies for 'healthy adult bathers'. The values are determined using a known relationship between bacterial density in water and illness rates, and the distribution of bacterial levels at a swimming site.

Table 2 outlines the different microbial assessment categories with the estimated probabilities of a water user experiencing a gastrointestinal illness (GII) or acute febrile respiratory illness (AFRI) when swimming at a site. As an example, if a site was assigned a "C" classification for every 1000 persons swimming at this site it is estimated that 50 to 100 persons may experience a gastrointestinal illness. This does not imply that the site will persistently result in illness. However, during the right conditions such as heavy rainfall susceptible persons may experience an illness if they ingest the water.

**Table 2: Microbial Assessment Categories (NHMRC, 2005, pg 75).**

| Category | 95$^{th}$ percentile (enterococci) | Basis of derivation | Estimation of probability |
|---|---|---|---|
| **A** | = 40 /100mL | No illness seen in most epidemiological studies | GII risk: <1%<br>AFRI risk: <0.3% |
| **B** | 41-200 /100mL | 200/100mL is above the illness threshold in most epidemiological studies | GII risk: 1-5%<br>AFRI risk: 0.3-1.9% |
| **C** | 201-500 /100mL | Substantial ? in risk of adverse effects where dose-response data available | GII risk: 5-10%<br>AFRI risk: 1.9-3.9% |
| **D** | >500 /100mL | Significant risk of high levels of illness transmission | GII risk: >10%<br>AFRI risk: >3.9% |
| **GII: gastrointestinal illness AFRI: acute febrile respiratory illness** | | | |

A number of methods for calculating the 95$^{th}$ percentile are detailed in the NHMRC Guidelines. The method utilised by each regulatory authority is based on data availability, statistical considerations and local resources. The 95$^{th}$ percentile calculations detailed in this report are derived from an automated spreadsheet designed by Dr. Richard Lugg. The method standardises the 95$^{th}$ percentile results to reflect as closely as possible the infection risks shown in Table 2.

In order to calculate the 95$^{th}$ percentile a data set of 100 samples within a 5 year roll over period is desirable. The more historical data available the more precise the 95$^{th}$ percentile estimate is. (NHMRC, 2005, pg 72). The number of samples collected for each Swan and Canning River sampling sites ranges from 41 – 66 samples. Factors such as the year the sites were commissioned, staffing resources and additional sampling assistance from local authorities has impacted on the number of samples collected for each site. It is important to take this into consideration when reviewing the MACs. Until such time that 100 samples are collected for each site only a provisional MAC can be assigned to a location.

Additionally, both dry and wet weather sampling results have been included in the 95$^{th}$ percentile calculations. In general, most of these recreational water sites experience good water quality during dry summer periods. However, during summer rainfall events and subsequent days following heavy rainfall, all sites, particularly the more susceptible ones (e.g. sites with stormwater drains) may experience elevated bacterial levels.

Anecdotal evidence indicates that most people do not generally go swimming during or immediately after rainfall. However, for the purpose of this report both dry and wet weather results have been taken into consideration. The purpose of the microbial assessment category is to give an indication of general water quality over the period that the site remains available for swimming, during all variations in summer climatic conditions. Unless measures are implemented to prevent people from accessing the water during and after rainfall events wet weather enterococci results must be included in the calculations. Therefore, the 95$^{th}$ percentiles may represent poorer water influenced by the deterioration experienced during summer rainfall.

Table 3 (following page) summaries the microbial assessment categories for each site during 2001–2006 (where available), with a direct comparison to the previous 2001–2005 MAC's. The five year period includes samples collected during five bathing seasons. A bathing season in the Perth metropolitan area is recognised as November through to April. Therefore, the 95$^{th}$ percentiles calculated in this report for 2001-2006 include data from the start of the bathing season in November 2001 to the end of the bathing season in April 2006 (five bathing seasons).

Appendix one details all enterococci values for each location from November 2001 to April 2006.

Table 4 (below) summaries the number of sites within each A, B, C or D category for 2001–2006 with a comparison to the previous years MAC. A slight improvement is apparent, and similar improvements have been noted in the South West of the state. The most likely explanation is the dropping off of higher readings from the 2000-2001 season.

**Table 4: Summary of Microbial Assessment Categories for 2000-2005 Compared to 2001-2006**

| Microbial Water Quality Assessment Categories | Swan River & Canning River (28) | |
|---|---|---|
| | 2000-05 | 2001-06 |
| A | 0 | 1 |
| B | 15 | 18 |
| C | 9 | 6 |
| D | 4 | 3 |

**Table 3: Summary of Microbial Assessment Category for Swan and Canning River sampling sites**

| Site Description | Time of sampling period | Number of samples | Percent of observations below lowest enum. Value <10mpn/100 ml | Percent of observations less than 33 mpn/100mL | Percent of observations above 157 mpn/100mL | Assigned geometric mean* | Standardised 95th percentile* | Microbial Water Quality Assessment Category 2001-2006 | Microbial Assessment Category 2000-05 |
|---|---|---|---|---|---|---|---|---|---|
| Middle Swan Reserve | 01 - 06 | 51 | 6 | 16 | 41 | 81.2 | 2820 | D | D |
| Ray Marshall Park (First Ave) | 01 - 06 | 53 | 8 | 55 | 15 | 27.6 | 610 | D | D |
| Success Hill Reserve | 01 - 06 | 47 | 11 | 43 | 6 | 13.5 | 485 | C | C |
| Kings Meadow Reserve (Helena River) | 01 - 06 | 54 | 6 | 50 | 7 | 20.9 | 470 | C | C |
| Sandy Beach Reserve (Kenny-Reid Sts) | 01 - 06 | 53 | 9 | 64 | 4 | 11 | 205 | C | C |
| Garvey Park (Fauntleroy Ave) | 01 - 06 | 60 | 13 | 65 | 0 | 23.1 | 215 | C | C |
| Hinds Res (Garrett Road-Jetty-Milne) | 01 - 06 | 53 | 21 | 54 | 6 | 30.9 | 300 | C | C |
| Cracknell Park (Riversdale Rd) | 01 - 06 | 48 | 23 | 67 | 2 | 9.4 | 145 | B | B |
| Belmont Park (end Beach-Goodwood) | 03 - 06 | 48 | 17 | 79 | 2 | 5.5 | 105 | B | B |
| East Street Maylands Yacht Club | 03 - 06 | 41 | 12 | 59 | 15 | 44.9 | 445 | C | D |
| Coode Street South Perth | 01 - 06 | 53 | 36 | 72 | 4 | 7.9 | 170 | B | C |
| Narrows Bridge | 01 - 06 | 53 | 40 | 85 | 2 | 3.6 | 75 | B | B |
| Hackett Drive, Crawley (Kiosk) | 01 - 06 | 52 | 42 | 81 | 6 | 6.7 | 145 | B | C |
| Hackett Drive, Crawley (Tree) | 03 - 06 | 42 | 52 | 86 | 0 | 3.5 | 75 | B | B |
| Como Beach North | 03 - 06 | 41 | 83 | 93 | 2 | 3.3 | 70 | B | B |
| Como Beach South | 03 - 06 | 42 | 79 | 86 | 5 | 4.9 | 130 | B | B |
| Como Beach Jetty | 01 - 06 | 53 | 79 | 96 | 2 | 3.3 | 70 | B | B |
| Abrahams Reserve Beach | 03 - 06 | 41 | 68 | 90 | 0 | 2.1 | 45 | B | B |
| Deep Water Point Beach (Near Jetty) | 03 - 06 | 52 | 60 | 96 | 0 | 1.6 | 45 | B | B |
| Shelley Beach (Near Drain) | 03 - 06 | 41 | 51 | 85 | 7 | 46.1 | 990 | D | C |
| Waylen Bay (Scout Hall) | 03 - 06 | 56 | 73 | 96 | 2 | 4.1 | 90 | B | B |
| Cunningham Street (Applecross) | 01 - 06 | 66 | 67 | 97 | 2 | 2.2 | 30 | A | C |
| Point Walter (Kiosk) | 03 - 06 | 53 | 68 | 89 | 6 | 4.6 | 100 | B | B |
| Point Walter (Boat Ramps) | 03 - 06 | 53 | 64 | 96 | 4 | 6.3 | 50 | B | B |
| Keane Street Beach (50m S Irvine St) | 01 - 06 | 53 | 45 | 83 | 8 | 6.4 | 135 | B | D |
| Johnston Street-Hill Tce Beach | 03 - 06 | 41 | 76 | 95 | 5 | 4.5 | 95 | B | B |
| Bicton Baths | 01 - 06 | 66 | 65 | 96 | 2 | 2.0 | 45 | B | B |
| Preston Point - John Tonkin Park | 03 - 06 | 43 | 65 | 88 | 2 | 17.2 | 50 | B | B |

All calculations for microbial assessment categories for each site are provided in appendix one.

*

**Assigned geometric mean** — The assigned geometric mean is the geometric mean of the observed distribution of enterococci after adjustments have been made for the purpose of calculating the standardised 95$^{th}$ percentile. Geometric means are a type of statistical average that minimises the effects of both high values. They are widely used for assessing changes in recreational water quality over time by health and environment agencies across the world.

**Standardised 95th percentile** — The standardised 95$^{th}$ percentile is the 95$^{th}$ percentile of a lognormal distribution of enterococci with the same calculated infection risk as that of the observed distribution, but having a log standard deviation of 0.81, the same as the reference distribution used in the WHO and NHMRC Guidelines. 95$^{th}$ percentiles are estimates of the level below which 95 percent of all the values in a distribution are most likely to lie.

### 5.1 Discussion of Microbial Assessment Categories

The results indicate that there has been a marked improvement in microbial assessment categories for 2001-2006 in comparison to the 2000-2005 period. Nineteen sites have been assigned an 'A' or 'B' category compared to only fifteen the previous year. Nine sites have been assigned a 'C' or 'D' category compared to thirteen the previous year. In total microbial assessment categories for six sites have be reclassified, with all other sites remaining the same MAC as the previous year. Table 5 outlines all re-classified sites for 2001-2006 with explanations for these re-classifications.

