

Appendix A

Indicators and Guidelines

Bacterial indicators

The assessment of water quality under the Beachwatch Partnership Program (BPP) during the 2008–2009 summer season was based primarily on the level of faecal contamination, using the bacterial indicators faecal coliforms and enterococci.

Faecal coliforms, also known as thermotolerant coliforms, are a group comprised of the organisms *Escherichia coli*, *Klebsiella pneumoniae* and *Enterobacter aerogenes*. Faecal coliforms are strongly associated with faecal waste and therefore are excellent indicators of recent faecal contamination. Faecal coliforms are not reliable indicators of aged faecal contamination, owing to their short survival times in marine waters.

Enterococci are a subgroup of faecal streptococci and include four streptococci species: *Streptococci faecalis*, *S. faecium*, *S. gallinarum* and *S. avium*. In contrast to faecal coliforms, enterococci survive for longer periods in seawater and are thus good indicators of the presence of aged faecal contamination.

Most pathogens are not easily detected in water. Where reliable laboratory methods exist, they generally require the collection of large volumes of water; analysis is costly, and it can take a week or more to obtain a result. In addition, decisions about how many, and which, specific pathogens to test for need to be made.

Owing to these difficulties, indicator organisms are used as fundamental monitoring tools for assessing the potential presence of pathogenic organisms. An indicator organism should:

- 1) be easily detectable by using simple laboratory tests
- 2) generally not be present in unpolluted waters
- 3) appear in concentrations that can be correlated with the extent of the contamination
- 4) survive under similar conditions as the pathogens of concern.

The most common indicator organisms are enteric bacteria, such as faecal coliforms and enterococci. These bacteria are excreted in faeces, are usually harmless, and are rarely present in unpolluted waters. Bacteria are much easier to detect than viruses and protozoans, and enumeration methods have been developed for commercial-scale analysis.

Limitations

Bacterial indicators are imperfect measures of the health risks associated with swimming in recreational waters. Limitations associated with the use of bacterial indicators include the following:

- 1) Bacterial indicators demonstrate the presence of faecal material, not necessarily the presence of viable pathogens.
- 2) Analysis of bacterial indicators takes 24 to 48 hours, so it is not possible to know the potential risk at the time of swimming.
- 3) Bacterial indicators vary in their ability to predict potential risks to human health. Some indicators have been shown to have a greater statistical relationship to disease than others.

Australian guidelines

Recreational water quality guidelines provide an indication of the probability of swimmers developing illnesses derived from the water, but the actual risk depends on many factors. These factors include, in particular, the bacterial indicator to pathogen ratio, which varies with time and is usually unknown.

The water quality presented in this report was assessed using the National Health and Medical Research Council's *Australian Guidelines for Recreational Use of Water* (NHMRC 1990). The NHMRC 1990 criteria for the assessment of microbial contamination are presented in Table A1.

Table A1: NHMRC (1990) guidelines used for compliance assessment in the BPP

Marine or estuarine waters are considered unsuitable for swimming if, for five samples taken at regular intervals over a period not exceeding one month:

- the median faecal coliform density exceeds 150 cfu/100 mL; or
- the second-highest faecal coliform density is equal to or greater than 600 cfu/mL; or
- the geometric mean enterococci density exceeds 33 cfu/100 mL.

Note: The guideline for enterococci appears as *Note 1* in the NHMRC (1990) guidelines.

New Australian guidelines

New guidelines for recreational water quality were released by NHMRC in June 2005, and following review in 2006 they were officially released in February 2008 (NHMRC 2008). The guidelines incorporate many of the most recent directives of the World Health Organization's guidelines for recreational waters (WHO 2003). The NHMRC guidelines have also drawn upon aspects of *Catchments for Recreational Water: Conducting and Assessing Sanitary Inspections* (WSAA 2003) and the New Zealand *Microbial Water Quality Guidelines for Marine and Freshwater Recreational Areas* (NZMFE 2002).

Thermotolerant (faecal) coliforms and *E. coli* have traditionally been used to assess the level of contamination of waters from both human and animal faeces. Although it is now widely recognised that *E. coli* are preferable to thermotolerant coliforms (because many members of the latter can grow in the environment), epidemiological studies do not show a clear dose-response relationship between these coliforms and bathers' disease outcomes. In contrast, faecal streptococci and enterococci have shown a clear dose-response relationship to disease outcomes in temperate north European waters (WHO 2003).

