Recreational Water Quality Objectives and Standards: Phase I – data collection, presentation and recommendations

R&D Technical Report P2-253/TR

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Website: www.environment-agency.gov.uk

ISBN: 1857056639

Dissemination Status:
Internal - Released to Regions
External – released to Public Domain

Statement of Use:
The information and recommendations contained in this report will be considered by the Agency used to inform and guide policy in the future development of recreational water quality objectives and standards.

Keywords:
Recreational water use areas, public health, legislation, guidelines, standards, watersports, classification schemes.

Research Contractor:
This document was produced under R&D Project no. P2-253 by:
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Website: http://www.eihms.surrey.ac.uk/robens/env/rcpeh.htm

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EXECUTIVE SUMMARY

Surface and coastal waters are used for a variety of recreational activities involving varying degrees of contact with the water. The beneficial effects of water and its recreational use have been long recognised. However, individuals using water for recreational purposes also expose themselves to a variety of health hazards. These include accidents such as drowning and spinal injury; poor microbiological quality of the water resulting from sewage discharges and agricultural runoff; and naturally occurring hazards such as leptospirosis and toxic cyanobacteria. Leisure activities, including water-based recreation are likely to increase and the effects of the health hazards that recreational water users face will probably gain more prominence in the future. Those responsible for monitoring and regulating the quality of recreational water use areas are liable to face increasingly complex challenges in the future as the number of users increase and the recreational uses diversify.

Recreational bathing water quality in the UK has been regulated by the European Community Bathing Waters Directive since 1976. Since the drafting of this legislation, and many of the standards adopted throughout the World, considerable research has been undertaken to investigate the health effects associated with bathing in recreational waters. In recent years, with the availability of wet suits, the behaviour of users has changed and coastal and inland waters are used year-round for a variety of activities such as surfing and diving involving prolonged immersion in the water.

It is now recognised globally that recreational water standards need updating to reflect the new scientific knowledge that has emerged, the change in behaviour of users and their expectations towards their quality of life. This report aims to identify a set of objective criteria with which to categorise waters according to use, measure trends and changes and ensure that uses are adequately protected.

A review of global recreational water standards show the inconsistencies in parameters measured and standards not only between countries but also within countries. Compliance with standards is generally based on microbiological quality of the water body. Physical, chemical and aesthetic parameters are identified but are generally not considered in compliance. However, aesthetic parameters will become particularly pertinent where the use of the recreational water use area is ‘passive’ such as picnicking, walking, horse-riding etc.

Very few previous attempts have been made globally to classify water according to use. It is apparent that accurate figures for the scale of participation in various watersports do not exist and at present there is no formal system for collecting this data. A classification system based on use the levels of participation needs to be established.

A suitable set of health-related criteria which could be used to categorise waters based on the health risks to users must be identified. Despite the achievements that have been made in research into the health effects of swimming in sewage contaminated marine waters very few epidemiological investigations have been conducted into health effects of watersports other than swimming in marine waters. Currently there is insufficient epidemiological data to identify health-related standards for other activities in marine waters or for feshwaters. Behavioural patterns of recreational

water users are not well known, in particular time spent in the water and the volume of water ingested, which will directly influence the degree of contact with infectious and toxic agents, and other potential hazards - physical, chemical and aesthetic found in recreational water.

ACKNOWLEDGEMENTS

The author would like to thank Dr Steve Pedley and Dr Gareth Rees, Robens Centre for Public and Environmental Health for assisting in the final review of this report and the following for providing information: Mr Richard Lugg, Dr Graham Mcbride, Dr Alfred Dufour, Dr Jamie Bartram, Mr Tim Turner and Mr Peter Cornell.

CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

In the UK it is estimated that over 20 million people use the British coast each year, in addition to inland waters and their surrounding areas, for a variety of activities. The National Centre for Social Research (1998) reported there were 241 million day visits to the sea/coast in Great Britain in 1998, with people prepared to travel an average of 43 miles to reach the coast.

The growth of sports which involve intimate contact with the water such as surfing, windsurfing and scuba diving and the use of wet suits which allow prolonged immersion in water, emphasise the need for standards that adequately protect the health of recreational water users. In addition to immersion sports many people use recreational water use areas for non-contact sports such as walking, horse-riding and picnicking. The well-being associated with the recreational use of water (i.e. mental relaxation, fresh air, physical exercise etc) and the economic implications associated with recreational waters emphasise the importance of both bacteriological and aesthetic water quality.

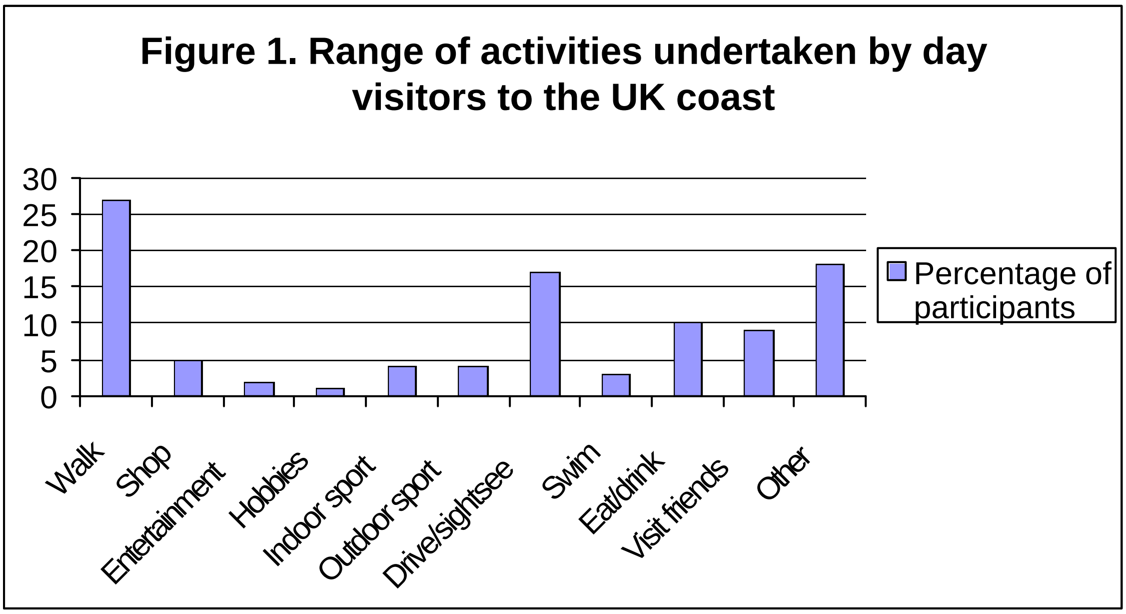
The quality of recreational bathing waters in the UK is currently defined under the EC Bathing Waters Directive (76/160/EEC; CEC, 1976). This Directive is applicable to all designated bathing waters and the standards do not distinguish between fresh or marine waters. Other legislation such as the Freshwater Fisheries Directive and the Urban Waste Water Treatment Directive also impact on recreational water users. In recent years much attention has been focused on the health implications of the recreational use of water and globally standards and guidelines are being revised. It is recognised that a harmonised approach to risk analysis and risk management is needed to overcome the limitations in the current approaches to the regulation of hazards in recreational waters which better reflects the health risks and provides greater scope for management intervention.

Present regulatory schemes for recreational waters focus on microbiological quality and are aimed at the protection primarily of bathers. The UK Environment Agency recognises that recreational waters are used for a variety of activities and that there is a need to have a set of objective criteria with which to categorise waters according to use, measure trends and changes and ensure that uses are adequately protected by limits in authorisations.

