Healthy Waterways

ONE CLEAR VISION

Managing Microbial Risks in Recreational Waters

Training Manual

December 2016

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Acknowledgements

The sanitary survey methodology outlined in this manual has been adapted from the Recwatch Training Manual, 2011, which was informed by the Beach Watch Program in New South Wales. This methodology also takes into consideration the methods being used in the Seqwater & GHD 'Sanitary survey of drinking water catchments - Development of methodology for pollution risk assessment', (Baker et al, 2015), and Government of Western Australia, Department of Health, Public Health 'Recreational Waters – Sanitary Inspection Report Form'.

This resource has been developed by Healthy Waterways staff Anne Cleary, David Logan and Ryan Davis with significant input from the members of the Human Health Scientific Expert Panel and Healthy Waterplay Steering Committee, including representatives from Queensland Health, consultancies, universities, councils, water utilities and water providers in South East Queensland and interstate. The feedback, testing and review of the work by officers and experts have sought a practical resource useful to waterway managers, backed by up-to-date local expertise, guidance and research. Thanks most of all to the users of this resource, who are working to achieve safer use of our recreational waters.

Disclaimer

Healthy Waterplay Program

The Healthy Waterplay Program is a regional initiative in South East Queensland supported by local governments, water utilities, state government, universities and other relevant organisations. Healthy Waterplay supports regionally consistent monitoring, reporting and management of human health risks in recreational waterways.

For further information about Healthy Waterways, please email hww@healthywaterways.org or telephone (07) 3177 9100.

About this version

This version (December 2016) of the Healthy Waterplay training manual contains the sections related to completion of Sanitary Inspections and assigning suitability grades to recreational water sites. It has been developed to guide monitoring of catchments and safe recreation in South East Queensland (SEQ) from late 2016 onwards.

This document improves on the previous Healthy Waterways Rec Watch manual, providing more transparent and evidence-based criteria to prioritise and assess condition of recreational water sites. A common regional framework that guides sanitary inspections in SEQ and ensures a consistent approach is used to assess and report the microbiological condition and associated potential human health risk of recreational waters.

A common regional approach also facilitates collective use of data within the Healthy Waterways Monitoring Program and Report Card, leading to a better understanding of the contribution of water-based recreation to people's lifestyle and livelihoods. Driving action and inspiring regional investment to manage human health hazards within catchments, and promote and improve safe water-based recreation.

This Manual is for anyone responsible for the assessment and management of recreational waters, including:

Catchment Managers: desiring to quantify the impact of microbial pollution on the condition of waterways and recreational waters, identifying priority investments to improve condition.

Environment or Environmental Health Officers: who require a step-by-step, repeatable, consistent process to measure human health risk(s) for multiple recreation sites and justify actions taken to manage them.

This Manual is written as a practical, step-by-step method to increase the capacity of waterway managers and officers to prioritise recreational sites and conduct sanitary inspections of recreational sites. Images and case studies are used throughout to demonstrate techniques, relevant issues for South East Queensland (SEQ) and expected outcomes that may be encountered whilst conducting sanitary inspections or reporting recreational water condition.

This manual includes:

- Background information and explanation of terms
- Overview of monitoring methods and review processes
- Site prioritisation
- Pre-. and post-field data collection methods and worksheets
- Field observation checklists and worksheets
- Risk matrix and score calculation method and tables
- Reporting and review guidance

Your comments, questions and feedback are welcome for ongoing improvement of this resource and effective monitoring, management and use of our recreational waters and waterway benefits.

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Abbreviations

AFRI	acute febrile respiratory illness
BAV	beach action value
e.g.	for example (*exempli gratia*)
FIB	faecal indicator bacteria
GI	gastrointestinal
GM	geometric mean
LOAEL	lowest observed adverse effect level
MAC	microbial assessment categorisation
NEEAR	National Epidemiological and Environmental Assessment of Recreational Water
NGI	NEEAR-GI illness
NOAEL	no observed adverse effect level
SIC	sanitary inspection categorisation
STP	sewerage treatment plant
STV	statistical threshold value
US EPA	United States Environmental Protection Agency
WHO	World Health Organization (United Nations)
WQS	water quality standard(s)

Definitions

Annual Suitability Grade is used to categorise potential risk to human health associated with a recreational site and refers to the combined results of the Sanitary Inspection survey and MAC results.

Asset Register, a list or database, storing information on all identified recreational water locations.

Consequence Rating assesses and quantifies potential consequences for pollutants at recreational sites. Consequence rating is determined and applied as a multiplier to likely

pollutant sources influencing water quality at recreational sites to determine a pollution risk score. Generally considers pollutant sources, type and concentrations/volumes.

Contaminant is an undesired material although it does not have to cause harm.

Flushing is the movement of water through a site that leads to a turn-over or replacement/ replenishment of water at that site. It includes freshwater flows, as well as tidal flows, wind-driven currents and water mixing in estuaries and coastal recreation sites. Open ocean beaches can be considered to have very high flushing, while enclosed bays typically have low flushing based on restricted flows. Concentration and residence time of pollutants at a site will be influenced by relative levels of flushing.

Greywater is wastewater generated from activities such as laundry, dishwashing and bathing.

Hazard is a source of potential harm or a situation with potential to cause loss or injury.

Hazards, hazardous events and risks

Although the terms 'hazard' and 'risk' are often used interchangeably, their meanings differ. In this Manual the terms hazard, hazardous event and risk are used as follows:

> **Hazards** are biological, chemical, physical or radiological agents that have the potential to cause harm (i.e. loss of life, injury or illness). The presence of microbial pollution at a recreation site increases the chance of waterborne infection, a hazard that can cause illness and in some cases death.
>
> **Hazardous events** are incidents or situations that can lead to the presence of a hazard. For example, sewage overflows during high rainfall are hazardous events that can transport large quantities of microbial pollution to waterways and associated recreation sites.
>
> Determining risk involves considering the probability or likelihood that a hazard or hazardous event will occur, and the associated consequence if it does.
>
> **Risk – to public health** (from the National Health and Medical Research Council (NHMRC) Guidelines, 2008) is the likelihood of identified hazards causing harm in exposed human populations in a specified timeframe; inclusive of the severity of consequences. Generally *risk* is assessed as the *likelihood* (e.g. highly likely, unlikely) a hazard/hazardous event will occur weighted by the *consequence(s)* of the associated harm (eg severe, inconsequential.)
>
> **Risk – to water quality** as a surrogate measure for public health risk (for the purpose of Sanitary Inspection), risk to water quality is the likelihood of identified hazards causing a decrease in water quality, including the severity of the consequences to water quality.
>
> During the sanitary inspection process, harm to exposed populations is not measured directly, but is inferred from the level of microbial pollution or microbial water quality at the recreational site. The water quality measure is a surrogate indicator for the risk of harm to exposed human populations, and is used in place of public health risk for the Sanitary Inspection Risk assessment.
>
> Site risk categorisation (which utilises Sanitary Inspection categorisation and Microbial assessment categorisation using measured levels of microbial pollution to define risk at

sites), and an assessment of site management interventions, such as user-awareness, signage and site closures, allow managers to assess the ***likelihood*** of a population's exposure to harm.

Combining this ***likelihood*** with actual usage numbers and duration, vulnerability of users and known ***consequences*** of recreating in the water at levels of observed microbial pollution, allows assessment of ***risk*** of harm to exposed populations.

Industrial discharge is any wastewater discharge from a regulated or unregulated industrial activity that enters waterways through dedicated infrastructure. For sanitary inspection purposes, industrial discharge includes licensed and/or reported outfalls from industries likely to be sources of microbial pollution such as abattoirs and food processing facilities. Stormwater discharges from industrial estates, sewage and runoff from agricultural practices should not be considered industrial discharge.

Lacustrine wetlands are large, open, water-dominated systems (for example, lakes) larger than 8 ha. This definition also applies to modified systems (e.g. dams and lakes), where water flow is typified by similar characteristics (e.g. deep, standing or slow-moving waters > 8 ha).

Location, refers to the geographic location in which the recreational site is situated. The location should extend to all areas or land-uses that could potentially influence water quality, specifically microbial pollutants at the site.

Long Ocean Outfall, Diffuser, a pipe or point that discharges treated wastewater into the ocean, usually at depth, and regulated distances from shore.

Palustrine wetlands are primarily vegetated non-channel environments of less than 8 hectares. They include billabongs, swamps, bogs, springs, soaks, etc., and have more than 30% emergent vegetation.

Pollution is the presence of any substance or material that may cause a harmful effect on humans, animals and/or plants.

Pollution Risk Score is the score given in Sanitary Inspections to quantify the risk of pollutants affecting recreational sites.

Population refers to human population of a local community. Specifically, the population of humans that would recreate at a site.

Primary contact recreation is any activity where the whole body or face is frequently immersed in water. Or, where the face is frequently wet by spray and the likelihood of water being ingested, inhaled or in contact with ears, noses and skin lesions is enhanced. Examples of primary contact recreation are swimming, diving, surfing, water skiing and white-water canoeing.

Priority Ranking is determined using the HWP Manual and SI tool and refers to the degree to which management of any site is given precedence in relation to other recreational sites in a management zone.

Recreational waters are considered any natural fresh, marine or estuarine bodies of water used for the purpose of human leisure or enjoyment. These include natural lakes, rivers, tidal washed pools and marine baths or pools with seawater exchange and other human-made constructions

(e.g. quarries, artificial lakes, reservoirs) that are filled with predominantly untreated natural waters. Recreational waters do not include non-natural, treated, private or public swimming pools as different regulations and management apply to swimming pool recreation.

Secondary contact recreation is any activity where only the limbs are regularly wet, and swallowing water is unusual. Examples of secondary contact recreation are boating, fishing, rowing, kayaking, dragon boating and wading.

Sewage (wet weather) Overflows, see **Sewage Treatment Plant Bypass,** below.

Sewage Treatment Plant Bypass, occurs when sewage treatment plant capacity is exceeded and untreated wastewater is discharged into receiving waters to avoid sewage treatment plant and town infrastructure and residences being inundated. This often occurs during high rainfall events and is related to low levels of separation between sewage and stormwater systems.

Site refers to the specific recreational site being assessed or managed.

Water Quality the chemical, physical, biological, and radiological characteristics of water as it relates to the ability to maintain predefined purposes or processes (usually natural or human fitness for use).

Wetlands are areas of permanent or periodic/intermittent inundation with water that is static or flowing fresh, brackish or salt; including areas of marine water which at low tide does not exceed 6 metres in depth. To be a wetland the area must have one or more of the following attributes:

- the area at least periodically supports plants or animals that are adapted to, and dependent on, living in wet conditions for at least part of their life cycle, or;
- the area substratum is predominantly undrained soils that may become periodically saturated, flooded or ponded long enough to develop anaerobic conditions in the upper soil layers, or;
- the substratum is not soil and is saturated with water, or covered by water at some time.

(Wetland definition, WetlandInfo, Department of Environment and Heritage Protection, Queensland, 2016)

4.3 Purpose of this training manual

This training manual has been developed to provide a consistent procedure for implementing management with a degree of confidence as a result of consistent, rigorous monitoring and reporting on public health risks in recreational waters.

To achieve recreational waters that are safer to use and that are used safely.

Recreational waters that are safe to use are those in which the potential risks to human safety and wellbeing are 'minor' or 'low'. Where risk can be considered higher and waterways are 'unsafe' without management, risk must be mitigated or communicated in a way to ensure risk is reduced or removed for recreational users.

Sanitary inspections seek to identify all sources of contamination that could affect recreational water quality and assess the risk to public health posed by these sources. The sanitary survey provides an "assessment of the area's susceptibility of influence from faecal contamination" (WHO 1999).

Knowledge of the catchment hydrology, geography, land-use, management, pollution sources and receiving water processes gained from the sanitary inspection provides a good foundation for:

- investigating pollution incidents
- prioritising and implementing pollution abatement and/or mitigation measures
- providing sound advice to the community on where and when to use recreational areas where contact with water is likely to occur.

This manual is designed to substantially increase the capacity and capability of water resource managers and regulators in South East Queensland to monitor recreational waters and to support the implementation of Chapter 5 – Microbial Quality of Recreational Water of the NHMRC Guidelines 2008.

"Preventive risk management practices should be adopted to ensure that designated recreational waters are protected against direct contamination with fresh faecal material, particularly of human or domesticated animal origin." (NHMRC Guidelines 2008)

This manual also provides information needed to meet recreational water monitoring and management requirements under the Queensland Public Health Act 2005.

Objectives of this training manual

- Understand the risk management framework for recreational waters
- Understand the microbial quality guidelines
- Select suitable locations/sites for assessment, including identifying recreational locations and pollution sources, assess the likelihood and consequence of contamination and grade recreational areas using a priority matrix
- Undertake sanitary inspections and enter data into the Sanitary Inspection Database
- Design a sampling program, collect water samples and manage them
- Manage and analyse data and provide suitability grades for recreational areas
- Develop a Communications Plan to report results to the community
- Develop an Incident Response Plan and implement management controls.

Note: this manual does not contain consideration of aesthetic / passive water recreation as it focuses on public health risk as a result of interaction with water via primary or secondary recreation.

1.2 How to use this training manual

Whether a manager is starting out, or is a seasoned inspector of recreational waters, different parts of this manual will be more or less useful depending on the level of experience and expertise of the practitioner and the objectives of their program. Listed below are a selection of scenarios that may arise in the course of managing recreational waters and relevant sections useful following that point:

Table 1: Management scenarios and recommended chapters and sections

Scenario	Manual sections	Description
I am just starting out	Chapters 1, 2 & 3	Getting started, Overview of risk management, selection and prioritisation of sites for management
I know the theory, have some priority sites and just need a way to collect and record the relevant data to inform management and investment decisions.	Chapter 4 & Appendix A	Conducting Sanitary inspections, Healthy Waterplay report and worksheets
I'm supervising a team of officers and need to communicate a consistent monitoring approach for assessing condition of recreational waters.	Section 2.1, 3.1, 4.1, 5.1 & Appendix A	Overviews of risk management, site selection, sanitary inspections, and water sampling, reporting templates and worksheets
I have completed relevant sanitary inspections and now want to calculate a suitability grade for my sites and report appropriate risk messages	Chapters 6 & 7	Calculating suitability grades, promoting recreation and reporting risks
I have undertaken monitoring in the past and want to repeat the process to determine what has changed in the catchment.	Chapter 8 & Appendix A	Field observation sheets and monitoring reviews
I want to determine the best mitigation measures to put in place.	Chapter 8 & Appendix A	Management actions and management worksheet
I have implemented some mitigation measures and want to justify whether to continue them and/ or adjust frequency and extent of monitoring appropriately.	Chapters 4, 5 & 8	Additional field inspections, water sampling and monitoring review

2.1 Waterway recreation in South East Queensland

Not only are waterways an integral part of our lifestyle and cultural identity, they are also a significant economic asset underpinning our tourism and recreation industries. Waterway related tourism boosts local business, generates jobs and attracts investment.

The nature-based tourism industry is critical to South East Queensland's economy, generating approximately $2.9 billion of SEQ GPA per year. Our waterways are one of the main reasons international and domestic visitors travel to South East Queensland. For example, 61% of all inbound visitors to Australia identified nature-based activities as the key purpose of their visit. Moreton Bay Marine Park alone attracts 12.4 million domestic visits every year making it Queensland's most popular park.

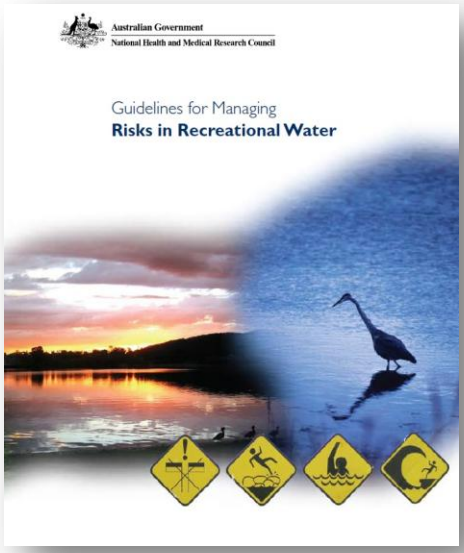
Tourism in SEQ and Queensland more generally, is highly reliant on the availability and quality of nature-based tourism experiences. Research undertaken in 2007 indicates that domestic nature-based tourism in Queensland is more reliant on water activities when relatively compared to NSW, Victoria, or Australia as a whole (Table 1). Tourism and recreation activities are heavily reliant on the actual and perceived health of our recreational waters. Therefore, we need to ensure that recreational waters are managed as effectively as possible so that as many people as possible can derive the health and wellbeing, social, and economic benefits from using our waterways for recreation.

Table 2 Domestic nature-based tourism market – key activities (Tourism Queensland, 2007)

Activity	% of nature-based tourists undertaking activities			
	QLD	NSW	Vic	Australia
Bushwalking	60%	67%	67%	65%
Visit parks and reserves	57%	53%	53%	57%
Water activities	22%	6%	3%	9%
Wildlife watching	7%	7%	2%	5%

2.2 Guidelines for managing risks in recreational waters

In 2008, the Australian Government's National Health and Medical Research Council endorsed the *Guidelines for Managing Risk in Recreational Water* (NHMRC Guidelines). The NHMRC Guidelines supersede the Australian Guidelines for Use of Recreational Water (NHMRC 1990) and replace some sections of the *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC 1992). The NHMRC Guidelines are based on the World Health Organisation (WHO) *Guidelines for Safe Recreational Water Environments* (WHO 2003) and combine international best practice with an understanding of Australian waters to provide guidance relevant to Australian conditions.



The NHMRC Guidelines serve as a tool for each state and territory to develop standards and resources appropriate for local conditions and circumstances. The aim of the guidelines is to encourage the adoption of a nationally harmonised approach for the management of the quality of coastal, estuarine and freshwaters used for recreation. The NHMRC Guidelines are recognised as the authoritative reference on recreational water quality in Australia.

Within Queensland, the *Public Health Act* 2005 (the Act) explicitly identifies water that 'includes drinking water, water used for recreational purposes, recycled water, waste water and sewage' when describing regulated public health risks. The Act assigns responsibility for regulating all public health risks associated with non-drinking water and non-recycled water (see section 11.1.b.iv) to local government. Under authority of the Act, and in line with advice from the NHMRC Guidelines, local governments of Queensland can set standards for management of recreational water appropriate for local conditions and circumstances.

The NHMRC Guidelines advocate a preventative, risk-based approach to the management of recreational waters, focusing on assessing, managing and reducing risks.

The Risk Management Framework includes:

- *Identification of hazards* – A hazard is a chemical, biological or physical agent that has the potential to cause harm, such as death, illness or injury (NHMRC/NRMMC 2004).
- *Assessment of risk* – Risk is the likelihood that a hazard or hazardous event will occur and the consequences if it does. Hazards may pose greatly differing risks. Risk increases with the likelihood of the hazardous event occurring and the magnitude of the consequences. A hazard which occurs infrequently and has little impact on human health will be assessed as low risk. In contrast, a hazard which is known to occur with some regularity and leads to increased risk to human health will be assessed as high risk.
- *Management of risk* – The NHMRC 2008 guidelines provide a framework for managing risk, advocating that attention and resources should be focused on the level of risk rather than the existence of a hazard.

Healthy Waterplay Program

The Healthy Waterplay Program in South East Queensland works in partnership with local and state government to support regionally consistent monitoring, reporting and management of microbial quality of recreational water appropriate to the South East Queensland setting.

The 2010 Environmental Health Monitoring Program (EHMP) Review identified the need for a regional human health recreational waterway risk monitoring program (EHMP Review, 2010). In July 2011, driven by the impacts of the January floods, the Healthy Waterways Healthy Waterplay Program was established. In its first year the Program focused on regional capacity building through the delivery of RecWatch training*. In addition a Healthy Waterplay Steering Committee (HWSC) was established in 2012. Similarly, a Human Health Scientific Expert Panel was established the same year. The HWSC drives the delivery of a regional Healthy Waterplay Program. The primary focus of this Program is on the assessment and management of microbial risks in recreational waters. This includes the risks associated with both primary and secondary contact recreation. In the future this focus has the potential to expand to include other human health risks associated with recreational waters such as algae, and associated consumption of accumulated biotoxins and exposure to toxicants.

Applying the guidelines

To manage microbial risks in recreational waters the NHMRC Guidelines outline a process which collects microbial water quality data to calculate a **Microbial Assessment Category (MAC)** coupled with assessing the catchment for pollution sources and calculating a **Sanitary Inspection Category (SIC)**. Together the Microbial Assessment Category (MAC) and Sanitary Inspection Category (SIC) are used to determine the **suitability grade** of a recreational area primary or secondary contact (see process below). The suitability grade ranges from very poor through to very good.

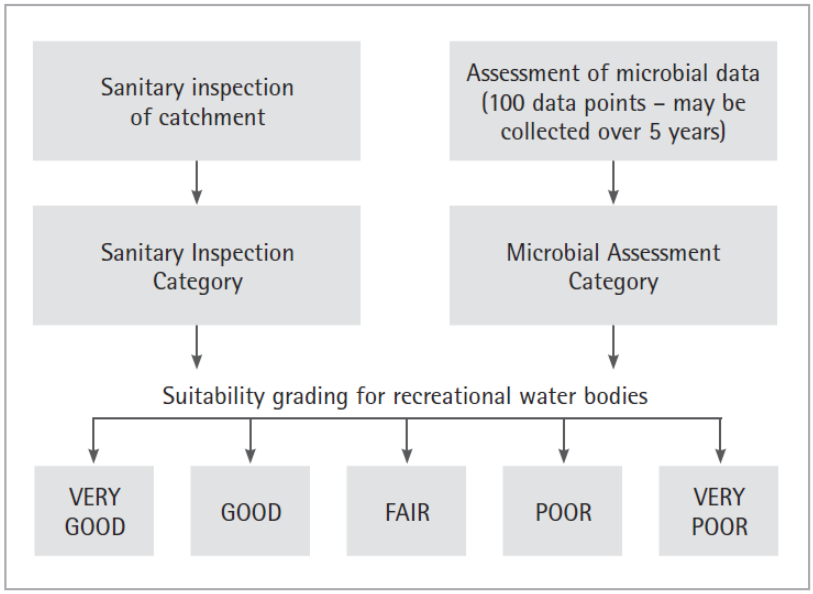


Figure 1: Flow diagram illustrating components of assigning Suitability Grade for recreational waters

Sanitary Inspection Focus

This Manual focuses on categorising risk to human health from recreational water sites using Sanitary Inspections and Microbial Assessment Categorisation (MAC) to categorise risk. The most important consideration with the sanitary inspection is to understand what is going on in a site's associated catchments. This information should be collected over time to provide as complete a picture as possible of the inputs from the catchments that may impact on recreational waters.

Chapters 3 through to Chapter 7 of this Manual serve as a procedure for Sanitary Inspection of Recreational Water Sites culminating in guidelines for reporting of results and management. This is done by assessing relevance and site prioritisation for management by assessing multiple risk factors and assigning Priority Ratings (Chapter 3). Undertaking assessment of likelihood and consequence of pollutant sources at the site by way of Sanitary Inspection Categoristaion (Chapter 4). Conducting microbial water quality monitoring and site Microbial Assessment Categorisation (Chapter 5). Assigning recreation site Recreation Suitability Grades using SIC and MAC results (Chapter 6). Reporting and management of sites based on Suitability Grading (Chapter 7).

*Rec Watch training was developed by NSW Department of Environment and Climate Change to act as a tool for managing human health risk in recreational; waters as per Chapter 5, NHMRC 2008.

The initial sanitary inspection can take the form of a 'screening approach', with each inspection providing information to build a subsequent more comprehensive report attempting to identify all possible sources of pollution impacting recreational waters. This baseline information can be referred to in future investigations, and when undertaking annual sanitary inspections to determine if circumstances have changed over time. Consistent inspection can help to direct management actions and verify water quality testing. The most important aspect of the sanitary inspection is to identify human faecal sources that are likely to pollute recreational waters. While animal sources also contribute a public health risk, particularly from hoofed animals, faecal pollution from animal sources are *generally* considered a lower risk to human health than that of human origin.

As microbiological water quality data increases and can be confidently interpreted, significance can be placed on the microbial results. Sanitary Inspection would still play an important role in site management in these instances as annual inspections are be used to identify pollutant sources and possible mitigation strategies as well as categorise risk.