The NHMRC 2008 guidelines were adopted by the NSW government in May 2009 at the start of the winter sampling period. Beachwatch has reviewed its monitoring and reporting protocols on the basis of these guidelines and is now using enterococci as the single preferred indicator, as advocated by WHO (2003) and NHMRC (2008).

Data collected over the 2009–2010 summer season by councils participating in the Beachwatch Partnership Program will be assessed under the NHMRC 2008 guidelines. An overview of the new guidelines is provided in Appendix B.

Appendix B

New Recreational Water Quality Guidelines

Introduction

The new National Health and Medical Research Council (NHMRC) *Guidelines for Managing Risks in Recreational Waters* represent a major revision of the previous guidelines by focusing on the assessment and management of hazards to minimise health risks. Under the new guidelines, recreational water quality at swimming sites is no longer reported as percentage compliance based on microbial data, but classified from Very Poor to Very Good using a matrix based on sanitary inspection and microbial assessment categories. This approach provides information on possible sources of pollution and numerical data on the likely level of faecal pollution. It also grades beaches according to their suitability for swimming.

Beachwatch Programs will bring their monitoring and reporting protocols in line with the new national guidelines over the 2009–2010 reporting period and will conduct training for local councils.

Sanitary Inspection

The aim of a sanitary inspection is to identify all sources of faecal contamination which could affect a swimming location and assess the risk to public health posed by these sources. It is a qualitative assessment of bacterial water quality at the site, and should, to some degree, correlate with the bacterial water quality results obtained through sampling.

Through the assessment process, beaches are categorised to reflect the level of risk of exposure to faecal contamination. There are five categories (Very Low, Low, Moderate, High and Very High) which are to be reviewed annually.

The knowledge of the catchment, pollution sources and receiving water processes gained from the sanitary inspection provides beach managers with a good foundation for investigating pollution incidents, prioritising and implementing pollution abatement measures, and providing sound advice to the community on where and when to swim.

Microbial Water Quality Assessment

Faecal indicator bacteria

Quantitative microbial risk assessment using enterococci can be used to estimate indirectly the risk to human health by predicting infection or illness rates for given densities of particular pathogens. Although epidemiological studies do not show a clear dose–response relationship between faecal coliforms and bathers' disease outcomes, enterococci have shown a clear dose–response relationship to disease outcomes in temperate north European waters (WHO 2003).

Under the new NHMRC 2008 guidelines, enterococci are the single, preferred faecal indicator, as advocated by the World Health Organisation (WHO 2003).

Microbial assessment category calculation

The Microbial Assessment Category is determined from the 95th percentile of a dataset of at least 100 enterococci data points. The four categories (A to D) relate to levels of risk of illness in adults undertaking whole-of-body contact in the swimming location being assessed, as determined from

key epidemiological studies (Table B1). NHMRC recommends that Microbial Assessment Categories be calculated from a rolling five year dataset, with at least 20 samples collected each year.

Table B1: Microbial assessment categories (NHMRC 2008)

Category	95 th Percentile of enterococci (cfu/100 mL)	Basis of derivation	Estimation of probability
A	≤40	No illness seen in most epidemiological studies	GI* illness risk <1% AFRI** risk <0.3%
B	41–200	Upper level is above the threshold of illness transmission reported in most studies	GI illness risk >1–5% AFRI risk 0.3 –1.9%
C	201–500	Represents a substantial elevation in the probability of adverse health outcomes	GI illness risk >5 –10% AFRI risk >1.9 –3.9%
D	>500	Above this level there may be a significant risk of high levels of illness transmission	GI illness risk >10% AFRI risk >3.9%

* GI = gastrointestinal

** AFRI = acute febrile respiratory illness

A consideration in determining the Microbial Assessment Category is that the threshold enterococci levels for each of the four categories were determined by the World Health Organisation from a dose-response relationship applied to enterococci data collected at swimming locations across Europe. These threshold levels will represent different probabilities of illness if the distribution of enterococci data from swimming locations in NSW differs from the European distribution. In recognition of this, Dr Richard Lugg (Department of Health, Western Australia) has developed a Microsoft® Excel tool for calculating a modified 95th percentile; it uses a parametric approach and takes into account the distribution of data.