The objective of the current report is to review existing or proposed water quality standards which may form the basis for the derivation of a set of standards, which could be used to classify or categorise waters according to their recreational use.

2. SCALE AND FREQUENCY OF USE OF RECREATIONAL WATER BODIES IN ENGLAND AND WALES

Coastal and freshwaters are highly valued as recreational resources and are widely utilised for a range of activities. Demand for the UK coast as a leisure resource has been increasing at about 7% per year during the mid 1990's (The Countryside Agency, 2000). The range of uses made of the coast by UK day visitors is shown in Figure 1.



Source: The Countryside Agency, 2000

In addition to coastal areas lakes and rivers are highly valued for sport and relaxation. The numbers of people who wish to gain access to rivers and lakes for these activities is increasing (Environment Agency, 1999).

The US Environmental Protection Agency (US EPA) have identified two classes of recreation – primary (activities where people engage in activities that could result in the ingestion of water or immersion – swimming, kayaking, water skiing etc) and secondary (those activities where the majority of participants would have very little direct contact with the water and where ingestion of water is unlikely, such as wading, canoeing, motor boating, fishing etc.). World Health Organisation (WHO) (WHO, 1998) have identified four classes of recreational usage of water environments:

- No contact – where the enjoyment is of aesthetic beauty of the water environment. There is normally no contact with water, and the water is incidental enjoyment of the activity. These include walking, horse-riding, bicycling, angling, picnicking etc.

- Incidental/ Limited contact – such as boating, rowing or fishing

- Meaningful direct contact that involved negligible risk of swallowing water, e.g. wading, surfing and windsurfing

- Extensive direct contact with full body immersion and a meaningful risk of swallowing water, e.g. swimming, scuba diving. Children are likely to appear in this group as they play for long periods of time in recreational waters and are considered to be more likely to swallow (or even intentionally drink) recreational water.

There are 551 designated coastal bathing areas in the UK and 11 designated freshwater sites. In England and Wales there are approximately 40,000 Km of rivers (Environment Agency, 1999) and of those about 5090Kms are fully navigable inland waters (DETR, 2000). Almost all of the waterways system in the UK is used for leisure – including boating, angling and informal recreation. It is estimated that 165 million visits are made to British Waterways canals and rivers annually. There are around 100,000 licensed boats on the waterways and a further 3000 during holiday periods (DETR, 2000). The recreational use of towpaths and other waterside paths has also increased in the last 20 years by walkers, horse-riders, birdwatchers and cyclists.

Despite the perception of the popularity of watersports there is a lack of information regarding the precise scale of use of recreational water bodies and the actual numbers of people participating in the various activities. Telephone enquiries to a number of national organisations such as Sport England, Royal Society for the Prevention of Accidents (RoSPA) and governing bodies of sports revealed very limited information. Governing bodies of sports maintain information on membership numbers but these are severe underestimates since many people undertake watersports on a casual basis. RoSPA are initiating research into the scale of use, primarily with the aim of establishing the number of accidents that occur in inland waters (P. Cornell, Head of Water Safety, RoSPA, personal communication, 2001). The European Commission was unaware of any organisation that collects data on the number of bathers using coastal or freshwater areas.

Surfers Against Sewage have compiled a table of watersports undertaken at a variety of undesignated bathing areas (Appendix 1). However, this does not include the quantities of people undertaking the sport or the length of contact with the water.

A report by WRc in 1990 (National Rivers Authority, 1990) attempted to estimate the length of time devoted to a variety of activities in two unnamed leisure parks in the UK over a single day. The results are shown in Table 1.

Table 1 Man-hours devoted to the various recreational activities on the lakes at two leisure parks on May 27 1990 (Source: National Rivers Authority, 1990a)

Activity	**Leisure park 1**		**Leisure park 2**	
	Lake D	**Lake E**	**Lake F**	**Lake G**
Boating	0	37	440	65
Wind-surfing	0	5	0	37
Canoeing	81	4	53	9
Bathing and paddling	1	3	7	0
Total (hours)	82	49	499	111

Angling

The National Federation of Anglers maintain figures for the number of angling clubs and members but do not keep records of the number of visits to water bodies although it is estimated that an angler will, on average make 10 fishing outings per year. In 1990 there were 534 angling clubs in the UK with 285,000 members; in 1999 368 clubs were registered with an average of 364 members per club.

In order to fish for salmon, trout, freshwater fish or eels in England and Wales persons over the age of 12 years must have an Environment Agency Rod Fishing Licence. Between April 2000 and March 2001 the Environment Agency sold 1.1 million licences (Environment Agency, 2000a). However, this is thought to be a severe underestimate of the number of actual anglers thought to be active in England and Wales. The actual figure is thought to be nearer to 4 million.

Scuba Diving

The British Sub Aqua Club (BSAC) was able to provide figures for membership of their clubs: Figures give membership at each year end. 'Guesstimates' only are available until 1965, after which precise records were kept.

1953	Formed	1960	5,000	1965	6,813
1966	7,979	1967	8,350	1968	9,241
1969	11,299	1970	13,721	1971	14,898
1972	17,041	1973	19,332	1974	22,150
1975	23,204	1976	25,310	1977	25,342
1978	27,510	1979	30,579	1980	24,900
1981	27,834	1982	29,590	1983	32,177
1984	32,950	1985	34,861	1986	34,210
1987	34,500	1988	32,960	1989	34,422
1990	36,434	1991	43,475	1992	47,192
1993	50,356	1994	51,156	1995	52,247
1996	51,460	1997	51,112	1998	50,121
1999	44,501	2000	44,332		

In the absence of any single authority able to provide accurate figures, BSAC estimates that the total 'UK sports diving population' to be in the order of 200,000, many of whom are former BSAC members who now dive privately with friends and not as members of a club or association. BSAC is the largest representative diving club in UK.

It is very difficult to provide an estimate of the global population of divers. No single authority is publishing figures. The following are estimates of the number of active divers world-wide, based on the very limited amount of factual information available.

Great Britain	200,000	Europe	1,000,000
Middle East	100,000	Far East	1,500,000
Americas	2,500,000	African Continent	150,000
Australasia	600,000		

(The British Sub-Aqua Club personal communication, 2001)

Numbers of person participating in watersports in the United States

The statistical abstract of the United States (1997) estimated the numbers of persons participating in selected sports activities based on a survey of 15,000 households. Those related to water are given below: however, there is no indication as to whether swimming activities are in a swimming pool or open water (Table 2).

Table 2. Participation in selected sports activities, USA 1995

Activity	Total	Sex		Age						
		Male	Fe-male	7-11	12-17	18-24	25-34	35-44	45-54	55-64
Swimming	61,531	28,944	32,587	11,255	10,098	6,880	10,809	10,905	5,172	3,110
Fishing Freshwater	39,262	26,444	12,838	4,621	4,363	4,430	7,961	7,782	4,919	2,703
Fishing Marine	10,717	7,685	3,032	687	1,059	1,189	2,152	2,268	1,686	819

Source: Statistical Abstract of the United States 1997.

Individual watersport centres would perhaps be expected to have accurate figures for bodies of water where participants pay to enter the site. The Holme Pierrepont National Watersports Centre was contacted. They pointed out that figures are kept for people undertaking 'taster' sessions for various sports but no figures are kept for 'casual' users who constitute a significant proportion of people using the centre.