Continuous improvement

Sanitary inspections are part of a process of continuous improvement where together with our members, the Healthy Waterplay Steering Committee and Healthy Waterways and Catchments seek to increase community recreational use and connection with waterways in acknowledgement of the many benefits of doing. In doing this we are committed to managing sites and enabling the community to make informed choices regarding recreating in natural waterways and implications for human health.

Figure 2: Conceptualised Waterway management adaptive management loop

In the broader context of waterway management in SEQ, monitoring water quality and mitigating potential risk to public health in waterways increases wellbeing and the associated benefits provided by waterways, which are reported annually in the Healthy Waterways Report Card.

Chapter 3: Prioritising Recreational Waters for Management

3.1 Overview

The resources required for comprehensive management of all identified recreational waters may not always be available. Programs are best tailored to meet specific local needs and available resources. The key to achieving this is to undertake a priority evaluation and classification, enabling water resource managers to assign a Priority Rating to recreational sites and determine the management needs of recreational waters in their local area. The approach encompasses four steps (detailed further in following sections):

Step 1. Identify recreational water locations and record in asset register

Step 2. Through desktop review, identify which of the potential pollution sources is likely impacting the site

Step 3. Score the multiple risks of microbial pollution impacting the site

Step 4. Calculate the priority rating of the site.

The approach is based on a qualitative risk assessment utilizing readily available information on type(s) of recreational use, importance to the local community, and the potential for pollution to impact the site. Each recreational area is classified by a priority rating, determined by:

- The likelihood of sources of pollution impacting the site. This is determined via knowledge of a local area in conjunction with consultation of available data.
- The consequence of microbial pollution present at the site; scored against five key risk areas relevant to environmental health and encompassing a range of local government responsibilities (as derived from enHealth, 2012).

Recreational waters are then assigned a Priority Rating (i.e. very high to very low). Locations classified as high or very high priority should attract more management resources to optimise associated resource allocation.

Wherever possible, the Priority Rating process should be done as a team exercise. The approach outlined in the following sections of this manual is a guideline only. Where organisations have existing prioritisation frameworks/processes they are encouraged to consult these for use in recreational waters. The information generated during the Priority Ratings classification process provides a starting point for completing Sanitary Inspection surveys for the recreational waters chosen for prioritised active management. Priority Ratings classification should be reviewed regularly, at time scales suitable to capturing changes influencing microbial water quality and associated risk to human health and social and economic factors, ideally annually.

Prioritisation is designed to be a relatively rapid desktop process, requiring less time than the sanitary survey. Expect up to 1 hour per site if you have all associated mapping and relevant data in front of you (subsequent Priority Ratings assessments may take less time as processes become more familiar).

3.2 Step 1 – Identify recreational water locations and record in asset register

Recreational waters definition

Recreational waters *are considered to be any natural fresh, marine or estuarine bodies of water that are used for recreation. These include lakes, rivers, tidal washed pools and marine baths that interchange with seawater, as well as human-made constructions (e.g. quarries, artificial lakes, reservoirs) that are filled with predominantly untreated natural waters. Recreational waters do not include swimming pools as different regulations and management needs apply to recreation in and around swimming pools.*

This recreational waters definition does not imply active management of all recreational waters. Actively managed recreational waters sit as a subset of recreational waters. Carrying out a priority evaluation and classification will determine which recreational waters require active management.

Recording recreational water locations in an asset register

In many cases there may be more than one recreational site at a location (e.g. beach, bay or river). Factors to consider when identifying recreational water locations include the presence of a surf club, facilities such as boat ramps, toilets, showers and change-rooms, water access points such as parks or reserves, netted swimming enclosures, water proximal areas that are commonly used by the public and, in particular, small children.

All recreational waters should be located, mapped and recorded in an asset register. This is a list or database, storing information on all identified recreational water locations. The register may be a standalone database or part of a broader wetland or water asset database. An asset register can provide water resource managers with the following benefits:

- Reduced cost of data capture, and quick and easy data access
- A resource for informed planning and budgeting for maintaining and rehabilitating recreational waters
- A 'one-stop shop' for waterway managers seeking information, avoiding duplication and uncertainty around which information to use.

To create an asset register, first identify what information should be included, based on the needs of your organisation. Table 2 outlines the types of information that could be included in a recreational water asset register. Asset registers can be spreadsheet-based, GIS-based, or combined GIS and asset management software (e.g. Maximo®). When deciding what form of asset register to use, consider who will use it and what it will be used for. A water resource manager developing an asset register for recreational waters is likely to already have asset registers for other types of assets. The custodians of these other asset registers should be consulted and actively engaged in the process to ensure consistency across the organisation. Once an asset register is established, it must be regularly maintained to ensure it provides accurate and up-to-date information.

Table 3 Types of information that should be included in an asset register for recreational waters

Category	Example of information to include	Source/s
Identifier	Unique identification (ID) code for each location. This code becomes the link for all databases	Manually created, automated in Geographic Information System (GIS)
Name	Site name, park name or street name	Manually created and identified using combination of GIS, Nearmap, Google maps and street directory, Wetland*Maps*
Location	Street address, Grid reference, Latitude and Longitude	GIS (cadastre)
Site access	Road or pathway leading to site, ramp or stairwell into waterway, parking facilities, etc.	Nearmap, Google maps, field assessment, local knowledge
Catchment/basin	Catchment and sub-catchment name and area	GIS (catchment boundaries)
Current recreation use	Type of primary or secondary contact (as per definitions on page 7 of this manual)or aesthetic recreation	Field assessment, management plans, tourism and recreation departments
Recreation Users	Groups using the site and recreation numbers on weekdays, weekends, holidays and seasons	Field assessment, consultation, recreation and tourism plans
Profile/amenity	Proximity to residential/commercial areas, amenity provisions (seating, pathways, barbeques, playgrounds, signs etc.), aesthetic values/issues, recreational usage, etc.	GIS (land use, proximity), field assessment, consultation
Safety	Batter slopes (that is, substrates that transition at an angle between horizontal and vertical, either above and below water level), presence and condition of fencing and barriers	Field assessment, management plans, master plan, as-constructed drawings, consultation
Connectivity	Isolated, within a riverine system, within a floodplain	GIS, field verification, Nearmap, Google maps, Wetland*Maps*
Fringe area	Riparian zone, (that is vegetation that is situated adjacent, alongside or into waterways), surrounding wetland zone	GIS, development approvals, as-constructed drawings, field verification, Nearmap, Google maps, Wetland*Maps*
Formation	Artificial, modified from natural, canal, reservoir	GIS, development approvals, as-constructed drawings, field verification, Nearmap, Google maps, Wetland*Maps*
Direct management responsibility	Local government division, local government team	GIS
Sewerage within catchment	Sewered, un-sewered, combination within catchment	GIS, contact relevant water utility
General description	General description of the site specifics that have not already been captured, including key issues, aesthetic values, location, size, amenity values and proximity to land uses	GIS, Nearmap, Google maps, field assessment, consultation, Wetland*Maps*

Physical features	Presence of islands, shape, structures, etc.	GIS (aerial photographs, Digital Elevation Map, drainage, stormwater), Nearmap, Google maps, field assessment
Park governance and spatial features	Service levels: Local, district, region etc.	GIS (parks layer or hierarchy)
Water type – Salinity, temperature and Ph	Fresh, brackish, saline Tidal – yes or no Ph – alkaline or acidic	field assessment, GIS
Water quality	*In situ* data (turbidity, dissolved oxygen) Nutrients (total phosphorus, filtered reactive phosphorus, total nitrogen, ammonia, nitrogen oxides) Bacteria (*Escherichia coli,* enterococci)	Historical datasets or monitoring, field assessment, consultation
Substratum	Mud, sand, rock, cobble	Substrate classifications
Hydraulic function	Location and qualitative condition of inlets and outlets, description of inlets or outlets, flooding, regular overtopping, persistent high/low water levels, erosion/scour	GIS (stormwater, WSUD, drainage), field assessment, consultation
Aquatic habitats	Structure and condition of aquatic macrophytes, % cover, % native or exotic, % floating, emergent, submerged, exotic species present (weeds/fauna), presence of snags, overhang, shading, etc.	Field assessment, maintenance schedules, management plans, consultation
Riparian/wetland habitats	Structure and condition of surrounding riparian/wetland vegetation, % cover, % native or exotic, % floating, continuity, exotic species present (weeds/fauna), connectivity/corridor, etc.	Field assessment, maintenance schedules, management plans, master plan, consultation
Maintenance data	Maintenance undertaken, resources used, who undertook works on facilities and parks.	Maintenance schedules and reports, contracts and invoices
Cost	Direct and indirect costs of managing site	Maintenance schedules and report, contracts and invoices
Public feedback	Public feedback (positive and negative) received regarding recreational water location. Likely to multiple departments.	Reactive Email, phone call, on-site discussions, surveys and consultations
Note: The above list is not exhaustive and further information where relevant should be captured and stored, nor should the absence of individual information for sites preclude registration. Each organization should determine what information they have available and whether or not it is suitable to include on the asset register.		

3.3 Step 2 – Identify the sources of pollution impacting each recreational water site

The major sources of microbial pollution in recreational waters come from:

- **Sewage Treatment Infrastructure (**refer section 1.2, p 12, Table 3.3, column 2.)
- **Sewage treatment plants within 2 km of recreational waters**
- **Sewage pump stations and emergency relief overflow structures (EROS) within 500 m of recreational waters.**

Sewage is wastewater from both domestic and/or industrial sources and generally a by product of human use or consumption. This wastewater can come from toilets, showers, kitchens or laundries and can contain faeces, urine and chemicals such as surfactants and detergents. Sewage is normally transported via the sewerage system to a sewage treatment plant where it is fully treated, including disinfection to reduce microbial levels, before discharge into a waterway or reuse. Along with the network of pipes and the sewage outfall, sewage infrastructure includes pump stations and emergency relief overflow structures (EROS) or discharge outlets. *It should be noted that whilst all sewage is wastewater, not all wastewater is sewage. Wastewater can have many other sources such as industrial wastewater from mining or manufacturing, farming and livestock production etc.*

In Queensland, under the *Environmental Protection Regulations 2008*, sewage treatment plants servicing greater than 21 equivalent people are considered environmentally relevant activities and are regulated by the Department of Environment and Heritage Protection.

> Sewage overflows can be caused by heavy rainfall, mechanical faults at sewage treatment plants or pump stations, or broken or blocked sewer mains. Sewage overflows can result in untreated sewage being discharged directly into waterways through overland flows or through the stormwater system. Wet weather overflows are more common, where sewage volume is increased and diluted by large inputs of stormwater flowing into sites. Dry weather overflows are less likely, but have greater consequence to water quality as less dilution occurs before the pollution reaches recreation sites.

On-site sewerage facilities (serving less than or equal to 21 equivalent people)
Septic systems and small treatment plants located within 200 m of recreational waters.

On-site sewerage facilities, such as septic systems, are independent sewage treatment systems not connected to a central sewage treatment system. They normally service single households or properties. If on-site sewerage facilities are incorrectly installed or poorly maintained they can act as a potential source of microbial pollution.

Industrial discharges
Industries that process animal products or faecal matter and discharge wastewater within 1 km of recreational waters.

Industrial sites can contribute (typically) point source discharges near to or directly into waterways or a recreational site. Industrial discharges do not include stormwater discharges from industrial estates.

Animals (agricultural, domestic and wild)
Agricultural and recreational activities involving farm animals and/or large numbers of wild or domestic animals present within 200 m of recreational waters.

Faeces from farm animals (e.g. horses and cows), domestic animals (e.g. cats and dogs) and wild animals (e.g. birds and possums) can end up in waterways and pose a risk to human health. Places where large numbers of animals come together can include cattle grazing areas, horse pasturing and race courses, piggeries, poultry farms, dog off-leash areas, or roosting and feeding areas for native birds, flying foxes and other species. In most instances, microbial pollution from animal sources *generally* represents a lower risk to human health compared to faecal pollution from human sources. However, microorganisms derived from animals can still have an adverse impact on human health and these influences should be investigated and assessed accordingly.

Stormwater

Stormwater outfall pipes and open drains discharging into waterways, within 500 m of recreational waters.

Stormwater is rain or water that runs off grass, roofs, roads and footpaths into the stormwater system. The stormwater system is designed to drain habituated areas by channelling water to storages, creeks, rivers, beaches or bays where it is discharged. Most stormwater is not treated and carries pollutants that can make our waterways unsafe for human contact. Stormwater can contain pollutants such as faeces containing pathogens (bacteria, viruses and parasites), litter, oil, pesticides, surfactants, detergents, grass clippings and soil.

Recreational sites

Groups of people swimming or wading within 5 m of each other at recreation site during busy periods and absence of toilet facilities within 200 m of recreational waters.

Bather-derived faecal pollution may present a significant health risk, particularly if the site experiences high bather densities and is subject to poor flushing (e.g. lakes, reservoirs). If toilet facilities are not readily available the likelihood of bathers burying waste nearby or defecating into the water is substantially increased, particularly in the case of small children.

Boating discharges

Boats with onboard septic systems using boat ramps, harbours, marinas, moorings, ferry berths, anchorages or jettys within 1 km of recreational waters.

Untreated sewage and greywater discharges from boats can create human health problems if discharged into recreational waterways. Greywater is wastewater generated from activities such as laundry, dishwashing and bathing. It is illegal to discharge sewage from a boat into a designated recreational waterway.

Waterway discharges

Waterways; including adjoining tributaries, rivers, canals or occasional flows from semi-enclosed lagoons, that discharge within 2 km of recreational waters.

Recreational sites that are located on a waterway downstream or down-current from an adjoining waterway are vulnerable to impacts of pollution in the respective waterway discharges. These could pose a health risk, particularly if the discharging waterway receives large volumes of pollutants at high concentrations e.g. stormwater runoff, sewage treatment plant, industrial discharges). It is important to consider pollution sources entering the waterways that discharge into, flow through or influence the recreational site. Potential pollution sources within 5 km of the recreational site should be considered as the discharge source waterway can convey pollution from a distance to the recreational water site. An important discharge source waterway type to consider is semi-enclosed coastal lagoons, particularly for beaches and coastal recreation sites. Following wet weather events, semi-enclosed lagoons can open more fully and discharge polluted water, impacting the recreational site. Canals are another source of waterway discharge in this category.

Other

Other sources of microbial pollution may be identified for the recreational waters that do not fit in the above categories. These should be included in any site risk assessment, either by application of the most relevant likelihoods and consequences associated with one of the pollution sources listed above, or developing new likelihood and consequence ratings for the pollution source.

How far out should you look from the site?

The distances used in this manual take into account the way relevant pollution sources are likely to travel to a nearby waterway and the recreational site. In urban areas, stormwater infrastructure can quickly connect most land areas to a nearby waterway, and most pollutants are likely to reach their nearest waterway through this mechanism or regulated outfall pipes. In rural areas, overland flows and gullies are likely transport mechanisms. Distances used also allow consideration of likely mitigation factors that filter or dilute relevant pollutants. See relevant modules for more information on recommended distances from waterways and recreational sites at which to consider real and potential microbial pollution sources.

For large recreational sites, estimate distances to pollution sources from the most used area of the site (e.g. access points, swimming enclosures), or from the perimeter of the site if usage is distributed evenly across the whole area. It is important to consider pollution sources that are within the recreational site **catchment**. There are instances where a pollution source is within the designated distance described in this Manual but due to catchment hydrology flow away from the recreational site being assessed and are therefore not an influence on microbial pollution and associated human health risk at the site.

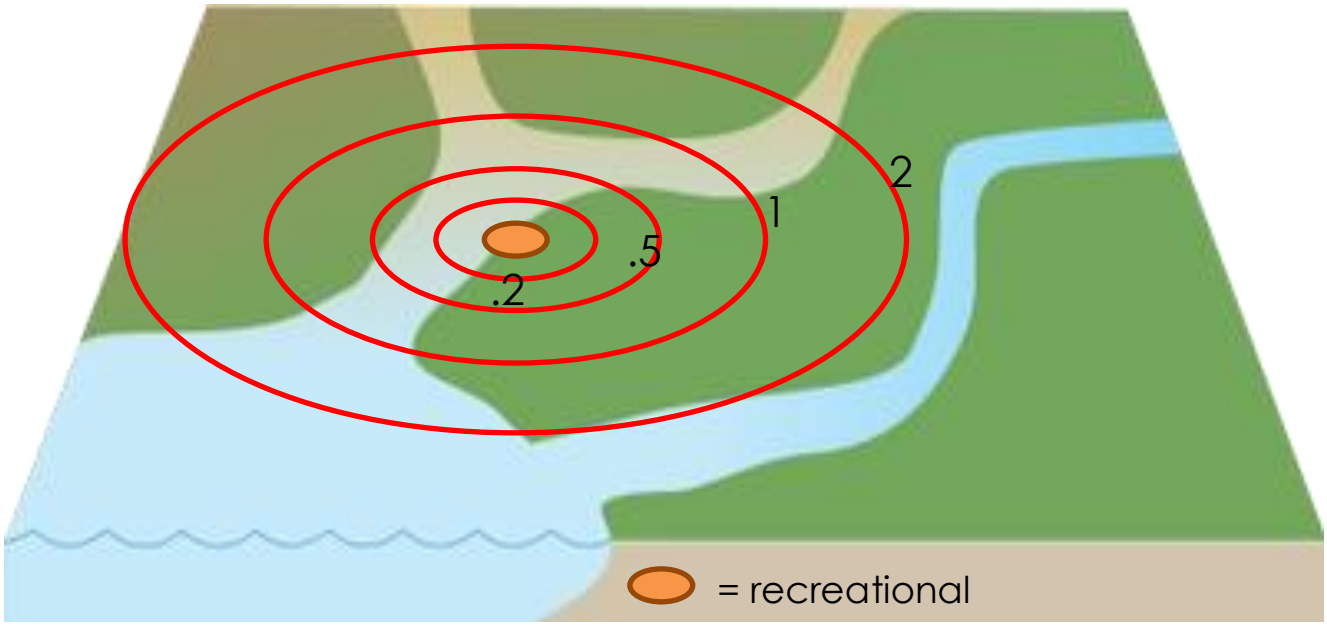


Figure 3: Radial distance's from the recreational site in kilometers.

Health impact ratings

A potential health impact rating has been assigned to each pollution source based on the estimated impact of each pollution source on human health (Table 3). Human faecal sources of microbial pollution have the greatest impact on human health, with hoofed animals having the second greatest impact, and other warm-blooded animals having the least impact of these sources. In most instances, microbial pollution from animal sources *generally* represents a lower risk to human health compared to faecal pollution from human sources. However, microorganisms derived from animals can still have an adverse impact on human health and these influences should be investigated and assessed accordingly.

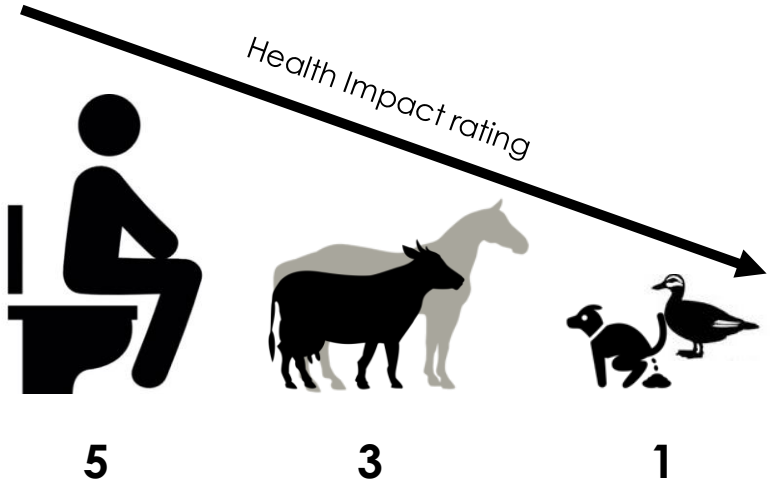


Figure 4: Human health impact of various faecal sources

Table 4. Health impact rating by source as per sources considered in the Healthy Waterplay Sanitary Inspection tool (Appendix A).

Pollution source		Health Impact Rating
Module 1.	Sewage Treatment Infrastructure and Overflows	5
Module 2.	On-site sewage systems	5
Module 3.	Industrial discharges	3
Module 4.	Animals (agriculture, domestic and wild)	3 (hoofed) 1 (other)
Module 5.	Stormwater	3
Module 6.	Recreational sites	3 (toilet) 5 (no toilet)
Module 7.	Boating discharges	5
Module 8.	Waterway discharges	3
Module 9.	Other (if required)	1-5

Note: Health Impact Ratings in subsequent versions of this manual will include *Escherichia coli (E. coli)* scores associated with estimated daily pathogen loads and risk associated with cyanobacteria in future years.

Pollution sources relevant to the site

The health impact ratings are used to prioritise sites and known pollution sources for further investigation and management in consideration of the pollution sources potential for influencing human health negatively. The likelihood and consequence of various hazards associated with each pollution type is assessed in more detail during the Sanitary Inspection Survey, within the relevant Pollutant Assessment Modules (Appendix A) for the assessed site.

Through a desktop analysis, identify which of the above pollution sources are likely to be entering or influencing water quality at the recreational site. Use this information to answer the questions

posed in *Step 1. Calculate the management priority of the site* section of Healthy Waterplay Sanitary Inspection tool (Appendix A). Depending on the data source, record the confidence you have that the answer is true (Low: expert opinion and anecdotal information/knowledge, Medium: expert opinion backed by spatial data/information, High: expert opinion with spatial data/information, prior survey and event data relating to pollution sources.)

3.4 Step 3 – Assess the multiple risks of microbial pollution

An assessment of the potential overall risk of microbial pollution from relevant sources impacting on recreation and public health will determine the priority sites that require further assessment and appropriate management. The Healthy Waterplay Sanitary Inspection Survey (Appendix A) initial questions are focused on rapid assessment of risks and implications in order to prioritise sites for management. This process involves the following 3 basic components:

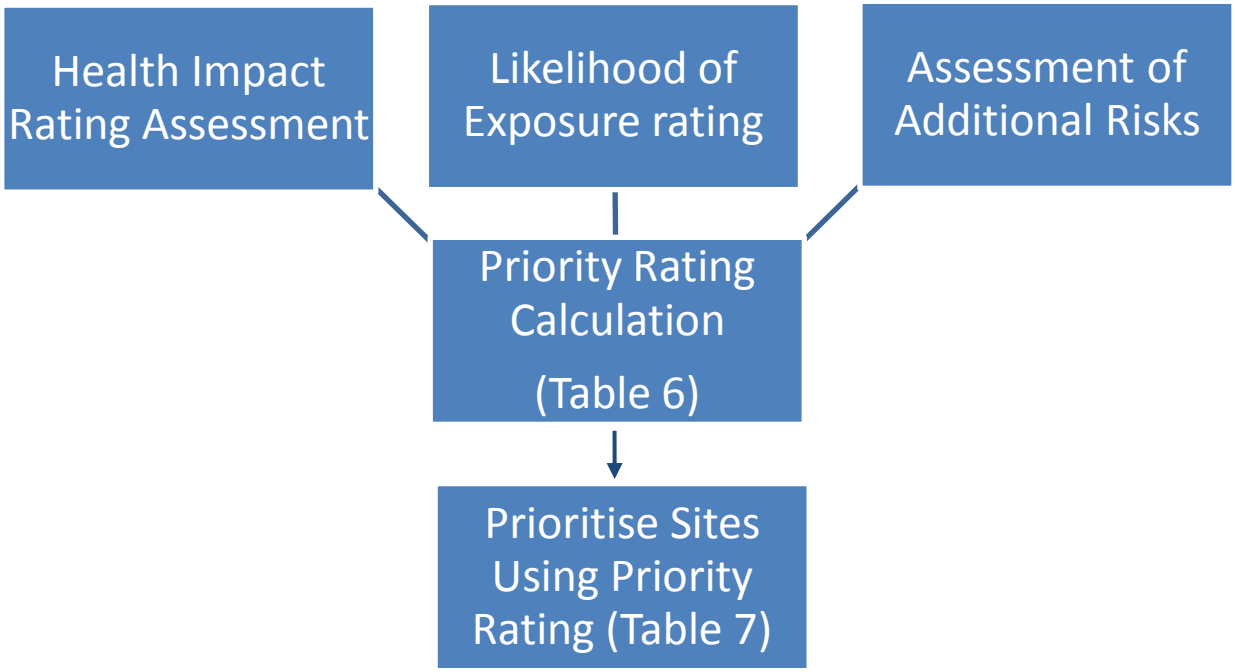


Figure 5: Prioritising recreational sites for managing risk to human health

In 2012 enHealth released '*Risky business – a resource to help local governments manage environmental health risks*' to raise awareness of how to minimise the financial, health and reputation risks related to the environmental health responsibilities of local governments, and thereby protect the interests of both their communities and their organisation. The resource identified five key risk areas relevant to environmental health which encompass a range of local government responsibilities. The five risk areas are:

- **Risk to human safety and wellbeing** – How is the safety and wellbeing of the community impacted by this situation or incident?
- **Legal and economic risk** – What is the cost to the community, business and the local government of this situation/incident, and what is the potential legal cost to local government?
- **Risk to strategic and governance position or reputation** – Could this situation impact on the local government's corporate capacity and/or reputation?
- **Risk to capacity to deliver services** – What is the impact on the local government's ability to deliver services?
- **Risk to the environment** – Could this situation or incident cause environmental harm?