Beach classification

Under the new guidelines, beaches are classified on the outcome of the sanitary inspection and the microbial water quality assessment (Table B2). The beach classification is a long-term assessment of water quality at each swimming location. It is reviewed annually by using rolling datasets including the most recent microbial results, as well as updated information on potential sources of faecal contamination.

Table B2: Classification matrix for faecal pollution of recreational waters (NHMRC 2008)

		Microbial Assessment Category (95 th percentile enterococci cfu/100 mL)			
		A ≤ 40	B 41–200	C 201–500	D >500
Sanitary Inspection Category (susceptibility to faecal contamination)	Very low	Very good	Very good	Follow up	Follow up
	Low	Very good	Good	Follow up	Follow up
	Moderate	Good	Good	Poor	Poor
	High	Good	Fair	Poor	Very poor
	Very High	Follow up	Fair	Poor	Very Poor

The five-level classification for recreational waters ranges from Very Good to Very Poor. There is also a requirement for follow-up where there is potential discrepancy between the results of the microbial water quality assessment and the sanitary inspection. The beach grades provide an indication of the susceptibility of the water body to faecal pollution and guidance to users on the relative suitability for recreation. The classification grades are further defined as:

- **Very Good** – Consistently excellent water quality with very few potential faecal pollution sources. Water is considered safe for swimming at all times.
- **Good** – Generally good water quality with few potential faecal pollution sources. Water is considered safe for swimming most of the time but may be susceptible to pollution after heavy rain.
- **Fair** – Water body is occasionally susceptible to faecal pollution, usually triggered by heavy rainfall. Swimming should be avoided during and following heavy rainfall for one day at ocean beaches and up to three days in harbour swimming sites.
- **Poor** – Water body is susceptible to faecal pollution, particularly after heavy rain. Swimming should be avoided during and after heavy rain and if there are signs of pollution such as discoloured water, fast-flowing or strong-smelling drains, or street litter floating in the water or on the tide line.
- **Very Poor** – Water body is very susceptible to faecal pollution with many potential pollution sources. Water quality results indicate that this location is not suitable for swimming most of the time and should be avoided at all times.

Beach classification also provides the basis for regulatory requirements and assessment of compliance with them. Importantly, information collated for the beach classification feeds into the risk assessment and risk management process.

Appendix C

Further Reading

This section provides additional sources of information on monitoring and assessment of bacteriological water pollution and recreational water quality. The information given here is not comprehensive. The intention is to provide a starting point and to list some of the most recent resources available relating specifically to the Sydney region.

1. Reports and texts

ANZECC (Australian and New Zealand Environment and Conservation Council) (2000). *Core environmental indicators for reporting on the State of the Environment*, ANZECC, Canberra.

(Guideline information for recreational water quality indicators)

Apte, S. C., Batley, G. E. and Ashbolt, N. J. (1993). *Rapid Detection of Faecal Coliforms in Coastal Waters*. Australian Water and Wastewater Association 15th Federal Convention 18–23 April 1993, Technical Papers Vol. 2.

(Research and development – monitoring faecal coliforms in marine waters – rapid assessment for early warning)

Ashbolt, N. J. (1995). Health-related water microbiology: Australia leads: But where next? *Water Journal*, Vol. 22 No. 2 May/June 1995, Australian Water and Wastewater Association, Sydney.

(Discussion on research and development for recreational and drinking water quality indicators and guidelines – includes alternative health-related indicators)

Ashbolt, N. J., Riedy, C. and Haas, C. N. (1997). *Microbial Health Risk at Sydney's Coastal Bathing Beaches*. Australian Water and Wastewater Association 15th Federal Convention 16–21 March 1997 Vol. 2, pp. 104–111.

(Microbial quantitative risk assessment at Sydney's urban coastal beaches using historical microbial data – models used to estimate exposure to pathogenic bacteria, protozoa and a model virus – enteric viruses pose the highest risk to bathers at Sydney ocean beaches)

Australian Water Technologies (1993). *Long Term Beach Water Quality Reporting Series – Reports 1–8*. Water Board, Sydney.

Report 1–Sampling Strategies and Methods of Analysis 1965–1992

(Summary of bacteriological data held by AWT for the period 1965–1992 from Sydney and Illawarra regions.)

Report 2–Assessment of Water Quality of Sydney's Metropolitan Beaches

(Beach water quality for the period 1969–1991 for Sydney beaches – assessments are based on appropriate bacteriological water quality guidelines – likely pollution sources are discussed.)