Gammie and Wyn-Jones (1997) conducted an investigation into the health risks posed by hepatitis A to surfers and windsurfers in the UK. Within this study participants were asked to provide information on the frequency of windsurfing and number of locations windsurfed per annum. The results showed that the number of locations surfed per annum varied between 2 and 55 with a mean of 9 and a median of 6. The number of locations windsurfed per annum varied from a minimum of 2 to a maximum of 50 with a mean of 15 and a median of 13.

It is clear that different types of activities involve different levels of contact with water and different duration of time in which contact with the water is made. This will influence the level of risks to human health from exposure to pollution and therefore influence the drafting of standards. It is recommended that accurate information on the intensity of participation in different activities is gathered in order to quantitatively or qualitatively assess the risks faced by participants.

In addition to the different water qualities required by different users, there are other needs of the various users which should also be taken into account. There are often competing uses of a water body for different activities – different uses may require specific characteristics and standards. For example, canoeists may require the following: a river, lake or reservoir with the physical characteristics that enable a canoe to pass along it; the permission of the owner of the water, unless there are public rights of navigation; points on the bank which enable them to launch and land safely; access to public road and parking facilities and permission to carry canoes across the land between their transport and water. A body of water used by canoeists may also be used by anglers who, as well as requiring easy access, require permission to fish and security of tenure. They will also require undisturbed fish, an area which is undisturbed by non-authorised users and maintenance of the quality of the aquatic environment.

3. PUBLIC HEALTH IMPLICATIONS OF THE USE OF WATER FOR RECREATIONAL PURPOSES

The hazards that are encountered in recreational water environments vary from site to site as does the nature and extent of exposure and type of activity. Most available information relates to health outcomes arising from exposure through swimming and ingestion of contaminated water. Recreational waters generally contain a mixture of pathogenic and non-pathogenic microbes. These microbes may be derived from sewage effluents, the recreational population using the water, livestock, industrial processes, farming activities and wildlife; and in addition indigenous pathogenic micro-organisms. Bathers are at risk when an infective dose of a organism colonizes a suitable growth site in the body and leads to disease. These sites are typically the alimentary canal, eyes, ears, nasal cavity and upper respiratory site.

The dose required to infect 50% of individuals (ID_{50}) depends upon the specific pathogen, the form in which it is in when encountered, the conditions of exposure and the hosts' susceptibility and immune status. The dose required to initiate an infection may be very few viable units especially where viral and parasitic protozoan illness are concerned (Fewtrell *et al.,* 1993; Okhuysen *et al.,* 1999), e.g. hepatitis A or cryptosporidium. In reality recreational water users rarely experience a single isolated encounter with a pathogen, and the effects of multiple and simultaneous exposures to pathogens are poorly understood (Esrey *et al.*, 1985).

Recreational water users are exposed to other risks as well as poor microbiological quality of the water: accidents and physical hazards (leading for example to drowning or injury); exposure to heat and sunlight; contamination of beach sand or sediment; exposure to algae and their products; naturally-occurring hazards such as leptospirosis, dangerous aquatic organisms and chemical contamination (WHO, 1998). The level of risk posed by these hazards varies with location and the type of activity undertaken.

3.1 Recreational Water Risk Assessment

In order to assess the level of risk posed by a water body to recreational users, the varied nature of the hazards to human health and well-being presented by the use of the recreational water should be assessed. A full audit of the relative importance of the resultant health effects and the resources required to mitigate those effects should be undertaken.

Quantitative microbiological risk assessment (QMRA) can be useful in determining the risk of infection from the use of recreational water. In its simplest form, it consists of four steps: hazard assessment, exposure assessment; dose-response analysis and risk characterisation.

The main constraint to using this approach for recreational waters is that currently data are lacking on the level of ingestion of recreational water, and levels may vary significantly between different groups of users. This approach is still in its infancy but can potentially be used to reinforce epidemiological evidence suggesting disease transmission is possible at recreational water use areas where water quality would have traditionally passed historical water standards (WHO, 2001).

3.1.1 Degree of water contact and factors affecting the degree of bather infection

A significant uncertainty in recreational water risk assessment is the actual exposure level associated with inhalation, ingestion and skin contact with contaminated water and the corresponding level of illness that users experience. Although the frequency of illness or infections can be assessed through epidemiological studies, the factors that contribute to these adverse effects – other than entering the water – are not well documented. The degree of water contact directly influences the degree of contact with infectious disease, toxic agents and other potential hazards found in recreational waters and therefore the likelihood of contracting illness and the severity of symptoms.

Behavioural patterns of recreational water users, such as the time spent in the water and the volume of water swallowed, have not been well-defined. Estimates of the quantity of water ingested during typical swimming episodes are scarce. Streeter in 1951 attempted to develop a bather risk factor (Streeter, 1951). To do this he used the coliform-Salmonella ratio developed by Kehr and Butterfield (1943), the number of bathers exposed, the approximate volume of water ingested per day per bather and the average coliform density per ml of bathing water. More recent research has developed this approach further and the relationship between the level of indicator species and the burden of disease has been used to derive the WHO Guideline values for microbiological quality of marine recreational waters (WHO, 1998). This is further discussed in section 4.2.

The US EPA estimate 100 ml of water enters the mouth and nasopharynx during a typical swimming episode (EPA, 1999). WHO (2001, page 14) assumes 20-50 ml of water per hour of swimming. A review of the literature did not reveal any published estimates of the quantities of water ingested during other activities.

Skin abrasions or cuts may also contribute to user-associated infections, but are rarely documented. The personal hygiene of recreational water users while in the water (which may also significantly alter the quality of the water) is also poorly documented. The density of users (bather load) at smaller recreational water bodies may be a significant factor in the user-to-user transmission of disease. In addition, certain characteristics of the water body and activity may predispose the users to be at risk from hazards other than microbiological, such as physical hazards and naturally occurring hazards such as leptospirosis. These will be discussed in section 5.

3.1.2 Risk reduction and rationale for classifying waters according to use

The overall basis for a risk reduction strategy could depend on broad classifications of recreational activities, according to the degree of contact with water. This is because water contact is the prime factor influencing hazard types likely to be encountered by water users. The degree of water contact directly influences the degree of contact with infectious disease, some physical hazards and toxic agents found in contaminated water and therefore the likelihood of contracting illness and the severity of the symptoms experienced. The WHO attempted to identify the hazards associated with activities linked with recreational water use by classifying them into levels of contact (WHO, 1998; adapted in Table 3). The levels of contact are largely based on those defined by the National Technical Advisory Committee to the Secretary of the Interior (1968) and of those recommended by Pike and Gale (1992).

Table 3. Hazards associated with recreational water use

Activity and level of contact	Hazards
Non-contact recreation – where there is normally no contact with water, but where water is incidental enjoyment of the activity.	
Boating under power (1,2,4,5)	1. Falling-in, drowning
Picnics (1,2,4,5)	2. Leptospirosis (freshwater)
Walking (1,4,5)	3. Sunburn, erythema, sunstroke, skin cancer
Sun-bathing (3,5)	4. Aesthetic revulsion, including odour
Bird-watching (2,4,5)	5. Bites from mosquitoes and other vectors
Incidental contact recreation – where the limbs are regularly wetted and greater contact is unusual	
Rowing, sailing, canoe touring (1,2,3,5)	1. Falling in, drowning
Paddling, adults (1-8)	2. Leptospirosis (freshwater)
Angling (1,2,9,10)	3. Cyanobacterial toxicoses (freshwater)
	4. Injury (treading in broken glass etc)
	5. Sunburn, sunstroke, skin cancer
	6. Stings of weaver fish (seashore)
	7. Swimmers itch (schistosomiasis, freshwater ponds)
	8. Infection from beach sand through skin infections
	9.Aesthetic revulsion
	10. Infection following skin injury and repeated exposure to water
Whole body contact recreation – where the whole body, or the face frequently wetted by spray and where it is likely that water will be swallowed	
Sub-aqua diving (1-8, 10)	1. Drowning
Long distance swimming (1-7, 9,10, 12)	2. Waterborne infections*
Surfing (1-3, 6,7,10, 12)	3. Water-washed infections**
Water skiing (1-10, 12)	4. Leptospirosis (freshwater)
Rafting (1-3, 6-8)	5. Cyanobacterial toxicoses (freshwater)
Bathing (1-12)	6. Impact injury
Windsurfing (sailboarding) (1-8, 10, 12)	7. Injury to skin e.g. treading on broken glass
Children's exploratory activities (1-9, 11, 12)	8. Collision with, entrapment by wrecks, piers, weirs, sluices and underwater obstructions
Paddling by young children (1-5, 7, 9, 11, 12)	9. Stings of weaver fish, jellyfish, sting rays
	10. Attack by marine animals e.g. Moray eels
	11. Swimmers itch (schistosomiasis, freshwater)
	12. Sunburn, sunstroke, skin cancer