The risk to human safety and wellbeing is the most significant risk to be considered in prioritisation of recreational waters to be managed. Consequences to public health of being exposed to microbial hazards are rated minor, low, moderate, high and extreme as outlined in Table 4.

Table 5: Consequences of exposure to microbial hazards to human safety and wellbeing

Minor	Low	Moderate	High	Extreme
No medical attention required Any injury or illness is minimal No loss of life	Potential for health impacts and/or medical treatment Medical attention may be required, but no hospitalisation required No loss of life	Medical attention or ongoing medical treatment is required No hospitalisation or long-term effects Potential of temporary disability No loss of life	A single fatality Serious injury or illness leading to hospitalisation Need for ongoing treatment and possibility of permanent disability Multiple serious injuries	Multiple fatalities or potential for multiple fatalities Potential for multiple and/or definite permanent disabilities

Sourced form From Risky Business (enHealth 2012)

As the consequence to public health is not often directly measured in a local setting, the Health Impact rating of different pollution sources (as listed in Table 3) and likelihood of exposure to waterborne pathogens (see next section) are used as surrogate measures.

Assess the Likelihood of Exposure

Likelihood of community members being exposed to microbial pollution is influenced by the type, volume and amount of time that microbial pollution is present at the site, as well as the numbers and type of people recreating, types of recreation and the length of time they spend in contact with the water. Likelihoods are rated: Rare, unlikely, possible, likely and almost certain.

Use Step 2 Qualitative descriptors of likelihood of exposure to health risks in Appendix A of this Manual to calculate a likelihood of exposure rating for your sites. Depending on the nature of the site being assessed coupled with the risk management culture and focus of the responsible organisation, not all Exposure Factors may be relevant. If this case arises, assign a rating of n/a and a score of zero to that particular factor.

Assess Additional Risks

Qualitative descriptors of impacts associated with additional risk categories are used to further assess the risks of microbial pollution impacting a site from legal, financial, reputational, service provision and environmental perspectives **(use Step 3: Qualitative descriptors of impacts associated with additional risk categories in Appendix A of this Manual).** The assessment of legal, economic and reputational risks should take into account the impact on businesses, tourism and site managers should recreational (water) sites need to be closed, or members of the community become ill or die from recreating at the site. Assessment of risk to service provision and the environment should consider community expectations associated with the site and the condition of the surrounding environment.

3.5 Step 4 – Calculate the priority rating of the site

Combine the scores associated with the Relative Health Impact of microbial pollution, likelihood of exposure to pollution and additional risks. Based on the overall score, use **Step 4: Calculating site Priority Rating** in Appendix A of this Manual to calculate the Priority Rating for your recreational water site.

Table 6 Priority Rating Calculation

Overall Risk Score	Priority Rating	Recommended Management Response
81-100	Very High	Allocate resources for carrying out routine enterococci monitoring and sanitary inspection to assign suitability grade to site.
61-80	High	Allocate resources for carrying out routine enterococci monitoring and sanitary inspection to assign suitability grade to site.
41 – 60	Medium	Consider for future management when sufficient resources are available.
21 – 40	Low	Assess site in the future to determine if the priority rating changes. No immediate management action required.
0 – 20	Very Low	Assess site in the future to determine if the priority rating changes. No immediate management action required.

Repeat the process for all recreational water sites listed in the Asset Register and record their scores and priority ratings in **Step 5: Record all *Management Priority Rating* results to allow ranking as to priority** in Appendix A of this Manual.

Table 7 Recording Health and Wellbeing risk associated with microbial pollution at recreational water sites. As defined in Step 5 of *Calculate the management priority rating of the site,* page 11, Healthy Waterplay Sanitary Inspection Survey (Appendix A *this Manual).*

Site Name	Risk to Health and Wellbeing		Additional Risks (out of 50)	Total (out of 100)	Priority Rating
	Health Impact (out of 25)	Level of Exposure (out of 25)			
Site 1					
Site 2					
Site 3					

4.1 Undertaking Sanitary Inspections

Sites that receive a Priority Rating of High or Very High are prescribed routine enterococci monitoring and sanitary inspection to assign suitability grade to site. The sanitary survey methodology outlined in this chapter has been adapted from the Recwatch Training Manual, 2011 and considers methods used in the Seqwater '*Sanitary survey of drinking water catchments – Development of methodology for pollution risk assessment*', (Baker etal 2015).

The sanitary inspection serves three key functions:

1. Assess the catchment for pollution sources and calculate a Sanitary Inspection Category (SIC) which, together with the Microbial Assessment Category (MAC), is used to determine the suitability grade of a recreational water site.
2. Inform appropriate management for that site through sanitary survey results identification and assessment of pollution sources impacting it; including frequency of ongoing monitoring.
3. Provide guidance regarding relevant site-associated elements to site investigations resulting from warning trigger values obtained during routine enterococci monitoring.

The most important sanitary inspection consideration is an understanding of what is going on in the associated catchments. This information should be collected and updated over time to provide as complete a picture as possible of the catchments inputs that may impact on the recreational waterway.

Objectives of monitoring

The objectives of a sanitary inspection are to:

- identify all the real and potential sources of microbial contamination which could affect recreational water quality
- assess the risk to public health posed by this microbial pollution.

The Sanitary Inspection must take into consideration temporal and spatial influences of pollution on water quality at the site, and results should correlate to some degree with microbial water quality results obtained through sampling and analysis. Poor correlation between Sanitary Inspection categorisation and microbial water quality results can be common and this phenomenon is addressed in Chapter 6.3. A sanitary inspection of an existing recreational area should be conducted just prior to the swimming season. Swimming season generally extends through the warmer months of the year when use of recreational sites is highest, typically this is from September through to May in SEQ, but managers are encouraged to consult local guidelines where there is any doubt. Subsequent inspections should look for new sources of

microbiological hazards and review the adequacy of any sampling programme and corrective measures in place to deal with existing hazards. (NHMRC 2008 p32), Bartram and Rees (2000).

Frequency of monitoring

The frequency at which subsequent Sanitary Surveys should be carried out is dependent on the results of the Suitability Grade received for that site as a result of Sanitary Inspection and microbial water quality monitoring . For example, a site that is impacted by few pollution sources and receives a 'Very Good' Suitability Grade will require less frequent monitoring and surveying. Sites that receive 'Poor' or 'Fair' suitability grades should be surveyed every 12-24 months.

Data Quality

A consistent data collection and analysis approach is essential for meaningful comparisons between sites and for assessing the effectiveness of management interventions. Specific numbers and numerical ranges should be used for relevant factors such as discharge distances from waterways and sites, frequency of pollutant discharge/input events and visitation. For example, in this manual it is recommended that an inspection consider sewage treatment infrastructure up to 2 km from a site. Adhering to this distance criterion will increase confidence the same likelihood and consequence level is applied to this potential pollutant source at all assessed sites. Where possible, published studies and expertise have been used to support selection of such numerical distance/range values in this manual.

Worksheets and worked examples are provided within specific Module sections of this Manual to facilitate a consistent approach to data collection and analysis. Carefully document any modifications to the inspection criteria added to satisfy local needs within relevant sections of the Sanitary Inspection modules, such as additional questions or pollutant sources, then in detail document modifications (including date, person making modification, reason for modification and (their opinion of) potential impact on assessment) in the **Detailed Modifications to the Inspection Criteria** of the Sanitary Inspection tool (pg 39. Appendix A).

Data Use

The knowledge of the catchment, pollution sources and receiving water processes gained from the sanitary inspection provides water resource managers with a good foundation for investigating pollution incidents, prioritising and implementing pollution abatement measures, and providing informed advice to the community on where and when to use recreational areas where contact with water may occur.

The inspection process

There are four key steps to a sanitary inspection:

Step 1. Identify sources of faecal contamination and gather information on the frequency, duration and intensity of impact. Information may be sourced from:

a) Desktop study, including maps, reports and published data

b) Field inspections
c) Reconnaissance surveys
d) Interviews with information holders

Step 2. Assess risk for each identified faecal contamination source.

Step 3. Determine the site Sanitary Inspection Category (SIC) for the (overall risk to human health).

Step 4. Hold workshops with stakeholders to review pollution sources and risk assessment.

4.2 Step 1 Identify sources and gather information

You need to confirm which microbial pollution sources are impacting the site being assessed, then gather information on these sources via desktop studies, field inspections, reconnaissance surveys and interviews with key stakeholders.

Desktop study

Catchment area maps are a very useful Sanitary Inspection starting point. Maps showing land use, catchment size; presence of creeks, rivers and lagoons, and location of infrastructure such as sewage/wastewater treatment plants and boating facilities are particularly useful. Water quality, hydrological and meteorological reports can provide information on the impact of rainfall, frequency and extent of faecal pollution events, bacterial density or load from sources such as stormwater discharges or sewage overflows, and the extent of tidal flushing. Reports on the performance of sewage/wastewater infrastructure may contain information on discharge volumes, treatment levels, the frequency of bypasses, sewage overflows and chokes, and effluent quality.

Field inspections

Field inspections are a critical Sanitary Inspection component. They are required to:

- verify or ground-truth desktop study information
- collect a range of unpublished or unavailable information such as number of toilets and/or showers, site and intra-site features of interest GPS coordinates, location and size of stormwater drains, presence of aquatic or native animals, location and number of boats, size of car parks, etc.

Along with on-site Sanitary Inspection visits; water sampling, maintenance, complaint follow ups and facility/parks inspections provide very good opportunities to record site usage and visual evidence of pollution and pollution mitigation measure at a site, or gain anecdotal evidence from people using or living near the recreation site.

Field inspections can be time-consuming, and require careful planning to ensure data is obtained in a consistent, systematic way. Some accompanying resources to take along include:

- Copy of last assessment
- Recent weather records (ca. 12 months)
- Maps relevant to identified pollution sources
- Contact details for key landholders, marinas, and user groups
- Water sampling equipment (for incident assessments or as part of routine monitoring)

- Protective gear

Reconnaissance surveys

Sampling programs designed to assess the impact of sources of faecal pollution may be required in some instances. These reconnaissance surveys involve collection of water samples upstream and downstream of source input locations, and where possible, sampling of the source itself. In some cases, the source of faecal contamination may be unknown and chemical biomarkers and microbial source tracking parameters can be employed to assist source identification (NHMRC 2008). Identifying sources of faecal contamination can be a complex and difficult task, expert advice and the appropriate organisations should be sought out to assist in this undertaking.

Interviews

Sanitary Inspection information can also be sourced from individuals or organisations with responsibilities or interest at or in close proximity to the recreation site. For example:

- lifeguards may hold information on site use including number of visitors and user groups, pollution sources and other conditions affecting the site, and general site conditions.
- sewage/wastewater system operators or regulators generally have information on the proximal sewer system and treatment system, including location and overflow frequency
- council planners may hold information on the stormwater drainage system, land use, presence of on-site sewage treatment systems, animal exercise areas, location of wastewater re-use areas and a record of complaints or illnesses

Local residents or user groups may also be important sources of information.

As with field inspections, gathering information through interviews can be time-consuming and must be carefully planned. A list of interview questions should be drawn up in advance and reviewed to ensure consistency and completeness.

Dry and wet weather conditions

Site use and pollution sources can vary with weather conditions, particularly rainfall. The number of people using recreational waters is generally substantially lower on rainy days, and many pollution sources, such as stormwater or sewage overflows, occur primarily in response to rainfall. The risk associated with each pollution source (see Pollutant Assessment Modules 1-9 in the **Sanitary Inspection report, Appendix A of this Manual**) should be assessed during dry weather conditions and wet weather conditions, and the highest resultant risk used when reporting site SIC and MAC classifications.

It should be noted that wet weather conditions will persist for some period after rain has ceased. Wet weather can be defined from its influence on pollution sources, including:

- the amount of rainfall necessary to trigger wet weather pollution sources (this defines the wet weather starting point).
- the level of flushing or tidal movement that transports pollution away from the recreational site and dilutes pollution concentrations at the site (this defines the wet weather end point prior to return to dry weather conditions).

(Example: Wet weather continues for up to 24 h after heavy rain (> 50 mm in 24 h), dry weather conditions return 3 d after very heavy rain.)

For management purposes, it may be useful to assign separate wet weather and dry weather classifications to a site. Rain-sensitive sites may receive 'good' Suitability Grades under dry conditions but 'poor' during rainfall-driven events, or *vice versa*.(NHMRC 2008 appendix 4).

4.3 Step 2 Assess the risk for each identified pollution source

There are nine Pollutant Assessment Modules for assessing recreational sites. These modules are based on the nine principal sources of pollution causing human health risks at recreational water sites. You only need to complete the modules corresponding to identified pollution source(s) relevant to the respective recreational site being assessed. For each Pollutant Assessment Module a pollutant risk to human health is calculated by assessing the likelihood of pollution at the recreation site and the consequence of pollution at the recreation site. Once determined, the likelihood of pollution at the site and the consequence of pollution at the site are multiplied to determine Pollutant Assessment Module, pollutant risk to human health score.

The Sanitary Inspection modules are:

Module 1. Sewage Treatment Infrastructure and Overflows
Module 2. On-site sewage systems
Module 3. Industrial discharges
Module 4. Animals (agriculture, domestic and wild)
Module 5. Stormwater
Module 6. Recreational sites
Module 7. Boating discharges
Module 8. Waterway discharges
Module 9. Other (if required)

Assume primary contact

To ensure consistent comparisons between sites, assessments of risks to public health are based on the assumption that primary contact is occurring, even for sites predominantly used for secondary contact purposes. The *consequence* rating reflects the estimated impact pollutant loads will have on site water quality with respect to the health of primary contact recreators.

Assess for the past year / busy parts of the year

For calculation of Annual Suitability Grades, risk from pollution must be considered in context of a year's worth of activity. For example, if birds are present only during migration periods, then risk of faecal pollution from animals is higher in those months and additional site visits or information gathering regarding animal densities during that time may be required.

Pollutant source hazards and characteristics

For each module, key hazards associated with each source, and factors that influence *likelihood* and *consequence* of water quality hazards at the site are identified.

There are many factors that will influence the *likelihood* and *consequence* of microbial pollution reaching a recreation site, and the extent to which it poses a public health risk. It is not necessary to measure all influences and only the key, easy-to-measure characteristics associated with

hazards have been used in this manual to assist and defend risk-associated management decisions.

Note: Managers are encouraged to make use of existing complimentary information such as in-depth studies regarding pollution types, to justify and document changes to ranking and scoring matrices used in this manual and accompanying sheets.

Likelihood of microbial pollution reaching the site

Within each Pollutant Assessment Module, the *likelihood rating* (rare, unlikely, possible, likely or almost certain) is assigned to key hazards or hazardous events and based on the likelihood that microbial pollution is reaching the recreation site. For each pollution source, it is important to consider the likelihood:

- a microbial pollution hazard exists or associated hazardous event occurs (e.g. frequency of sewage overflow)
- microbial pollution enters a waterway (e.g. distance of overland transport of animal waste)
- microbial pollution reaches the site (e.g. distance of stormwater drain from site)

Each *likelihood rating* is weighted with a specific score:

Likelihood	Score
Rare	1
Unlikely	2
Possible	3
Likely	4
Almost Certain	5

Table 8: *Likelihood ratings* and scores

Averaging of likelihoods

In some modules, multiple hazards contribute to the risk (e.g. dogs and wild birds). To provide a risk rating for those modules, the likelihood scores are averaged as below:

$$\text{Pollution likelihood score} = \frac{\text{Likelihood of hazard 1} + \text{likelihood of hazard 2} + \ldots}{\text{Number of hazards}}$$

Example

$$\text{Module 6: Animals likelihood score} = \frac{\mathbf{1}\text{ (rare for wild birds)} + \mathbf{5}\text{ (almost certain for dogs)}}{\mathbf{2}\text{ (types of animal sources)}}$$

Animals Likelihood score = **3**

Consequence of microbial pollution to water quality at the site

A *consequence rating* (insignificant, minor, moderate, major and catastrophic) is also assigned based on the impact that pollutant type has on water quality at the site.

Each consequence rating is weighted with a specific score:

Consequence	Score
Insignificant	1
Minor	2
Moderate	3
Major	4
Catastrophic	5 or more

Table 9: *Consequence ratings* and scores

Combining health impacts and mitigation

The consequence to water quality is a combination of:

- The number of faecal indicator bacteria indicative of pathogen presence in raw pollution (health impact rating)
- Effectiveness of any mitigation measures that may reduce the microbial pollution load present at the site (e.g. level of sewage treatment).

Microbial pollution source	Health Impact
wildlife and domestic animal sources	1
hoofed animal sources	3
mixed source likely to contain human faecal input	5
human sources	5

Table 10: *Consequence* of Microbial pollution source for human health risk and score

Mitigation measure outcome	Score
Minimal reduction of viable pathogens	-1
Partial reduction of viable pathogens	-2
Major reduction of viable pathogens	-3
Almost total elimination of viable pathogens	-4

Table 11: *Consequence* of microbial pollution mitigation measure for human health risk and score

Pollution consequence score = health impact rating & mitigation measure

Example

Onsite systems consequence score = **5** (human source) - **2** (annual maintenance)

Onsite systems consequence score = **3**

Some mitigation measures will reduce both the *likelihood* of contaminants reaching a waterway and its *consequences* should it happen. This is reflected in the hazards and score calculations described in each Pollutant Assessment Module.

Attenuation and dilution of microbial pollution

Particular waterway conditions such as tidal flushing, volume of flow and processes such as microbial die-off and sedimentation will reduce microbial pollutant load as it travels to, and resides at, a site. This attenuation has been factored-in when determining likelihood ratings associated with distances between site and river discharges.

Microbial Pollution Risk ratings and scores

Each microbial pollution source can be assigned a risk rating pertaining to its impact on site water quality.

Table 12. Microbial pollution risk rating matrix

Risk of Microbial pollution impacting the site		Microbial Pollution Consequence categories				
		Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Microbial Pollution Likelihood categories	Rare (1)	Very Low 1	Low 2	Low 3	Low 4	Moderate 5
	Unlikely (2)	Low 2	Low 4	Moderate 6	Moderate 8	High 10
	Possible (3)	Low 3	Moderate 6	Moderate 9	High 12	High 15
	Likely (4)	Low 4	Moderate 8	High 12	High 16	Very High 20
	Almost Certain (5)	Moderate 5	High 10	High 15	Very High 20	Very High 25

Circle the pollution risk rating based on where your calculated risk score sits in the following ratings:

Table 13

Risk Scores	0-1	2-5	6-9	10-16	17+
Risk rating	Very Low	Low	Moderate	High	Very High

Pollution risk score = pollution likelihood score x pollution consequence score

Pollution Risk Score	Risk Rating	Recommended Management Response
20-25	Very High	
10-19	High	
5-9	Medium	
2-4	Low	
0-1	Very Low	

Table 14: Pollution Risk Score and Risk Rating

Pollutant Assessment Module 1 - Sewage Treatment Infrastructure

Treatment failures and transport of raw sewage are primary hazards for microbial pollution of recreational sites, increasing human health risks. The risk of sewage entering a recreational site includes the following hazards:

- Wet weather overflow or by-pass at: Sewage plant, pumping station, Sewage Discharge Outlets (SDO) and other Emergency Relief Overflow Structures (EROS)
- Dry weather overflow due to malfunctioning plant, pumping station, blockages or improper sewerage system connections
- Leaks from broken sewerage pipes and other infrastructure
- Improper sewerage connections resulting in discharge through stormwater outlets.
- Insufficient treatment of wastewater discharge into waterways

They occur during:

- Sewage transport to treatment plants
- Sewage treatment at the plant
- Sewage discharging via an outfall

In order to determine microbial pollution source likelihood and consequence scores for Sewerage Treatment Infrastructure Pollutant Assessment Module 1, information is required on the Sewage Treatment Plant (STP) outfall location, level of treatment, frequency of treatment bypasses and presence of visual indicators of sewage contamination at the site. Other STP assets such as sewer pumping stations (SPS) and Sewage Discharge Outlets (SDOs) are also evaluated within this Pollutant Assessment Module to account for sewer overflow risk.

Sewage treatment networks capacity to transport and treat raw sewage can be adversely affected by wet weather events due to stormwater infiltration of the sewerage system. Due to low level separation of sewerage network infrastructure and incorrect stormwater connections where urban stormwater drainage is connected to the sewerage network, sewerage infrastructure can become inundated beyond capacity during rainfall events. In these instances EROS are built into the network.

EROS are devices built into sewerage treatment and transportation systems to accommodate sewage wastewater flows exceeding the capacity of the system to treat or transport raw sewage wastewater. Systems are designed so that in such instances, pressure within the treatment and transport system is released through EROS into local waterways and creeks in order to avoid back-ups and overflows (into residential properties is a principal concern). Capacity to manage and treat wastewater and sewage can be adversely affected by either mechanical failure, blockage of the treatment and transport mechanism, or inundation of the network with rainwater caused by poor stormwater and wastewater system separation. In some instances, engineered structures may hold or treat EROS-discharge prior to release into waterways.

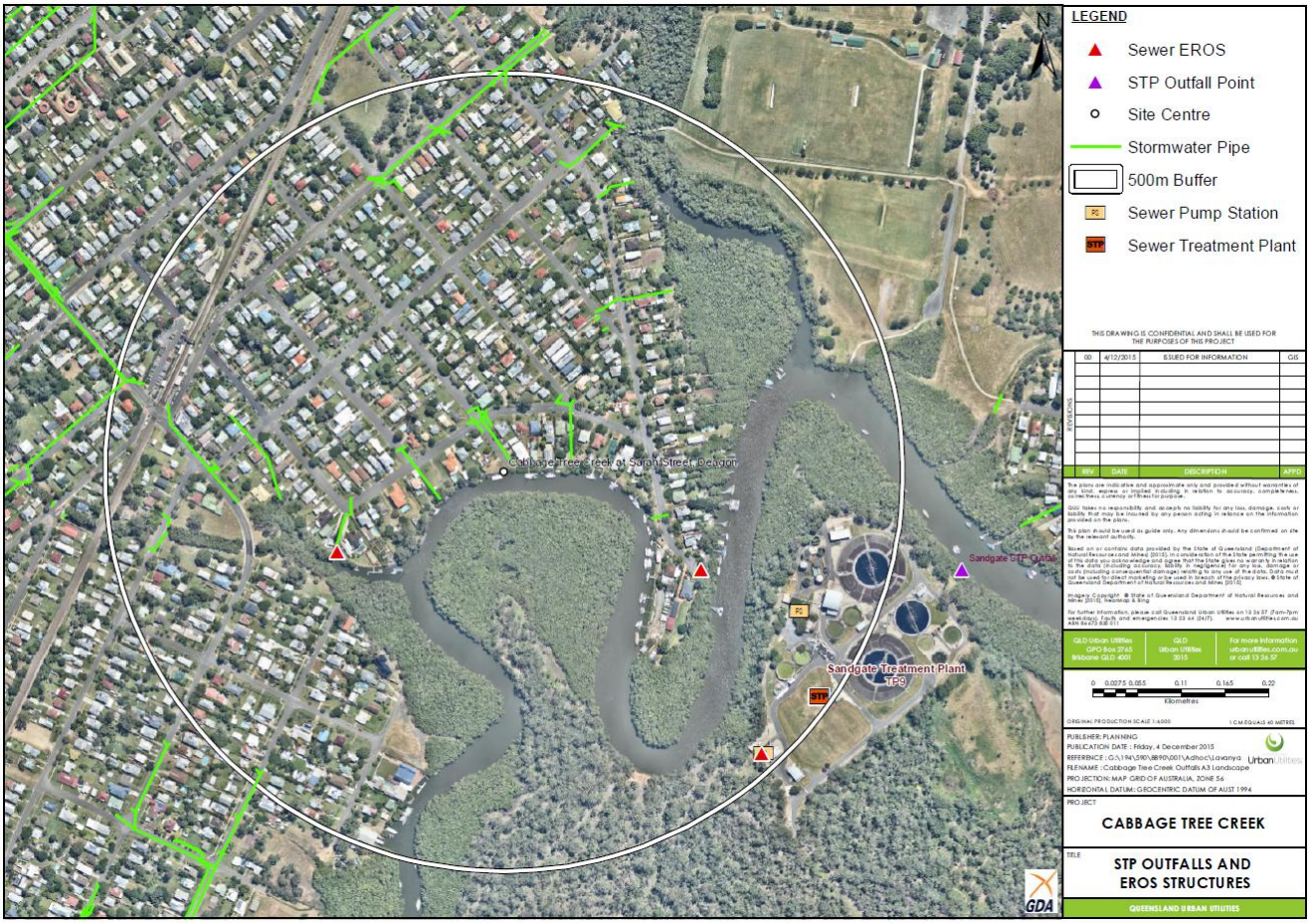


Figure 6: Sewerage infrastructure, including EROS and potential stormwater transport pipes within 500 m of a recreational water site. Recreational site is white dot in the centre of the 500 m perimeter.