Report 3–*Trends in Densities of Faecal Coliforms at Seven Target Beaches in Sydney*
(Examination of trends in faecal coliform levels at seven Sydney beaches between 1969 and 1991 – comparisons are made between pre- and post-deepwater ocean outfall commissioning bacterial counts.)

Report 4–*Assessment of Water Quality of Beaches in the Illawarra Region*
(Review of current water quality of Illawarra beaches)

Report 5–*Spatial and Temporal Variations in Bacterial Densities at Selected Sydney Beaches*
(Determination of the major sources of variation associated with faecal coliform sampling.)

Report 6–*The Influence of Some Environmental Factors on Densities of Faecal Coliforms at Fourteen Sydney Beaches*
(Twenty-four-hour rainfall, hours of sunshine, wind direction and speed and tide are examined for influence on faecal coliform counts.)

Report 7–*Trends in Visual Sewage Pollution and Densities of Faecal Coliform Bacteria and their Use as Indicators of Bathing Water Quality at 14 Sydney Beaches*
(Visual sewage pollution between the years 1969 and 1990 – associations between faecal coliform counts and visual sewage pollution indicators.)

Report 8–*Trends in the Concentration of Grease at 13 Sydney Beaches*

Australian Water Technologies, Sydney Water, NSW Environment Protection Authority (2000). *Offshore Sediment Program 2000: Report – Final*, AWT, Sydney.

Bartram, J., Rees, G. (2000). *Monitoring Bathing Waters: A Practical Guide to the Design and Implementation of Assessments and Pilot monitoring programs*. European Commission, World Health Organization, and United States Environmental Protection Agency, E & F Spon, London.

(European guide to developing a recreational water quality monitoring program)

Beachwatch (1995). *Beachwatch Winter Season 1994*. EPA (NSW), Sydney.

(Bacterial monitoring results for Sydney ocean beaches, Winter 1994 – visible sewage pollution indicators – correlation study between faecal coliforms and rainfall for ocean beaches)

Beachwatch (1995). *Beachwatch 1995 Season Report*. EPA (NSW), Sydney.

(Bacterial monitoring results for Sydney ocean beaches, Summer 1994–1995 – visible sewage and stormwater pollution indicators – correlation between visible indicators and bacteria – correlations between rainfall and bacteria – effluent and plume distribution study from Cronulla and Warriewood shoreline outfalls)

Beachwatch (1996). *Harbourwatch 1995 Season Report*. EPA (NSW), Sydney.

(Bacterial monitoring results for Sydney Harbour, Botany Bay, Georges River and Port Hacking beaches, Summer 1994–1995 – background to Harbourwatch program – pollution in Sydney Harbour – factors affecting water quality in Sydney Harbour)

Beachwatch (1996). *Beachwatch and Harbourwatch 1996 Season Report*. EPA (NSW), Sydney.

(Bacterial monitoring results for Sydney ocean, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking beaches, Summer 1995–1996 – changes to Bulletin criteria – impact of drains on flagged areas – sediment bag monitoring of faecal coliforms – Secchi disk – community expectations of Beachwatch)

Beachwatch (1997). *Beachwatch and Harbourwatch 1997 Season Report*. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – communications initiatives – microbiological quality assurance program – post-rainfall recovery study.

Beachwatch (1998). *Beachwatch and Harbourwatch 1997–1998 State of the Beaches*. Sydney, Hunter, Illawarra. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – communications initiatives – microbiological quality assurance program – post-rainfall recovery study – Olympic study)

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Beachwatch (2000). *Beachwatch and Harbourwatch 1999–2000 State of the Beaches*. Sydney, Hunter, Illawarra. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – microbiological quality assurance program – effect of rainfall on Sydney beach compliance – post-rainfall recovery study – Olympic study)

Beachwatch (2001). *Beachwatch and Harbourwatch 2000–2001 State of the Beaches*. Sydney, Hunter, Illawarra. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – microbiological quality assurance program – Beachwatch on the Web – effect of rainfall on Sydney beach compliance – post-rainfall recovery study – Olympic study)

Beachwatch (2002). *Beachwatch and Harbourwatch 2001–2002 State of the Beaches*. Sydney, Hunter, Illawarra. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – microbiological quality assurance program)

Beachwatch (2003). *Beachwatch and Harbourwatch 2002–2003 State of the Beaches*. Sydney, Hunter, Illawarra. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – microbiological quality assurance program)