Numbers in parenthesis refer to numbered hazards – column 2

*Infections caused by pathogens derived from faecal pollution (typhoid and paratyphoid fevers, shigellosis, infectious hepatitis, pharingconjunctival fever, gastroenteritis, cryptosporidiosis; **Infections caused by water interfering with the body's natural defences and washing opportunist pathogens from the skin and other body surfaces onto sensitive sites, e.g.s outer ear infections, conjunctivitis, some fungal and other skin infections.

(Adapted from WHO, 1998).

For each type of activity more than one hazard will be encountered. In some cases the risk will be from the microbiological quality of the water, but in other cases physical, chemical, aesthetic or other issues may be more important. Measures for risk reduction will therefore need to be tailor-made to each activity and circumstance. Use management is clearly an important factor in the protection of health of recreational water users. Any health-related standards system that is proposed must relate to a notion of 'acceptable' risk (Wyer *et al.*, 1999) or 'tolerable risk'. Whilst the definition of 'acceptable' health risk or 'tolerable' health risk is a socially negotiated decision, epidemiological studies carried out in the field of recreational use of water help to provide a quantification of risks associated with bathing or other activities in recreational waters. Of the epidemiological studies that have been conducted into health effects of recreational use of water – the primary focus has been on *swimming*-associated illness. These studies have been carried out to: (1) determine which symptoms or illnesses swimmers are at a higher risk for relative to non-swimmers; (2) quantify the magnitude of any increase in risk; (3) establish a mathematical relationship between various bacteriological indicators of sewage pollution with increased illness among swimmers. This is a pre-requisite to establishing standards based on a dose-response relationship.

The main body of epidemiological evidence concerning the health implications of the recreational use of water focuses on the effects of faecal contamination of bathing waters and the incidence of gastro-intestinal diseases and other transmissible diseases to participants in water recreation. The epidemiological data concerning some of the other hazards is weaker, especially concerning drowning and physical hazards (WHO, 1998).

4. EPIDEMIOLOGICAL EVIDENCE LINKING ILLNESS WITH USE OF RECREATIONAL WATER ENVIRONMENTS

The extent to which health risks amongst bathers are quantitatively associated with faecal pollution has been debated for many years. Such information is essential to evaluate and adjust current or developing new standards.

The first reviews of the incidence of disease associated with the use of recreational waters were undertaken by the American Public Health Association in the early 1920's. Simons *et al.,* (1922) attempted to determine the prevalence of infectious diseases, which may be transmitted by swimming pools and other bathing places.

Major epidemiological studies were conducted between 1948 and 1950 by the United States Public Health Service (Stevenson, 1953) to investigate the link between bathing and illness. The findings concluded that there was an appreciably higher overall illness incidence rate in people who swam in Lake Michigan, Chicago in 1948 and on the Ohio River at Dayton, Kentucky in 1949 compared with non-swimmers regardless of the bathing water quality. It was concluded by Stevenson that based upon the results of this study the stricter bacterial quality requirements could be relaxed without a detrimental effect on the health of bathers.

However, Moore (1959) undertook a similar study in the UK, the results of which contradicted those of Stevenson (1953) and the subject became one of controversy for many years. It was acknowledged in 1972 by the US EPA that there was a lack of valid epidemiological data with which to set guideline standards for recreational waters. There followed a number of epidemiological studies throughout the World (Table 4), the largest in the UK being conducted in the early 1990's (Kay *et al.,* 1994; Pike, 1994). In many of the studies identified in Table 4 the rate of certain symptoms or symptom group, was found to be significantly related to the count of faecal indicator bacteria or bacterial pathogens. The credible associations were found between gastro-intestinal symptoms (including 'highly credible' or 'objective' symptoms) and indicators such as enterococci, faecal streptococci, thermotolerant coliforms and *Escherichia coli (E. coli).* There are relatively few studies which report associations with other symptoms although there is evidence of an association between ear, eye, skin and to a lesser degree respiratory ailments, with swimming in recreational waters. Several of the studies found that the symptom rates were more frequent in the lower age group (Cabelli, 1983; Fattal, UNEP/WHO, 1987; UNEP/WHO, 1991; Pike, 1994).

There are a number of methods that can be used to conduct epidemiological studies into the health effects of recreational water usage: (a) Retrospective case-control studies – this study begins with evidence of a disease and works back to establish the cause. It is most useful for linking illnesses to environmental exposures; (b) prospective cohort studies – where individuals are recruited for participation in the recreational water exposure prior to the day of experiment. The bathers and non-bathers (control group) are self-selected and not randomised in this study. Both cohorts are followed up for a period of time by telephone or in person, to gather data on the acquisition of symptoms. Data on the quality of the water is gathered by sampling on the day of exposure; (c) randomised trials – this is also a 'prospective' study design but volunteers are recruited at the start of the experiment. The subjects are interviewed, subject to a medical examination and then randomised into bather and non-bather groups. Both groups arrive on the beach on a predetermined day and the bathers undertake a period of water exposure, whilst the non-bathers remain on the beach. Post-exposure interviews and medical examinations are undertaken a week after exposure and complete a further postal questionnaire to examine any illnesses with longer incubation periods. Water quality is measured at the time and place of exposure for each bather.

It should be emphasised that there are a number of shortcomings associated with each of the methodologies. There is the possibility of an underestimation of illness since studies are carried out on healthy adult bathers. Children, the elderly and the immuno-suppressed who may be most susceptible to illness are not included in such studies for ethical reasons. Children often spend considerably more time in the water than adults and their behaviour is likely to result in the ingestion of water.

In addition interviews can lead to false perception of illness; self reporting of symptoms may result in bias; the quality of the recreational water may not be sufficiently poor to present a significant infective challenge and the time interval for the post exposure questionnaire may not be long enough. Confounding factors associated with the illnesses linked with microbiologically contaminated bathing water are difficult to quantify (Gammie and Wyn-Jones, 1997).

The design of the study is extremely important but it must be recognised that there will be circumstances where one design will be more appropriate than another. For example it would not be appropriate to use a randomised design to investigate the health implications of water sports activities such as white water rafting or other potentially hazardous activities. In this case a form of prospective cohort design would be the most appropriate.

The main criteria to be considered in the choice of the appropriate methodology are the objectives of the study and the validity of the findings, as well as logistical and ethical constraints.