**Table 5: Explanation for Re-classification of MACs for 2001 – 2006 Period**

| Site Name | MAC reclassifications | Explanations |
|---|---|---|
| East Street Maylands Yacht Club | D to C | • A high value recorded in January 2004 resulted in the previous D category. An increase in sampling regime, with majority of subsequent enterococci values well within safe recreational levels has improved the MAC.<br>• This site is influenced by stormwater discharge from the Maylands/Inglewood main drain particularly during rainfall events. |
| Hackett Drive, Crawley (kiosk) | C to B | • A number of isolated slightly elevated bacterial levels in 2003 resulted in the previous C category. This was likely to be due to a large avian population continually sited on the old jetties located at this site. The jetties have since been removed and the avian population has since declined. All subsequent enterococci values were well within safe recreational levels. |
| Cunningham Street (Applecross) | C to A | • One slightly elevated enterococci value recorded in April 2004 resulted in this site being classified as C. An increase in sampling regime, with all subsequent enterococci values well within safe recreational levels has resulted in an improved MAC. |
| Keane Street beach (50m south Irvine st) | D to B | • A high enterococci value recorded in early 2001 resulted in this site being classified as D. This value is no longer included in the assessment. An increase in sampling regime with all subsequent enterococci values well within safe recreational levels has resulted in an improved MAC for this site. |

**Table 5 continued: Explanations for Re-classification MACs for 2001 – 2006 period**

| Site Name | MAC reclassifications | Explanations |
|---|---|---|
| Shelley Beach (near drain) | C to D | • A high enterococci value recorded in February 2003 and April 2004 resulted in this site being re-classified as D.<br>• This site is influenced by stormwater discharge from the Modillion Avenue main drain particularly during rainfall events and it is important to take this into consideration when swimming at this location.<br>• All enterococci values recorded from November 2004 to April 2006 have been well within safe recreational levels. |
| Coode St | C to B | • A number of high values recorded in 2001 have now been excluded from the overall calculations. Majority of all subsequent samples have been within safe recreational levels.<br>• This site is influenced by a stormwater drain. This needs to be taken into consideration when swimming at this location. |

## 6.0 Comparison of Rainfall Events With Elevated Enterococci Results

Summer rainfall events are known to contribute to elevated enterococci levels in a waterway. Rainfall collects animal excreta from the surrounding catchment areas such as forests, pastures and urban settings, and potentially human excreta from overwhelmed sewage treatment plants, and washes it into waterways. Stormwater drains play a huge part in discharging polluted rain water into a recreational water site.

To examine the effects of summer rainfall on elevated enterococci levels in the rivers, a comparison of enterococci values greater than 200mpn/100ml recorded during 2002–2006 has been carried out. A total of 97 samples during 2002-06 recorded enterococci values above 200mpn/100ml.

Rainfall data recorded by Bureau of Meteorology rainfall stations – Perth Metro (9225), Melville (9068), Fremantle (9192) and West Swan (9163) - were used to obtain rainfall data. The station in closest proximity to the sampling site was used to compare rainfall data against. In summary:

- On the day of sampling 18 out of 97 (18%) samples were associated with rainfall ranging from 0.2mm to 5mm.
- One day prior to sampling, 34 out of 97 (35%) samples were associated with rainfall ranging from 1.4 to 12mm (of these, 9 sites also recorded rain on day of sampling).
- Two days prior to sampling, 12 out of 97 (12%) samples were associated with rainfall ranging from 0.4 to 1.6mm (of these sites, 12 sites also recorded rainfall at least one other day prior to sampling.
- Three days prior to sampling, 29 out of 97 (30%) samples were associated with rainfall ranging from 0.6mm to 9mm (of these sites, 20 samples were associated with rainfall at least one other day prior to sampling)

Although not the sole contributor, summer rainfall data indicates that rainfall events do contribute to periods of elevated enterococci values. It is important for the community to be aware of the increased health risk rainfall presents to water quality. The NHMRC Guidelines suggest avoiding water contact for up to three days after heavy rainfall in river and estuarine systems before participating in recreational activities.

# 7.0 Sanitary Inspection Categories (SIC)

The second part to classifying a water body in accordance with the NHMRC Guidelines is to undertake a sanitary inspection of each site. This involves identifying all sources of faecal contamination which may affect the water body such as stormwater drains, native animals, sewage outfalls, septic tanks, and boating activities.

The information collected from the sanitary survey is used to allocate a recreational water site into an appropriate sanitary inspection category (SIC) by determining the site's susceptibility to faecal pollution, with particular focus on sources of human origin. There are five SIC's, categorised as 'Very low', 'Low', 'Moderate', 'High' or 'Very High'.

The sanitary survey places more emphasises on identifying human faecal pollution sources entering a site. Due to the species barrier from humans to animals, the range of pathogens of public health importance is generally assumed to be less in animal excreta than in human excreta, thus representing a significantly lower risk to human health (NHMRC, 2005, pg 62).

Sanitary survey information has been collected for the Swan and Canning River sampling locations as per table 6. This was achieved by providing a standard survey checklist (appendix two) to each relevant local authority to complete. Local knowledge is imperative in helping to identify local faecal pollutant sources. On-site inspections were also completed by Environmental Health Directorate field sampling officers who are familiar with all sampling locations. Additional information was supplied by other government agencies, including the Swan River Trust and Water Corporation.

The NHMRC Guidelines provide a general discussion of the method used to assign sanitary inspection categories. However, the New Zealand *Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (2003)* and the Water Services Association of Australia (WSAA) document *Catchments for Recreational Water: Conducting and Assessing Sanitary Inspections* (2003) have developed more specific approaches for assigning a SIC. The Environmental Health Directorate has used both documents for guidance in assigning a provisional SIC to the Swan and Canning River sampling sites. Refer to Appendix three for the methodology applied. Table 6 details the identified faecal pollution sources for each sampling location with the assigned provisional sanitary inspection category.

### 7.2 Discussion of sanitary inspection categories

The NHMRC Guidelines are deliberately conservative and categorise a beach by taking into account its highest ranked risk source. There are no direct human faecal sources known to discharge regularly into the Swan or Canning Rivers, therefore the risk to public health is lowered. Sources of direct human faecal pollution (e.g. wastewater outfalls) are a greater risk to public health compared to those of animal origin. Animal faecal pollution does present some degree of risk; however, the range of pathogenic organisms from animal excreta is much narrower than that of human excreta, thus representing a lowered risk to public health.

The sanitary survey has taken into account a number of 'potential' indirect human faecal sources. These included boats, sewage pumping stations, ablution blocks, and septic tanks. Generally, these sources do not present an immediate threat to public health. They represent a probability that faecal contamination from these sources may occur on occasions. For example, a malfunctioning sewage pumping station or ablution block may discharge untreated wastewater directly into a river.

All direct and non-direct faecal contamination risks need to be taken into consideration when assessing a water body's suitability for swimming to ensure the public is aware that the water is vulnerable to faecal contamination.

Due to no identified direct human faecal sources discharging into the rivers the highest ranked risk sources is assigned 'Moderate'. Moderate pollutant sources generally indicate the presence of faecal sources such as stormwater drains, boat moorings or high birdlife.

**Table 6: Microbial Sources Identified With Corresponding SIC for Swan and Canning River Sites (based on appendix three)**

| Site Description | Bacterial pollution sources (within 500m radius) | | | | | | | | | | | | SANITARY INSPECTION CATEGORY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stormwater drain within 500m *Water Corporation main drain | Animals | | Septic | Pumping station | Boat moorings | Abluti-on Blocks | | Bather Density | | | | |
| | With low intensity agriculture/urban/rural catchments | High Level birdlife. | Potential run-off from feral animals. Low level birdlife. | Surrounding tanks <100m | Pumping station or Wastewater treatment plant within immediate or nearby location | High number of boat moorings or popular anchorage area. | Onsite toilet facilities - sewer | Onsite toilet facilities - septics | High bather density, high dilution | Low bather density, high dilution | High bather density, low dilution | Low bather density, low dilution | |
| **Assessment Category Risk** | **Mod** | **Mod** | **Low** | **Mod** | **Low** | **Mod** | **VL** | **L** | **L** | **VL** | **M** | **L** | |
| Middle Swan Reserve | X | X | | X | | | | X | | | | X | M |
| Ray Marshall Park (First Ave) | X* | X | | X | X | | | | | | | X | M |
| Success Hill Reserve | X | | X | X | | | X | | | | | X | M |
| Kings Meadow Reserve | X* | X | | | X | | | | | | | X | M |
| Sandy Beach Reserve | X | X | | X | | X | X | | | | | X | M |
| Garvey Park | X* | | X | X | X | | X | | X | | | | M |
| Hinds Res | X* | | X | | X | | X | | X | | | | M |
| Cracknell Park | X | | X | | | | X | | | X | | | M |
| Belmont Park | X | | X | | | | X | | X | | | | M |
| East Street Maylands Yacht Club | X* | | X | | X | | X | | | X | | | M |
| Coode Street South Perth | X | | X | | | | X | | X | | | | M |
| Narrows Bridge | X | | X | | X | | | | X | | | | M |
| Hackett Drive, Crawley (Kiosk, Jetties) | X | | X | | X | X | X | | X | | | | M |
| Hackett Drive, Crawley (Tree) | X | | X | | X | X | | | X | | | | M |
| Como Beach North | X | | | | X | | X | | X | | | | M |
| Como Beach South | X | | | | X | | | | X | | | | M |
| Como Beach Jetty | X | | | | X | | | | X | | | | M |
| Abrahams Reserve Beach | X* | | X | | X | | X | | | | | | M |
| Deep Water Point Beach | X | | X | | X | | X | | X | | | | M |
| Shelly Beach (Near Drain) | X* | | X | | | | X | | | X | | | M |
| Waylen Bay (Scout Hall) | | | X | | X | | | | X | | | | L |
| Cunningham Street (Applecross) | X | | X | | X | | | | | X | | | M |
| Point Walter (Kiosk) | X | | X | | | | X | | X | | | | M |
| Point Walter (Boat Ramps) | X | | X | | | | | | X | | | | M |
| Keane Street Beach (50m S Irvine St) | X | | X | | X | X | | | X | | | | M |
| Johnston Street-Hill Tce Beach | X | | X | | X | X | | | X | | | | M |
| Bicton Baths | | | X | | X | X | X | | X | | | | M |
| Preston Point - John Tonkin Park | X | | X | | X | X | X | | X | | | | M |

VL – Very Low, L – Low, M – Moderate, H – High, VH – Very high

## 8.0 Provisional Beach Grades

The final step to assigning a provisional classification or beach grade to a recreational water body is to use the classification matrix outlined in Table 7. The microbial assessment category for each location is combined with the sites sanitary inspection category to provide a final classification of 'Very Good', 'Good', 'Fair', 'Poor' or 'Very Poor' to each site. There is also a requirement for 'follow-up' where there is potential discrepancy between the results of the microbial assessment category and sanitary inspection category (NHMRC, 2005, pg 88). 'Follow up' requires an additional inspection of a site to investigate reasons as to why enterococci results do not match with the faecal pollutant sources identified.

The overall classifications or beach grades have not been defined in the NHMRC Guidelines. Consequently, the Environmental Health Directorate has defined the beach grades for river and estuarine waters with guidance from the New Zealand *Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas* document, as outlined below:

- **Very Good:** Water is considered safe for swimming at all times. Consistently very good water quality tests and very few potential contamination sources indicate that water quality at this location should be of a high standard.
- **Good:** Conditions are safe for swimming most of the time. Water quality tests are generally good on nearly all occasions and there are few potential faecal pollution sources identified. Standard advisories should be followed such as avoiding swimming 3 days after heavy rainfall in river and estuarine waters.
- **Fair:** Conditions are generally okay for swimming, although water quality tests may show times of elevated bacteria mostly due to animal pollutant sources (e.g. bird faeces) and rainfall. Swimming should be avoided during periods of high rainfall events, and if the water is discoloured.
- **Poor:** Conditions are generally not okay for swimming, as indicated by historical sampling results. There may be a higher risk of illness if you ingest the water, particularly by the very young, the very old and those with compromised immunity. Swimming or putting your head under the water should be avoided. Activities such as wading, canoeing, boating and fishing are still suitable. High bird life, narrow rivers, low dilution, low salinity and stormwater pollution may help pathogens survive longer in these waters, particularly after rainfall events.
- **Very Poor:** Avoid swimming at these locations, as there are direct discharges of faecal material. Permanent signage may be erected at the beach stating that swimming is not recommended.