Beachwatch (2004). *Beachwatch and Harbourwatch 2003–2004 State of the Beaches*. Sydney, Hunter, Illawarra. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – microbiological quality assurance program)

Beachwatch (2005). *Beachwatch and Harbourwatch 2004–2005 State of the Beaches*. Sydney, Hunter, Illawarra. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – microbiological quality assurance program)

Beachwatch (2006). *Beachwatch and Harbourwatch 2005–2006 State of the Beaches*. Sydney, Hunter, Illawarra. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – microbiological quality assurance program)

Beachwatch (2007). *Beachwatch and Harbourwatch 2006–2007 State of the Beaches*. Sydney, Hunter, Illawarra. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – microbiological quality assurance program)

Beachwatch (2008). *Beachwatch and Harbourwatch 2007–2008 State of the Beaches*. Sydney, Hunter, Illawarra. EPA (NSW), Sydney.

(Bacterial monitoring of Sydney, Hunter and Illawarra ocean beaches, Sydney Harbour, Pittwater, Botany Bay, Georges River and Port Hacking – microbiological quality assurance program)

Guest, C., Douglas, R. and Woodruff, R. (1999) *Health and the Environment*. Australian Conservation Foundation, Australian Medical Association, Fitzroy, Vic.

(Public Health – Environmental Health – Environmental Study – Health Planning, Australia)

Healthy Rivers Commission (2000). *Independent Inquiry into the Georges River – Botany Bay System*. HRC, Sydney.

(Analysis and assessment of water quality of Georges River – Botany Bay catchment health)

Healthy Rivers Commission (2000). *Securing Healthy Coastal Rivers: A Strategic Perspective*. HRC, Sydney.

Healthy Rivers Commission (2002). *Independent Inquiry into Coastal Lakes*. HRC, Sydney.

(Analysis and assessment of water quality of NSW Coastal Lake health)

Leeming, R., Nichols, P. D. and Ashbolt, N. J. (CSIRO Division of Marine Research) (1998). *Distinguishing Sources of Faecal Pollution in Australian Inland and Coastal Waters using Sterol Biomarkers and Microbial Faecal Indicators*. Urban Research Association Australia, Melbourne.

Legge-Wilkinson, M. (1996). *Human Impact on Australian Beaches*. Surfrider Foundation Australia Limited, Sydney.

(Analysis of results from the SOS95 Beach Questionnaire organised by Surfrider Foundation Australia, which documented and assessed human impacts on beaches around Australia)

National Health and Medical Research Council (2008) *Guidelines for Managing Risks in Recreational Waters*, Canberra.

NSW Environment Protection Authority (1996). *Sydney Deep Water Outfalls Environmental Monitoring Program: Final Report Series Volumes 1–7*. EPA (NSW), Sydney.

(Provides background information, overall assessment and results of the Sydney Deep Ocean Outfalls program)

Raffensperger, C. and Tickner, J. A. (1999) *Protecting Public Health and the Environment: Implementing the Precautionary Principle*, Island Press, Washington

(Precautionary principle – environment protection – government policy, United States – health risk assessment)

Roberts, E. R. (2000). *Water Quality Control Handbook*, McGraw-Hill. New York.

Short, A. D. (1993). *Beaches of the New South Wales Coast – a Guide to their Nature, Characteristics, Surf and Safety*. Australian Beach Safety Management Program, Sydney.

(Comprehensive guide to NSW beaches – Includes beach dynamics, rip profiles, surf characteristics, Surf Life Saving Club information, surf rescue and water safety)

Water EcoScience Pty Ltd: Urban Research Association of Australia (1999). *Alternative Microbiological Indicators of Water Quality*. Urban Water Research Association Australia, Melbourne.

Waterways Authority (2000). *Sewage Pollution from Vessels Discussion Paper – Findings and Proposed Actions*. Waterways Authority, Sydney.

(Outlines current situation, legislation – boat populations – infrastructure – other jurisdictions – key findings – public health – environment – pump-out facilities – monitoring, compliance and education – proposed actions)

Wong, T. H. F., Breen, P. F., Somes D. and Nicholas, L. G. (1999). *Managing Urban Stormwater using Constructed Wetlands*. Cooperative Research Centre for Catchment Hydrology and Monash University, Department of Civil Engineering, Monash University, Victoria.