4.1 Studies Investigating Activities Other Than Swimming

It has been recognised that the type and severity of health risks associated with the microbiological quality of water may vary with different kinds of activities (Fewtrell *et al.*, 1994b). The vast majority of epidemiological studies has been conducted in marine waters (Table 4) and have investigated health effects of bathing. To date there are very few epidemiological studies which have considered special interest activities (Table 4).

Evans *et al.*, (1983) found no evidence of any particular health risk from short-term immersion in Bristol City Docks. However, Philipp *et al.*, (1985) studied the health of snorkel swimmers in the same body of water who were immersed for 40 minutes and revealed that statistically significantly more swimmers reported gastrointestinal symptoms compared with the control group, even though the water complied with the EEC bathing water standards.

Medema *et al.,* (1997) investigating the risk of gastroenteritis in triathlete swimmers estimated that the exposure of triathletes during a competition was between 15 and 40 minutes and exposure was relatively intense; 75% of all triathletes in his study reported knowingly ingesting surface water during swimming. Triathletes were compared with duathletes and it was reported that although the health risks for triathletes was not significantly higher than for run-bike-runners (biathletes) symptoms were higher in those athletes that had been exposed to water in the week after the event: gastrointestinal (7.7% vs 2.5%), respiratory (5.5% vs 3.7%), skin/mucosal (2.6% vs 1.2%), general (3.5% vs 1.2%) and total symptoms (14.8% vs 7.4%).

The results of the study of van Asperen (1998) were consistent with that of Madema *et al.,* (1997). The study showed that of those who reported swallowing water during the swimming period reported gastroenteritis more frequently (6.8%) than those that did not (3.8%). The percentage of triathletes swallowing water was 72%.

Table 4. Major epidemiological studies investigating the health effects from exposure to recreational water conducted between 1953 and 1996 (adapted from Pruss, 1998)

First Author	Year	Country	Type of water
Fleisher*	1996	UK	Marine
Haile*	1996	US	Marine
Van Dijk	1996	UK	Marine
Asperen	1995	Netherlands	Fresh
Bandaranayake*	1995	New Zealand	Marine
Kueh*	1995	Hong Kong	Marine
Medical Research Council*	1995	South Africa	Marine
Kay*	1994	UK	Marine
Pike*	1994	UK	Marine
Fewtrell	1994	UK	Fresh
Schrinding	1993	South Africa	Marine
McBride	1993	New Zealand	Marine
Foulon	1983	France	Marine
Corbett	1993	Australia	Marine
Harrington	1993	Australia	Marine
Schrinding	1992	South Africa	Marine
Fewtrell*	1992	UK	Fresh
Jones	1991	UK	Marine
Balarajan	1991	UK	Marine
Alexander	1991	UK	Marine
UNEP/WHO*	1991	Israel	Marine
UNEP/WHO*	1991	Spain	Marine
Cheung*	1989	Hong Kong	Marine
Ferley*	1989	France	Fresh
Lightfoot	1989	Canada	Fresh
New Jersey Department of Health	1989	USA	Marine
Brown	1987	UK	Marine
Fattal, UNEP/WHO*	1987	Israel	Marine
El Sharkawi	1986	Egypt	Marine
Philipp	1985	UK	Fresh
Seyfried*	1985	Canada	Fresh
Dufour*	1984	US	Fresh
Cabelli*	1983	Egypt	Marine
Calderon	1982	USA	Marine
Cabelli*	1982	USA	Fresh and marine
El Sharakwai	1982	Egypt	Marine
Mujeriego*	1982	Spain	Marine
Hoadley	1975		
Public Health Laboratory Service (PHLS; Moore)	1959	UK	Marine
Stevenson*	1953	USA	Fresh and Marine

*indicates the rate of certain symptoms or symptom group was found to be significantly related to the count of faecal indicator bacteria or bacterial pathogen.

Table 5. Epidemiological studies considering water activities other than bathing

First Author	Date	Type of study and activity	Country	Type of water
Fewtrell	1992	White water canoeing	UK	Freshwater
Fewtrell	1994	Cohort – rowing and marathon canoeing (low water contact)	UK	Fresh-water canals and estuarine
Medema	1995	Triathlon	Netherlands	Freshwater
Gammie	1997	Surfers/ windsurfers	UK	Marine and freshwater
Lee	1997	White-water canoeing	UK	Freshwater
Van Asperen	1998	Prospective cohort Triathlon	Netherlands	Freshwater
Philipp	1985	Snorkelling	UK	Freshwater docks
Evans	1983	Variety of watersports	UK	Freshwater docks

The difference in risk between the various uses of recreational waters lies primarily with the duration of exposure and the quantity of water ingested. However, very little data exists which accurately estimates the duration of immersion and the quantity of water ingested according to activity. BSAC for example estimate that in winter the average length of a scuba dive is 20-30 minutes but in summer it can be more than one hour (Alistair Reynolds, BSAC Technical Manager, personal communication, 2001). The average volume of water consumption during a typical dive is not known.

In recent years the popularity of activities which involve contact with water has grown and the availability of the wet suit has altered the public use of recreational water – prolonged periods of immersion are now becoming normal and activity occurs throughout the year and not just during the bathing season of May-September. The European bathing water standards (i.e. the 1976 bathing water Directive, 76/160/EEC; CEC, 1976) were not based on any epidemiological evidence. The revised guidelines and standards emerging throughout the world take into account the epidemiological evidence accrued over the past years. However, a gap still remains in the literature which addresses the health risks associated with activities other than bathing and there remains a need to conduct further epidemiological studies on persons undertaking a variety of activities.

4.2 The Relative Risk of Bacteriological Quality of Recreational Water

The results from the majority of epidemiological studies identified in Tables 5 and 6 have identified a link between the recreational use of water and minor illnesses in healthy adult bathers and, to a limited extent, participants of other watersports. Most of these studies were conducted in marine waters which conform to bathing water standards. Despite the acknowledged limitations in the design of epidemiological studies (see for example, Kay and Dufour, 2000), the results have led to the development of site-specific dose-response curves of the probability of illness over increasing indicator organism exposure for marine recreational waters and coastal swimmers (Wyer *et al.,* 1999). Based on the randomised epidemiological studies of coastal bathers in the United Kingdom (Kay *et al.,* 1994), Wyer *et al.,* (1999) provided an example of tolerable risk in terms of faecal streptococci density equivalent to 'background' or non-water related gastrointestinal disease. The actual expected disease burden at a particular recreational water location can be calculated for any recreational water environment if a suitable dose-response curve is available and the indicator probability density function can be drawn (WHO, 2001).

The WHO recently developed Guideline values for seawater derived from these dose-response curves (Table 6). However, at present, no epidemiological studies from freshwater areas have been reported that provide adequate data to derive similar Guideline values for freshwaters. The balance of evidence suggests that, under many circumstances, the same level of faecal indicator bacteria in freshwater environments may correspond to a greater health risk than in a marine environment (WHO, 1998) although studies show conflicting results: Dufour (1984) reported the illness rate in seawater swimmers to be about three times greater than in freshwater swimmers; similar rates are found in the studies of Kay *et al.,* (1994) and Ferley *et al.,* (1989). Die-off rates of bacterial indicators are different in marine and freshwaters (section 4.3), while human viruses are inactivated at similar rates in these environments. WHO have stated that application of the Guideline values derived for seawaters (Table 6) to freshwaters would not be appropriate, and it appears that based on the evidence available the Guideline would be conservative in the absence of suitable epidemiological data for freshwaters. The US EPA also advocate separate water quality criterion for seawater and freshwater (EPA, 1984). A single microbiological value is currently proposed by WHO, and the EC for all recreational activities, because insufficient evidence exists at present to do otherwise (WHO, 1998).