An interim classification or beach grade has been assigned to each Swan and Canning River sampling site outlined in table 8. The grades are provisional and dependent on annual review as additional information becomes available and until five years of data is obtained.

**Table 7: Classification Matrix for Faecal Pollution of Recreational Water Environments (NHMRC, pg 88)**

| | | **Microbiological Assessment Category** (Enterococcal 95th percentiles/100mL) | | | | |
|---|---|---|---|---|---|---|
| | | **A** =40 | **B** 41–200 | **C** 201–500 | **D** >500 | **Exceptional circumstances†** |
| **Sanitary Inspection Category** (suscept-ibility to faecal influence) | **Very low** | Very Good | Very Good | Follow up+ | Follow up+ | |
| | **Low** | Very Good | Good | Follow up+ | Follow up+ | |
| | **Moderate** | Good | Good | Poor | Poor | |
| | **High** | Good | Fair | Poor | Very Poor | |
| | **Very high** | Follow up* | Fair | Poor | Very Poor | |
| | **Exceptional circumstances†** | | | | | **Action** |

**Table 8: Provisional Classification for Sampling Sites Located Within The Swan And Canning Rivers**

| Site Description | Microbial Assessment Category (provisional) | Sanitary Inspection Category (provisional) | Overall Beach Grades (provisional) | Traffic Light Classification (refer to table 8) |
|---|---|---|---|---|
| Middle Swan Reserve | D | Moderate | Poor | Red |
| Ray Marshall Park (First Ave) | D | Moderate | Poor | Red |
| Success Hill Reserve | C | Moderate | Poor | Red |
| Kings Meadow Reserve (Helena River) | C | Moderate | Poor | Red |
| Sandy Beach Reserve (Kenny-Reid Sts) | C | Moderate | Poor | Red |
| Garvey Park (Fauntleroy Ave) | C | Moderate | Poor | Red |
| Hinds Res (Garrett Road-Jetty-Milne St) | C | Moderate | Poor | Red |
| Cracknell Park (Riversdale Rd) | B | Moderate | Good | Green |
| Belmont Park (end Beach-Goodwood) | B | Moderate | Good | Green |
| East Street Maylands Yacht Club | C | Moderate | Poor | Red |
| Coode Street South Perth | B | Moderate | Good | Green |
| Narrows Bridge | B | Moderate | Good | Green |
| Hackett Drive, Crawley (Kiosk, Jetties) | B | Moderate | Good | Green |
| Hackett Drive, Crawley (Tree) | B | Moderate | Good | Green |
| Como Beach North | B | Moderate | Good | Green |
| Como Beach South | B | Moderate | Good | Green |
| Como Beach Jetty | B | Moderate | Good | Green |
| Abrahams Reserve Beach | B | Moderate | Good | Green |
| Deep Water Point Beach (Near Jetty) | B | Moderate | Good | Green |
| Shelly Beach (Near Drain) | D | Moderate | Poor | Red |
| Waylen Bay (Scout Hall) | B | Low | Good | Green |
| Cunningham Street (Applecross) | A | Moderate | Good | Green |
| Point Walter (Kiosk) | B | Moderate | Good | Green |
| Point Walter (Boat Ramps) | B | Moderate | Good | Green |
| Keane Street Beach (50m S Irvine St) | B | Moderate | Good | Green |
| Johnston Street-Hill Tce Beach | B | Moderate | Good | Green |
| Bicton Baths | B | Moderate | Good | Green |
| Preston Point – John Tonkin Park | B | Moderate | Good | Green |

### 8.1 Discussion of Assigned Beach Grades

One limitation identified with applying the NHMRC classification matrix is the lack of distinction between the potential health risks associated with sites assigned a microbial assessment category of 'C' and sites assigned a microbial assessment category of 'D', when combined with similar moderate faecal pollutant sources. For example, Sandy Beach Reserve has a MAC of C ($95^{th}$ percentile of 205) and moderate pollutant sources identified (stormwater). When compared to Middle Swan Reserve which has a MAC of D ($95^{th}$ percentile 2820) and moderate pollutant sources identified (high birdlife) the overall beach grade for each location is 'poor'. There is no clear distinction between the associated health risks identified at each location, with Sandy Beach Reserve clearly demonstrating a much lower risk to health.

The classification matrix outlined in the World Health Organisation (WHO) *Guidelines for safe recreational water environments Volume 1* which the NHMRC Guidelines are based on, recognises this distinction. Using the WHO classification matrix would see six of the sites currently assigned a 'red' or 'poor' beach grade reclassified to 'fair' or 'amber' grades.

### 8.2 Traffic Light Classifications

For easier interpretation by the community of the health risks a particular site may pose to a water user a traffic light system of green, amber or red has been developed. Green represents the safer areas to swim and red represents the recreational areas of higher risk. Table 9 outlines the three levelled classification system currently used by the Environmental Health Directorate.

There are nineteen green sites, and nine red sites identified in the Swan and Canning Rivers. Majority of the red sites are located in the Upper Reaches of the Swan River where environmental conditions such as narrow rivers, low dilution, and low salinity levels may help concentrate and prolong the survival of pathogens in these waters.

The classifications will be detailed on the Healthy Swimming website at www.healthyswimming.health.wa.gov.au in time for the November bathing season.

**Table 9: Traffic Light Classifications**

| | |
|---|---|
|  | **Very Good:** Water is considered safe for swimming at all times. Consistently very good water quality tests and very few potential contamination sources indicate that water quality at this location should be of a high standard.<br>**Good:** Conditions are safe for swimming most of the time. Water quality tests are generally good on nearly all occasions and there are few potential faecal pollution sources identified. Standard advisories should be followed such as avoiding swimming 3 days after heavy rainfall in river and estuarine waters. |
|  | **Fair:** Conditions are generally okay for swimming, although water quality tests may show times of elevated bacteria mostly due to animal pollutant sources (e.g. bird faeces) and rainfall. Swimming should be avoided during periods of high rainfall events, and if the water is discoloured. |
|  | **Poor:** Conditions are generally not okay for swimming, as indicated by historical sampling results. There may be a higher risk of illness if you ingest the water, particularly by the very young, the very old and those with compromised immunity. Swimming or putting your head under the water should be avoided. Activities such as wading, canoeing, boating and fishing are still suitable. High bird life, narrow rivers, low dilution, low salinity and stormwater pollution may help pathogens survive longer in these waters, particularly after rainfall events.<br>**Very Poor:** Avoid swimming at these locations, as there are direct discharges of faecal material. Permanent signage may be erected at the beach stating that swimming is not recommended. |

## 9.0 Environmental Health Strategies to Manage Recreational Water Risks

The grading of recreational water bodies is considered to be the most effective way of providing the public with sufficient information about the general state of a beach for them to make an informed decision about the risk of recreational contact. This form of classification can also provide incentives for taking action locally to reduce pollution of popular beaches.

To increase community awareness of recreational water quality and to effectively manage pollution events a number of initiatives have been implemented by the Environmental Health Directorate with assistance from local governments. These include:

**Public Awareness Campaigns and Educational Resources**

1. **Healthy Swimming website**
   In December 2005 the 'Healthy Swimming in Western Australian Waterways' website www.healthyswimming.health.wa.gov.au was created. The website details information on healthy swimming practices and beach grades for the Swan and Canning Rivers sampling locations, and has been deemed a success with over 4000 river users viewing the site within the first six months of being online. The website is also used to communicate information on emergency pollution events such as sewage overflows, and will include beach grades for Perth coastal beaches, Rottnest Island and a number of popular regional waterways.

2. **How Safe are Natural Waterways? brochure**
   In January 2006 the EHD published the "How Safe are Natural Waterways" brochure which provides an overview of the health risks associated with natural bodies of water. The brochure has been developed for dissemination by local authorities to key recreational water users including local schools, surf life saving associations, and canoeing clubs. Key organisations including the Royal Life Saving Association (WA), Department of Education and Training, Department of Environment and Conservation and the Swan River Trust have been provided details of the brochure and Healthy Swimming website.

3. **Amoebic Meningitis brochure**
   The Amoebic Meningitis brochure was reviewed in 2005 and republished. The brochure provides water users with advice on the risk of contracting amoebic meningitis in recreational waters.

4. **Awareness of increased risks during rainfall events**
   Standard press releases issued during emergency contamination events such as wastewater overflows now include the standard public reminder "to avoid swimming during and after rainfall events".

5. **Start of the bathing season press release**
   At the start of the bathing season in November each year it is anticipated that a press release advising the public on general healthy swimming practices and a reminder of the Healthy Swimming website will be released.