2. Internet Sites

www.begavalley.nsw.gov.au – Bega Valley Shire Council (accessed 03 July 2009)

www.ballina.nsw.gov.au – Ballina Shire Council (accessed 03 July 2009)

www.clarence.nsw.gov.au – Clarence Valley Shire Council (accessed 03 July 2009)

www.environment.nsw.gov.au – Department of Environment and Climate Change (NSW)
(accessed 03 July 2009)

(Information regarding environmental legislation, programs, and other environmental information. Links to other sites relating to the environment.)

www.environment.nsw.gov.au/beach/BWPilot.htm – Beachwatch Partnership Pilot Program Overview (accessed 03 July 2009)

(Access to Beachwatch Partnership Pilot Program resources and information)

www.environment.nsw.gov.au/beach – Beachwatch (accessed 03 July 2009)

(Summary of Beachwatch and Harbourwatch programs, state of the beaches, pollution causes, health information and links to other relevant sites.)

www.environment.nsw.gov.au/stormwater (accessed 03 July 2009)

(Describes the urban stormwater program and stormwater treatment devices as well as Stormwater Trust applications and conditions of funding.)

www.environment.gov.au – Environment Australia (accessed 03 July 2009)

(This Federal Government environment site provides information on national environmental issues, programs, legislation, policy and new initiatives for environmental management.)

www.esc.nsw.gov.au – Eurobodalla Shire Council (accessed 03 July 2009)

www.dpi.nsw.gov.au/fisheries – NSW Fisheries (accessed 03 July 2009)

www.gosford.nsw.gov.au - Gosford City Council (accessed 03 July 2009)

www.health.nsw.gov.au – NSW Department of Health (accessed 03 July 2009)

(This site contains information on public health issues)

www.nhmrc.gov.au/publications/synopses/eh38.htm – National Health and Medical Research Council (accessed 11 June 2008)

(Health information in relation to recreational water use)

www.hunterwater.com.au – Hunter Water Corporation (accessed 03 July 2009)

(Water quality and sewage treatment/disposal information for the Hunter region)

www.kempsey.nsw.gov.au – Kempsey Shire Council (accessed 03 July 2009)

www.livingthing.net.au – NSW Environment Service Sector (accessed 03 July 2009)

(This site provides a comprehensive listing of environment online information services.)

www.portstephens.nsw.gov.au – Port Stephens Council (accessed 03 July 2009)

www.maritime.nsw.gov.au – NSW Maritime Authority (accessed 03 July 2009)

(Contains information regarding NSW coastal conditions, the Annual Report and a discussion paper on sewage from vessels. Describes pollutant sources for waterways.)

www.mccn.org.au/ – Marine and Coastal Community Network (accessed 03 July 2009)

(Provides information on marine and coastal environmental issues Australia wide. The network promotes information-sharing between community groups, government agencies and industry.)

www.richmondvalley.nsw.gov.au – Richmond Valley Council (accessed 03 July 2009)

www.slsa.asn.au – Surf Lifesaving Australia (accessed 03 July 2009)

(General beach information, surf safety and patrol dates)

www.streamwatch.org.au/ – Streamwatch (accessed 03 July 2009)

(State community water quality and action network)

www.sydneywater.com.au – Sydney Water Corporation (accessed 03 July 2009)

(Water quality and sewage treatment/disposal information for the Sydney – Illawarra region. Introduces 'WaterPlan 21', the Corporation's vision for sustainable wastewater management.)

www.surfrider.org.au – Australian Surfrider Foundation (accessed 03 July 2009)

(Aimed at surfers. Provides information on pressures and issues affecting the coastal environment.)

www.waterwatch.org.au – Waterwatch Australia (accessed 03 July 2009)

(This site contains national information on water quality monitoring and education programs that develop strategies to address water problems.)

www.who.int/water_sanitation_health/bathing/en/index.html – World Health Organization (accessed 03 July 2009)

(International health information in relation to recreational water use)

www.wyongsc.nsw.gov.au – Wyong Shire Council (accessed 03 July 2009).

3. Other sources

A list of the Department's publications is available from the Department's Environment Line on 131 555. Alternatively, the list can be viewed on the Department's internet site at www.environment.nsw.gov.au.

Other sources of information on water quality are State of the Environment reports published by local councils, and the NSW State of the Environment Report, which is published every three years by the Department.