Table 6. WHO guideline values for microbiological quality of recreational waters (WHO, 1998; 2001)

95th percentile value of faecal streptococci/ 100 ml	Basis of derivation	Estimated risk
40	This 95th percentile value is below the NOAEL in most epidemiological studies.	**<1% GI illness risk** **<0.3% AFRI risk** This relates to an excess illness of less than one incidence in every 100 exposures. The AFRI burden would be negligible.
41–200	The upper 95th percentile value (200/100 ml) 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.	**1–5% GI illness risk** **>1.9% AFRI illness risk** The upper 95th percentile value of 200 relates to an average probability of one case of gastroenteritis in 20 exposures. The AFRI illness rate at the upper 95th percentile would be 19 per 1000 exposures.
201–500	This level represents a substantial elevation in the probability of all adverse health outcomes for which tentative dose–response data are available.	**5–10% GI illness risk** **1.9–3.9% AFRI illness risk** This range of 95th percentiles represents a probability of 1 in 10 to 1 in 20 of gastroenteritis for a single exposure. Exposures in this category also suggest a risk of AFRI in the range 19–39 per 1000 exposures.
>500	Above this level, there may be a significant risk of high levels of minor illness transmission and a potential risk of more serious illnesses.	**>10% GI illness risk** **>3.9% AFRI illness rate** There is a >10% chance of illness per single exposure, and the water should be considered a public health risk. The AFRI illness rate at the upper 95th percentile point of 500 enterococci per 100 ml would be 39 per 1000 exposures or approximately 1 in 25 exposures.

Notes:

1. Abbreviations used: AFRI = acute febrile respiratory illness; GI = gastrointestinal; LOAEL = lowest-observed-adverse-effect level; NOAEL = no-observed-adverse-effect level.
2. The "exposure" in the key study was a minimum of 10 min bathing involving three immersions. It is envisaged that this is equivalent to many immersion activities of similar duration, but it may underestimate risk for longer periods of water contact or for activities involving higher risks of water ingestion (see also note 7).
3. The 'estimated risk' refers to the excess risk of illness (relative to a group of non-bathers) among a group of bathers who have been exposed to faecally contaminated recreational waters under conditions similar to those in the key studies.
4. The functional form used in the dose–response curve assumes no excess illness outside the range of the data (i.e., at concentrations above 158 faecal streptococci/100 ml). Thus, the estimates of illness rate reported above are likely to be underestimates of the actual disease attributable to recreational-water exposure.
5. This table would produce protection of "healthy adult bathers" exposed to marine waters in temperate north European waters.
6. It does not relate to children, the elderly or immunocompromised, who would have lower immunity and might require a greater degree of protection. There are no available data with which to quantify this, and no correction factors are therefore applied.
7. Epidemiological data on fresh waters or exposures other than bathing (e.g., high-exposure activities such as surfing or whitewater canoeing) are currently inadequate to present a parallel analysis for defined reference risks. Thus, a single microbiological value is proposed, *at this time*, for all recreational uses of water, because insufficient evidence exists at present to do otherwise. However, it is recommended that the severity and frequency of exposure encountered by special interest groups (such as bodysurfers, board riders, windsurfers, sub-aqua divers, canoeists and dinghy sailors) be taken into account.
8. Where disinfection is used to reduce the density of indicator bacteria in effluents and discharges, the presumed relationship between faecal streptococci (as indicators of faecal contamination) and pathogen presence may be altered. This alteration is, at present, poorly understood. In water receiving such effluents and discharges, faecal streptococci counts may not provide an accurate estimate of the risk of suffering from mild gastrointestinal symptoms or of AFRI.
9. Risk attributable to exposure to recreational water is calculated after the method given by Wyer *et al.* (1999), in which a $\log_{10}$ standard deviation of 0.8103 was assumed.
10. Note that the values presented in this table do not take account of health outcomes other than gastroenteritis and AFRI. Where other outcomes are of public health concern, then the risks should be assessed and appropriate action taken.
11. Guideline values should be applied to water used recreationally and at the times of recreational use. This implies care in the design of monitoring programmes to ensure that representative samples are obtained. It also implies that data from periods of high risk may be ignored if effective measures were in place to discourage recreational exposure.

4.3 Special Characteristics of Freshwaters Used for Recreational Activities

In the UK and elsewhere, there has been a marked increase in the recreational use of inland waters, e.g. lakes, reservoirs, rivers and canals (Gammie and Wyn-Jones, 1997). There has been a considerable amount of work undertaken to determine the differential survival rates of inactivation of enteric micro-organisms in fresh and marine water (Hanes and Fragala, 1967; Chamberlain and Mitchell, 1978; Dufour, 1984; WHO, 1999b). Although figures vary, average survival times (T_{90}) for *E. coli* in freshwater have been estimated as 3.9 days in freshwater and 0.8 days in marine water (WHO, 1999b). For enterococci the T_{90} in freshwater is estimated as 4.4 days and 2.5 days in seawater (WHO, 1999b). Due to the known difference in survival of indicator bacteria and enteric pathogens in marine and fresh waters (Dufour, 1984), the results of epidemiological studies conducted in marine waters cannot be applied to freshwater sites (van Asperen *et al.*, 1998). There remains a need to conduct further epidemiological studies in freshwaters in order for suitable standards to be established for these types of waters (WHO, 1998).

Freshwater bathing sites may be enclosed bodies of water and fairly static such as lakes, or running waters such as rivers. Both pose features which require special consideration in the setting of health-related standards to protect water users. The bacterial concentration in river and lake water is determined by faecal pollution from both point and non-point sources. Major point sources of pollution include sewage effluents, combined sewer overflows, industrial effluents and animal sources. Non-point sources of pollution relate to agricultural activity within the watershed, and are influenced by the type of livestock and its density. Urban surfaces also contributes significantly to the pollution load. There is therefore the potential for a higher proportion of animal faecal material to be present in these waters as well as other contaminants such as oil and heavy metals as opposed to coastal waters. Enclosed freshwater areas are more susceptible to catchment-derived wastes e.g. rural run-off in comparison to municipal discharges which coastal bathing areas are generally subject to.

Faecal material is transported from the watershed surface to the river and subsequently to the coastal environment. The transport of microbial and other contamination is controlled by the flow of water, and changes in flow are determined by rainfall and by the hydrogeological characteristics of the basin which have a significant impact on the concentration of microbes transported. In riverbed sediments the survival times of bacteria are significantly increased (WHO, 1998) and the bacteria readily resuspend when the river flow increases (Ferley *et al*, 1989; Environment Agency, 2000b).

Enclosed and static freshwaters may have more difficulties in ‘mixing’ than rivers, making lakes and ponds suitable for the colonisation of naturally-occurring hazards such as leptospirosis, schistosomes or *Naegleria fowleri*, and toxic cyanobacteria. Certain areas of lakes or enclosed freshwaters may also accumulate more faecal material than others – for example the bankside may accumulate contamination from animals. In addition, particular physical hazards are posed by fast moving rivers to recreational water users. This should be considered when devising classifications for freshwater bathing sites and will be discussed in section 5.