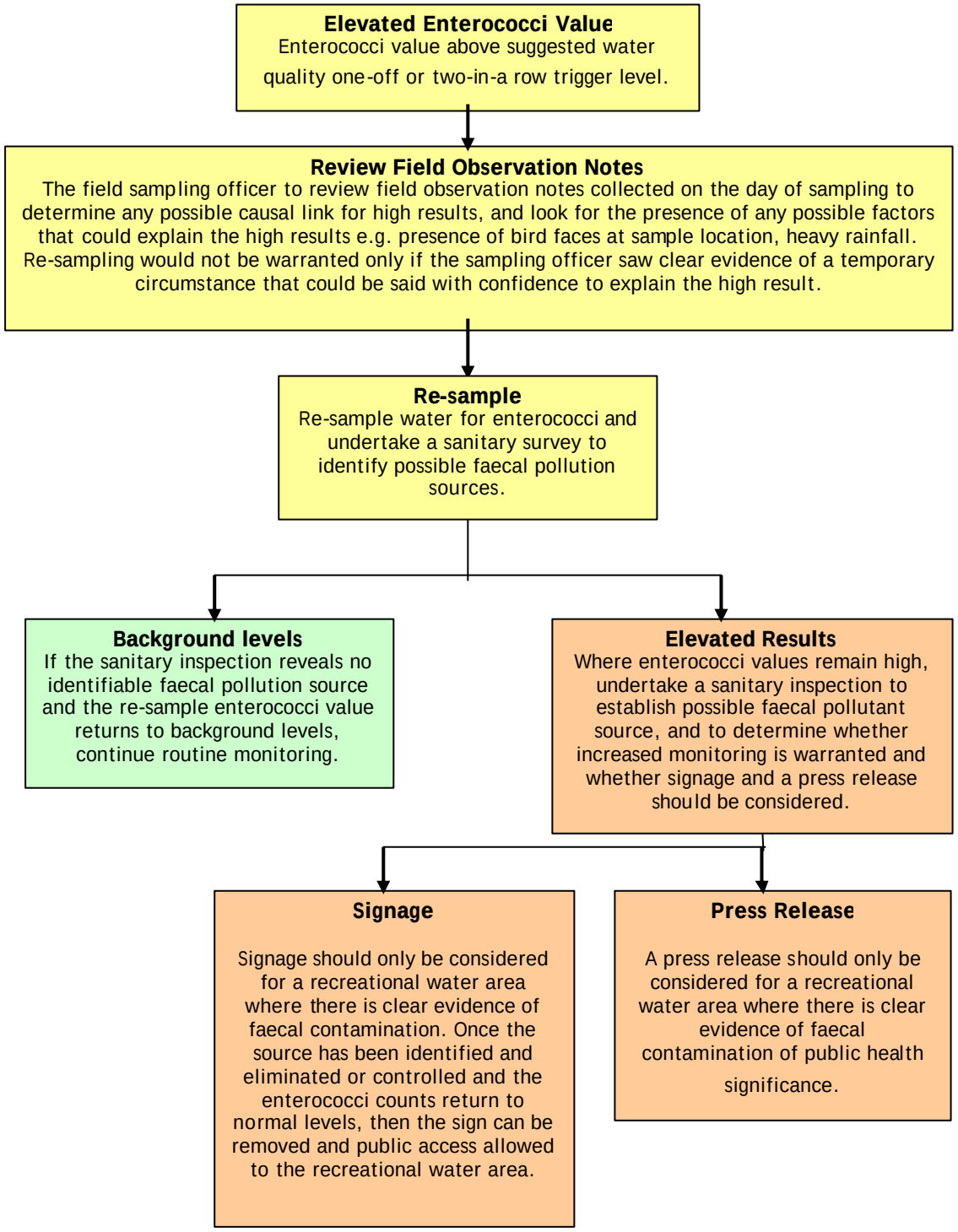
## Health Response Protocols

1. **Wastewater Overflow Response Protocol**
   In 2003, the EHD with input from a number of key government agencies, including Water Corporation, Swan River Trust, Department of Environment and Conservation and Local Government, developed a Wastewater Overflow Response Protocol to ensure accidental wastewater overflow events are coordinated effectively to reduce the risk to public health.

2. **Elevated Bacterial Response Plan**
   Where high enterococci values are recorded during routine monitoring the EHD has developed a response plan outlined in figure 2 which instigate when to investigate and resample the water. The response plan is initiated when the assigned one-off or two-in-a-row trigger level for a given site is exceeded. The one-off and two-in-a row trigger level is calculated based on the $99^{th}$ and $90^{th}$ percentile of the sites historical microbial data. The response approach ensures a timely response to recreational water quality issues.

3. **Increased sampling regime**
   With assistance from Local Governments the EHD has increased the number of microbial samples collected from a number of sites along the Swan and Canning Rivers to try and achieve at least twenty samples per site per year. The increased sampling regime assists in assigning accurate microbial assessment categories.

**Figure 2: Response Procedure for Elevated Enterococci Values in Recreational Water Samples**



## 10.0 Discussion

The provisional beach grades for the Swan and Canning River sampling sites provide a clear indication that the Upper Reaches of the Swan River tend to yield higher enterococci values compared to the lower Swan. A comparison of the Upper and Lower reaches of the Swan River signifies a number of differences in the two areas which may account for these variations in enterococci concentrations. These include:

1. **Narrower channels:** The Upper Swan is characterised by narrow channels which can result in lower dilution rates compared to other parts of the river. Higher dilution assists in dispersion and diluting bacterial concentrations in water.

2. **Lower salinity levels:** The Upper Swan is unaffected by saline intrusion from the Indian Ocean which results in lower salinity levels in this section of the river. The die off rate for enterococci has been documented to be quicker in marine waters with a higher salt content compared to fresh water environments (WHO, 1999, pg 11). Therefore, lower salinity levels can help to prolong the survival of enterococci.

3. **Sunlight exposure:** It is likely that tree shade along the Upper Swan reduces the exposure of sunlight penetrating the water. Solar radiation is known to contribute to the rapid die-off rate of most bacteria. (WHO, 1999, pg 13). A reduction in solar exposure will reduce enterococci inactivation, possibly contributing to elevated enterococci concentrations in the Upper Swan.

4. **Higher turbidity:** Turbidity levels are noted to be much higher in the Upper Swan which suggests that turbidity plays a significant role in elevated enterococci concentrations. Increased turbidity result in less solar radiation penetrating into the water which assists in the breakdown of bacteria.

5. **Wildlife:** It can be assumed that there is a greater proportion of wildlife in the Upper Swan compared to many areas of the Lower Swan due to more natural habitats available such as reeds and trees. Large avian populations such as geese, ducks and parrots are continually sited in the water in the Upper Swan areas which would contribute to faecal pollution of the water.

All of these factors could operate to produce higher pathogen levels as well as enterococci.

Additionally, those sites with stormwater drains discharging into the water during summer rainfall events are also inclined to experience elevated bacterial levels. Rainfall is known to contribute to elevated enterococci, and stormwater assists in washing animal excreta from parks and gardens, farms and urban settings and potentially human waste from illegal cross connections into the water during rainfall events.

Sites identified with a large stormwater or main drain discharging directly into the beach, such as Maylands Yacht Club and Shelley Beach Reserve, also present a higher degree of risk to bathers particularly during rainfall events when polluted water is discharged directly into the swimming beach. The drains also make the beaches susceptible to unknown discharges not related to rainfall such as illegal cross connections or other catchment activities causing polluted water to flow into the beach.

Ideally management interventions should be implemented by managers of stormwater drains to reduce the effects of stormwater runoff into waterways. Stormwater interventions would reduce the level of bacterial contamination in the water following rainfall events, and are likely to have a huge impact on the overall recreational water quality of the Swan and Canning Rivers. With the mitigation of stormwater contamination many of the assigned beach grades are likely to improve.

On occasions, wastewater overflows from Water Corporation owned infrastructure have also been known to occur in the river systems which have resulted in immediate threats to public health. However, management procedures are in place to minimise the risk to public health when wastewater overflows occur. Apart from the potential for malfunctioning wastewater infrastructure, no known direct human faecal pollution sources have been identified to discharge directly into the Swan and Canning Rivers.

Due to no human sources directly discharging into the river systems it is considered that those sites assigned as 'red' classification represent less of a risk to public health than might otherwise be expected. Sources of faecal pollution from animal origin, particularly from native animals, present a much lower risk to humans as the range of pathogenic organisms is much narrower than that of human origin.

Majority of the red sites are located in the Upper Swan were participation in whole-of-body contact activities such as swimming are minimal. This section of the river is generally used for secondary contact activities such as canoeing, boating and fishing. Natural hazards including low visibility, high river banks, fewer beaches and submerged trees and rocks make swimming in these parts of the river relatively unsafe.

When assessing the need for permanent on-site signage the 95$^{th}$ percentile needs to be taken into consideration and whether or not elevated enterococci results are associated with temporary events e.g. rainfall, or a persistent problem. The Environmental Health Directorate will engage discussions with relevant Local Governments where 'red' sites have been identified, in particular those sites with a microbial assessment category of D, to discuss the appropriate management responses to these locations.

Where a MAC of C has been assigned to a sampling location with an overall beach grade of 'red', continued close monitoring and assessment will be necessary to ensure there is no further decline in the bacterial quality of these waters. Additional investigation into the source of enterococci levels may also be warranted to determine the origin of elevated enterococci levels (e.g. human or animal). This could be achieved by coprostanol analysis, which would assist in appropriate health warnings and mitigation of pollutant sources.

Notwithstanding this, there is a need for increased community awareness on the health risks present in the Swan and Canning Rivers and all WA recreational waterways. The Healthy Swimming website is seen as an important communication channel to effectively present this information to the WA community. Additional supporting roles from Local Governments, and educational institutions such as primary and secondary schools, are further channels to be utilised to help increase awareness on recreational water safety.

## 11.0 Conclusion

The provisional beach grades for all twenty eight sites within the Swan and Canning Rivers illustrate that there were nineteen green sites (Good) and nine red sites (Poor). Overall these provisional classifications are generally good and indicate that majority of the bacterial sampling sites within the Swan and Canning Rivers are acceptable for whole of body contact recreational activities.

The beach grades have taken into account a number of factors including historical microbial sampling data and known direct and indirect faecal pollutant sources. The grades are deliberately conservative and assign a sanitary inspection category according to its highest ranked pollutant source. As there are no direct human faecal pollutant sources known to be discharging regularly into the Swan and Canning Rivers, the risks to public health are lowered considerably.

Those sites assigned red grades are mostly located in the Upper Reaches of the Swan River. Elevated bacterial levels in these areas are likely to be due to a combination of factors such environmental conditions (low salinity, increased turbidity, and low dilution), as well as high bird populations and rainfall events. The majority of these sites are also located in areas where participation in whole-of-body contact activities such as swimming are not as popular in comparison to other parts of the Swan due to natural hazards making the water relatively dangerous and inaccessible to swim in.

The assignment of beach grades to the Swan and Canning River sampling sites is seen as the most effective way of providing the public with information on the potential health risk factors to help them make an informed decision about where and when they want to go swimming. Management strategies including on-site signage, stormwater mitigation and public education and awareness campaigns are important strategies to reduce the risks associated with recreational waters and public health.

## 12.0 Recommendations

12.1 That the current Swan and Canning River classifications to feature on the Healthy Swimming website prior to the November 2006 -2007 bathing season.

12.2 That the Environmental Health Directorate request additional sampling assistance from local governments for the 2006 – 2007 bathing season with the purpose of increasing the number of samples needed to calculate microbial assessment categories.

12.3 That the Environmental Health Directorate engage with the Swan River Trust to explore additional strategies to increase public awareness on safer swimming practices in the Swan and Canning Rivers.

12.4 That a copy of this report be featured on the Healthy Swimming website.

12.5 That a copy of this report to be provided to the following agencies to assist in management interventions aimed at reducing recreational risks to water users of the Swan and Canning Rivers;

- City of Perth
- Shire of Peppermint Grove
- Town of Mosman Park
- Town of East Fremantle
- City of Melville
- City of Canning
- City of South Perth
- City of Bayswater
- City of Nedlands
- Town of Victoria Park
- City of Gosnells
- City of Belmont
- City of Swan
- Town of Bassendean
- City of Subiaco
- Swan River Trust
- Department of Environment and Conservation
- Department of Water
- Water Corporation

12.6 That the Environmental Health Directorate engages discussions with relevant local governments identified with red sites within their jurisdiction to discuss additional management interventions.

12.7 That the Environmental Health Directorate investigates additional testing (e.g. coprostanol analysis) to confirm the origin of elevated enterococci levels from higher risk sampling site.