The Department's library holds books, reports and journals relating to most aspects of water quality monitoring and assessment. The library is located on level 15 in Head Office (59–61 Goulburn Street, Sydney) and is open to academics, researchers, postgraduate students, environment groups, council officers and other government employees. An appointment to use the library resources is essential and can be made by calling (02) 9995 5000.

In the Sydney region there are other specialist libraries and information centres that hold information on water quality and related issues. These libraries include the Coastal Environment Centre, the Water Reference Library and the Manly Environment Centre. Government authorities and agencies engaged in water resources management, such as Sydney Water, also have libraries open for research purposes.

References

ANZECC (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. National Water Quality Management Strategy. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra

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Bega Valley Shire Council (2008). *State of the Environment Report 2008*. Bega Valley Shire Council, Bega, NSW. Accessed on 15 June 2009
<http://www.envcomm.act.gov.au/soe/rsoe2008/begavalley/index.shtml>

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Coffs Harbour City Council (2004) *State of the Environment Comprehensive Report 2004*. Coffs Harbour City Council, Coffs Harbour, NSW.

DEC (2004a). *Monitoring and Reporting Coastal Recreational Water Quality: Information Package and Field Manual*. Department of Environment and Conservation (NSW), Sydney.

DEC (2004b). *Beachwatch Partnership Pilot Program State of the Beaches 2002–03*. Department of Environment and Conservation (NSW), Sydney.

DEC (2004c). *Beachwatch Partnership Pilot Program State of the Beaches 2003–04*. Department of Environment and Conservation (NSW), Sydney.

DEC (2006a). *Beachwatch Partnership Program State of the Beaches 2004–05*. Department of Environment and Conservation (NSW), Sydney.

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DECC (2007). *Beachwatch Partnership Program State of the Beaches 2006–07*. Department of Environment and Climate Change (NSW), Sydney.

DECC (2008) *Beachwatch Partnership Program State of the Beaches 2007–08*. Department of Environment and Climate Change (NSW), Sydney.

Eurobodalla Shire Council (2007). *Annual State of the Environment Report*. Eurobodalla Shire Council, Moruya, NSW.

Gosford City Council (2006). *Supplementary State of the Environment Report (Sustainability Report) 2006*. Gosford City Council, Gosford, NSW.

- Kempsey Shire Council (2006). *State of the Environment Supplementary Report 2005–2006*. Kempsey Shire Council, West Kempsey, NSW.
- Newcastle City Council (2008). *State of the Environment 07/08*. Newcastle City Council, Newcastle, NSW.
- NHMRC (1990). *Australian Guidelines for Recreational Use of Water*. Australian Government Publishing Service, Canberra.
- NHMRC (2008). *Guidelines for Managing Risks in Recreational Water*. Australian Government Publishing Service, Canberra.
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- Port Stephens Council (2006). *Supplementary State of the Environment Report 2005–2006*. Port Stephens Council (2006), Raymond Terrace, NSW.
- Richmond Valley Council (2006). *2006 Supplementary State of the Environment Report*. Richmond Valley Council, Casino, NSW.
- Shoalhaven City Council (2003). *State of the Environment Report 2000–2003*. Shoalhaven City Council, Nowra, NSW.
- Tourism Research Australia (2008) *Tourism Profiles for Local Government Areas in Regional Australia*. Tourism Research Australia, Belconnen, ACT.
- WHO (2003). *Guidelines for Safe Recreational Water Environments*. Vol. 1. Coastal and fresh waters. World Health Organization, Geneva.
- WSAA (2003). *Best Practice Environmental Management. Catchments for Recreational Water: Conducting and Assessing Sanitary inspections*. Occasional Paper No. 8 – May 2003. Water Services Association of Australia.
- Wyong Shire Council (2007). *State of the Environment Report 2006/07 – Wyong Shire*. Wyong Shire Council, Wyong, NSW.

Glossary

Algae: Comparatively simple chlorophyll-bearing plants that are capable of photosynthesis. They occur in the aquatic environment and can be microscopic in size.

Algal bloom: Discolouration of the water environment due to a change in species composition and abundance of marine and estuarine microalgae.

Bacteria: See *Enterococci* and *Faecal coliforms*.

Bloom: an unusually large composition and abundance of organisms, usually algae, made up of one or a few species.

Blue-green algae (also referred to as cyanobacteria): A photosynthetic bacterium that can occur in fresh and salt water and can produce substances toxic to animals. The blue-green is due to the presence of phycocyanin pigments. Includes *Anabaena* and *Microcystis* spp. High concentrations affect suitability of water for recreation and potable supplies.