5. REVIEW OF CURRENT GLOBAL RECREATIONAL WATER QUALITY STANDARDS

Tables 7 and 8 present international, national and local guidelines/standards for recreational waters throughout the World. The standards vary widely reflecting different levels of water use protection, but all relate to primary contact recreation or shellfish harvesting. Regulatory schemes for the microbiological quality of recreational water is generally based on percentage compliance with faecal indicator organisms. Since it is not possible to test for all potential pathogens in a water sample, a water sample is tested to determine whether it has been polluted by faecal material. The presence of an indicator organism such as *E. coli* – one whose presence in water indicates that the water has received contamination of an intestinal origin - is therefore determined. The standards are applicable to both marine and freshwaters generally, except in the US, although it is now recognised that survival of indicator bacteria and pathogens is different in the two environments (section 4.3). Standards vary not only from country to country but also within countries. About one third of all US states use the EPA recommended indicator organisms for monitoring fresh and coastal waters – i.e. *E. coli* or enterococci. However, other states continue to use faecal coliforms and a small number still use total coliforms to indicate water quality (EPA, 1999). The inconsistent choice of indicator organisms for monitoring recreational waters has resulted in instances of one US State prohibiting use of recreational waters that were considered safe by a neighbouring state. Most of the Latin American countries, except Brazil and Peru, have adopted US standards directly, or with minor modifications, from those applied in the USA before 1986.

There are a number of recognised inadequacies with the sampling procedures employed to determine the microbiological monitoring of bathing waters. These primarily relate to the inconsistency in the methods employed to sample waters (location and depth of sample can be influenced by weather and beach topography); duration of time and storage conditions between sampling and analysis; and analytical methodology for microbiological quality of the water.

Although the most commonly used faecal indicator bacteria at present are thermotolerant coliforms and *E. coli* the body of evidence to date points to enterococci or faecal streptococci as the indicator which correlates best with health outcomes for both marine and freshwater, and *E. coli* for freshwater (Godfree *et al.*, 1997; WHO, 1998). For this reason the most recently revised and developed marine recreational water guidelines/standards are being expressed in terms of faecal streptococci (section 6). For freshwaters, better correlations have been obtained with faecal coliforms/*E. coli* but insufficient evidence is available for derivation of health-related standards for freshwaters at present.

Coliform densities have been shown to be affected by a number of factors such as season, tides, sewage discharge patterns, spatial factors and variable factors such as weather conditions and discharges. In addition, microbiological counts are dependent on the method of enumeration. The current flexibility in the methods of coliform and faecal streptococci analysis may make comparisons between bathing areas difficult and results open to criticism. As well as different techniques for enumeration, different recovery media, different procedures for resuscitation, different temperatures and time of incubation can all result in the recovery of different proportions of the total population of bacteria due to their different selectivity.

It has been suggested that there should be more emphasis on maximising the number of samples obtained in order to make a more accurate estimation of the likely densities of indicator bacteria to which recreational water users are exposed to (Fleisher, 1990). Many agencies base criteria for recreational water compliance on the 95% compliance levels (i.e. 95% of the sample measurements taken must be below a specific value in order to meet the standard) which although easily understood is less reliable statistically than other methods such as the geometric mean. However, the geometric mean does not reflect the variability in the distribution of the water quality data.

Another method of analysing the water quality data is by calculating the 95th percentile by generating a probability density function based on the distribution of indicator organisms over a defined bathing area (WHO, 2001). Previous recommendations based on 20 or fewer samples are now considered not statistically representative due to the variation in microbiological faecal indicators. WHO (2001) recently recommended that increasing sample numbers towards 100 samples (by pooling historical data from multiple years if necessary and appropriate) would increase precision of the estimate of the 95th percentile.

5.1 Non-Bacteriological Parameters for Measuring Water Quality

Regulatory schemes for the quality of recreational water have generally been based on percentage compliance with faecal indicator counts (CEC, 1976; EPA, 2000; Tables 7 and 8). Other parameters such as aesthetic and physico-chemical parameters are included but are generally not considered in compliance, although where tourism is of particular importance such as the Caribbean both the bacteriological and aesthetic water quality are very important. This was recently agreed by the Caribbean Environment Programme (CEPPOL) who held Regional meetings to discuss monitoring and control of sanitary quality bathing and shellfish-growing marine waters in the Wider Caribbean. It was concluded that the Member Countries should adopt EEC, WHO or US EPA standards or guidelines for bacteriological quality of bathing waters until sufficient information is available, based on future epidemiological studies undertaken in the Caribbean, to modify the current standards (Salas, 2000).

Table 7. Current recreational water quality standards – applicable to marine and freshwaters unless stated otherwise

Country	**Shellfish Harvesting**		**Primary contact recreation**			**Protection of indigenous organisms**		**References**
	Total coliforms /100ml	Faecal coliforms /100ml	Total coliforms /100ml	Faecal coliforms /100ml	Other	Total coliforms /100ml	Faecal coliforms /100ml	
Brazil		100%<100	80%<5000	80%<1000				Brazil Ministerio del Interior, 1976
Canada					*E. coli* 2000/L[n] Enterococci 350/L			Minister of Supply and Services Canada, 1992
Colombia			1000	200				Colombia, Ministerio de Salud, 1979
Cuba			1000a	200a 90%<400				Cuba, Ministerio de Salud, 1986
EEC Europe			80%<500c 95%<10000d	80%<100c 95%<2000d	Faecal streptococci 90%<100 /100ml c Salmonella 95%<0/litre Enteroviruses 95%<0 PFU/10 litre q			EEC, 1976
Ecuador			1000	200				Ecuador, Ministerio de Salud Publica, 1987
France			<2000	<500	Faecal streptococci <100 /100ml			WHO, 1977
Israel			80%<1000g					Argentina, INCYTH, 1984
Japan	70		1000			1000		Japan, Environmental Agency
Mexico	70e		80%<1000I			10,000e		Mexico,

	90%<230		100%<10000k			80%<10,000 100%<20000		SEDUE, 1983
New Zealand		Median MPN of 14 per 100 mL. <10% <43/100 mL			35p enterococci per 100 mL			Ministry of Health, Ministry for the Environment, 1999
Peru	80%<1000	80%<200 100%<1000	80%<5000i	80%<1000i		80%<20000	80%<4000	Peru, Ministerio de Salud, 1983
Poland					*E. coli*<1000			WHO, 1975
Puerto Rico	70h 80%<230			200h 80%<400				Puerto Rico, JCA, 1983
United States, California	70e		80%<1000ij 100%<10000k	200aj 90%<400 l				California State Water Resource Board (no date)
United States USEPA		14a 90%<43			Enterococci 35a (marine) 33a (fresh) *E.coli* 126a (fresh)			USEPA Dufour and Ballentine, 1986
Former USSR					*E. coli* <100			WHO, 1977
UNEP /WHO		80%<10 100%<100		50%<100n 90%<1000n				WHO/UNEP, 1978
Uruguay				<500n <1000o				Uruaguay, DINAMA, 1998
Venezuela	70a 90%<230	14a 90%<43	90%<1000 100%<5000	90%<200 100%<400				Venezuela, 1978
Yugoslavia			2000					Argentina, INCYTH, 1984

a Logarithmic average for a period of 30 days of at least 5 samples

b Minimum sampling frequency – fortnightly

c Guide

d Mandatory

e Monthly average

f At least 5 samples per month

g Minimum 10 samples per month

h At least 5 samples taken sequentially from the waters in a given instance

i. Period of 30 days

J. Within a zone bounded by the shoreline and a distance of 1000 feet from the shoreline or the 30 foot depth contour, whichever is further

k Not a sample taken during the verification period of 48 hours should exceed 10,000/100 ml

l Period of 60 days

m 'Satisfactory' waters, samples obtained in each of the preceding 5 weeks

n Geometric mean of at least 5 samples

o Not to be exceeded in at least 5 samples

p seasonal median

q Compliance required in 95% of samples

Table 8. Water quality standards for the protection of marine recreational activities arising from Black Sea Region, European Union and related legislation