## 14.0 References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# Appendix 1
# Enterococci Values recorded during 2001 to 2006

**Middle Swan Reserve**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 20 |
| 20-Nov-01 | 160 |
| 18-Dec-01 | <10 |
| 11-Jan-02 | 30 |
| 22-Jan-02 | 86 |
| 12-Feb-02 | 1700 |
| 26-Feb-02 | 73 |
| 11-Mar-02 | 41 |
| 20-Mar-02 | 63 |
| 13-Nov-02 | 30 |
| 16-Feb-03 | 41 |
| 26-Feb-03 | 63 |
| 12-Mar-03 | 5200 |
| 03-Apr-03 | 340 |
| 17-Apr-03 | 52 |
| 30-Apr-03 | 210 |
| 28-May-03 | 200 |
| 05-Nov-03 | 63 |
| 19-Nov-03 | 910 |
| 04-Dec-03 | 130 |
| 16-Dec-03 | 180 |
| 08-Jan-04 | 380 |
| 19-Jan-04 | 150 |
| 04-Feb-04 | 120 |
| 19-Feb-04 | 500 |
| 11-Mar-04 | 840 |
| 17-Mar-04 | 1200 |
| 06-Apr-04 | 1200 |
| 21-Apr-04 | 1800 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | 74 |
| 15-Dec-04 | 180 |
| 21-Dec-04 | 31 |
| 13-Jan-05 | 410 |
| 01-Feb-05 | 150 |
| 14-Feb-05 | 120 |
| 01-Mar-05 | 63 |
| 14-Mar-05 | 260 |
| 11-Apr-05 | 97 |
| 18-Apr-05 | 160 |
| 04-Nov-05 | 52 |
| 16-Nov-05 | 2 |
| 29-Nov-05 | 230 |
| 21-Dec-05 | 74 |
| 10-Jan-06 | <10 |
| 06-Feb-06 | 52 |
| 20-Feb-06 | 52 |
| 10-Mar-06 | 52 |
| 28-Mar-06 | 110 |
| 04-Apr-06 | 390 |
| 27-Apr-06 | 750 |

**Ray Marshall Park**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 52 |
| 20-Nov-01 | 510 |
| 18-Dec-01 | 20 |
| 11-Jan-02 | 10 |
| 22-Jan-02 | 20 |
| 12-Feb-02 | 86 |
| 26-Feb-02 | 30 |
| 11-Mar-02 | 30 |
| 20-Mar-02 | <10 |
| 12-Apr-02 | 10 |
| 24-Apr-02 | 74 |
| 13-Nov-02 | 10 |
| 16-Feb-03 | 10 |
| 26-Feb-03 | 20 |
| 12-Mar-03 | 110 |
| 03-Apr-03 | 170 |
| 17-Apr-03 | 190 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | 30 |
| 19-Nov-03 | 130 |
| 04-Dec-03 | 10 |
| 16-Dec-03 | 10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | 10 |
| 04-Feb-04 | 210 |
| 19-Feb-04 | 700 |
| 11-Mar-04 | 31 |
| 17-Mar-04 | 97 |
| 06-Apr-04 | 150 |
| 21-Apr-04 | 86 |
| 03-Nov-04 | 20 |
| 22-Nov-04 | 20 |
| 15-Dec-04 | 52 |
| 21-Dec-04 | 97 |
| 13-Jan-05 | 20 |
| 01-Feb-05 | 10 |
| 14-Feb-05 | 20 |
| 01-Mar-05 | 30 |
| 14-Mar-05 | 52 |
| 11-Apr-05 | 31 |
| 18-Apr-05 | 63 |
| 04-Nov-05 | 63 |
| 16-Nov-05 | 11 |
| 29-Nov-05 | 190 |
| 21-Dec-05 | 10 |
| 10-Jan-06 | 10 |
| 23-Jan-06 | 41 |
| 06-Feb-06 | 20 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | 41 |
| 28-Mar-06 | 140 |
| 04-Apr-06 | 720 |
| 27-Apr-06 | 360 |

**Success Hill Reserve**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 85 |
| 20-Nov-01 | 110 |
| 18-Dec-01 | 41 |
| 11-Jan-02 | 10 |
| 22-Jan-02 | 41 |
| 12-Feb-02 | 10 |
| 26-Feb-02 | 10 |
| 11-Mar-02 | 74 |
| 20-Mar-02 | <10 |
| 12-Apr-02 | 30 |
| 24-Apr-02 | 41 |
| 13-Nov-02 | 20 |
| 14-Feb-03 | 52 |
| 26-Feb-03 | 63 |
| 12-Mar-03 | 370 |
| 03-Apr-03 | 30 |
| 17-Apr-03 | 63 |
| 30-Apr-03 | 31 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 85 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | 74 |
| 08-Jan-04 | 41 |
| 19-Jan-04 | 30 |
| 20-Jan-04 | 41 |
| 04-Feb-04 | 130 |
| 19-Feb-04 | 550 |
| 11-Mar-04 | 10 |
| 17-Mar-04 | 52 |
| 06-Apr-04 | 74 |
| 21-Apr-04 | 120 |
| 03-Nov-04 | 20 |
| 22-Nov-04 | 52 |
| 15-Dec-04 | 250 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | 52 |
| 01-Feb-05 | 120 |
| 14-Feb-05 | 52 |
| 01-Mar-05 | 41 |
| 14-Mar-05 | 20 |
| 11-Apr-05 | 10 |
| 18-Apr-05 | 31 |
| 04-Nov-05 | <10 |
| 16-Nov-05 | 3 |
| 29-Nov-05 | 52 |
| 21-Dec-05 | 20 |
| 23-Jan-06 | 120 |

# Appendix 1
# Enterococci Values recorded during 2001 to 2006

**Kings Meadow Reserve**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 20 |
| 20-Nov-01 | 130 |
| 18-Dec-01 | 10 |
| 11-Jan-02 | 20 |
| 22-Jan-02 | 20 |
| 12-Feb-02 | 41 |
| 26-Feb-02 | 20 |
| 11-Mar-02 | 51 |
| 20-Mar-02 | 10 |
| 12-Apr-02 | 10 |
| 24-Apr-02 | 52 |
| 13-Nov-02 | 20 |
| 16-Feb-03 | 20 |
| 26-Feb-03 | 20 |
| 12-Mar-03 | 52 |
| 03-Apr-03 | 86 |
| 17-Apr-03 | 74 |
| 30-Apr-03 | 10 |
| 28-May-03 | 31 |
| 05-Nov-03 | 74 |
| 19-Nov-03 | 52 |
| 04-Dec-03 | 20 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | 20 |
| 19-Jan-04 | 20 |
| 04-Feb-04 | 20 |
| 19-Feb-04 | 490 |
| 11-Mar-04 | <10 |
| 17-Mar-04 | 10 |
| 06-Apr-04 | 96 |
| 21-Apr-04 | 290 |
| 03-Nov-04 | 10 |
| 22-Nov-04 | 74 |
| 15-Dec-04 | 160 |
| 21-Dec-04 | 20 |
| 13-Jan-05 | 110 |
| 01-Feb-05 | 74 |
| 14-Feb-05 | 96 |
| 01-Mar-05 | 41 |
| 14-Mar-05 | 85 |
| 11-Apr-05 | 10 |
| 18-Apr-05 | 20 |
| 04-Nov-05 | 52 |
| 16-Nov-05 | 2 |
| 29-Nov-05 | 23 |
| 21-Dec-05 | 52 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | 31 |
| 06-Feb-06 | 52 |
| 20-Feb-06 | 52 |
| 10-Mar-06 | 63 |
| 28-Mar-06 | 63 |
| 04-Apr-06 | 260 |
| 27-Apr-06 | 120 |

**Sandy Beach Reserve**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 31 |
| 20-Nov-01 | 74 |
| 18-Dec-01 | 10 |
| 11-Jan-02 | <10 |
| 22-Jan-02 | <10 |
| 12-Feb-02 | 30 |
| 26-Feb-02 | 52 |
| 11-Mar-02 | 30 |
| 20-Mar-02 | 10 |
| 12-Apr-02 | 31 |
| 24-Apr-02 | 10 |
| 13-Nov-02 | 20 |
| 14-Feb-03 | 20 |
| 26-Feb-03 | 31 |
| 12-Mar-03 | 63 |
| 03-Apr-03 | 63 |
| 17-Apr-03 | 74 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | 10 |
| 19-Nov-03 | 52 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | 10 |
| 08-Jan-04 | 10 |
| 19-Jan-04 | 10 |
| 04-Feb-04 | 31 |
| 19-Feb-04 | 1100 |
| 11-Mar-04 | 20 |
| 17-Mar-04 | 98 |
| 06-Apr-04 | 73 |
| 21-Apr-04 | 170 |
| 03-Nov-04 | 86 |
| 22-Nov-04 | 20 |
| 15-Dec-04 | 41 |
| 21-Dec-04 | 20 |
| 13-Jan-05 | 41 |
| 01-Feb-05 | 74 |
| 14-Feb-05 | 20 |
| 01-Mar-05 | 10 |
| 14-Mar-05 | 52 |
| 11-Apr-05 | 10 |
| 18-Apr-05 | 10 |
| 04-Nov-05 | 63 |
| 16-Nov-05 | 9 |
| 29-Nov-05 | 41 |
| 21-Dec-05 | 20 |
| 10-Jan-06 | 20 |
| 23-Jan-06 | 20 |
| 06-Feb-06 | 41 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | 31 |
| 28-Mar-06 | 31 |
| 04-Apr-06 | 20 |
| 27-Apr-06 | 41 |

**Garvey Park**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 84 |
| 20-Nov-01 | 90 |
| 18-Dec-01 | <10 |
| 11-Jan-02 | 110 |
| 22-Jan-02 | 10 |
| 12-Feb-02 | 96 |
| 26-Feb-02 | 41 |
| 11-Mar-02 | 10 |
| 20-Mar-02 | 10 |
| 12-Apr-02 | <10 |
| 24-Apr-02 | 10 |
| 13-Nov-02 | 20 |
| 16-Feb-03 | <10 |
| 26-Feb-03 | 20 |
| 12-Mar-03 | 31 |
| 03-Apr-03 | 20 |
| 17-Apr-03 | 86 |
| 30-Apr-03 | 10 |
| 28-May-03 | 31 |
| 05-Nov-03 | 30 |
| 19-Nov-03 | 63 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | 10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | 31 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 130 |
| 11-Mar-04 | 41 |
| 17-Mar-04 | 74 |
| 06-Apr-04 | 74 |
| 21-Apr-04 | 110 |
| 03-Nov-04 | 63 |
| 22-Nov-04 | 20 |
| 15-Dec-04 | 74 |
| 21-Dec-04 | 20 |
| 13-Jan-05 | 31 |
| 01-Feb-05 | 20 |
| 14-Feb-05 | 41 |
| 01-Mar-05 | 31 |
| 14-Mar-05 | 10 |
| 11-Apr-05 | 31 |
| 18-Apr-05 | 10 |
| 04-Nov-05 | 31 |
| 16-Nov-05 | 9 |