The location of STP's and associated outfalls in relation to the recreational site are used to score the likelihood of risk from sewage treatment plants and outfalls. Consequence scoring for sewage treatment plants and outfalls as they relate to risk to human health at the recreational site consider pollution source type and other management measures aimed at reducing risk to human health. Considerations for consequence and likelihood are summarised below (see Module 1 Appendix A for detailed considerations).

<u>Assessment of likelihood of risk to human health for STPs</u>

STP location – add likelihood score if within 2 km of the site

Frequency of treatment bypasses – note: mitigated by systems designed with sufficient capacity for flow levels through the sewage treatment network

Presence of visual indicators – evidence overflows or leaks have occurred

<u>Assessment of Consequence of risk to human health for STPs</u>

Treatment level and type

Assessment of likelihood for wastewater discharges into receiving waters increasing risk to human health

Location of wastewater discharge points

Catchment development (population density)

Discharge volume

Existing water quality of receiving waters

Presence of visual indicators

Large concentrations of pathogen in sewage

Assessment of consequence of wastewater discharges into receiving waters increasing risk to human health

Pollution source

Consequence mitigation or management measures

Wet weather overflows are best understood via effective monitoring and modelling of sewer system flows, a shared understanding between Utilities, councils and the community management of asset condition and illegal stormwater connections. Wet weather overflows can be reduced through management actions aimed at decreasing separation between sewerage and stormwater drainage networks and increasing treatment and transport capacity.

Asset condition

The physical state of sewerage plants, pipes and pumps deteriorates over time through wear and tear or additional demands extreme events and population growth place on the system. Systems that are leaky due to cracks, frequently blocked through root infiltration of pipes, or close to capacity during low to moderate rainfall events, can be considered **below average condition**. Expert opinions from those undertaking physical inspections of infrastructure, installing flow meters and conducting flow monitoring and modelling, can be used to better understand the condition of sewerage assets near recreational waters as it relates to likelihood and consequence of sewage overflows. This information can then be used to accurately assess the likelihood of sewage overflows impacting recreational water in Pollutant Assessment Module 1 in Appendix A of this Manual. Expert advice may need to be engaged to assess Asset Condition with a degree of accuracy, consult council asset and infrastructure departments or water utilities where necessary.

Illegal stormwater connections

It is standard practice to keep stormwater and sewerage systems separate and prohibit discharge of stormwater to sewers. Sewerage infrastructure that has **illegal stormwater connections** may experience high flows exceeding sewer system design capacity, leading to sewage overflows dependent upon the number of illegal connections, area drained and capacity of the sewage network. Critical STP processes can also be disrupted by high flows, leading to increased treatment bypass. Expert opinions from those undertaking installation and physical inspections of stormwater

and sewerage infrastructure can be used to better understand how illegal connections to sewerage infrastructure near recreational waters influence likelihood and consequence of risk to human health at recreational sites. This information can then be used to accurately assess the likelihood of sewage overflows impacting recreational water in Pollutant Assessment Module 1 in Appendix A of this Manual. Expert advice may need to be engaged to assess Surrounding Asset Condition with a degree of accuracy, consult council asset and infrastructure departments or water utilities where necessary. It is also important to consider the influence of the number of connections on the sewage system. In this instance Illegal Stormwater Connection should be considered *'few'* where the number of connections has little or no impact on sewage treatment capacity as it relates to bypass or overflow at the recreational site. Where Illegal Stormwater Connections are known to have an influence or the number of illegal connections is unknown, assume *'many'*.

South East Queensland example of stormwater infiltration and overflow of sewerage treatment network

This year, Queensland Urban Utilities (QUU) completed a two-year Critical Sites Monitoring Program (CSMP) that involved implementing Hawk-Eye technology to improve management of sewage overflows resulting in a healthier environment and improved public health impacts. To monitor sewer levels and alert our control room in the event of a sewage overflow, QUU installed > 326 Hawkeye remote telemetry units into maintenance holes located near emergency relief overflow structures (EROS). Sewage overflows are typically caused by blockages in pipes, power supply interruptions or stormwater entering and overloading the sewerage system. An overflow occurs when the sewage flow exceeds the capacity of the sewerage pipe. When this happens, an EROS diverts sewage resulting in an overflow. Preventing sewage overflows is a high priority for QUU. As a result of the installation of the Hawk-Eyes and the CSMP QUU can:

• reduce the public health and environmental impacts of overflows on waterways by immediately responding to overflows that may have previously been unnoticed,

• reduce the impact of overflows on customers by immediately responding to, and cleaning up, overflows on private properties,

• improve planning with increased knowledge of the impacts of overflows and by using sewage overflow data to validate catchment-based risk assessments,

• ensure just-in-time investment in sewerage system upgrades by using sewage height datasets from the new monitoring equipment to validate hydraulic sewerage models used in master plans.

Due to the success of this project, QUU are now looking into how we can roll out various applications of this technology to provide an enhanced service to customers, communities and the environment.

Adapted from Queensland Urban Utilities 2013-2014 Annual Report. QUU, 2014

Module 2 - On-site sewage systems

Septic systems and small treatment plants located <u>within 200 m</u> of recreational waters.

If on-site sewerage facilities are incorrectly installed or poorly maintained they can act as a potential source of microbial pollution. Pollutant Assessment Module 2 considers factors influencing the likelihood and consequence of on-site sewage treatment systems influencing microbial pollutants and associated risk to human health at recreational sites.

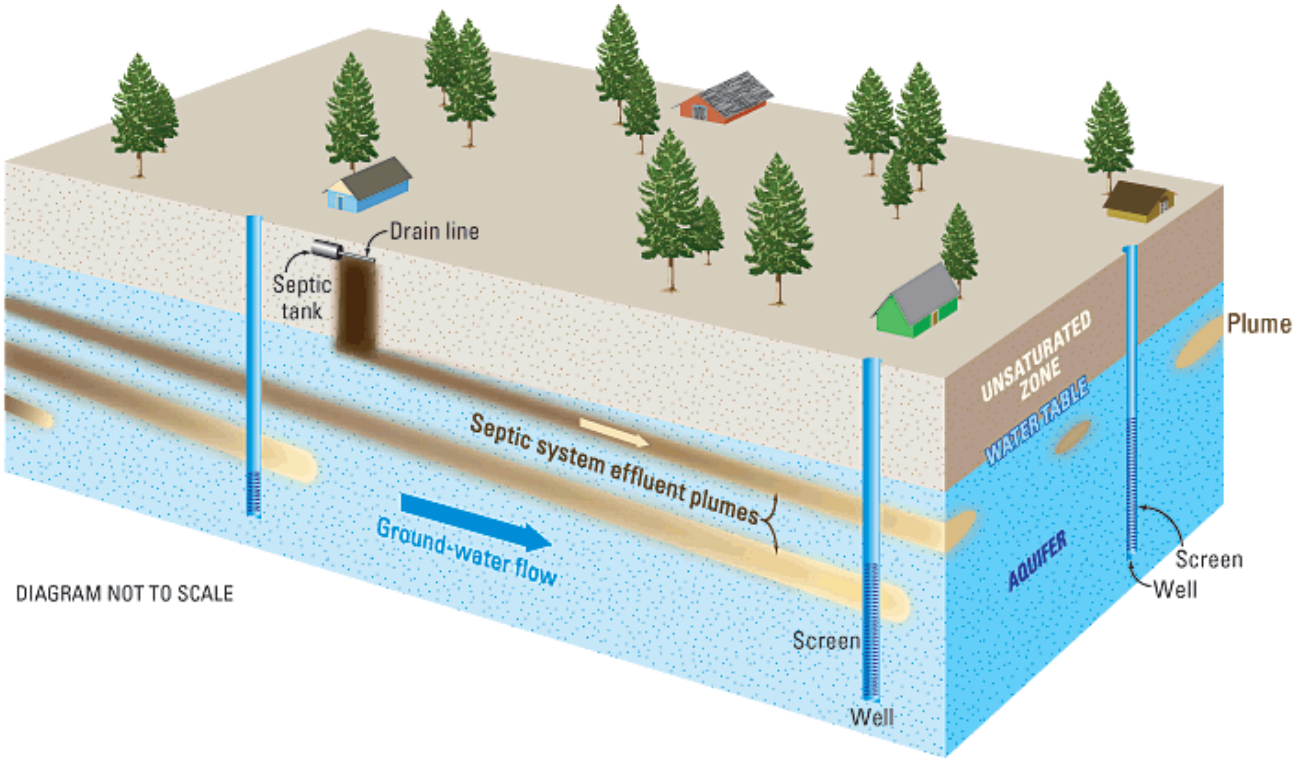


Figure 7: (USGS 2007) Illustration showing sewage infiltration and groundwater effluent plume from septic treatment system. Where septic systems are in close proximity to recreation sites, poorly managed systems have the capacity to deliver significant concentrations of faecal pollutants to recreational sites via groundwater flow.

In order to make best use of available resources, it is important to determine up front which systems are of most relevance to assess as potential pollution hazards. On-site systems within 200 m of the recreational water site are of highest priority. Beyond this, consider those on-site systems located within 200 m from the edge of stormwater drainage channels or waterways discharging near to the site, including upstream reaches of freshwater, estuarine and marine recreation sites. Consider stormwater drainage channels discharging within 500 m of the site, and waterways that discharge within 1 km of the site (see Pollutant Assessment Module 5: Stormwater and Pollutant Assessment Module 8: Waterway Discharges for more explanation). Include all properties with septic systems for a total distance of 2 km along the length of these channels or waterways from the point of discharge affecting the waterway (that is, the discharge point within 1 km).

Where more than one septic system exists on a single lot, systems are to be clustered and treated as a single system for the purpose of *likelihood* of impact categorisation. Where multiple dwellings or buildings are serviced by a single system the system will be treated as a single system for the purpose of *likelihood* of impact categorisation. The number of systems *within the cluster* will be considered in terms of *consequence* of on-site systems.

Septic systems and stormwater are assumed to be equivalent to primary treated sewage. (page 80 NHMRC guidelines). Primary hazards considered in Pollutant Assessment Module 2: On-site Sewage systems for assessing the likelihood of on-site systems impacting recreational waters sites include systems that dispose of effluent via surface effluent irrigation, sub-surface effluent irrigation and no effluent irrigation.

Surface effluent irrigation refers to the practice of disposing of on-site septic system effluent through above ground dispersal using sprinkler or flood irrigation (or similar). For the purpose of Sanitary Inspection categorisation, the dispersed effluent is considered to have undergone secondary treatment (i.e. nutrient removal). Sub-surface piped effluent irrigation involves disposal through wicking by way of evapo-transpiration or leaching of effluent into sub-soil. For the purpose of Sanitary Inspection categorisation, sub-surface irrigation disposed effluent is considered to have undergone primary treatment only. Self-contained on-site sewage systems that rely on pumping, transport and off-site disposal of effluent should not be considered effluent irrigation systems.

Determining slope:

Percentage Slope of the land can be measured by "rise over run" or Height divided by Distance x 100.

The link below provides two simple ways to measure Percentage Slope in the field; either with two people 30 m apart, or using a level, plank and tape measure and averaging calculated slopes. Consult appropriate guides for examples of methodology.

South East Queensland Case Study demonstrating the influence of on-site sewage systems on microbial pollutant loads at recreational sites

During routine water sampling, high levels (exceedence of trigger values for management action) of enterococci were detected at a popular freshwater swimming hole. In the days preceding the sample there was a heavy rainfall event. The rain persisted intermittently for a number of weeks during the summer storm season and elevated enterococci results continued. The site was closed as a precaution as trigger values were exceeded. The site is located in a rural area surrounded by farms, with nearby cattle and other farm animals a likely microbial pollution source during a rainfall event. However, after the rains ceased, elevated enterococci levels continued. As a result of this, a site assessment was conducted to identify the pollution source. The site assessment did not reveal obvious sources of microbial pollution, however a septic tank was identified servicing the public toilet facilities located within 200 metres of the waterway. The toilet facilities were serviced regularly and appeared in good condition, without obvious odours or evidence of overflow.

As a precaution, officers requested the maintenance team conduct a test of the septic tank to determine if there had been any damage or cracks to the tank that could be resulting in leaks that are not visible at ground level. Fluoroscein dye was added to the toilet septic tank and detected in the proximal waterway with elevated enterococci levels. It was subsequently found that a small crack in the tank had caused leakage into an area near the waterway. The tank was subsequently repaired, water quality improved and the site re-opened. Frequency of septic tank maintenance was increased and no subsequent incidents have occurred.

Popular South East Queensland freshwater swimming hole with well-maintained on site toilet facilities. However the receiving on-site sewage treatment system was contributing to elevated faecal indicator bacteria concentrations down-stream at this recreational site.

Module 3 - Industrial discharges

An industrial discharge is considered as a point source of pollution other than from a Sewage Treatment Plant or stormwater drain. Industrial discharge includes point-source discharges from activities that operate under an Environmentally Relevant Activity (ERA) license, or reported outfalls from industries likely to be sources of microbial pollution such as abattoirs, intensive agriculture (piggeries, chicken batteries), tanneries and food processing facilities. It does not include stormwater discharges from industrial estates, and stormwater discharges from industrial areas should be considered under Pollutant Assessment Module 5: Stormwater. For the purpose of impact *likelihood* categorisation, high-hazard commercial processing activities are defined as those involving any type of faecal material, animal parts, raw materials of agricultural origin, fermentation, rendering, fertiliser, food processing and activities generating trade wastewater likely to contain microbial pollution.

High-hazard industry processes have a health impact rating of two or greater. While animal sources also contribute a public health risk, particularly from hoofed animals, faecal pollution from animal sources are *generally* considered a lower risk to human health than that of human origin. Treatment chains for removal or mitigation of potential health impact associated with microbial contamination prior to discharge can include pre-treatment of discharged wastewater. Risk mitigation management measures are considered within the microbial water quality *consequence* categorisation section of the Pollutant Assessment Module3: Industrial Discharges.

Module 4 – Animal sources (agriculture, wild and domestic)

Animals have the capacity to negatively impact water quality at recreational sites through microbial contamination via the presence of associated animal faecal matter or by-products such as nutrients. The following attributes are likely to cause impacts on recreational sites:

- Direct animal access to waterways (e.g. hoofed animals use site as watering point, dogs swim at site, waterfowl reside at site).
- Animal depositions (including manure piles) within 50 m of intermittent or permanent waterways influencing microbial water quality at a recreational site.
- Presence of agriculture (e.g. feed lots, dairies, piggeries, poultry farms, grazing).

Animal sources can be transported through overland runoff directly to a site, through gullies and drains that flow to the site, or via a river/tributary. All three transport mechanisms are taken into account.

For agricultural activities, primary factors include the animal stocking intensity and use of fertilisers such as biosolids and animal waste which can be a source of microbial pollution-particularly if applied at high concentrations or unto unsuitable soils and/or topographies. The term biosolid refers to any by-product or organic matter derived from sewage. In many instances sewage or effluent (treated or untreated) derived as a by-product of agricultural production is used on-site or on-sold as a fertiliser. The use or storage of biosolids on or near a waterway site substantially increases the likelihood of microbial contamination.

Local guides or expert advice should be sought when considering the influence of aquatic birds and other native animals where there is some doubt in the assessor as to the presence or influence of these animals, or where the assessor is inexperienced in identifying or calculating the presence and abundance of these animals.

Likelihood of animals impacting recreational water considers primary and secondary hazards in relation to fenced and buffered waterways. In this instance, watercourses can be considered fenced, where fencing of any type actively precludes wildlife from entering a waterway; and, Buffered watercourses have vegetation in place at the waterways edge capable of slowing down flows and filtering or settling faecal matter in transit.

The variable nature of agricultural activities increases uncertainty in determining whether animals are regularly present in locations where they have been observed, and whether or not they have access to relevant waterways. Utilising local knowledge through interviews with key stakeholders such as landholders will help reduce this uncertainty.

When calculating the *likelihood* of microbial pollution from animal sources, ensure the site is assessed for the presence of mitigation factors that may reduce pollutant transport to waterways. These mitigating factors include:

- riparian zone fencing (preventing animal access and waste deposition directly into waterways)
- vegetated riparian buffer strip adjacent to the waterway (restricting movement of animal waste).

The *consequence* to microbial water quality of Pollutant Assessment Module 4: Animal sources considers the type and number of animals, as well as mitigating management factors. Hoofed

animals are considered to be of greater influence on human pathogenic microorganisms such as *Cryptosporidium* and *Giardia spp.*

Where an intensive, ERA licenced agricultural operation has been considered under Pollutant Assessment Module 3: Industrial Discharges, it should not be considered in terms of the point source discharge component of this module. However, where there is potential for microbial contamination through diffuse stormwater run-off that is not point-source related, the site should be considered for this module (Pollutant Assessment Module 4: Animal Sources) also.

Bell's Beach Case Study

Moreton Bay Council carried out an investigation of consistent faecal indicator bacteria peaks (well above 500 enterococci/100 ml) after rainfall at Bell's Beach; a popular swimming and jet skiing site. The area is highly urbanised with several stormwater pipes discharging into the site itself and surrounding location, with the majority of the site captured by the stormwater network. Water sampling was conducted over 100 consecutive days within the concrete drain near the mouth, and in the middle and upper reaches of Bell's Creek along with source tracking and sanitary inspections. Faecal sterol biomarkers of human contamination were absent, with birds identified as the main source of microbial pollution. This was supported by the sanitary inspection, which revealed no indication of potential sources human contamination. Council is investigating ways to reduce the wild bird source of microbial contamination. Recreational water monitoring results (enterococci cfu/100ml)are reported weekly on council's website during the swimming season to inform the public, with a permanent sign in place warning people of potential microbial pollution and health risks at the site during and after rain events.

Advisory sign at Bell's Beach, Clontarf

Module 5 - Stormwater

Module 5 considers the influence of the stormwater drainage system on microbial levels at recreational sites. Stormwater drains can contribute very significant pollution loads to recreational waterways and need to be thoroughly assessed. Stormwater is rain or water that runs off grass, roofs, roads and footpaths into the stormwater system; which is designed to drain water away from built infrastructure and modified areas in order to avoid flooding. The stormwater system is composed of pits or traps that capture stormwater runoff and funnel it through channels or pipes to local waterways where it is discharged. Most stormwater is not treated via dedicated treatment chains and has the potential to carry accumulated faecal and chemical pollutants.

For the purpose of categorising the *likelihood* of stormwater impact on recreational water, stormwater catchment size and land-use type are considered. Catchment size should be considered in relation to volume of water delivered or discharged to the recreational site. Catchment land use is considered for its potential to influence *likelihood* via the probable associated types or concentrations of contaminants. All stormwater discharge points within a 500 m radius of the site should be considered, and likelihood of stormwater impact is related to distance of stormwater discharge point(s) to the site. High-density areas include those with a majority of buildings more than two stories high, with low-density urban areas those where the majority of buildings are two stories or less.

In some instances *likelihood* of stormwater system impact will be somewhat mitigated through stormwater treatment chains. Stormwater treatment chains and technologies are organic or mechanical devices installed in urban or rural stormwater systems to remove nutrients and contaminants prior to discharge into waterways. Stormwater treatment devices include organic vegetated systems such as bio-retention basins or dams, artificial wetlands, swales or filtering/buffering strips; and mechanical/constructed infrastructure such as sediment traps, filtration devices and stormwater harvesting devices. The location, number, efficacy and maintenance of these treatment types should be considered when determining potential to influence stormwater impact likelihood.

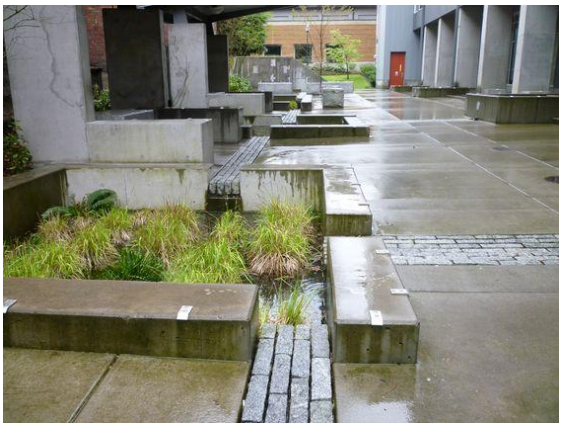
Local Government asset-, or infrastructure-associated officers may likely need to be consulted in determining the location and size of the stormwater system being considered. Expert knowledge may also be required to assess treatment chain or device efficacy for in mitigating potential contaminants. At the very least a detailed map or spatial representation of the stormwater network should be obtained, consulted, and ground-truthed. Where expert knowledge is unavailable, conservative estimates should be used when considering stormwater treatment device efficacy and potential to mitigate pollutant loads and likelihood of risk to human health.

The *consequence* component of Pollutant Assessment Module 5: Stormwater considers pollution source type, the number of discharge points within 500 m of the site and mitigating treatment measures as they relate to the percentage of the stormwater system and percentage of stormwater treated, by volume. There is also the ability to consider novel or site-specific factors likely to influence site stormwater impact consequence.

The stormwater Pollutant Assessment Module should not consider the influence of stormwater and rainfall events *on the sewage treatment network* or the influence of incorrect sewage connections on the stormwater system, as these influences are accounted for in Module 1- Sewage Network. The stormwater module should also not consider the impact of pollutants

derived from overland flow or run-off associated with agricultural land-use, as these influences are considered in Pollutant Assessment Module 4: Animal Sources. Stormwater run-off and stormwater systems discharging from industrial sites *should* be considered within this module; *however* point-source discharges associated with industrial processes are to be considered in Pollutant Assessment Module 3: Industrial Discharges.

Figure 8: Examples of Stormwater treatment devices


a)


b)


c)


d)

a) Rain water garden and interception, b) bio-retention basin, c) inline treatment chains under construction, d) multi-stage stormwater separation system.

Pollutant Assessment Module 6 – Recreators

Faecal contaminants in bathing areas are known hazards to water quality and human health. Potential shedding of pathogens and accidental release of faecal matter during bathing is an important influence on bathing area contaminant levels. This influence and associated risk is exacerbated at sites where bather population densities are high with low levels of flushing. The absence or presence of toilets at the site will also influence the suitability of the waters for human health. Personal watercraft and boats that do not have on-board toileting facilities should be included in this Pollutant Assessment Module.

The *likelihood* of bathers impacting recreational water considers bather density per square metre (calculated using the equation in Box 1 in Pollution Assessment Module 6 Recreational Sites, of the Sanitary Survey Inspection tool, Appendix A of this Manual. The *likelihood*, component also considers the absence or presence of toilet facilities and the types of recreational contact exhibited at the site. Toilet facilities consider maintenance schedules and degree to which toilets are maintained. Evidence of poor maintenance can include facilities that are not clean, not functioning or facilities that would generally put people off using them. Frequency of maintenance refers to how often cleaning and general maintenance of the facilities occurs.