Catchment: The area that drains surface runoff from precipitation into a stream, river and/or tributaries or urban stormwater drainage system.

Colony forming unit (CFU): A microorganism propagule (spore or cell) from which a colony has grown. For purposes of analysis, one CFU represents one viable organism.

Contaminant: A substance, chemical, or microorganism that makes a medium (water) impure, infected, radioactive, or lower in quality.

Contamination: The process by which any physical, chemical or biological substance (usually human-made/anthropogenic) is introduced into the environment.

Compliance, bacteriological: The finding that waters for *primary contact recreation* (see below) contain a lower density of CFUs (see above) than the values set down in guidelines.

Criteria: Standards based on the analysis of scientific data that provide guidelines for the appropriate use of water.

Cyanobacteria: see *Blue-green algae*.

Detection limit: The minimum concentration that can be detected under ideal analytical conditions.

Enterococci: Bacteria of the genus *Enterococcus* that may be used to determine the extent of faecal contamination of recreational waters. The *Enterococcus* group is a sub-group of faecal streptococci. It is differentiated from other faecal streptococci by growth at higher temperatures and salt concentrations in the laboratory, and by the ability to survive in marine waters under conditions that are unfavourable for most other faecal microorganisms.

Estuary: A part-enclosed coastal water body open to the ocean, characterised by tidal effects and the mixing of fresh water and seawater.

Faecal coliforms: Mesophilic bacteria that inhabit the intestines of humans and other warm-blooded animals. Faecal coliforms are abundant in bird and mammal faeces and are used as indicators of sewage pollution in marine and fresh waters. These organisms have relatively short lifespans in marine waters, indicating the presence of relatively recent sewage contamination.

Freshwater: Water with a low concentration of dissolved salts (salinity less than 0.5 parts per thousand).

Indicator microorganisms: Bacteria (generally faecal coliforms and/or enterococci) that indicate the relative degree of faecal contamination in waterways. Indicators are generally used to monitor recreational water quality, because searching for specific microorganisms that cause disease, such as viruses, is both difficult and costly.

Influent: Wastewater entering a sewage treatment plant.

Median: The middle point in a set of data. Defined as the number relative to which half of the scores are greater and half of the scores are lower.

Pathogens: Disease-causing organisms such as bacteria, viruses and fungi, which can cause diseases in plants and animals. Pathogens can be present in high concentrations in municipal sewage and industrial and other type of discharges.

Percentile (e.g. 80th): Within a sample set of five samples, the value below which four of the five values (i.e. 80 per cent) used to calculate the median (see above), fall.

Plume: A stream of water containing a high concentration of suspended materials and/or *pollutants* (see below) entering a water body.

Pollutants: Chemicals, biological substances, particles, or thermal changes that are discharged into bodies of water and are potentially detrimental to the environment.

Primary contact recreation: Recreational use of waters that involves bodily immersion or submersion, facilitating direct contact with water; includes activities such as swimming, diving, water skiing and surfing.

Primary sewage treatment: The physical treatment of sewage, designed to remove solids (sludge) via settling floatable solids such as oil, fats and grease by first screening and then ponding the effluent.

Quality assurance/quality control (QA/QC): Procedures and checks used to ensure that accurate and reliable results are obtained from environmental sampling and analysis.

Secondary contact recreation: Recreational use of waters that involves some direct contact with water but is associated with a low probability of swallowing water. Includes activities such as paddling, wading, boating and fishing.

Secondary sewage treatment: Biological and/or chemical treatment of sewage designed to remove the majority of organic matter and solids through several possible processes by using anaerobic bacteria, chemicals and settling ponds.

Sewage treatment plant (STP): The site of convergence and treatment of household, commercial and industrial sewage via the sewerage system. Sewage is treated at an STP to either primary, secondary, or tertiary level before being discharged as effluent to receiving waters.

Tidal flushing: The process by which water in an estuary is replaced with oceanic water as a result of the flow of water caused by the tides.

Toxicant: An agent or material capable of producing an adverse response in a biological system, seriously injuring structure or function, or resulting in death.

Wastewater management systems: Systems designed for the treatment of domestic wastewater in a septic environment, used generally in residential settings.

Water quality: The characteristics of water in regard to its physical, chemical and biological properties.