# Appendix 1
# Enterococci Values recorded during 2001 to 2006

| | |
|---|---|
| 29-Nov-05 | 63 |
| 21-Dec-05 | 31 |
| 10-Jan-06 | 20 |
| 23-Jan-06 | 31 |
| 24-Jan-06 | <10 |
| 06-Feb-06 | 74 |
| 07-Feb-06 | 30 |
| 20-Feb-06 | 52 |
| 21-Feb-06 | 41 |
| 09-Mar-06 | 10 |
| 10-Mar-06 | 10 |
| 21-Mar-06 | 63 |
| 04-Apr-06 | <10 |
| 04-Apr-06 | 41 |
| 18-Apr-06 | 20 |
| 27-Apr-06 | 10 |

**Hinds Reserve**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | <10 |
| 20-Nov-01 | 85 |
| 18-Dec-01 | 330 |
| 11-Jan-02 | 20 |
| 22-Jan-02 | 20 |
| 12-Feb-02 | 30 |
| 26-Feb-02 | 160 |
| 11-Mar-02 | 10 |
| 20-Mar-02 | 20 |
| 12-Apr-02 | <10 |
| 24-Apr-02 | 10 |
| 13-Nov-02 | 10 |
| 14-Feb-03 | 10 |
| 26-Feb-03 | 10 |
| 12-Mar-03 | 41 |
| 03-Apr-03 | 30 |
| 17-Apr-03 | 63 |
| 30-Apr-03 | 30 |
| 05-Nov-03 | 20 |
| 19-Nov-03 | <10 |
| 04-Dec-03 | 41 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | 52 |
| 04-Feb-04 | 20 |
| 19-Feb-04 | 600 |
| 11-Mar-04 | 20 |
| 17-Mar-04 | 20 |
| 06-Apr-04 | 52 |
| 21-Apr-04 | 74 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | 31 |
| 15-Dec-04 | 74 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | 63 |
| 01-Feb-05 | 74 |
| 14-Feb-05 | 31 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | 41 |
| 11-Apr-05 | <10 |
| 18-Apr-05 | 52 |
| 04-Nov-05 | <10 |
| 16-Nov-05 | 10 |
| 29-Nov-05 | 63 |
| 21-Dec-05 | 20 |
| 10-Jan-06 | 30 |
| 23-Jan-06 | 63 |
| 06-Feb-06 | 86 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | 86 |
| 28-Mar-06 | 52 |
| 04-Apr-06 | 41 |
| 27-Apr-06 | 52 |

**Belmont Park**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 16-Feb-03 | 20 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | 10 |
| 03-Apr-03 | 20 |
| 17-Apr-03 | 52 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 20 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | 31 |
| 19-Jan-04 | 41 |
| 04-Feb-04 | 31 |
| 19-Feb-04 | 30 |
| 11-Mar-04 | 20 |
| 17-Mar-04 | 20 |
| 06-Apr-04 | 10 |
| 21-Apr-04 | 20 |
| 03-Nov-04 | 20 |
| 22-Nov-04 | 20 |
| 15-Dec-04 | 30 |
| 21-Dec-04 | 10 |
| 13-Jan-05 | 10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | 20 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | 20 |
| 11-Apr-05 | 20 |
| 18-Apr-05 | 63 |
| 04-Nov-05 | 10 |
| 16-Nov-05 | 1 |
| 29-Nov-05 | 41 |
| 21-Dec-05 | 10 |
| 10-Jan-06 | 31 |
| 23-Jan-06 | 20 |
| 24-Jan-06 | 20 |
| 06-Feb-06 | 20 |
| 07-Feb-06 | 41 |
| 20-Feb-06 | 74 |
| 21-Feb-06 | 52 |
| 09-Mar-06 | 10 |
| 10-Mar-06 | 74 |
| 21-Mar-06 | 74 |
| 28-Mar-06 | 230 |
| 04-Apr-06 | <10 |
| 04-Apr-06 | 31 |
| 18-Apr-06 | 20 |
| 27-Apr-06 | 20 |

**Cracknell Park**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 16-Feb-03 | 20 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | 10 |
| 03-Apr-03 | 20 |
| 17-Apr-03 | 52 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 20 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | 31 |
| 19-Jan-04 | 41 |
| 04-Feb-04 | 31 |
| 19-Feb-04 | 30 |
| 11-Mar-04 | 20 |
| 17-Mar-04 | 20 |
| 06-Apr-04 | 10 |
| 21-Apr-04 | 20 |
| 03-Nov-04 | 20 |
| 22-Nov-04 | 20 |
| 15-Dec-04 | 30 |
| 21-Dec-04 | 10 |
| 13-Jan-05 | 10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | 20 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | 20 |
| 11-Apr-05 | 20 |
| 18-Apr-05 | 63 |
| 04-Nov-05 | 10 |
| 16-Nov-05 | 1 |
| 29-Nov-05 | 41 |
| 21-Dec-05 | 10 |

# Appendix 1
# Enterococci Values recorded during 2001 to 2006

| | |
|---|---|
| 10-Jan-06 | 31 |
| 23-Jan-06 | 20 |
| 24-Jan-06 | 20 |
| 06-Feb-06 | 20 |
| 07-Feb-06 | 41 |
| 20-Feb-06 | 74 |
| 21-Feb-06 | 52 |
| 09-Mar-06 | 10 |
| 10-Mar-06 | 74 |
| 21-Mar-06 | 74 |
| 28-Mar-06 | 230 |
| 04-Apr-06 | <10 |
| 04-Apr-06 | 31 |
| 18-Apr-06 | 20 |
| 27-Apr-06 | 20 |

**East St, Maylands**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14-Feb-03 | 20 |
| 26-Feb-03 | 31 |
| 12-Mar-03 | 500 |
| 03-Apr-03 | 180 |
| 17-Apr-03 | 20 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 74 |
| 04-Dec-03 | 10 |
| 16-Dec-03 | 10 |
| 08-Jan-04 | 20 |
| 19-Jan-04 | >24000 |
| 04-Feb-04 | 31 |
| 19-Feb-04 | 62 |
| 11-Mar-04 | 84 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | 20 |
| 21-Apr-04 | 10 |
| 03-Nov-04 | 5500 |
| 22-Nov-04 | 200 |
| 15-Dec-04 | 74 |
| 21-Dec-04 | 10 |
| 13-Jan-05 | 200 |
| 01-Feb-05 | 190 |
| 14-Feb-05 | 85 |
| 01-Mar-05 | 20 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | 31 |
| 18-Apr-05 | 10 |
| 04-Nov-05 | 52 |
| 16-Nov-05 | 9 |
| 29-Nov-05 | 52 |
| 21-Dec-05 | 52 |
| 10-Jan-06 | 20 |
| 23-Jan-06 | 86 |
| 06-Feb-06 | 51 |
| 20-Feb-06 | 20 |
| 10-Mar-06 | 31 |
| 28-Mar-06 | 31 |
| 04-Apr-06 | 10 |
| 27-Apr-06 | 74 |

**Coode St, South Perth**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 74 |
| 20-Nov-01 | <10 |
| 18-Dec-01 | 10 |
| 11-Jan-02 | 86 |
| 22-Jan-02 | 41 |
| 12-Feb-02 | 31 |
| 26-Feb-02 | 20 |
| 11-Mar-02 | <10 |
| 20-Mar-02 | 20 |
| 12-Apr-02 | 10 |
| 24-Apr-02 | <10 |
| 13-Nov-02 | 460 |
| 14-Feb-03 | 31 |
| 26-Feb-03 | 20 |
| 12-Mar-03 | 10 |
| 03-Apr-03 | 85 |
| 17-Apr-03 | 52 |
| 30-Apr-03 | 52 |
| 05-Nov-03 | 110 |
| 19-Nov-03 | 110 |
| 04-Dec-03 | 31 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | 31 |
| 19-Jan-04 | 20 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | <10 |
| 11-Mar-04 | 52 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | 20 |
| 21-Apr-04 | 74 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | 63 |
| 15-Dec-04 | 31 |
| 21-Dec-04 | 160 |
| 13-Jan-05 | 20 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | 10 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | 10 |
| 18-Apr-05 | 41 |
| 04-Nov-05 | 31 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | <10 |
| 21-Dec-05 | <10 |
| 10-Jan-06 | 10 |
| 23-Jan-06 | 30 |
| 06-Feb-06 | 41 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | <10 |
| 27-Apr-06 | <10 |

**Narrows Bridge**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 52 |
| 20-Nov-01 | 31 |
| 18-Dec-01 | 41 |
| 11-Jan-02 | 72 |
| 22-Jan-02 | 41 |
| 12-Feb-02 | 41 |
| 26-Feb-02 | 20 |
| 11-Mar-02 | <10 |
| 20-Mar-02 | <10 |
| 12-Apr-02 | <10 |
| 24-Apr-02 | 10 |
| 13-Nov-02 | <10 |
| 14-Feb-03 | 20 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | 30 |
| 03-Apr-03 | <10 |
| 17-Apr-03 | 20 |
| 30-Apr-03 | 10 |
| 05-Nov-03 | 10 |
| 19-Nov-03 | 31 |
| 04-Dec-03 | 20 |
| 16-Dec-03 | 10 |
| 08-Jan-04 | 10 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 20 |
| 11-Mar-04 | 10 |
| 17-Mar-04 | 52 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | <10 |
| 03-Nov-04 | 10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | 20 |
| 01-Feb-05 | 10 |
| 14-Feb-05 | 10 |
| 01-Mar-05 | 40 |
| 14-Mar-05 | 10 |
| 11-Apr-05 | 10 |
| 18-Apr-05 | <10 |

# Appendix 1
# Enterococci Values recorded during 2001 to 2006

| | |
|---|---|
| 04-Nov-05 | <10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | 160 |
| 21-Dec-05 | 10 |
| 10-Jan-06 | 10 |
| 23-Jan-06 | 10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | 20 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | <10 |
| 27-Apr-06 | <10 |

**Hackett Drive (Kiosk)**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 31 |
| 20-Nov-01 | 20 |
| 18-Dec-01 | <10 |
| 11-Jan-02 | 170 |
| 22-Jan-02 | 31 |
| 12-Feb-02 | <10 |
| 26-Feb-02 | 10 |
| 11-Mar-02 | 10 |
| 20-Mar-02 | 10 |
| 12-Apr-02 | <10 |
| 24-Apr-02 | <10 |
| 13-Nov-02 | <10 |
| 14-Feb-03 | <10 |
| 26-Feb-03 | 10 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | 200 |
| 17-Apr-03 | 20 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | <10 |
| 04-Dec-03 | 470 |
| 16-Dec-03 | 10 |
| 08-Jan-04 | 10 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | 31 |
| 19-Feb-04 | 74 |
| 11-Mar-04 | 10 |
| 17-Mar-04 | 20 |
| 06-Apr-04 | 74 |
| 03-Nov-04 | 10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | 10 |
| 21-Dec-04 | 63 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | 41 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | 41 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | <10 |
| 18-Apr-05 | 10 |
| 04-Nov-05 | 10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | 10 |
| 21-Dec-05 | <10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | <10 |
| 06-Feb-06 | 41 |
| 20-Feb-06 | 41 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | 10 |
| 27-Apr-06 | 20 |