Bather density impacts the *likelihood of contamination* as well as *likelihood of exposure* to contaminants. The criterion for absence of toilets in relation to likelihood of impact refers to the presence or absence of toilet facilities within 200 m of the recreation site waters. Toilets available for use **at the site**, but further than 200 metres away from the water, due to spatial characteristics of the site (eg. some urban beaches) and in environments where it is acknowledged that toilets will be more than 200 meters away but use can be planned, **may** be considered as a mitigating factor in the *consequence* of impact section. It is asserted here that any mitigation of *consequence* under *Other Management Measures* should be considered carefully, based on evidence and assigned only after thorough consultation and seeking of expert opinion.

The *consequence* of recreational water user densities impact on recreational water quality is related to human sources of faecal pollution. Several management measures or mitigating factors can be considered in reducing associated impact consequence. Sites unlikely to have small children recreating refers to sites where children are absent during field inspection and sites where there are risks to child safety such as high impact surf zones, diving platforms, or similar. The presence and functionality of toilet facilities is considered where toilets are available for use at the site. Sites that are under tidal influence, wave action, high flow or current have an increased capacity to disperse faecal contaminants, and are considered for their ability to mitigate consequence. Site specifics and spatial and environmental variability should be considered in assessing the effect of these parameters in reducing contaminant levels, and relevant expert knowledge should be sought where relationships between flushing and dilution are unclear. Other site-specific mitigation factors should also be considered, such as supply of port-a-loos or like during times of high use or for events or where bather density is high due to sporting event or like where bather shedding or defecation is unlikely.

Case Study regarding bather density, shedding and faecal contaminant concentrations in recreational waters.

Microbial water quality was monitored throughout an annual event known as the"Mirror Lake Jump". This event involves large numbers of students from a university campus in Ohio, USA immersing themselves in a relatively small urban lake (2600 m^3). The emersion was full contact exposure where more than one thousand individuals jumped into the water simultaneously. The event was monitored for bather density and changes to water quality over time. This involved tracking faecal indicator bacteria prior to, during and after the event.

Samples were taken to analyse faecal indicator bacteria (*E. coli,* enterococci) and analysis of genetic faecal contamination markers was performed, as was standard physical chemical parameters of water quality. This analysis revealed that significant correlations were observed between the number of jumpers and levels of turbidity, enterococci, *E. coli*, human-associated and antibiotic-resistance genetic markers. FIB concentrations during the event exceeded water quality action values by orders of magnitude. This was attributed to bather faecal shedding and re-suspension of substrate sediment and associated FIB which likely occurred during the event.

Adapted from Marion et al, 2015

Pollutant Assessment Module 7 – Boating discharges

In Queensland it is illegal to discharge sewage from a boat into a designated recreational waterway. Further to this all discharges form recreational vessels are conditioned under the *Transport Operations (Marine Pollution) Act 1995* and the *Transport Operations (Marine Pollution) Regulation 2008.* Despite these conditions, discharges from recreational vessels remain a threat to water quality parameters relevant to human health in South East Queensland.

Pollutant Assessment Module 6 Recreational Sites in the sanitary inspection survey considers the likelihood and consequence of the influence of recreational boating on water quality for recreational sites. Specifically, Pollutant Assessment Module 7 considers boats and discharge of effluent through disposal of sullage into water and implications for influencing risk to human health at recreational sites, as opposed to pumping of sullage (sink, bath and shower waste water) tanks at dedicated pump-out facilities. Heavy boat traffic can also increase microbial pollution via "over the side" ablutions, however this type of pollution should be considered in Pollution Assessment Module 6: Recreational Sites. The presence of marinas, harbours, jetties, boat ramps, moorings, ferry berths and anchorage at recreational sites-as well as the presence, location and density of recreational watercraft of any size-are indicators that discharges from boats could be a contributing source of pollution to the site.

The *likelihood* of boating discharges impacting the recreation site considers site boating density and the absence or presence of site sullage pump-out facilities and toileting facilities. Boating density is considered a primary hazard and categorised by the number of boats within a 100 m radius of the site. Toilet facilities and pump-out facilities are considered secondary influences on likelihood of faecal pollution and their influence is assessed by the presence or absence of one or the other, or both.

The *consequence* to microbial water quality considers pollution source type, and management measures such as education and extension programs aimed at increasing compliance with discharge of sullage as per regulated requirements.

Many medium-to-large recreational vessels have on-board toileting systems where wastewater (including sewage) is held and in some instances treated for disposal at a later date. Pump-out facilities refer to built infrastructure receiving effluent from vessels for disposal or treatment. These facilities are available for general use and located at most marinas, anchorages and harbours. Information regarding location of pump-out facilities can be found at the Maritime Safety Queensland website- http://www.msq.qld.gov.au/Marine-pollution/Sewage.aspx

The influence of boating on *likelihood* of direct(defecation in water) faecal contamination of recreational waters is considered within Pollutant Assessment Module 6-Recreational Sites. Consequence for recreational boaters is considered under the Secondary Contact consequence multiplier in Pollutant Assessment Module 6-Recreational Sites. However Module 6 only considers the influence of boating activities allowable by law to within a distance of 50 m of recreating bathers. In most instances, this would limit Module 6 to assessing the risk influence (likelihood of associated faecal pollution) of non-powered craft only. The influence of an individual vessel should only be considered once (in either Module 6 or 7), and the distance between the recreation site and the vessel should be used as the initial determinant as to which Pollutant Assessment Module a vessel should be considered in. Persons responsible for Sanitary Inspection Surveys should consult this manual and relevant State and local regulations when

assessing likelihood and consequence considerations for risk to human health of Pollutant Assessment Module 7: Boating Discharges and use best judgement in categorising risk from recreational boaters.

Figure 9: Get more maritime sewage management information from http://www.msq.qld.gov.au/Marine-pollution/Sewage.aspx

Module 8 – Waterway discharges

The waterway discharge module accounts for pollution sources occurring at a distance, but due to the conveyance of the waterway can result in the water quality of the recreational site being impacted. Hence, when managing recreational water sites that are influenced by upstream rivers, creeks or tributaries it is important to consider pollution sources entering the waterway at **greater distances** than those assessed within pollutant Assessment Modules 1 through 7 for the recreational site. In particular, point source pollution such as sewage treatment plants, stormwater and industrial discharges should be considered.

The influence of specific pollution sources already considered under other Modules should not be included within this module. However, pollution types assessed in the other 8 Modules should be considered here for their influence on waterways discharging or flowing into or past the recreation site. Discharges from semi-enclosed coastal lagoons may also be a significant source of faecal contamination during and for several days following wet weather when the lagoon opens and discharges into, or upstream of, the recreational water site.

Considerations for *likelihood* of waterway discharges impacting recreational water include the number of pollution sources discharging into the waterway influencing the recreational site, and the distance between the discharging waterway and the recreational site.

The *consequence* of waterway discharges to microbial water quality considers source type in terms of potential microbial pollutant sources. Management measures are considered for their ability to reduce consequences of microbial pollutant sources present. The presence or absence of actively managed and protected riparian buffer zones present in the discharging waterway, and the presence and implementation of a whole-of-catchment management plan reduce consequences for human health.

NOTE: Sewage treatment plants, industrial discharges, and stormwater discharges within 2 km of the recreational sites are assessed under modules 1, 3 and 5, respectively.

Module 9 – Other microbial pollution

Other sources of microbial pollution may be identified for recreational waters that do not fit in the above categories. These should be included in site risk assessments, either by adopting the most relevant *likelihood* and *consequence* ratings associated with one of the pollution sources listed above, or developing new *likelihood* and *consequence* ratings for the particular pollution source.

The *likelihood* for the other microbial source to contribute microbial pollution to the recreational water is categorised as one of five levels (rare to almost certain). This should consider the distance from the recreational site and the type of influence or delivery.

Consequence to microbial water quality considers the type of source. Management measure types or mitigating factors are also considered and these should include those considered within the other 8 assessment modules.

Note: Relevant expert knowledge should be consulted where required, a conservative approach used where influence or outcomes of mitigating factors are uncertain.

4.4 Step 3 Calculate Sanitary Inspection Category

Microbial pollution *likelihood* and *consequence* scores from the nine Pollutant Assessment Modules above are used to calculate overall site *Risk Scores* (5 ratings- very low to very high)at the end of each individual Pollutant Assessment Module. The Risk Scores are then converted to Microbial Source Risk Ratings for each Pollutant Assessment Module source. In Step 4 of the Sanitary Inspection Survey (page 37 Appendix A. of this Manual) these overall site Microbial Source Risk Ratings (5 ratings- very low to very high) are applied to a risk matrix to determine an *Overall Site Score-Risk of Microbial Pollution*.

This is done by applying a multiplier for each Pollutant Assessment Module assessed for the Recreational Site. Multipliers related to the *Microbial Source Risk Rating* for each Pollutant Assessment Module reflect the potential for risk to human health at the Recreational Site with regard to the pollution source being assessed. These ratings- Very Low, Low, Moderate, High and Very High, reflect potential risk to human health of very low, low, moderate , high and very high respectively. The number of Pollutant Assessment Modules per *Microbial Source Risk Rating* are then summed and multiplied by the *Risk Rating* multiplier to arrive at an Overall Site Score for each *Microbial Source Risk Rating*. Overall Site Scores are then summed to arrive at the Final Score for *Overall Site Score-Risk of Microbial Pollution*.

The *Overall Site Score-Risk of Microbial Pollution* is then used to determine the *Sanitary Inspection Category* of the Recreational Site in Step 5 of the Sanitary Inspection Survey (Appendix A). Sanitary Inspection Categories are determined by where the *Overall Site Score- Risk of Microbial Pollution* is situated within the following breaks, As per Step 5.

Table 15: Step 5, Sanitary Inspection Categorisation

Very Low	< 1
Low	1-8
Moderate	9-49
High	50-199
Very High	≥ 200

4.5 Step 4 Hold stakeholder workshop to review Sanitary Inspection results

Once the initial sanitary inspection is complete, or near completion, a workshop should be held to review the information, the assumptions made, and the sanitary inspection risk assessment findings. The workshop may also be used to identify and fill information gaps and identify additional faecal pollution sources. While the workshop objective is to gain consensus on the sanitary inspection report and Sanitary Inspection Category, this may not always be possible. The risk assessment process is subjective and not all participants will necessarily agree on the associated input information or findings. Gain consensus as far as possible, adopting a majority view where necessary, and ensure dissenting views are documented.

The workshop should include stakeholder representatives such as:

- user groups
- environment groups
- lifeguards
- beach and recreational waters managers
- local council
- wastewater managers and water utilities
- State government (Department of Environment and Heritage Protection, Queensland Health.

Where a large number of sanitary surveys need to be reviewed, more than one workshop may need to be held. Note that the workshop/review process should be held following the initial Sanitary Inspection survey but is not required following the annual surveys unless substantial changes to scoring (a whole shift in grade) are found during annual revision.

Chapter 5: Microbial Water Quality Monitoring

5.1 Sampling for Microbial Water Quality

Once the Sanitary Inspection Survey is completed the resulting Sanitary Inspection Categorisation (SIC) gives an indication of the potential of a site regarding risk to human health of recreating in site water. It is important to consider actual microbial water quality in conjunction with SIC results as an indicator of actual risk present under average prevailing conditions. Assessment of microbial water quality is done by water sampling and analysis of Faecal Indicator Bacteria (FIB) concentration(s). There are several FIB suitable for assessing human health risk. Both *Escherichia coli* and enterococci are approved and used as faecal indicators in a majority of monitoring of water microbiological quality. The Healthy Waterplay program recommends testing for enterococci bacteria as recommended by the WHO, NHMRC and Rec Watch guidelines.

Sampling for microbial water quality should be conducted at recreational sites for the purpose of collecting and storing data in order to categorise the microbial water quality signature of the site by way of Microbial Assessment Categorisation (MAC), as well as regular monitoring of water quality for exceedence of trigger values for management actions.

5.2 Sampling Design

This chapter outlines the strategy for monitoring recreational water quality that should be implemented until sufficient water quality data have been collected to adequately assess site performance for microbial water quality. In most cases this will optimally be, and is recommended to be at least three recreational seasons (three years) and numbering toward 100 samples at the site. However, MAC assessments can be undertaken using considerably less data however in these instances assessments may be less reliable than those where more data is available.

A good monitoring program is not simply data collection. The objective is to provide information and knowledge about the site, preferably at the least cost. In the case of microbiological monitoring of recreational water quality, the general objective is to inform relevant managers and the public of potential health risks. As such, samples for microbial water quality assessment should always be taken at locations where people recreate in the site water. Samples should be collected at knee depth near the shore as this is the area used by small children and also presents less risk to the officer taking the sample. Please refer to Section 3.5 Collecting samples and 3.5.1 Surface waters in *Monitoring and Sampling Manual 2009 Environmental Protection (Water) Policy 2009* (DEHP 2009). Analytical laboratories have strict protocols around storage and holding times of sampling which generally require samples to be stored on ice in a lightproof container immediately following collection and that the sample is held for no longer than 6-8 hours before analysis in order to avoid erroneous results. Please contact the analytical service provider for your organisation for requirements prior to sampling.

5.3 Sampling Frequency

Samples should be collected during periods of site recreational use. Duration of sampling is typically defined by the length of the season-of-use, which varies considerably with climate. The time of day samples are collected must also be taken into consideration. Factors such as tides, winds, waves, pollution inputs and the number of people using the recreational area can all

affect bacterial levels. There is also reported evidence that daily variations in UV exposure affect bacterial levels. Where possible, the time of sampling should coincide with the time of highest risk. For example, if you know that a pollutant source operates only on an outgoing tide then take samples at that time; if afternoon winds are likely to drive pollution onshore, collect samples at that time. Where a daily pattern in bacterial levels is unlikely, sampling times should be randomised. Do this by beginning your sampling at different times of the day, by varying the order in which you sample locations and/or use of a random number table/generator.

Initially, weekly sampling is required for determining recreational site public health risk. Sampling more frequently than this in order to gain more data for the purpose of MAC is not recommended due to an increased potential for bias. Sampling on a 6-day roster is recommended as this will ensure all days of the week are successively sampled. The popularity of sites on weekends, the additional costs of weekend sampling, and weekend availability of laboratories for sample analysis are important factors to be considered. In order to collect the recommended 100 site sample results needed to calculate the Microbial Assessment Category (MAC), samples should initially be collected as frequently as possible over the range of conditions when the site is in use. If resources are limited, it is better to reduce the number of sampling program sites than sampling frequency. Once enough sample results have been obtained, and sanitary inspections show no change over several years, the recommended monitoring schedule in Table 9 can be adopted.

Table 16: SIC and recommended monitoring schedule

Sanitary Inspection Category	Monitoring Schedule	Frequency of Sanitary Inspection
Very Low or Low	Minimum of five samples per year during season	Annual
Moderate or High	20 samples at regular intervals during the season of peak-use. Additional sampling if abnormal results are found.	Annual
Very High	Minimum of five samples per year. Where sites are closed to use sampling regimes should align with management objectives	Annual

5.4 Occupational Health and Safety

Occupational Health and Safety (OH&S) is a major issue that needs to be carefully considered when implementing a water quality monitoring program. Employers should consult their employees on health, safety and welfare matters associated with site assessment, including sampling. The following information is a guide to some of the hazards that may be encountered while sampling, and some of the ways risks can be controlled.

Identifying OH&S hazards

Field sampling hazards should be identified and risks assessed by the field staff and their managers and fully documented. Hazards that may be encountered in a program for monitoring recreational water quality are likely to include, but are not limited to:

- motor vehicle accidents
- exposure to elements (UV radiation, cold)
- foot injuries (cuts, needle punctures)
- contact with pathogenic microorganisms
- musculoskeletal injuries (from carrying Eskies, bending to sample, etc.)
- working in remote areas
- dangerous surf, drowning.

In addition, staff undertaking sampling should be physically and mentally capable of performing fieldwork. Training is an essential risk management strategy and should include familiarisation with potential environmental hazards, familiarisation with sampling protocols, use of equipment, qualifications to drive vehicles, safety procedures familiarisation, and knowledge of first aid.

OH&S Risk minimisation plans

Once all hazards have been identified, water quality sampling/site assessment staff and managers should develop a risk minimisation plan. Ideally, risks should be eliminated. Where this is not reasonably practicable, risks must be controlled by implementing measures to reduce risk of harm to the lowest possible level. Once appropriate risk minimisation measures have been identified they should be documented in a safety plan. You should include an audit or review schedule to ensure that the plan is being implemented and that any deficiencies are identified and addressed in a timely manner.

5.5 Calculating Microbial Assessment Categorisation (MAC)

When enough samples have been collected and analysed the results can be used to derive a 95th percentile value for enterococci concentrations at the site. The 95th percentile value can be derived using either parametric (distribution) or non-parametric (percentile rank) methods. Parametric 95th percentile values assume a normal distribution of data and the 95th percentile value is determined by removing the upper 5% of the distribution values. Non-parametric values are determined by ranking the data set in ascending order and using a formula to assign rank and corresponding value to the 95th percentile value. There are minor benefits and disadvantages in using differing methodologies. There are a number of software packages available for 95th *percentile* calculation such as *EnteroAlert* and *Enterotester*. The use of these tools is recommended as an accurate and easy way to calculate parametric 95th percentile values. If required, non-parametric values can be calculated in Microsoft Excel.

Once the 95th percentile value is calculated the microbial concentration can be categorised in terms of potential human health risk associated with recreating at the site as shown in Table 10. The Healthy Waterplay Microbial Assessment Categorisation (MAC) utilises the framework recommended by NHMRC (2008).

Table 17: Microbial Assessment Categories (NHMRC Guidelines, 2008).

Basis of derivation of percentile values for determining microbial water-quality assessment categories

Category*	95th percentile value for intestinal enterococci/ 100 mL (rounded values)	Basis of derivation	Estimation of probability
A	≤40	This value is below the NOAEL in most epidemiological studies.	GI illness risk: < 1% AFRI risk: < 0.3% The upper 95th percentile value of 40/100 mL relates to an average probability of less than one case of gastroenteritis in every 100 exposures. The AFRI burden would be negligible.
B	41–200	The 200/100 mL value is above the threshold of illness transmission reported in most epidemiological studies that have attempted to define a NOAEL or LOAEL for GI illness and AFRI.	GI illness risk: 1–5% AFRI risk: 0.3–1.9% The upper 95th percentile value of 200/100 mL relates to an average probability of one case of gastroenteritis in 20 exposures. The AFRI illness rate would be 19 per 1000 exposures or approximately 1 in 50 exposures.
C	201–500	This represents a substantial elevation in the probability of all adverse health outcomes for which dose–response data are available.	GI illness risk: 5–10% AFRI risk: 1.9–3.9% This range of 95th percentile values represents a probability of 1 in 20 to 1 in 10 risk of gastroenteritis for a single exposure. Exposures in this category also suggest a risk of AFRI in the range of 19–39 per 1000 exposures or a range of approximately 1 in 50 to 1 in 25 exposures.
D	> 501	Above this level there may be a significant risk of high levels of illness transmission.	GI illness risk: > 10% AFRI risk: > 3.9% There is a greater than 10% chance of illness per single exposure. The AFRI illness rate at the guideline value of 500 enterococci per 100 mL would be 39 per 1000 exposures or approximately 1 in 25 exposures.

5.5 Trigger Values

The current national (NHMRC 2008) guidelines do not provide instruction on how to respond to single-sample results which exceed values which trigger management actions received during collection of microbiological monitoring results for calculating the microbial assessment category of a recreational water site. Therefore, in an attempt to aid of recreational water managers as they work towards assigning microbial assessment categories and long term management of their sites, Healthy Waterways has developed a Microbial Trigger Value Justification Paper. This presents the rationale behind use of microbial trigger values as a short-term approach for management of primary and secondary contact recreation waterway microbial health risk. Queensland Health supports inclusion of such a trigger value approach for short-term management in the review of the national guidelines. The recommended method applies numeric microbial trigger values for short-term management responses for primary contact and secondary contact recreation areas. Microbial trigger values were chosen to indicate the need for further investigation into causes of potentially harmful levels of pathogens at a reasonable level of public health concern; and to prompt additional public health risk mitigation, as necessary. The trigger values outlined in Box 1 are based on the categories and rationale set out

in the NHMRC Guidelines for Managing Risk in Recreational Water, 2008. The trigger values presented are recommended for fresh, estuarine and marine waters in South East Queensland.

Box 1: Recommended Trigger Values

For both primary and secondary contact recreational waterway use, respective one-off (single sample) microbial trigger values are recommended. These trigger values indicate when microbial indicator bacteria concentrations are sufficiently elevated to warrant either further investigation or action to reduce the risk of potential illness as a result of recreational use of a waterway.

Warning Trigger

The first one-off (single sample) value, known as the **warning trigger**, triggers intensive daily resampling and investigation within 24 h of receiving results:

- For **primary contact** this trigger value is equal to or greater than 200 enterococci per 100 mL
- For **secondary contact** this trigger value is equal to or greater than 1000 enterococci per 100 mL

Action Trigger

The second one-off (single sample) value, known as the **action trigger**, triggers immediate temporary closure of the recreational water area:

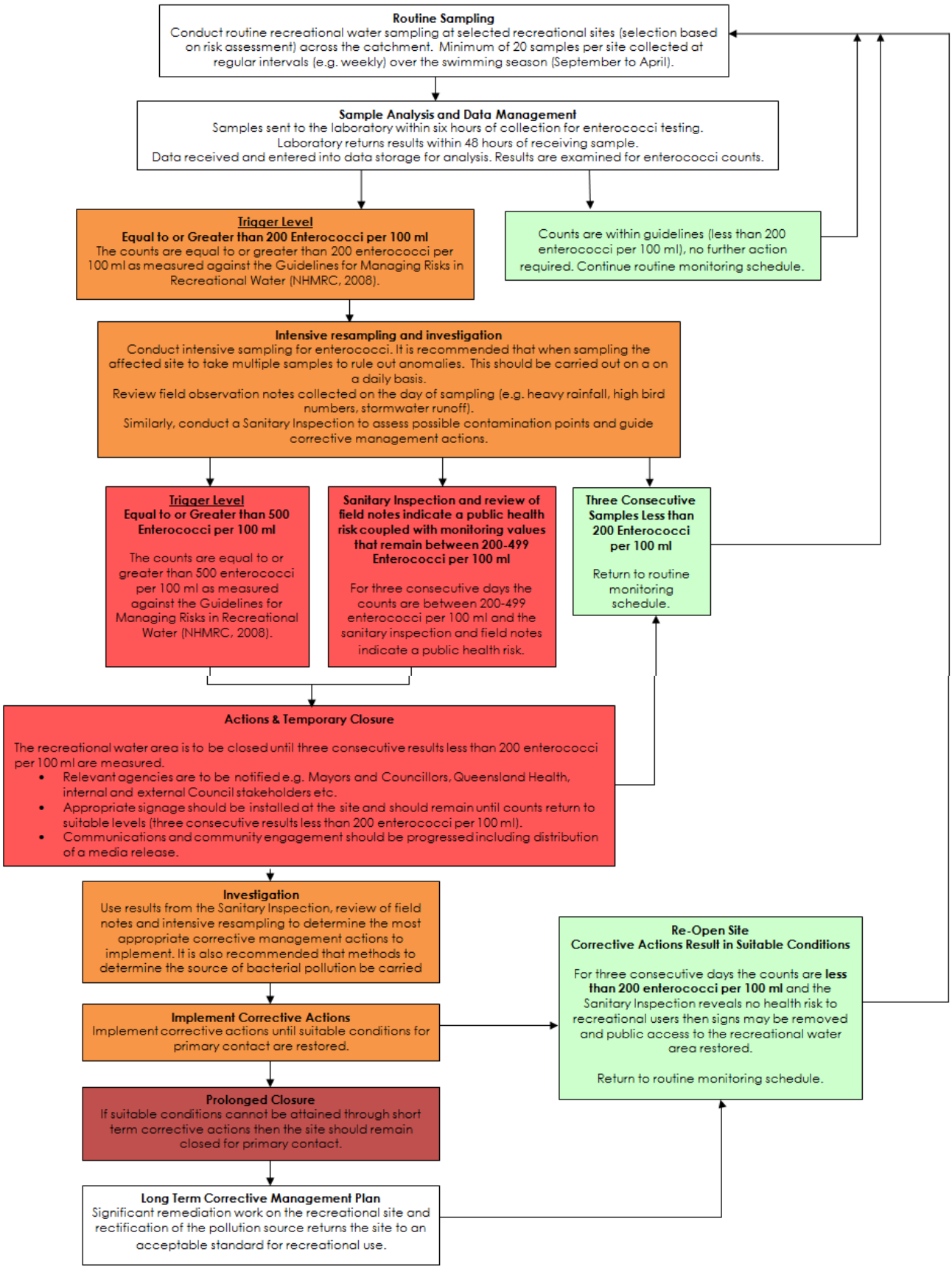
- For **primary contact** this trigger is equal to or greater than 500 enterococci per 100 mL.

Additional Considerations:

Primary Contact: If the response to the primary contact warning trigger results in three consecutive days where the counts are between 200-499 enterococci per 100 mL then the response should be elevated to an action trigger response and the site should be closed to primary contact recreation. Sites should remain closed to primary contact recreation until sampling results return to less than 200 enterococci per 100 mL for three consecutive samples. In the circumstance where the responsible agent has a thorough understanding of the recreational site, including understanding the catchment hydrology coupled with adequate monitoring data, and hence can justify reopening after two consecutive samples then this is deemed appropriate management. Further information on how to respond to primary contact trigger values is provided via the Regional Management Response Guideline Flowchart in Appendix 1.

Secondary Contact: If the response to subsequent microbiological testing in response to the secondary contact warning trigger results in counts remaining equal to or greater than 1000 enterococci per 100 mL then the responsible agent should assess the risk to the recreational user and determine if a temporary site closure is necessary.

Figure 10: Microbial Testing of Recreational Waters Regional Management Response Guideline Flowchart (for primary contact)



Chapter 6: Assigning Recreational Suitability Grades

6.1 Recreational Suitability Grades

The suitability of the site for recreation in relation to human health risk can be comprehensively categorised by combining SIC and MAC results. This results in the ability to classify the potential of the site to impact negatively on human health according to site spatial attributes (as considered in the Pollutant Assessment Modules 1-9)and incorporating the measured FIB concentrations. The classification matrix for assigning recreation suitability grades is presented in Table 2.

6.2 Classification

The Healthy Waterplay Recreational Suitability Grade classification matrix uses both the SIC (very low to very high) and MAC (95th percentile) categorisation results to assign a recreational suitability grade to each site. The Recreational Suitability Grade is defined by the cell where the row for SIC results and column MAC results intersect. The classification utilises five grades; 'very good', 'good', 'fair', 'poor' and 'very poor'. The recreational suitability grade can be used to:

- communicate site specific risk to the general public for them to make informed decisions regarding recreation and human health
- inform planning and policy around sites and associated infrastructure
- inform and implement management actions to reduce the recreational suitability grade and potential for negative health outcomes associated with recreating at the site.

Communicating risks to human health associated with recreating in water at sites, managing sites and site-specific risk are discussed in more detail in Chapters 7 & 8.

The Recreational Suitability Grade classification matrix also includes a 'follow-up' classification addressing differing MAC and SIC results. This follow-up classification is discussed in detail in Section 6.3.

Figure 11: Matrix for assigning recreational suitability grades.

		Microbial water quality assessment category (95th percentiles — intestinal enterococci/100 mL)				Exceptional circumstances[c]
		A ≤ 40	B 41–200	C 201–500	D > 500	
Sanitary inspection category (Susceptibility to faecal influence)	Very low	Very good	Very good	Follow up[b]	Follow up[b]	ACTION
	Low	Very good	Good	Follow up[b]	Follow up[b]	
	Moderate	Good[a]	Good	Poor	Poor	
	High	Good[a]	Fair[a]	Poor	Very poor	
	Very high	Follow up[a]	Fair[a]	Poor	Very poor	
	Exceptional circumstances[c]	ACTION				

a Indicates possible discontinuous/sporadic contamination (often driven by results such as rainfall). This is most commonly associated with the presence of sewage – contaminated stormwater. These results should be investigated further, and initial follow-up should include verification of the sanitary inspection category and ensuring that samples recorded include 'event' periods. Confirm analytical results, review possible analytical errors.

b Implies nonsewage sources of faecal indicators (eg livestock), which need to be verified.

c Exceptional circumstances are known periods of higher risk such as during an outbreak involving a human or other pathogen that may be waterborne (eg avian botulism — where outbreaks of avian botulism occur, swimming or other aquatic recreational activities should not be permitted), or the rupture of a sewer in a recreational water catchment area etc. Under such circumstances the classification matrix may not fairly represent risk/safety.

* In certain circumstances there may be a risk of transmission of pathogens associated with more severe health effects through recreational water use. The human health risk depends greatly on specific (often local) circumstances. Public health authorities should be engaged in the identification and interpretation of such conditions.

From NHMRC (2008)

6.3 Follow-up

The 'follow-up' classification is assigned where a potential difference exists between MAC and SIC categorisation results. Examples are where SIC category is 'very low' or 'low' while MAC 95TH percentile is above 200 CFU/100 ml, or; SIC category is 'very high' risk and MAC results are less than 40 CFU/100 ml the classification is 'follow-up'. The 'follow-up' assumption is that an error in either the SIC or MAC is responsible for the difference in results.

If a 'follow-up' Recreational Suitability Grade classification is assigned further investigation is needed in order to increase certainty of the respective site recreational suitability classification. For the SIC this involves review of the sanitary inspection for error(s) or implementing more detailed investigations of potential pollutant sources and actual risk. For MAC this may involve review of associated data, with a focus on sampling regime and protocol, data integrity/entry and representativeness, analytical methodology and statistical analyses.

Factors that may lead to the 'follow-up' being assigned include:

- clerical, analytical or statistical errors;
- failure to consider consequence of non-point sources in the sanitary inspection;
- sampling points that are not representative of all environmental variables;
- sampling points and regime failed to capture influence of sewage treatment and transport system(s);

- failure to consider the influence of stormwater drainage system in SIC; or overstatement of actual stormwater system risk (e.g. seasonality);
- MAC assessment calculated using insufficient or unrepresentative data
- extreme events, whether anthropogenic or natural in origin, arising from damaged infrastructure or inappropriate sewage disposal practices were not considered in the SIC;
- The relationship between environmental variables (such as tidal flushing) and MAC and SIC results are poorly understood and not considered in assessment.

Relevant expert knowledge should be consulted to confirm results of the initial 'follow-up' investigation. In terms of risk, human sources of faecal bacteria should be seen to present more risk than faecal bacteria derived from other sources. Routine analysis does not distinguish faecal source or type. Relevant experts experienced in faecal pollutant source tracking and associated risks to human health should be consulted in order to accurately assign risk in relation to the 'follow-up'. A degree of conservatism should be exercised when re-assigning grades based on factors outside the SIC framework, or where assigning a Recreational Suitability Grade classification where 'follow-up' investigations yield no change in Recreational Suitability Grade. It is also important to avoid "street-lighting" data by removing outliers or data randomly captured during an event to reduce 95th percentile values and MAC.

Chapter 7: Reporting

7.1 Overview of reporting Healthy Waterplay Recreational Suitability Grade

In most cases, recreational water quality is monitored to provide the community information on suitability for swimming or participating in other water-associated activities at a recreational area. If members of the community are provided this information they can make informed decisions about where and when to use waterways in recreational areas, and associated public health risks can therefore be reduced.

The benefits of effective communication include:

- Protection of human health through the efficient, effective and timely communication of health risks associated with recreational water use.
- Public support for the monitoring program.
- Develop a level of understanding of recreational water health, monitoring and risk assessment issues within the community.
- Build confidence in the managing organisation's undertaking of monitoring and assessment.
- Manage community concern(s) and public outrage.
- Managing designated responsibility and duties of care.
- Encourage and facilitate community ownership and participation.

Water resource managers need to provide recreational water users with **general advice** on water quality, in conjunction with **annual classifications**. **Water quality forecasts** (e.g. daily predictions, weekly "star" ratings) can also be developed and used to provide the community more immediate indications of recreational water quality. While these are not mandatory, they are very effective tools to support general advice regarding recreational water classification. Identifying the practical aspects of how communication will be delivered up-front will avoid confusion and frustration during implementation.

As a part of your organisation's field manual, the following questions should be asked and answered regarding communication of recreational water quality issues:

- Who is responsible for communication? Consider who is responsible within your council and within other authorities.
- How will the message be delivered? The urgency and the target audience will determine this. Don't forget to establish a protocol for informing council staff, councillors and specific users (e.g. surf life-saving clubs, oyster farmers).
- What forms of communication will be used in different scenarios? Scenarios could include pollution incidents and dissemination of daily, weekly, monthly and annual reports.
- When will communication be disseminated? For example, publication of advice on when (or when not) to swim, at the beginning of the swimming season. It is important to consider the frequency of communications and information and communicator overload.
- What messages should the communication convey? Messages may relate to health risks; the fact that council is investigating the cause of the problem; an announcement of when the problem has been fixed; whom to contact for further information; common sources of pollution and actions the community can undertake to improve water quality (see Healthy Waterways community factsheets http://healthywaterways.org/resources).

7.2 General advice

The Healthy Waterplay Program has developed five top tips for communities to follow to ensure they enjoy waterways safely (see Figure 11).

These top tips are distributed via:

- Community Service Announcements on Channel 7 (see video here: http://healthywaterways.org/initatives/healthywaterplay).
- Comprehensive eight page booklets and succinct overview brochures (download documents here: http://healthywaterways.org/resources/documents/).
- Social media: Facebook, Twitter and web-pages.
- Awareness raising campaigns involving online advertising.
- Targeted engagement with key recreational user groups via direct presentations and discussion.

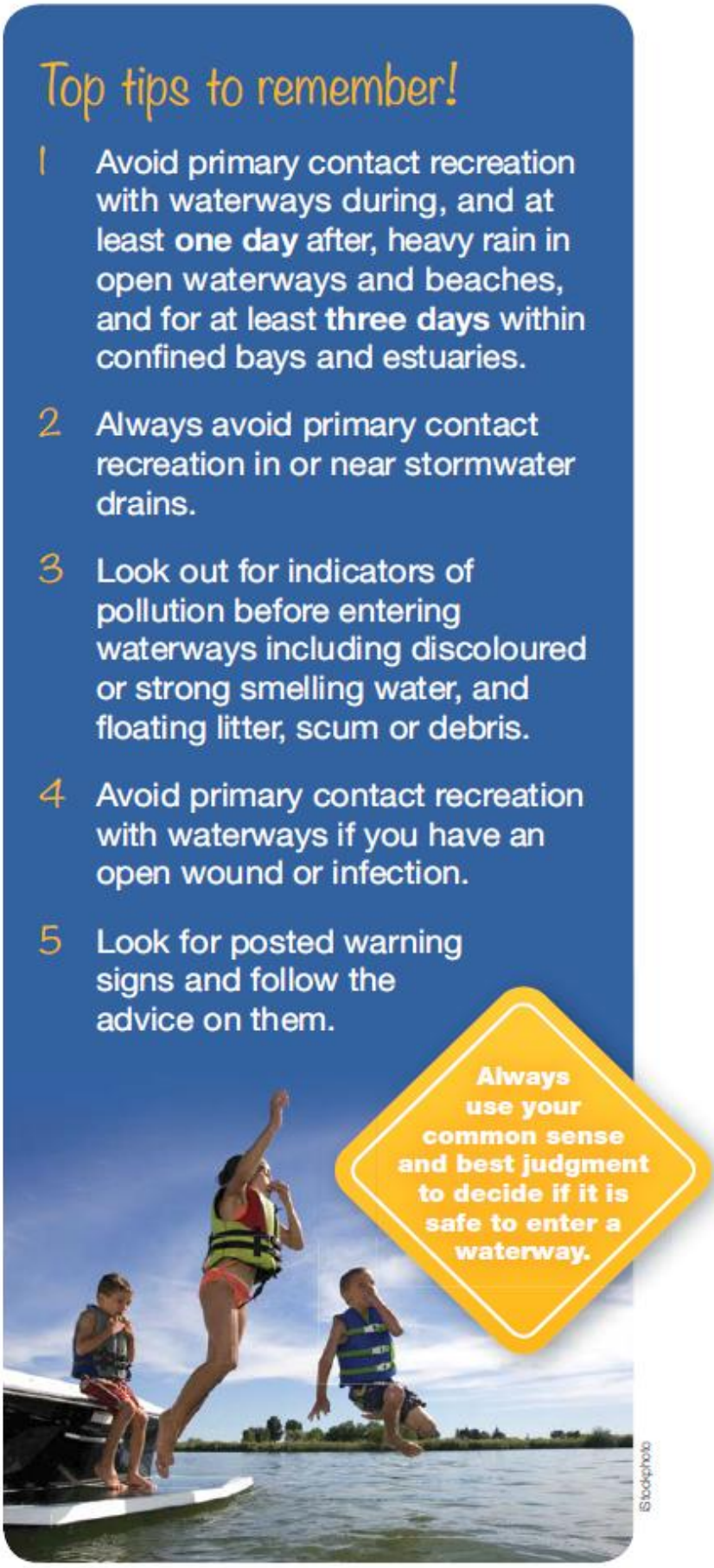


Figure 12.

7.3 Annual classification

The minimum level of reporting required by the NHMRC 2008 guidelines is an annual Recreational Water Classification, which is a Recreational Suitability Grade assigned using MAC and SIC results. This information could also be released as a press release at the start of the swimming season or holiday period(s) and displayed on signs at the site, on websites, or in a flyer with rates notices.

The recreational water classifications include general information that can assist the general public to determine when it is safe to use waters in recreational areas using the grades described in Chapter 6. The following information in Table 12 should also be included when reporting recreational water classifications to the community.

Table 18: Considerations for reporting recreational water quality to the community

Site Suitability Grade	Reporting Visual	Description Please always refer to local signage for further information on activities advised for these sites.
Very Good		**Water contact activities** – site is suitable for activities where the whole body or face is frequently immersed in water. The results of the microbial water quality assessment and sanitary inspection deem this site to be suitable for activities such as swimming, diving, surfing, water skiing, jet skiing and whitewater canoeing. **This site is also suitable for watercraft and land based activities.** Be sure to read any signage at the site for further information on activities that are allowed at this site.
Good		**Water contact activities** – for the majority of the year this site is suitable for activities where the whole body or face is frequently immersed in water. The results of the microbial water quality assessment and sanitary inspection deem that for the majority of the year this site is suitable for activities such as swimming, diving, surfing, water skiing, jet skiing and whitewater canoeing. However, owing to the catchment hydrology this site is impacted by factors such as heavy rainfall and may become temporarily unsuitable for water contact. Hence, be sure to read any signage at the site for further information on activities that are allowed at this site. **This site is also suitable for watercraft and land based activities.**

Fair	 OR 	**Watercraft activities** – site is suitable for activities where only the limbs are regularly wet, and swallowing water is unusual. The results of the microbial water quality assessment and sanitary inspection deem this site to be suitable for activities such as boating, fishing, rowing, kayaking, dragon boating and wading. **This site is also suitable for land base activities but not suitable for water contact activities**. Be sure to read any signage at the site for further information on activities that are allowed at this site.
Poor and Very Poor	 OR 	**Land based activities** – site is suitable for activities where there is normally no contact with the water or where water is incidental to the activity. The results of the microbial water quality assessment and sanitary inspection deem this site to be suitable for activities such as angling from the shore, picnicking, nature trails, cycling, photography. **This site is not suitable for water contact or watercraft activities.** Be sure to read any signage at the site for further information on activities that are allowed at this site.

7.4 Water quality forecasts

A major limitation with the use of bacterial indicators is that results are not available for 24-48 hours after sampling. During this time, recreational water users may be exposed to pathogenic microorganisms. To reduce risk to public health, site users need to be notified when pathogens *may* be present in recreational waters. This requires tools which provide a quick, reliable and conservative estimate of the level of faecal contamination. An advisory, such as a daily bulletin, based on the results of predictive modelling can be used to support the recreational water classification and general advice. One of the most commonly used predictive models is a rainfall-based alert curve. The model uses the statistical relationship between catchment rainfall and faecal indicator bacterial levels at a specific location. A wide range of other models is also available (USEPA 1999). Although predictive models are effective tools for supplementing actual sampling, it is important to emphasise models do not provide perfect predictions of actual conditions, only estimates of current conditions. Daily advice must be provided through easily accessed media. Not only does the advice need to be updated regularly (each morning during peak water recreation periods for designated recreational sites, but also during relevant events, rainfall during the day or reports of other pollution incidents may require further updates. A website is an ideal medium for disseminating this information. It can be readily updated and can include detailed information on pollution events, site closures and site conditions. The daily reports can also be faxed to local radio stations, caravan parks and/or motels for display on public noticeboards, and to lifeguards for their information and display at the site, where appropriate.

Examples of water quality forecast models and their application in mitigating risk to human health.

The revised Bathing Water Directive (2006/7/EC) came into force on 24 March 2006. The directive introduces a new recreational water classification system with more stringent water quality standards, with an emphasis on providing information to the public as well as enforcing "active water quality management" instead of simple "monitoring". This has lead to the following interesting and innovative developments in Europe.

- Bathing water quality predictions - Scottish EPA
  Scottish EPA have electronic signs at 23 sites that provide real-time predictions of bathing water quality. When the message: "BATHING NOT ADVISED TODAY RISK OF POOR WATER QUALITY" is displayed, it indicates a risk the quality of the bathing water at that time may be poor. In this circumstance, bathing is not advisable. When the message: "GOOD WATER QUALITY IS PREDICTED TODAY" is displayed, this means the water is likely to comply with bathing water quality standards. The sign status is then recorded via a computer control station, which enables switching to the relevant version of text message. Read more here.

- Bathing Water Data Explorer – Environment Agency UK
  Environment Agency UK has developed a set of data-driven modelling tools which predict whether water quality is likely to be above or below a pre-determined bacteriological threshold each day, using multiple triggers from real-time rainfall data and tidal predictions. As part of the joint-agency 'Bacti' project, machine-learning models have been developed based on Artificial Neural Networks (ANNs). Read more here.

- Smart Coasts = Sustainable Communities – Ireland and Wales
  As part of Smart Coasts research, two model types are being investigated: the first will be a simple black-box model where compliance is related to, for example, rainfall or river flow thresholds. The second will be a more complex process-based model linking land surface runoff with near-shore flow patterns producing pollutant concentrations at impacted bathing sites. The modelling tools will be designed to be generic, transferable and incorporate considerable practical operational input to their design. Read more here. Ireland currently report their monitored data via the Splash website and report their blue flag awards here.

- Bathing Water Quality Forecast - Copenhagen, Denmark
  Copenhagen, Denmark, has an early warning system for bathing water. The system provides a 4-day forecast for bathing water quality at different locations in Copenhagen Harbour. In addition, information is supplied about air and water temperatures, wind and current. The Copenhagen case study is discussed in this paper.

- Virtual Beach 3 - USEPA
  Virtual Beach 3 (VB3) is a free software package designed for developing site-specific statistical models for the prediction of pathogen indicator levels at recreational beaches. Version 3 was released in September 2013. VB3 reads input data from a text file or Excel document, assists the user in preparing the data for analysis, enables automated model selection using a wide array of possible model evaluation criteria, and provides predictions using a chosen model parameterized with new data. With an integrated mapping component to determine the geographic orientation of the beach, the software can automatically decompose wind/current/wave speed and magnitude information into along-shore and onshore/offshore components for use in subsequent analyses.

- Nowcast - Ohio USA
  Nowcasts are systems that inform the public of current bacterial water-quality conditions at

beaches on the basis of predictive models. During 2010–12, the U.S. Geological Survey (USGS) worked with 23 local and State agencies to improve existing operational beach Nowcast systems at four beaches and expand the use of predictive models in Nowcasts at an additional 45 beaches throughout the Great Lakes. The predictive models were specific to each beach, and the best model for each beach was based on a unique combination of environmental and water-quality explanatory variables.

- BeachCast - Great Lakes USA
  This website broadcasts critical information about beach advisories in the Great Lakes region and related human health information. This includes a free smartphone application that provides convenient, public access to real-time information on beach water quality advisories, weather and water conditions for 1,900 beaches in the Great Lakes region.

- SwimCast - Lake Michigan USA
  SwimCast measures air and water temperature, wind speed and direction, precipitation, relative humidity, wave height, lake stage, insolation (light energy) and other water quality parameters to help predict when *E. coli* levels are low enough to indicate safe swimming conditions or high enough to call for a swim ban.

Chapter 8: Management

8.1 Management Options

There are two main options for managing recreational sites following Recreational Suitability Grade assignment where suitability grades indicate management is required to mitigate or avoid negative outcomes. Firstly, the public require reliable and accurate information regarding water quality and potential impacts on human health of recreational water contact in appropriate time frames in order to make informed decisions. Secondly, where the risk to public is deemed unacceptable, given the location, value or potential exposure(s) of the recreational site or asset; site managers can implement strategies and actions that attempt to prevent or mitigate potential negative human health impacts. Management should use a consistent but flexible suite of measures to manage public health risk associated with using recreational sites and a 'one-size-fits-all' approach should be avoided.

8.2 Public Health Advice and Warnings

Recreational site managers should take steps to understand periods where water quality is reduced or unsuitable for primary contact and take appropriate action to inform the public. Many sites are suitable for recreation under the prevailing conditions for the majority of the time but experience elevated microbial pollution levels when the prevailing conditions change. Suitable and timely advice should be issued and the impact of both the advice and format should be assessed for suitability in protecting public health. This method of managing sites is suitable for sites where a spatial or environmental variable influences water quality over a short period of time, but the quality of water is most often suitable for primary contact, for instance:

- Sites where water quality is intermittently affected by stormwater influence on sewage treatment and transport system(s);
- Estuarine systems where entrances or drainage points 'close-over' causing pollutant(s) to accumulate due to low flushing levels or microbial blooms;
- Tide, wind or wave action negatively influences pollutant dispersal and dilution;
- Malfunction of sewage treatment and transport system(s).

Under these conditions, managers may wish to issue advisory information or site closures where appropriate. Levels, scales and types of advisories may vary and should reflect the scale, significance and potential for human health risk present at the site.

8.3 Pollution Prevention and Abatement

Preclusion and abatement of pollutants are effective ways reducing or mitigating faecal pollution at sites. By removing or reducing risk through management of influential variables such as stormwater infrastructure, sewage treatment networks and land-use impacts, sites can achieve lower MAC and SIC scores and significantly reduce the need for reactive management or advice. Industrial discharge, sewage discharge and overflows, diffuse source pollution from agricultural areas, and urban stormwater infrastructure and run-off are all amenable to reductions in pollutant load and risk through management actions.

Direct discharge

Direct discharge or point-source pollution points include sewage and industrial wastewater discharge points. In most instances these sources require licensing and are conditioned under licensing agreements to minimise or avoid potential human impacts. Impacts from these sources can be minimised by locating discharge points at suitable distances away from recreational sites, treating wastewater to a minimum tertiary level and ensuring disinfection of discharged effluent.

Event based or intermittent pollution

This type of pollution is largely event driven and typically influences recreational sites over short temporal periods. Rainfall or other environmental variables can influence water quality by a variety of means. The issue of most consequence to water quality is poor separation between stormwater drainage and sewage treatment networks whereby stormwater infiltrates the sewage network causing 'wet weather' overflows. Furthermore, excessive rainfall can reduce the capacity of treatment chains and cause sewage to flow into the stormwater system from incorrectly installed domestic sewage systems. Industrial discharge treatment systems of concern may also be negatively impacted by rainfall due to overflow and reduced treatment capacity.

Methods for mitigating or removing this influence include:

- Upgrading sewage transport networks by re-lining pipes, increasing capacity and efficiency of pumping stations and decreasing inputs;
- Reducing infiltration through management of incorrect installation of stormwater connections into sewage network;
- Buffering through use of retention tanks and tunnels;
- Post-overflow separation devices or treatment mechanisms.

These methods often require capital expenditure increases, and viability will depend on the influence of the system and apparent risk at the impacted waterway site. However, implementing these action types is often more reliable and cost-effective in mitigating and removing risk than other forms of management.