**Hackett Drive (tree)**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| | <10 |
| 14-Feb-03 | <10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | 10 |
| 17-Apr-03 | 10 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 20 |
| 04-Dec-03 | 52 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | 31 |
| 19-Jan-04 | 10 |
| 04-Feb-04 | 10 |
| 19-Feb-04 | 74 |
| 11-Mar-04 | 52 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | 86 |
| 21-Apr-04 | <10 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | 10 |
| 13-Jan-05 | 31 |
| 01-Feb-05 | 31 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | 20 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | <10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | <10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | 10 |
| 21-Dec-05 | 10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | 10 |
| 06-Feb-06 | 52 |
| 20-Feb-06 | 20 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | <10 |
| 27-Apr-06 | 52 |

**Como Beach North**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14-Feb-03 | <10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | <10 |
| 17-Apr-03 | 10 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 140 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 190 |
| 11-Mar-04 | <10 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | 74 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | <10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | 10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | 20 |
| 21-Dec-05 | 10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | <10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | <10 |
| 27-Apr-06 | <10 |

# Appendix 1
# Enterococci Values recorded during 2001 to 2006

**Como Beach South**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14-Feb-03 | <10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | 61 |
| 03-Apr-03 | <10 |
| 17-Apr-03 | <10 |
| 17-Apr-03 | 160 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 200 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 110 |
| 11-Mar-04 | <10 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | 120 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | 10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | 10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | 52 |
| 21-Dec-05 | 10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | <10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | <10 |
| 27-Apr-06 | <10 |

**Como Beach Jetty**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | <10 |
| 20-Nov-01 | <10 |
| 18-Dec-01 | 10 |
| 11-Jan-02 | <10 |
| 22-Jan-02 | <10 |
| 12-Feb-02 | 430 |
| 26-Feb-02 | 10 |
| 11-Mar-02 | <10 |
| 20-Mar-02 | <10 |
| 12-Apr-02 | <10 |
| 24-Apr-02 | 10 |
| 13-Nov-02 | <10 |
| 14-Feb-03 | <10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | <10 |
| 17-Apr-03 | <10 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 74 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 10 |
| 11-Mar-04 | <10 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | <10 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | 10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | 10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | <10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | <10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | 10 |
| 21-Dec-05 | <10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | 10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | <10 |
| 27-Apr-06 | 10 |

**Abrahams Reserve Beach**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14-Feb-03 | <10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | 52 |
| 17-Apr-03 | <10 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | <10 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | 41 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 10 |
| 11-Mar-04 | 31 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | 10 |
| 21-Apr-04 | 20 |
| 03-Nov-04 | 20 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | 10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | 63 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | 10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | <10 |
| 21-Dec-05 | <10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | <10 |
| 06-Feb-06 | 10 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | 10 |
| 27-Apr-06 | 41 |

# Appendix 1
# Enterococci Values recorded during 2001 to 2006

**Deep Water Point**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14/02/2003 | <10 |
| 26/02/2003 | <10 |
| 12/03/2003 | <10 |
| 3/04/2003 | 10 |
| 30/04/2003 | <10 |
| 5/11/2003 | 20 |
| 19/11/2003 | 10 |
| 4/12/2003 | 10 |
| 16/12/2003 | <10 |
| 8/01/2004 | 10 |
| 19/01/2004 | 10 |
| 4/02/2004 | 20 |
| 19/02/2004 | <10 |
| 11/03/2004 | <10 |
| 17/03/2004 | <10 |
| 6/04/2004 | 10 |
| 21/04/2004 | 63 |
| 3/11/2004 | <10 |
| 22/11/2004 | <10 |
| 15/12/2004 | <10 |
| 21/12/2004 | <10 |
| 13/01/2005 | 10 |
| 1/02/2005 | <10 |
| 14/02/2005 | <10 |
| 1/03/2005 | 10 |
| 14/03/2005 | <10 |
| 11/04/2005 | 20 |
| 18/04/2005 | 10 |
| 04-Nov-05 | <10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | 10 |
| 21-Dec-05 | <10 |
| 10-Jan-06 | 10 |
| 23-Jan-06 | <10 |
| 30-Jan-06 | <10 |
| 30-Jan-06 | 41 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 20-Feb-06 | 10 |
| 20-Feb-06 | <10 |
| 02-Mar-06 | <10 |
| 02-Mar-06 | <10 |
| 10-Mar-06 | 10 |
| 16-Mar-06 | <10 |
| 16-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 30-Mar-06 | <10 |
| 30-Mar-06 | 10 |
| 04-Apr-06 | 31 |
| 11-Apr-06 | <10 |
| 11-Apr-06 | 10 |
| 27-Apr-06 | <10 |

**Shelley Beach**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14-Feb-03 | 2200 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | 10 |
| 03-Apr-03 | 10 |
| 17-Apr-03 | 10 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 86 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | 20 |
| 08-Jan-04 | 10 |
| 19-Jan-04 | 10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 570 |
| 11-Mar-04 | 10 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | 4600 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | 10 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | 10 |
| 11-Apr-05 | 10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | 63 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | 10 |
| 21-Dec-05 | 20 |
| 10-Jan-06 | 10 |
| 23-Jan-06 | <10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | 10 |
| 04-Apr-06 | <10 |
| 27-Apr-06 | 41 |

**Waylen Bay (Scout Hall)**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14-Feb-03 | <10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | <10 |
| 17-Apr-03 | 31 |
| 30-Apr-03 | <10 |
| 28-May-03 | 30 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 110 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 10 |
| 11-Mar-04 | 10 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | 20 |
| 21-Apr-04 | 570 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | 31 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | <10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | <10 |
| 21-Dec-05 | <10 |
| 10-Jan-06 | 10 |
| 23-Jan-06 | <10 |
| 30-Jan-06 | 10 |
| 30-Jan-06 | 10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 02-Mar-06 | <10 |
| 02-Mar-06 | <10 |
| 16-Mar-06 | 10 |
| 16-Mar-06 | 10 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 30-Mar-06 | <10 |

# Appendix 1
# Enterococci Values recorded during 2001 to 2006

| | |
|---|---|
| 30-Mar-06 | 10 |
| 04-Apr-06 | <10 |
| 11-Apr-06 | <10 |
| 11-Apr-06 | <10 |
| 27-Apr-06 | <10 |
| 30-Jan-06 | 10 |
| 16-Mar-06 | <10 |

**Cunningham Steet**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 10 |
| 20-Nov-01 | 10 |
| 07-Dec-01 | 10 |
| 18-Dec-01 | <10 |
| 11-Jan-02 | <10 |
| 22-Jan-02 | <10 |
| 11-Feb-02 | <10 |
| 26-Feb-02 | <10 |
| 11-Mar-02 | <10 |
| 20-Mar-02 | 20 |
| 12-Apr-02 | <10 |
| 24-Apr-02 | <10 |
| 13-Nov-02 | 10 |
| 14-Feb-03 | <10 |
| 26-Feb-03 | 52 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | <10 |
| 17-Apr-03 | 20 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 10 |
| 04-Dec-03 | 10 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | 10 |
| 19-Jan-04 | 10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 31 |
| 11-Mar-04 | <10 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | 280 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | 10 |
| 13-Jan-05 | 10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | 10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | <10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | <10 |
| 21-Dec-05 | <10 |
| 10-Jan-06 | <10 |
| 30-Jan-06 | 10 |
| 30-Jan-06 | 20 |
| 23-Jan-06 | <10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 02-Mar-06 | 10 |
| 02-Mar-06 | 20 |
| 10-Mar-06 | 10 |
| 16-Mar-06 | <10 |
| 16-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 30-Mar-06 | <10 |
| 30-Mar-06 | <10 |
| 04-Apr-06 | 10 |
| 11-Apr-06 | <10 |
| 11-Apr-06 | <10 |
| 27-Apr-06 | <10 |

**Point Walter (Kiosk)**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14-Feb-03 | <10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | 20 |
| 17-Apr-03 | 230 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 10 |
| 04-Dec-03 | 10 |
| 16-Dec-03 | 10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 31 |
| 11-Mar-04 | <10 |
| 17-Mar-04 | 31 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | 120 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | 31 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | 10 |
| 11-Apr-05 | <10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | <10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | <10 |
| 21-Dec-05 | <10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | <10 |
| 30-Jan-06 | <10 |
| 30-Jan-06 | <10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 20-Feb-06 | 52 |
| 20-Feb-06 | <10 |
| 02-Mar-06 | 180 |
| 02-Mar-06 | 160 |
| 10-Mar-06 | <10 |
| 16-Mar-06 | 10 |
| 16-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 30-Mar-06 | <10 |
| 30-Mar-06 | <10 |
| 04-Apr-06 | 10 |
| 11-Apr-06 | 41 |
| 11-Apr-06 | 20 |
| 27-Apr-06 | <10 |

# Appendix 1
# Enterococci Values recorded during 2001 to 2006

**Point Walter (Boat Ramp)**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14-Feb-03 | <10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | <10 |
| 17-Apr-03 | 940 |
| 30-Apr-03 | 10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 10 |
| 04-Dec-03 | 10 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 31 |
| 11-Mar-04 | <10 |
| 17-Mar-04 | 10 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | 160 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | 10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | 20 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | 10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | 10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | <10 |
| 21-Dec-05 | <10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | <10 |
| 30-Jan-06 | <10 |
| 30-Jan-06 | <10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 20-Feb-06 | 20 |
| 20-Feb-06 | <10 |
| 02-Mar-06 | 20 |
| 02-Mar-06 | 10 |
| 10-Mar-06 | 10 |
| 16-Mar-06 | <10 |
| 16-Mar-06 | 10 |
| 28-Mar-06 | <10 |
| 30-Mar-06 | 10 |
| 30-Mar-06 | <10 |
| 04-Apr-06 | <10 |
| 11-Apr-06 | 20 |
| 11-Apr-06 | <10 |
| 27-Apr-06 | 10 |

**Keane Street**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 20 |
| 20-Nov-01 | 160 |
| 07-Dec-01 | 51 |
| 18-Dec-01 | 10 |
| 11-Jan-02 | 10 |
| 22-Jan-02 | 10 |
| 11-Feb-02 | <10 |
| 26-Feb-02 | 20 |
| 11-Mar-02 | 110 |
| 20-Mar-02 | <10 |
| 12-Apr-02 | <10 |
| 13-Nov-02 | 20 |
| 14-Feb-03 | <10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | 20 |
| 03-Apr-03 | 10 |
| 17-Apr-03 | 10 |
| 30-Apr-03 | 230 |
| 05-Nov-03 | 63 |
| 19-Nov-03 | <10 |
| 04-Dec-03 | 30 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | 10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 31 |
| 11-Mar-04 | 30 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | 140 |
| 21-Apr-04 | 170 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | 10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | 41 |
| 14-Mar-05 | 200 |
| 11-Apr-05 | <10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | 20 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | 10 |
| 21-Dec-05 | <10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | 10 |
| 06-Feb-06 | 10 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | 10 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | 10 |
| 27-Apr-06 | <10 |