Catchment pollution

Catchment pollution sources include all those that influence water quality that is delivered to or near a site by a waterway such as a creek or river. Potential associated pollutant sources should include all factors that influence water quality at the site identified and considered in the Sanitary Inspection Survey. All point-source discharges, relevant agricultural and industrial land-uses, stormwater influences and wildlife that drain, defecate or discharge into a waterway that influences water quality at the recreational site are amenable to management actions aimed at mitigating or reducing human health risk. When focusing on catchment pollution mitigation or abatement, managers should focus on major sources of pollution and predominant land-uses and how they influence water quality. Given the potential scope or scale of catchment-focused interventions, an inter-governmental, multi-agency approach amongst health, environmental management, industry and community is crucial to success of any catchment-based intervention.

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Healthy Waterways

ONE CLEAR VISION

Sanitary Inspection Report

Appendix A in Healthy Waterplay Training Manual

December 2016

Recreational Water Site Information

Site name? _____

Site reference number? _____

What is the water type? ☐ Ocean ☐ Estuarine ☐ Freshwater

☐ Other _____

What are the dimensions of the most popular water contact areas? (e.g. swimming areas or water around boat ramps) Length (m) _____ Width (m) _____ = Area (m^2) _____

What is the name of the catchment the site is located within? _____

What is the catchment area? _____ (km^2)

* You can use a contour map to estimate respective catchment size

How much of the catchment falls under different land uses? (Within 2 km radius of site)

Bushland _____ % Rural _____ % Urban _____ % Industrial _____%

Other _____%

Describe _____

Contact details Responsible Authority _____

Name _____

Position _____

Phone _____

Mobile _____

Fax _____

Email _____

Where is the site? Address _____

Latitude _____ Longitude_____

What are some of the key features that influence use of the site? (e.g. access points and infrastructure)

_____

_____

_____

_____

_____

How does water flow into, within, around and out of the site? (e.g. speed of flow, tidal or freshwater sources of water)

_____

_____

Mark below, or on an accompanying map, the key features and flows around the site

What level of flushing (water replenishment) occurs at the site the majority of the time?

□ High (e.g. coastal beaches, stretches of rivers)

□ Low (e.g. waterholes, enclosed bays, lagoons)

Recommended to use the 'float method' to estimate stream discharge where in doubt.

Does this site typically exceed enterococci trigger levels during the following rainfall events (tick where appropriate)?*

	Primary Contact Trigger Level (>200 cfu/100mL)	Secondary Contact Trigger Level (>1000 cfu/100mL)	Trigger Levels Not Exceeded
After light rain (5 mm in 24 h)			

After moderate rain (10 mm in 24 h)			
After heavy rain (20 mm in 24 h)			
After very heavy rain (50m m in 24 h)			
No relevant data available			

*Apply a maximum time criteria of up to 72 hours following rain events.

What date was the Recreational Water Site information last updated?

_____

Overall Site Use

What are the main activities occurring at this site through the year?

☐ Swimming ☐ Wading ☐ Surfing ☐ Jet Skiing ☐ Canoeing/Kayaking ☐ Fishing

☐ Sailing ☐ Boating ☐ Other _____

Who is using the site? ☐ Young children (< 7 yrs) ☐ Elderly (≥ 60 yrs)

☐ Adults and older children (≥ 7 yrs) ☐ Tourists

How many people use the site per day?

In holidays/ peak-use period _____ to _____ on weekdays & _____ to _____ on weekends

Non-holiday period _____ to _____ on weekdays & _____ to _____ on weekends

How much is this site used, relative to other sites in the same management region (managed by the responsible authority)?

☐ Close to least used ☐ Below average use ☐ Close to average use

☐ Above average use ☐ Close to most used

Is there off-street parking at the site? ☐ No ☐ Yes, number of off-street parking bays: _____

What number and types of businesses (within a 1 km radius) benefit from use of the site?

Number _____ Description _____

_____

What major events occur at the site? Name _____

Frequency _____

Name _____

Frequency _____

Name _____

Frequency _____

Name _____

Frequency _____

Are there any typical or ongoing conditions that deter people from entering the water?

☐ No ☐ Yes, details _____

Have there ever been complaints of illness from site recreational users recorded?

☐ No ☐ Yes, details_____

What date was the Overall Site Use information last updated?

_____

Use the supplied **Field Observation Checklist and Worksheet** to record site use and other site details during relevant sampling, maintenance or inspections visits to the site. This information can be used to estimate or update overall site use over time.

Determine the management priority rating of the site

This is a prioritisation tool that assesses the management priority of a recreational water site based on the following considerations:

- presence and absence of hazards (**Step 1**)
- likelihood of exposure to hazards (**Step 2**)
- level of risk to additional non-health/environmental aspects such as economy or capacity to deliver services (**Step 3**)

To give an overall priority score, combine the scores from Step 1–3 for the site and using the Table in Step 4 assign a management priority ranking for that site (**Step 4**). Repeat Steps 1-4 for all recreational water sites within your jurisdiction. Finally compile all the site priority ratings in a single source to allow easy ranking of priorities (**Step 5**).

Note: The actual level of risk to human health for the site will be determined through the full sanitary survey process.

Step 1: Identify sources of pollution and associated health impact rank at each recreational water site.

Answer questions 1-8 outlined below to determine the presence or absence of different pollution-source hazards at the site. When deciding the presence or absence of hazards, consider the quality and robustness of the data on which you are basing your decision (L: expert opinion and best judgement, M: expert opinion backed by mapping tools, H: expert opinion with mapping and prior survey and/or event data relating to pollution sources.) Record the level of confidence in the Confidence in Data column and consider this when ultimately creating management plans and recommendations for the site.

Health Impact Rating

Question No.	Question (answer N for any of the below that are downstream or have no way of connecting to the site)	(Y/N)	Confidence in data (H,M,L)	Health impact rank
1.1	Is there a sewage treatment plant* located within 2 km of the site?			3

1.2	Have sewage overflows** been recorded within 500 m of the site (e.g. pump station malfunctions, broken mains, wet weather overflows)?			3
2	Do surrounding properties within 200 m of site have on-site sewage facilities (e.g. septic tanks or small treatment plants serving less than 21 equivalent people)?			3
3	Is there an industrial discharge*** within 1 km of the site (e.g. abattoir or food processing facilities)?			2
4.1	Are agricultural animals and activities present within 200 m of the site (e.g. cattle grazing, horse race course, piggeries, poultry farms)?			2
4.2	Are large numbers of wild or domestic animals present within 200 m of the site (e.g. native bird [e.g. ibis, swamp hens] roosts and feeding areas, flying fox roosts, dog off-leash areas)?			1
5	Does stormwater discharge within 500 m of the site (e.g. stormwater outfall pipes, open drains)?			2
6.1	Are groups of people swimming or wading within 5 m of each other at this site during busy periods?			2
6.2	Are toilet facilities absent within 200 m of the site?			2
7	Is there a boat ramp, harbour, marina, moorings, ferry berth, anchorage or jetty within 1 km of the site?			3
8	Does a waterway**** discharge within 1 km of the site (e.g. flows from semi-enclosed lagoons (for beach recreation sites) or adjoining rivers, tributaries and canals that could influence the site)?			2
Health Impact Rating- add the scores for the pollution sources impacting the site (out of 25)				

* Smaller (often private) treatment plants serving less than 21 equivalent people are considered on-site systems in Queensland.

** Do not include one-time only overflows if mitigation has been put in place to stop this from occurring in the future.

*** Industrial discharge includes licensed and/or reported outfalls from industries likely to be sources of microbial pollution such as abattoirs and food processing facilities. It does not include stormwater discharges from industrial estates.

**** Include adjoining rivers and tributaries, as well as upstream sections of the same waterway on which the recreation site is located. Select those waterways with significant influences (e.g. sewage treatment plants, intensive agriculture or industrial discharges) occurring in the catchment greater than 2 km from the site, but still within a distance of 5 km.

Note: If data is not available, assume the pollution source is present until further investigation confirms it is not.

Step 2: Qualitative descriptors of likelihood of exposure to health risks and likelihood of potential impact

	Likelihood of exposure						
Exposure factors	**Rare (score = 1)**	**Possible (score = 2)**	**Likely (score = 3)**	**Very Likely (score = 4)**	**Almost certain (score = 5)**	**Confidence in data (H,M,L)**	**Score**
Frequency and type of recreation (in the peak-use season)	Primary or secondary contact recreation once a month or less	Only secondary contact recreation on weekends	Only secondary contact recreation most days of the week	Primary contact recreation on weekends	Primary contact recreation most days of the week		
Number of people partaking in primary contact activities on busy days	0	1-49	50-99	100-500	> 500		
Average duration of primary contact* activities among users on busy days	< 20 min.	20–40 min.	41–60 min.	61–120 min.	> 120 minutes		
Proportion of vulnerable people during recreation times**	0	< 10%	10-25%	26-50%	> 50%		
Site Resilience to pollution loads: Concentration and residence time of pollutants at the site based on flushing***	High flushing – majority of water at site is replaced within 48 hours				Low flushing – majority of water at site is not replaced within 48 hours		
Add up the Likelihood of Exposure scores (out of 25)							

* For secondary contact only sites at any frequency, consider as rare. For estimating the amount of hours spent in primary contact, consider the amount of time spent by the average person during their visit (e.g. a person may enter the water 3 times during a visit, swimming 20mins each time – totalling 1h of primary contact time).

** Certain groups in the community may be more vulnerable to contracting illness and infection than others. Children under seven years old, the elderly, people with compromised immune systems and people with open cuts and wounds are generally most at risk. If no site usage information is available, assume local community demographics gathered from census and other sources.

***flushing is the movement of water through a site leading to a turn-over or replenishment of water at that site. It includes freshwater flows, along with tidal, surf and wind-driven influences in estuaries and coastal recreation sites. Open ocean beaches can be considered very high flushing, while enclosed bays may be scored lower based on relevant currents and tidal flows.

Note: If data is not available, assume a conservative high level of risk and score a 4 for that factor likelihood. Data on site use can be sourced from site visits, tourism agencies and operators, lifesavers, recreational groups (e.g. dragon boating, sailing) and event organisers (e.g. Triathlon Queensland).

Step 3: Qualitative descriptors of impacts associated with additional risk categories

In addition to sources of pollution and associated health impacts assessed in Step 1, and the likelihood of exposure to health risks and likelihood of potential impact assessed in Step 2, it is important to also consider additional risks such as economic and risk to delivery of services. These additional risk categories have been adapted from the enHealth *Risky business – a resource to help local governments manage environmental health risks*, 2012.

	Risk Level						
Risk Category	Very Low (score = 2)	Low (score = 4)	Moderate (score = 6)	High (score = 8)	Very High (score = 10)	Confidence in data (H,M,L)	Score
Local Business - Economic Risk (businesses within 1 km supported by recreation at site).	0	1-2	3-5	6-10	>10		
Tourism and events - Economic Risk (amount of tourism and events at site)	Does not attract tourists or events.	Attracts tourists and/or events 1-2 times during the busy season.	Attracts tourists and/or events less than half the busy season.	Attracts tourists and/or events throughout the peak-use season	Attracts tourists and/or events all year round.		
Community Expectation for site to be managed - Risk to strategic and governance position or reputation*	No infrastructure .	Minor infrastructure on nearby land.	Minor infrastructure on land and in the water.	Major infrastructure on nearby land.	Major infrastructure on land and in the water.		
Relative Popularity - Risk to capacity to deliver services in the area	Least (or near-least) recreational use relative to other sites in the area.	Below average recreational use relative to other sites in the area.	Average recreational use relative to other sites in the area.	Above average recreational use relative to other sites in the area.	Highest recreational use relative to other sites in the area.		
Willingness to travel-** Risk to capacity to deliver services *** in the area	A site with similar services is available < 5 km away.	A site with similar services is available 5 - 10 km away.	A site with similar services is available 11 – 30 km away.	A site with similar services is available 31-60 km away.	A site with similar services is available > 60 km away.		
					Add the Additional Risk scores (out of 50)		

* Community expectations increase if the site has infrastructure to attract visitation or if sponsored/endorsed events occur at the site. Major infrastructure includes playgrounds, boat ramps & visitor information centres or equivalent buildings, etc. Major infrastructure should also consider environmental amenity and social/community values/perceptions.

** Based on willingness to travel indicated distance by car to a site with similar services, e.g. another surf beach.

*** Exclude passive recreation services like walking along the river bank. Compare to other sites within the same Local Government Area or appropriate management area. Some examples of services include surf beach with surf life saving services, freshwater recreation site with water all year round, sites with calm open water suitable for regattas and triathlons.

Note: If data is not available, assume a conservative high level of risk and score a 4 for that category.

Step 4: Calculating site Priority Rating

Add together the *Health Impact Score*, *Likelihood of Exposure Score* and the *Additional Risks Score* to produce an overall risk score out of 100. Use the below table to identify the *Management Priority Rating* for your site.

Overall Risk Score	Mgmt. Priority Rating	Recommended Management Response
81-100	Very High	Allocate existing resources for routine enterococci monitoring and *Sanitary Inspection* to assign *Recreational Suitability Grade* to site.
61-80	High	Secure and allocate resources for routine enterococci monitoring and *Sanitary Inspection* to assign *Suitability Grade* to site.
41 - 60	Medium	Consider for future management when sufficient resources are available.
21 - 40	Low	Note any increasing catchment pressures and assess site at an appropriate future date to determine if *Mgmt. Priority Rating* changes. No immediate management action required.
0 - 20	Very Low	Assess site in future to determine if *Mgmt. Priority Rating* changes. No immediate management action required.

Step 5: Record all *Management Priority Rating* results to allow ranking as to priority.

Repeat *Management Priority Rating* Steps 1 – 4 for all recreational water sites within your area of management responsibility. Compile the results of all your sites into a template similar to the one provided below, allowing for easy ranking of your sites.

Site Name	Health Impact (out of 25)	Likelihood of Exposure (out of 25)	Additional Risks (out of 50)	Overall Risk Score (out of 100)	Priority Rating

Sanitary Inspection Category Calculation

This is a risk assessment of microbial pollution sources within a catchment potentially impacting human health risk at recreational water sites that can be used to calculate a *Sanitary Inspection Category* for a site.

The desktop data collected as part of the site *Management Priority Rating* process will provide a good starting point for completing the *Sanitary Survey*, and relevant information should be transferred to the following module work sheets where applicable. To complete the module work sheets and to calculate the *Sanitary Inspection Category* for your recreational water site, the following five-step process is carried out as described below (shown in Figure1).

- Determine the *likelihood* of a pollution source impacting the recreational water (**Step 1**)
- Determine the *consequence* to microbial water quality based on the *Health Impact Rank* of the pollution source minus any mitigation factors that may be in place for that pollution source (**Step 2**)
- Calculate the risk from each pollution source based on *likelihood* and *consequence* scores (**Step 3**)

Repeat Steps 1-3 for each of the nine pollution assessment source modules, then combine the risk ratings from the nine modules to give an overall site risk rating (**Step 4**).

Convert the overall site risk rating into a *Sanitary Inspection Category* (**Step 5**).

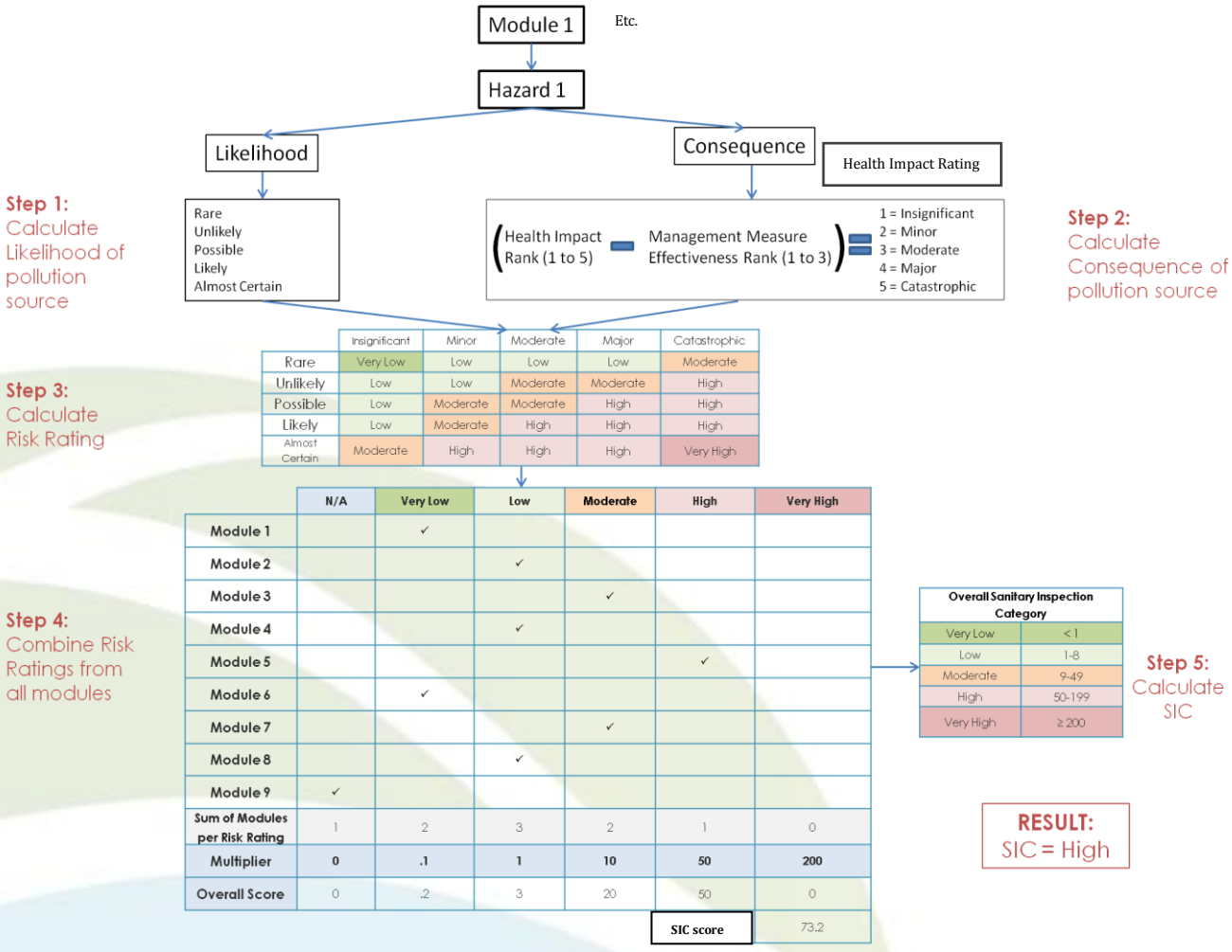

Figure 1: Overview of *Sanitary Inspection Category* (SIC) determination process.

Module 1: Sewage Treatment Infrastructure

Sewage Treatment Plant Outfall/s*

Name of outfall _____

Type of outfall ☐ storage lagoon ☐ direct discharge to waterway

☐ long ocean outfall ☐ no outfall, predominantly reuse

Distance to site (m) _____

Treatment failure / bypass in past year ☐ Yes ☐ No date of last failure _____

*Where more than one sewage treatment plant outfall are present asses both and use the highest scores of either for *likelihood* and *consequence* in calculating the *Human Health Score* for Pollution Assessment Module 1.

Sewage Treatment Plant Bypasses

Name of bypass _____

Distance to site (m) _____

Average discharge volume per event (mL) _____

Minimum treatment level of

Bypassed effluent ☐ None ☐ Primary ☐ Secondary/Lagoon ☐ Tertiary

Bypassed effluent disinfected ☐ Never ☐ Sometimes ☐ Always

Emergency Relief Overflow Structures

For each overflow structure in the catchment (or 500 m radius from a site), list:

Name/Asset ID	Address	Receiving Water	Date of last dry-weather overflow	Distance to site

Surrounding Asset(s) Condition

What is the condition of pipes and infrastructure? ☐ Above average ☐ Below average

How many illegal stormwater connections are likely or confirmed? ☐ Few ☐ Many

Note: If data is not available, assume below average condition and many illegal connections; to be confirmed with local experts.

***Likelihood* of sewage outfall(s) impacting recreational water** *(circle the relevant scores)*

Outfall Discharge location	No outfall, predominantly reuse	Storage lagoon 100-200 m from waterway	Long ocean outfall compliant with guidelines	Storage lagoon < 100m from waterway	Direct discharge to waterways*
Sewage treatment plant outfall	Rare (1)	Unlikely (2)	Possible (3)	likely (4)	Almost certain (5)
Final likelihood score – outfalls *(use highest circled score)*					

* If system failure is evident or plant is compromised during rainfall events, treat as direct discharge to waterways.

***Consequence* of sewage outfalls to microbial water quality** *(circle the relevant scores)*

Pollution source type	**Consequence scores**
Human source	5
Management measures	
Has discharged wastewater undergone secondary treatment?	-1
Has discharged wastewater undergone tertiary treatment?	-2
Has discharged wastewater undergone chlorination or UV treatment and is suitable for re-use/recycle?	-4
Other management measure(s) *(describe and assign effectiveness score accordingly)*	
Outfall(s) consequence score *(add the circled scores)*	

Sanitary risk to human health score for sewage outfalls?

Likelihood Score _____ x Consequence score _____ = _____

Likelihood of sewage overflows impacting recreational water *(circle the relevant scores)*

Emergency Relief overflow structure (EROS)* characteristics	Distance from site**	
	> 300m	≤ 300m
No overflows have occurred in past year	N/A	Rare (1)
Dry weather overflows have occurred in past year	Likely (4)	Almost certain (5)
Few wet weather overflows due to above average asset condition and/or few illegal stormwater connections	Possible (3)	Likely (4)
Frequent wet weather overflows due to below average asset condition and/or many illegal stormwater connections	Likely (4)	Almost certain (5)
Sewage overflow(s) likelihood score *(**average** the circled scores, where an EROS score of Almost Certain is assigned Sewage overflow likelihood score can be no less than 5)*		

* Sewage Pump Stations, Sewage Discharge Outlets and Sewage treatment bypass within 500 m of the site

** Measure distance from the recreation site to the likely entry point of the overflow into the nearest waterway influencing water quality at the recreational site. This could include direct discharge, sewage reaching waterways via overland flows from EROS within 200 m of waterway, or EROS connected via stormwater drains that discharge within 500 m of the site.

Consequence of sewage overflows to microbial water quality *(circle the relevant scores)*

Pollution Source Type	Consequence Score
Human source	5
Management measures	
Is there sewage overflow screening in place?	-1
Are asset condition improvements or illegal connection reductions occurring?	-2
Any other management measures? *(describe & assign effectiveness score accordingly)*	
Sewage overflow consequence score *(**add** the circled scores)*	

Human Health risk score- Sewage Overflows

Likelihood Score _____ x Consequence score _____ = _____

Risk Rating for Sewage Treatment Infrastructure module? *(circle rating based on the calculated Human Health risk score)*

Risk Scores	0-1	2-5	6-9	10-16	17+
Outfall Risk rating	Very Low	Low	Moderate	High	Very High
Overflow Risk Rating	Very Low	Low	Moderate	High	Very High

Module 1 Sewage Treatment Infrastructure Risk Rating (use highest Risk Rating determined above, either Outfall Risk Rating or Overflow Risk Rating) _____

Module 2: On-site Sewage Systems

Catchment Overview

How many septic tanks are present? _____ within 200 m of site _____ in the catchment

How many small treatment plants (serving < 21 equivalent people) are present?
_____ within 200 m of site _____ in the catchment

Site Overview

Distance of nearest system to site? (m) _____

How is the system's sewage effluent treated? (see table below for explanations)

- ☐ Surface effluent irrigation
- ☐ Sub-surface effluent irrigation
- ☐ No effluent irrigation

Any odours or discharges recorded? ☐ No ☐ Yes, details:

_____

_____

***Likelihood* of on-site sewage systems impacting the recreational water site** *(circle the relevant scores)*

Primary Hazard* (based on system located closest to site)	Secondary Hazards	Distance of system from recreational site		
		>100 m	50-100 m	< 50 m
Surface Effluent Irrigation typically secondary treated sewage effluent of a quality suitable for above ground spray irrigation	Hydraulic failure* Steep Slope**	Likely (4)	Almost certain (5)	Almost certain (5)
	Hydraulic Failure* Moderate Slope or Flat	Possible (3)	Likely (4)	Almost certain (5)
	Normal Function Steep Slope** Sand, Rock or Clay	Possible (3)	Likely (4)	Almost certain (5)
	Normal Function Steep Slope** Loam or Clay/Loam	Possible (3)	Possible (3)	Likely (4)
	Normal Function Moderate Slope or Flat Loam or Clay/Loam	Rare (1)	Unlikely (2)	Likely (4)
	Normal Function Moderate Slope or Flat Sand, Rock or Clay	Unlikely (2)	Possible (3)	Likely (4)
Sub-surface Effluent Irrigation typically primary treated sewage effluent which is discharged to an evapotranspiration area	Hydraulic Failure*	Likely (4)	Almost certain (5)	Almost certain (5)
	Normal Function as related to hydraulic flow*	Rare (1)	Unlikely (2)	Likely (4)

or mound [e.g. leach drains or soil absorption trenches				
No effluent irrigation sewage is either pumped out and removed from catchment or transported to a treatment facility	Hydraulic failure* Steep Slope**	Likely (4)	Almost certain (5)	Almost certain (5)
	Hydraulic failure* Moderate Slope or Flat	Possible (3)	Likely (4)	Almost certain (5)
	Normal Function as related to hydraulic flow*	Rare (1)	Unlikely (2)	Possible (3)
Final Likelihood score for onsite systems *(**average** the circled scores, where a Secondary Hazard score of Almost Certain is assigned, Final Likelihood score for onsite systems can be no less than 5)*				

* Hydraulic failure = overflow of effluent. If there is no record of failures available, hydraulic failure can be assumed if there is no written or verbal evidence of appropriate routine maintenance and the system was installed at least one year ago. Normal Function= sewage treatment system functions as designed and is fit for purpose, with evidence that there is no Hydraulic failure.

** Steep slope = > 10% slope. A moderate slope is regarded as 5-10% slope.

(Adapted from GHD & Seqwater (2015) *Sanitary survey of drinking water catchments - draft*)

Consequence of on-site systems to microbial water quality *(circle relevant scores)*

Pollution source	**Consequence Score**
Human Source	5
Is there more than one septic system located within 200 m of the site?	+1
Management measures	
Do regular (e.g. annual) on-site sewage system audits occur?	-1
Do audits and rectification of faulty on-site systems occur?	-3
Other management measure *(describe and assign effectiveness score accordingly)*	
On-site sewage systems consequence score for *(add up the circled scores)*	

Human Health risk score- Onsite Sewage Systems

Likelihood Score _____ x Consequence score _____ = _____

On-site sewage systems risk rating *(circle rating based on the calculated risk score)*

Risk Scores	0 to 1	2 to 5	6 to 9	10 to16	17+
Module 2 On-Site Sewage System Risk rating	Very Low	Low	Moderate	High	Very High

Module 3: Industrial Discharge/s *

What is the name of the industry outfall? _____

Is industry discharging directly into Recreational Site? ☐ Yes ☐ No

If no, what is the outfall distance to the Recreational Site waterway? (m) _____

What is the level of industrial wastewater treatment? ☐ Partial ☐ High standard (tertiary treatment and disinfection via UV or chlorination)

Details: _____

*Where more than one source of Industrial Discharge is present asses both and use the highest scores of either for *likelihood* and *consequence* in calculating the *Human Health Score* for Pollution Assessment Module 1.

***Likelihood* of industrial discharges impacting recreational water** *(circle relevant scores)*

Primary Hazard	Indirect discharge (> 100 m from waterway)	Indirect discharge (50-100 m from waterway)	Indirect discharge (< 50 m from waterway)	Direct discharge to waterway within 1 km of recreational water site
High-hazard process	Unlikely (2)	Possible (3)	Likely (4)	Almost certain (5)
Final likelihood score for industrial discharges *(average the circled scores)*				

***Consequence* of industrial discharges to microbial water quality** *(circle relevant scores)*

Pollution Source Type	Consequence score
Animal sources	3
Management measure	
Does wastewater undergo partial treatment?	-1
Is wastewater treated to a high standard (tertiary treatment and disinfection via UV or chlorination)?	-2
Other management measure *(describe and assign effectiveness score accordingly)*	
Industrial discharges consequence score *(add the circled scores)*	

Human Health risk score- Industrial discharges

Likelihood Score _____ x Consequence score _____ = _____

Industrial discharges risk rating? *(circle the rating based on the calculated risk score)*

Risk Scores	0 to 1	2 to 5	6 to 9	10 to16	17+
Module 3 Industrial Discharges Risk rating	Very Low	Low	Moderate	High	Very High

Module 4: Animals (agricultural, wild and domestic)

Only consider animals within 200 m of site. Animal sources greater than 200 m from site will be assessed in other modules.

Aquatic Birds:

Aquatic birds present? □ Yes □ No

Approx. number of aquatic birds? _____

Names/Species of aquatic birds present?: _____

Roosting structures present? □ Yes □ No

Other Comments: _____

_____

Native Animals:

Native animals present? □ Yes □ No

Approximate number? _____

Area of preferred wildlife habitat? _____

(e.g. riparian canopy over-hanging waterway-flying foxes)

Density of native animals? □ Low (> = 0.5) □ High (< 0.5)

(Number per m^2 of habitat)

Other Comments: _____

_____

Domestic Animals:

Domestic animal exercise area (e.g. dog park)? □ Yes □ No

Types of animals that use exercise area:? □ Dogs □ Horses
□ Other, details: _____

Dog-waste bags present? □ Yes □ No

Animals directly access water? □ Yes □ No

Animal exercise areas have animal faeces removed regularly □ Yes □ No

Other Comments: _____

_____

Agricultural Animals:

Fences keep animals from directly accessing waterway? □ Yes □ No

Farm animals present? □ Yes □ No

Description and approximate numbers _____

***Likelihood* of animals impacting recreational water** *(circle relevant scores)*

Primary Hazard	Secondary hazard***	Fenced Watercourse > 100 m	Fenced Watercourse 50-100 m	Fenced Buffered Watercourse < 50 m	Fenced Un-buffered Watercourse < 50 m	Direct Access to Waterway
Intensive agriculture (feed lots, dairies, piggeries, poultry farms etc.)	Steep Slope (> 10%)	Unlikely (2)	Possible (3)	Likely (4)	Almost Certain (5)	Almost Certain (5)
	Moderate (5-10%) or Flat Slope	Unlikely (2)	Unlikely (2)	Possible (3)	Likely (4)	Almost Certain (5)
Broad scale grazing (hoofed animals that range and feed in pastures)	Steep Slope (> 10%)	Unlikely (2)	Unlikely (2)	Possible (3)	Likely (4)	Likely (4)
	Moderate (5-10%) or Flat Slope	Rare	Unlikely (2)	Unlikely (2)	Possible (3)	Likely (4)
Wildlife and domestic animals	Steep Slope (> 10%)	Unlikely (2)	Possible (3)	Likely (4)	Likely (4)	Almost Certain (5)
	Moderate (5-10%) or Flat Slope	Rare	Unlikely (2)	Possible (3)	Possible (3)	Almost Certain (5)
Biosolids Fertiliser derived from animal faecal waste**	Steep Slope (> 10%)	Unlikely (2)	Possible (3)	Likely (4)	Almost Certain (5)	n/a
	Moderate (5-10%) or Flat Slope	Unlikely (2)	Unlikely (2)	Possible (3)	Likely (4)	n/a
Animals likelihood score *(**average** the circled scores, where a Secondary Hazard score of almost certain is assigned, Final Likelihood of animals impacting recreational water score can be no less than 5)*						

** Fencing of waterways doesn't reduce the likelihood of biosolids (stored on site, or slurry spread on land)influencing waterway microbial quality, although setback distance of biosolid stockpiles or placement from the waterway or site should be considered in assessing likelihood.

***Consequence* of animals to microbial water quality** *(circle relevant scores)*

Pollution Source type	**Consequence Score**
Hoofed animals, domestic and wild animals	3
Wildlife and domestic animals only (no hoofed animals)	1
1000+ animals	2
Management measure	
Do properties have and follow a waste management plan?	-1
Is a buffer zone of vegetation present to reduce overland flows reaching waterways?	-1
Is there evidence that the buffer zone significantly reduces microbial pollution entering the waterway?	-1
Other management measure(s) *(describe and assign effectiveness score accordingly)*	
Animals consequence score *(add the circled scores)*	

Human Health risk score- Animals

Likelihood Score _____ x Consequence score _____ = _____

Animals risk rating for this module? *(circle rating based the calculated risk score)*

Risk Scores	**0 to 1**	**2 to 5**	**6 to 9**	**10 to16**	**17+**
Module 4 Animals Risk rating	Very Low	Low	Moderate	High	Very High

Module 5: Stormwater

Site Overview

Number of stormwater drains? _____

(within 500 m of the site)

Primary land use? *(choose one)* □ High density urban □ Low density urban □ Rural - grazing

□ Rural – cropping □ Bushland/reserve

Drain Characteristics

Select two stormwater drains that have the most influence on your sampling site (or if there is only one drain, enter its details)

Drain 1: (the stormwater drain that discharges closest to the site)

Location _____

Authority _____

Distance to site (m) _____

Type: □ Box Culvert □ Creek □ Pipe

Discharge Area: □ Dune □ Beach □ Offshore □ Direct <50m □ Direct >50m

Drain 2: (the drain most likely to impact water quality at the site)

Location _____

Authority _____

Distance to site (m) _____

Type: □ Box Culvert □ Creek □ Pipe

Discharge Area: □ Dune □ Beach □ Offshore □ Direct ≤ 50 m □ Direct > 50 m

Describe attributes of the drain(s) that make them more likely to impact the site (e.g. largest, strongest flows, visual evidence of pollution, history of transporting sewage overflows)

_____

_____

***Likelihood* of stormwater impacting recreational water** *(circle relevant scores)*

Catchment size				
Very small catchment	**Small catchment (individual block)**	**Medium sized catchment (residential block or street)**	**Large catchment (multiple residential blocks or streets)**	**Very large catchment (town or suburb)**
Unlikely (1)	Possible (2)	Likely (3)	Almost certain (4)	Certain (5)
Dominant Catchment land use				
Bushland/reserve	**Rural – cropping**	**Rural – grazing**	**Low density urban**	**High density urban**

Unlikely (1)	Possible (2)	Likely (3)	Almost certain (4)	Certain (5)
Dominant Stormwater treatment				
***Advanced stormwater treatment**	**Stormwater detention (ponds)**	**Pervious surfaces without formal drainage**	**Stormwater drains, kerb and gutter**	
Unlikely (1)	Possible (2)	Likely (3)	Almost certain (4)	
Discharge distance**				
Indirect discharge (> 100 m from recreational water site)	**Indirect discharge (50-100 m from recreational water site)**	**Indirect discharge (< 50 m from recreational water site)**	**Direct effluent discharge to recreational water site**	
Possible (1)	Likely (2)	Certain (3)	Almost certain (4)	
Final Likelihood score for stormwater *(average the circled scores, where a Likelihood of stormwater impacting recreational water score of Certain is assigned, the Final Likelihood score for stormwater can be no less than 5)*				

* Advanced stormwater treatment includes wetland detention and proprietary *in situ* treatment devices such as rain gardens or filters.

** discharge distance to closest drain to recreational area

(Adapted from GHD & Seqwater (2015) *Sanitary survey of drinking water catchments - draft*)

Consequence of stormwater microbial water quality

Pollution Source Type	**Consequence score**
Definite mixed sources (evidence of human faecal contamination)	5
Possible mixed sources (could contain human sources)*	3
Three or more stormwater drains within 500 m of site	2
Management measure description	
Treatment devices in place for 10% of stormwater system	-1
Stormwater harvesting and treatment of more than 50% of stormwater	-2
Other management measure(s) *(describe and assign consequence score accordingly)*	
Stormwater consequence score *(add the circled scores)*	

*Where there is **evidence** of human faecal contamination, only consider as *definite*. Where possibility of human faecal contamination exists only consider as *possible*.

Human health risk score for stormwater

Likelihood Score _____ x Consequence score _____ = _____

What is the risk rating for this module *(circle rating based on the calculated risk score)*

Risk Scores	0 to 5	6 to 9	10to 16	17+
Module 5 Stormwater Risk rating	Very Low	Low	Moderate	High

Module 6: Recreators

Bathers

Number of bathers at peak-use times _____

How many days in the year are considered peak-use times? _____

Box 1: Bather Density Calculation

Site area as defined in *Site Details*

Number of bathers at busy times as determined above

(Number at busy times) divided by (Area) = _____ (people/m^2)

☐ High Bather density > = 0.2

☐ Low Bather density < 0.2

Toilet Facilities

Toilets facilities available within 200 m of site? ☐ Yes ☐ No

Distance from toilets to site (m)? _____

Total number of toilets? _____

Total number of showers? _____

Do toilet facilities show evidence of poor maintenance? ☐ Yes ☐ No

Frequency of Maintenance? _____

Date of last known maintenance? _____

Type of sewage system? ☐ Sewered

☐ On-site system: how often serviced?

_____

Discharges/Odours/Damage recorded that would affect toilet use? ☐ No

☐ Yes, details:

_____

_____

Note: If toilets are the closest septic system to the site, complete the risk assessment for this system in **Module 2** – ***On-site-septic systems***.

Likelihood of bathers impacting recreational water

Primary Hazard	Toilet Facilities Available		Toilet Facilities Absent **	
	Low density* of users	High density* of users	Low density* of users	High density* of users
Primary Contact immersion and child paddlers	Possible (3)	Almost certain (4)	Almost certain (4)	Certain (6)
Secondary Contact minimal immersion and boating	Unlikely (2)	Possible (3)	Possible (3)	Likely (5)
Passive Recreation no water contact	Rare (1)	Unlikely (2)	Unlikely (2)	Possible (3)
Bathers likelihood score *(average the circled scores)*				

* As calculated above in Box 1

** No toilet facilities are located within 200 m of the site or toilets facilities are in poor condition (unclean, broken) discouraging use. If condition of toilets over multiple inspections would discourage or prevent use, treat as absent.

(Adapted from GHD & Seqwater (2015) *Sanitary survey of drinking water catchments - draft*)

Consequence of recreators impacting recreational water quality

Pollution source type	Consequence Score
Human Source	5
Management measures	
Is the site unlikely to have small children recreating in water?	-1
Are toilets present and **functional** at recreational site?	-2
Is the site subject to a reasonable degree of flushing/dilution, is the site an ocean or estuarine site?	-2
Other management measure *(describe and assign Consequence score accordingly)*	
Final consequence score for recreation at site *(add up the circled scores)*	

Human health risk score- Recreators

Likelihood Score _____ x Consequence score _____ = _____

Recreators risk rating? *(circle the rating based on the calculated risk score)*

Risk Scores	0 to 1	2 to 5	6 to 9	10 to17	>17

Module 6 Recreator Risk rating	Very Low	Low	Moderate	High	Very High

Module 7: Boating Discharges

What is located within 1 km of site

- ☐ Marina
- ☐ Harbour
- ☐ Anchorage
- ☐ Boat ramp
- ☐ Permanent moorings
- ☐ Temporary moorings
- ☐ Jetty
- ☐ Ferry berth

Distance from site to nearest boat (m) _____

Number of boats near site _____

Number of boats with on-board toilets _____

Pump-out facilities provided

- ☐ No
- ☐ Yes, details:

_____

_____

Complaints of boat discharges

- ☐ No
- ☐ Yes, details:

_____

_____

On-shore toilets provided

- ☐ No
- ☐ Yes, details:

_____

_____

Note: if no data is available, assume all non-trailable boats, or boats with a cabin have toilet facilities on-board.

Likelihood of boating discharges impacting recreational water?

Primary Hazard*	Both onshore toilet and pump-out facilities provided	Onshore toilet facilities and no pump-out facilities provided	Pump-out facilities provided and no onshore toilet facilities provided	Pump-out and onshore toilet facilities not provided
Less than 20 boats within 100 m of site	Rare (0)	Unlikely (1)	Possible (2)	Likely (3)
20 – 50 boats within 100 m of sites	Unlikely (1)	possible (2)	Likely (3)	Almost certain (4)
> 50 boats within 100 m of site	Possible (2)	Likely (3)	Almost certain (4)	Almost certain (5)
Boating discharges likelihood score *(the circled score)*				

* If known, use number of boats with on-board toilets for this determination; otherwise use total number of boats. Microbial pollution entering waterways from people using smaller craft including motor boats, kayaks and small sailing boats will most likely occur during bathing, and be calculated as part of bather density (**Module 6 – Recreators**

Consequence to microbial water quality

Pollution Source Type	Consequence Score
Human Source	5
Management measure	
Are boat toilet maintenance education resources in place?	-1
Are education and toilet inspections occurring?	-2
Other management measure(s) *(describe & assign Consequence score accordingly)*	
Boating discharges consequence score *(add the circled scores)*	

Human health risk score- Boating discharges

Likelihood Score _____ x Consequence score _____ = _____

Boating discharges risk rating? *(circle rating based the calculated risk score)*

Risk Scores	0 to 1	2 to 5	6 to 9	10 to16	17+
Module 7 Risk rating	Very Low	Low	Moderate	High	Very High

Module 8: Waterway Discharges

What are the names and discharge distances of freshwater rivers, estuaries, canals or tributaries discharging within 1 km of the site? (where discharge can reach the site via tidal or freshwater flows).

Name Distance of discharge point from site

_____ (m)_____

_____ (m)_____

Note: it should be upstream for freshwater and estuarine sites

Pollution source(s) in river discharge? □ Urban stormwater □ Sewage outfall

□ Leachate from on-site wastewater systems

□ Agricultural runoff □ Intensive livestock production

□ Other, details: _____

***Likelihood* of waterway discharges impacting recreational water**

Pollution sources* within waterway discharges	Waterway Discharge Distance from the site	
	301 m to 1 km	≤ 300 m
Four or more pollution sources discharge into waterway	Almost certain (5)	Almost certain (5)
Three pollution sources discharge into waterway	Likely (4)	Almost certain (5)
Two pollution sources discharge into waterway	Likely (4)	Likely (4)
One pollution source discharges into waterway	Possible (3)	Possible (3)
No pollution sources discharge into waterway	Rare (1)	Unlikely (2)
Final Waterway Discharges likelihood score *(**average** the circled scores, where a Likelihood of Waterway discharges impacting recreational water score of Almost Certain is assigned, the Final Likelihood score for Waterway Discharges can be no less than 5)*		

* Pollution sources in water discharges should exclude those sources already considered in other modules (e.g. sewage treatment plants outside a 2 km radius from the site or an industrial discharge outside a 1km radius from the site).

***Consequence* of waterway discharges to microbial water quality**

Pollution Source Type	**Consequence Score**
Mixed sources (could contain human sources)	5
Management measure	
Are upstream riparian areas actively managed and protected?	-1
Has a whole of catchment management plan been implemented?	-2
Other management measure(s) *(describe and assign Consequence score accordingly)*	
Waterway discharges consequence score *(add the circled scores)*	

Human health risk score- Waterway discharges ?

Likelihood Score _____ x Consequence score _____ = _____

Waterway discharge risk rating? *(circle rating based on the calculated waterway discharge risk score)*

Risk Scores	**0 to 1**	**2 to 5**	**6 to 9**	**10 to16**	**17+**
Module 8 Waterway Discharge Risk rating	Very Low	Low	Moderate	High	Very High

Module 9: Other Microbial Pollution Sources

Description of other microbial source(s):

_____

_____

***Likelihood* of microbial pollution impacting recreational water?**

Likelihood	Tick (✓)
Rare	
Unlikely	
Possible	
Likely	
Almost Certain	

***Consequence* to microbial water quality?**

Please score the *Consequence to human health* of the microbial source. If this other source has the equivalent risk of:

- human sources = health impact rank of 5
- mixed source likely to contain human faecal input = health impact rank of 5
- hoofed animal sources = health impact rank of 3
- wildlife and domestic animal sources = health impact rank of 1.

Description of mitigation measure:

_____

_____

_____

Mitigation Effectiveness Score (-1 to -4): _____

To assign a *Mitigation Effectiveness Score*, consider the relative impact the management will have on the microbial source and its impact on water quality.

Microbial sources risk score?

Likelihood Score _____ x Consequence score _____ = _____

Microbial sources risk rating? *(circle rating based on the calculated risk score)*

Risk Scores	0 to 1	2 to 5	6 to 9	10 to16	17+

Module 9 Microbial Sources Risk rating	Very Low	Low	Moderate	High	Very High

Step 4 – Overall Site Score-Risk of Microbial Pollution Affecting Recreator Health

Use the table below to combine the *Risk Scores* from the nine modules to give an overall site risk rating.

	N/A	Very Low	Low	Moderate	High	Very High
Module 1 Sewage treatment infrastructure						
Module 2 On-site sewage systems						
Module 3 Industrial discharges						
Module 4 Animals						
Module 5 Stormwater						
Module 6 Recreational sites						
Module 7 Boating discharges						
Module 8 Waterway discharges						
Module 9 Other microbial pollution sources						
Sum of Modules per Risk Rating						
Multiplier	**0**	**0.1**	**1**	**10**	**50**	**200**
***Overall Site Score for each Risk Score category**						
					Sanitary Inspection Category Score.	

*Overall site score is determined by applying the multiplier for each risk score against the number of times each score is represented in the matrix. These are then added to arrive at the Sanitary Inspection Category Score.

Step 5 – Sanitary Inspection Category

Use table below to convert the *Sanitary Inspection Category Score* risk rating into a *Sanitary Inspection Category*.

Sanitary Inspection Category	
Very Low	< 1
Low	1-8

Moderate	9-49
High	50-199
Very High	≥ 200

Sanitary Inspection Category for this site: _____

Management

Which management controls are in place to warn people of periods of increased risk?

- ☐ None
- ☐ Permanent on-site signage
- ☐ Temporary on-site signage
- ☐ Media releases
- ☐ Beach closures
- ☐ Website
- ☐ Other, details _____

Provide details of

Advisories _____

_____

Do management controls effectively prevent people from entering the water during these periods?

- ☐ No
- ☐ Yes, details: _____

_____

Is there a management response plan in place to deal with exceptional events such as sewage overflows and bypasses?

- ☐ No
- ☐ Yes, details: _____

_____

Are any other management responses in place for this site?

_____

_____

_____

Detailed Modifications to the Inspection Criteria

Field Observation Checklist and Record

For optimal collection and storage of data, this sheet should be filled out during dedicated sanitary inspections visits, water sampling, maintenance, complaint follow-ups and facility/parks inspections.

Accompanying resources checklist: □ Copy of last assessment □ Recent weather records □ Maps relevant to identified pollution sources □ Contact details for key landholders, marinas, and user groups □ Water sampling equipment (for incident assessments) □ Protective gear

Survey details	Date _____ Time _____ Site Name _____ Officer _____ Weather _____ Rainfall in past 24 h □ none □ 1-5 mm □ 6-10 mm □ 11-20 mm □ > 20mm		
	Numbers	**Visual Evidence of pollution**	**Testimonials / comments***
At the site	Number of bathers _____ % children _____ % elderly _____ Other uses: □ Surfing □ Jet Skiing □ Canoeing/Kayaking □ Fishing □ Sailing □ Boating □ Other	□ Discolouration □ Slicks □ Excessive algal growth □ Debris □ Odours	
Within 200 m	Type of Animal Number _____ _____ _____ _____ _____ _____ toilets with issues _____ septics with issues _____	□ Animals in waterways □ droppings present □ Odours □ Toilet paper, waste on ground or in waterways	
Within 500 m	Number of Sewage overflows with issues _____ Number of Stormwater drains with issues _____ Stormwater flow □ None □ Low □ High	□ Odours □ Toilet paper, waste on ground or in waterways □ Discolouration □ Odours	
Within 1 km	Number of Boats _____ Adjoining Waterway Flow □ None □ Low □ High	□ Discolouration □ Odours □ Discolouration □ Odours □ Debris	
Within 2km	Sewage Outfall Flow □ None □ Low □ High	□ Discolouration □ Odours □ Debris	

Actions	
	Water samples collected _____ Maintenance requested _____ Other actions _____ Date scheduled for follow up / next visit _____

*Anecdotal evidence collected at the site from staff, officers, locals or other informed individuals.

Insert / sketch Map of site with relevant pollution sources