**Johnston Street**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14-Feb-03 | <10 |
| 26-Feb-03 | 170 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | 380 |
| 17-Apr-03 | <10 |
| 30-Apr-03 | <10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | <10 |
| 04-Dec-03 | 20 |
| 16-Dec-03 | <10 |
| 08-Jan-04 | <10 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | 31 |
| 19-Feb-04 | <10 |
| 11-Mar-04 | <10 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | <10 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | 10 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | 10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | 10 |
| 14-Mar-05 | 10 |
| 11-Apr-05 | <10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | <10 |
| 16-Nov-05 | <10 |
| 29-Nov-05 | <10 |
| 21-Dec-05 | 10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | <10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | <10 |
| 27-Apr-06 | 10 |

# Appendix 1
# Enterococci Values recorded during 2001 to 2006

**Bicton Baths**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 02-Nov-01 | 20 |
| 20-Nov-01 | <10 |
| 07-Dec-01 | 10 |
| 18-Dec-01 | <10 |
| 11-Jan-02 | 10 |
| 22-Jan-02 | 10 |
| 11-Feb-02 | 41 |
| 26-Feb-02 | 41 |
| 11-Mar-02 | <10 |
| 20-Mar-02 | 20 |
| 12-Apr-02 | <10 |
| 24-Apr-02 | <10 |
| 13-Nov-02 | 10 |
| 14-Feb-03 | <10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | <10 |
| 17-Apr-03 | 10 |
| 30-Apr-03 | 10 |
| 05-Nov-03 | <10 |
| 19-Nov-03 | 10 |
| 04-Dec-03 | <10 |
| 16-Dec-03 | 10 |
| 08-Jan-04 | 31 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 200 |
| 11-Mar-04 | <10 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | <10 |
| 03-Nov-04 | 10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | 10 |
| 21-Dec-04 | <10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | <10 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | <10 |
| 16-Nov-05 | 10 |
| 29-Nov-05 | <10 |
| 21-Dec-05 | 10 |
| 10-Jan-06 | <10 |
| 23-Jan-06 | <10 |
| 30-Jan-06 | 20 |
| 30-Jan-06 | 10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 20-Feb-06 | 20 |
| 02-Mar-06 | 10 |
| 02-Mar-06 | <10 |
| 10-Mar-06 | 10 |
| 16-Mar-06 | <10 |
| 16-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 30-Mar-06 | <10 |
| 30-Mar-06 | <10 |
| 04-Apr-06 | <10 |
| 11-Apr-06 | <10 |
| 11-Apr-06 | <10 |
| 27-Apr-06 | <10 |

**Preston Point**

| Sampling Date | Enterococci value mpn/100ml |
|---|---|
| 14-Feb-03 | 10 |
| 26-Feb-03 | <10 |
| 12-Mar-03 | <10 |
| 03-Apr-03 | <10 |
| 17-Apr-03 | 63 |
| 30-Apr-03 | 20 |
| 05-Nov-03 | 10 |
| 19-Nov-03 | <10 |
| 04-Dec-03 | 10 |
| 16-Dec-03 | 10 |
| 08-Jan-04 | 86 |
| 19-Jan-04 | <10 |
| 04-Feb-04 | <10 |
| 19-Feb-04 | 330 |
| 11-Mar-04 | <10 |
| 17-Mar-04 | <10 |
| 06-Apr-04 | <10 |
| 21-Apr-04 | 120 |
| 03-Nov-04 | <10 |
| 22-Nov-04 | <10 |
| 15-Dec-04 | <10 |
| 21-Dec-04 | 10 |
| 13-Jan-05 | <10 |
| 01-Feb-05 | <10 |
| 14-Feb-05 | <10 |
| 01-Mar-05 | <10 |
| 14-Mar-05 | <10 |
| 11-Apr-05 | 63 |
| 18-Apr-05 | <10 |
| 04-Nov-05 | 20 |
| 16-Nov-05 | 3 |
| 29-Nov-05 | <10 |
| 13-Dec-05 | <10 |
| 21-Dec-05 | 10 |
| 10-Jan-06 | <10 |
| 20-Jan-06 | <10 |
| 23-Jan-06 | <10 |
| 06-Feb-06 | <10 |
| 20-Feb-06 | <10 |
| 10-Mar-06 | <10 |
| 28-Mar-06 | <10 |
| 04-Apr-06 | <10 |
| 27-Apr-06 | 10 |

# Appendix 2
# Standard Sanitary Survey Checklist

**DATE** _____/_____/_____

**SITE IDENTIFICATION**

Type of site: ☐ Estuarine ☐ Coastal ☐ Enclosed Bay ☐ Other: _____

Site Name: _____ Northing: _____

Site Code: _____ Easting: _____

Name of Local Authority: _____

Name of Contact Person Compiling list: _____

**LAND USE**

Immediate Land Cover and Geography

☐ Forest/bush ☐ Sand dunes ☐ Hilly ☐ Flat

☐ Pasture ☐ Urban ☐ Swamp/mangrove ☐ Parks & Gardens

☐ Other _____

Urban

☐ Residential ☐ Harbour ☐ Sanitary landfills/old dumps

☐ Commercial ☐ Road/rail

☐ Industrial (specify) _____

Rural Land Use

☐ Sheep ☐ Dairy/beef ☐ Poultry ☐ Horses ☐ Feral

Is there potential for run-off from untreated animal effluent (e.g. dairy, piggeries, miking sheds etc)

☐ Yes ☐ No

Is there unrestricted stock access to waterways? (e.g. do cattle enter waterway) ☐ Yes ☐ No

Do other rivers or their tributaries flow into or near the site? ☐ Yes ☐ No

If yes, please specify: _____

**LAND USE**

Boating facilities

☐ Marina ☐ Permanent boat moorings ☐ Jetty ☐ Boat ramp

Is there a beach area? ☐ Yes ☐ No

Is the beach subject to above average summer/holiday bather loading? ☐ Yes ☐ No

Besides swimming do other water sports commonly occur in the water? ☐ Yes ☐ No

☐ Water skiing ☐ Jet-skiing ☐ Fishing ☐ Canoeing/kayaking ☐ Boating ☐ Catamaran

What types of people use the beach? ☐ Mixture ☐ Mostly elderly ☐ Children ☐ Tourists

# Appendix 2
# Standard Sanitary Survey Checklist

**IMMEDIATE AREA**

Is the area used as an animal exercise site? ☐ Yes ☐ No

If yes, are dog waste bags provided? ☐ Yes ☐ No

Are toilet facilities provided in the immediate area? ☐ Yes ☐ No ☐ Septic ☐ Sewer

Are car parking bays provided? ☐ Yes ☐ No

Are bbq facilities provided? ☐ Yes ☐ No

Are rubbish bins provided? ☐ Yes ☐ No

Additional comments: _____

**PREVIOUS LAND USES**

Have any previous land use activities occurred in the surrounding area which may contribute to elevated microbial levels in the water? E.G. ex landfill site, wastewater treatment plant.

**STORMWATER**

Do stormwater drains discharge within a 500m radius of the site? ☐ Yes ☐ No

If yes, how many _____

Provide maps of drainage points.

Are drains fitted with gross pollutant traps? ☐ Yes ☐ No

Is nutrient stripping provided for drains? ☐ Yes ☐ No

Are drains protected from sewage ingress? ☐ Yes ☐ No

Have any illegal cross-connections been detected on drains in the past? ☐ Yes ☐ No

If yes, please specify: _____

Is there a regular drain inspection /maintenance program? ☐ Yes ☐ No

Additional comments: _____

# Appendix 2
# Standard Sanitary Survey Checklist

**SEPTICS**

Are surrounding properties connected to septics? ☐ Yes ☐ No

If yes, provide maps of septic locations

Additional comments

**WILDLIFE**

Do native animals regularly frequent the area? ☐ Yes ☐ No

☐ Ducks ☐ Geese ☐ Seagulls ☐ Swans ☐ Parrots ☐ Other

Describe the density of the bird population: ☐ High ☐ Medium ☐ Low

Are structures present to promote birds nesting sites? E.G. jetty ☐ Yes ☐ No

**PREVIOUS HEALTH ALERT EVENTS**

Have any known events occurred in the water which has led to closure or reported illness? ☐ Yes ☐ No

☐ Algal bloom ☐ Wastewater overflow ☐ Other: _____

**OTHER POSSIBLE MICOBIAL CONTRIBUTORS**

**COUNCIL MANAGEMENT**

Are shorelines regularly inspected for pollution? ☐ Yes ☐ No

Is the local authority equipped with a sufficient number of Health Warning signs to erect during an emergency event e.g. wastewater overflow, ☐ Yes ☐ No

Are permanent health advice signs installed at the site warning people of hazards in the water? ☐ Yes ☐ No

Additional comments

# Appendix 3
# Sanitary Inspection Category Methodology

The below SIC methodology has been developed with guidance from the Water Services Association of Australia *Catchments for Recreational Water: Conducting and Assessing Sanitary Inspections* and the New Zealand *Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas*. A sampling location is assigned the highest ranked category identified.

| Faecal Pollution Sources | Description | Sanitary Inspection Category | Y/N |
|---|---|---|---|
| **Sewage outfalls** | Untreated wastewater is discharged directly to beach or adjacent area | Very High | |
| | Tertiary treated wastewater discharges directly to beach or adjacent area | High | |
| | Untreated wastewater is discharged several kilometres offshore | Low | |
| | Tertiary treated wastewater is discharged several kilometres offshore | Very Low | |
| | | | |
| **Stormwater** | Urban stormwater with direct run-off from intensive agriculture | High | |
| | Urban stormwater with low intensity agriculture/urban/rural catchment | Moderate | |
| | | | |
| **Riverine discharges** | Untreated wastewater discharges into riverine system | High | |
| | Tertiary treated discharges into riverine system, combined sewer discharges, sewer overflows | Moderate | |
| | Run-off from low-intensity agricultural/urban/rural catchment | Low | |
| | Bush/forest | Very low | |
| | | | |
| **Animals** | Unrestricted stock access to water, dense bird populations | Moderate | |
| | Intensive agricultural use in immediate catchment and potential for run-off from untreated animal effluent | Moderate | |
| | Potential for run-off from feral animals including those in bush and forest areas. Low level birdlife. | Low | |
| | Low level birdlife | Low | |
| | | | |
| **Ablution blocks** | Onsite toilet facilities - sewer | Very Low | |
| | Onsite toilet facilities – septic | Low | |
| | | | |
| **Septics** | Septic tanks located within 100m from waterbody | Moderate | |
| | | | |
| **Boat moorings** | Consistently high number of permanent boat moorings or anchorage area. | Moderate | |
| | | | |
| **Bather Density** | High bather density, high dilution | Low | |
| | Low bather density, high dilution | Very low | |
| | High bather density, low dilution | Moderate | |
| | Low bather density, low dilution | Low | |
| | | | |
| **No significant sources** | No sources of significants directly or indirectly effecting the waterway | Very Low | |
| **Overall Sanitary Inspection Category** | | | |

# Delivering a **Healthy WA**

Government of Western Australia
Department of Health