Parameter	Bulgaria	Georgia	Romania	Russia	Turkey	Ukraine	EC	Proposed Standard	Critical level for action
Tier 1 Parameters only									
Microbiological parameters									
E. coli (no per litre)		100	100	100		100	Guide value 1,000 Mandatory value 20,000	For all microbiological parameters, the quality standards and critical action levels will be decided by each individual country	
Total coliforms (no per litre)		5,000	10,000	5,000	2,000	5,000	Guide value 5,000 Mandatory value 100,000		
Enteroviruses (PFU/ 10 litres)		Zero		Zero		Zero	Mandatory value - zero in 95% of samples		
Faecal streptococci (no per litre)	50					Zero	Guide value 100 Mandatory value – 4,000		
Salmonella (no per litre)		Zero		Zero		Zero	Mandatory value – zero in 95% of samples		
Blue-Green algae		Zero		Zero		Zero			
Intestinal parasites		Zero		Zero		Zero			
Pathogens (total)		Zero		Zero		Zero			
Aesthetic Parameters									
Transparency	30 cm (Snelen scale)	30 cm (Snelen scale)		30 cm (Snelen scale)	>2m	30 cm (Snelen scale)	Guide value 2m Mandatory value 1m	>1m (T/90)	<1m
PH		6.5– 8.5		6.5– 8.5	6.0 – 9.0	6.5– 8.5	Mandatory value 6.0 – 9.0	6.0 – 9.0	Outside specified range
Colour	Without colour	Without colour		Without colour	Natural	Without colour	No abnormal change in colour	No change	+ change
Hydrocarbons (μg l-1)	50	50		50		50	No visible film on surface of water	50	50 or film present of water surface

Parameter	Bulgaria	Georgia	Romania	Russia	Turkey	Ukraine	EC	Proposed Standard	Critical level for action
Odour as Phenols (µg l-1 as C6H5OH)	No phenol odour – no value given	No phenol odour and less than 1.0		No phenol odour and less than 1.0	No phenol odour and less than 5.0	No phenol odour and less than 1.0	Guide value 0.005 Mandatory value no specific odour; 5.0	TBD	TBD
Surfactants (mg l-1 as lauryl sulphate)	0.1	0.1		0.1	No foam <0.3	0.1	Guide value 0.3 Mandatory value – no lasting foam	0.3 (T/100)	>500 T or Lasting foam
Tarry residue and floating waste		Absence		Absence		Absence	Guide value – Absence	Absence	Presence

For any parameter to be used as a regulatory parameter of public health significance for recreational waters it should:

- Have a health basis (to enable the derivation of guideline or mandatory values from epidemiological investigations)
- Have adequate information available with which to derive Guideline/Mandatory values (e.g. from epidemiological investigations)
- Have standard methods for analysis
- Be cost effective to test
- Make low demands on staff training
- Require basic equipment that is readily available.

For many of the hazards of significance to recreational water users which have been identified in Table 3, there is not sufficient evidence of a clear health basis from which to derive guidelines or standards. The primary risk to human health from recreational waters is considered to be from human excreta and therefore micro-organisms are most commonly used in compliance assessment. Aesthetic parameters and physico-chemical parameters are specified in some current standards but are rarely considered in compliance assessment.

Before water quality guidelines or standards can be set, it is essential to understand the general characteristics of the water body of interest and the effects of local environmental conditions, the processes that may affect the concentrations of the physical and chemical variables, and the factors that may modify the toxicity of these variables. This is true at whatever scale the guidelines and standards operate, whether international, European, national, regional or local (Pond *et al.*, 2000). There is a strong argument for assessing waters on a local basis in order to capture the impact of the nature and variability of locally operating processes on achievement of more generic–level standards (regional, national, European or international). Catchment surveys will reveal local factors, such as agricultural or industrial activity, as well as other non-outfall sources of faecal pollution such as small streams, wildlife, septic tanks and soak-aways, and inappropriate cross connection of foul waters to surface drains which can have a considerable impact on the water quality. In determining the likely hazards of physico-chemical variables, it is important to evaluate the degree of exposure that recreational users will encounter.

To meet the health targets set by water quality guidelines or standards, achievable objectives need to be established for water quality and associated management. The food and beverage industry use the Hazard Analysis Critical Control Point (HACCP) to ensure food and beverage safety. WHO are advocating the use of HACCP for recreational water management to address the needs for information for immediate management action and to use its information outputs for longer-term classification (WHO, 2001).

5.1.1 Aesthetic issues

The aesthetic issues of human concern deal primarily with well-being and health gain. In 1997, WHO emphasised the recreational values of tourism and their association with mental health. Emphasis was given to the aesthetic aspects, quietness, cleanliness of recreational areas and architecture (WHO, 1997a). The aesthetic value of recreational waters implies freedom from visible materials that will settle to form objectionable deposits, floating debris, oil, scum and other matter, substances producing objectionable colour, odour, taste or turbidity, and substances and conditions or combinations thereof in concentrations which provide undesirable aquatic life (Ministry of National Health and Welfare, Canada, 1992).

Perception by the general public of the beach aesthetic appearance and water quality has become increasingly important for both the physical and psychological well-being of users (House, 1993; Williams and Nelson, 1997). Certain aspects of aesthetic pollution have a greater impact on the public than others and it has been suggested that a weighting of importance should be placed on the determinands so that an overall aesthetic index could be created (NRA, 1996). Dinius (1981) found that water discolouration was a factor that led respondents to make a judgement about the level of pollution in an area. Any visually unpleasant pollutant has the potential to have a negative impact on tourism, whether or not it poses an actual health risk. Aside from the well-being associated with clean areas there are clear health considerations associated with aesthetic issues, for example: clarity and colour - poor estimation of depth may lead to drowning, obstruction of submerged hazards leading to spinal injury, brain and head injury, fractures, dislocations etc. Aesthetic factors are especially important where there is passive recreation or activities not involving contact with water. The microbiological parameters in this case could be considered of little importance in comparison to the aesthetic parameters.

Marine debris/litter – glass and other sharp objects may lead to cuts and lesions. Sewage-related debris, discarded food, dead animals and medical waste may be associated with microbiological hazards (Semple, 1989; Lowry, 1990; Philipp, 1991). Entanglement of scuba divers in underwater debris has been reported (Cottingham, 1989) and exposure to chemicals from leaking containers washed ashore in marine areas has been recorded (Dixon and Dixon, 1981). Table 9 presents the contributory factors to aesthetic hazards relevant to recreational waters. In terms of setting standards and classifying a water the factors of concern are those that relate to the water body and the surrounding catchment. The contributory factors attributable to the behaviour of the participants is presented for completeness.

Table 9. Principal contributory factors to aesthetic hazards relevant to the recreational water body and the behaviour of the participants

Hazards/adverse health effects	Contributory factors	
	Associated with the water body (marine and freshwater)	**Associated with the behaviour of the participants**
Well-being (psychological aspects)	Water clarity	Noise pollution – jet skis, hi-fis, traffic
	Colour	Litter dumping
	Odour	
	Litter	Litter from users
	Presence of oil and grease	
Microbiological hazards from litter	Presence of sewage related debris and medical waste	

The current EC bathing water Directive (76/160/EEC; CEC, 1976) considers aesthetic and psychological well-being associated with water exposure as well as biological purity (Table 10). The directive states that 'it is also desirable that bathing water should be clear, and not contain toxic substances or show traces of oil, and should have acceptable taste, odour and colour' (CEC, 1976). This assessment is based on fortnightly sampling and visual and olfactory inspection. As a guideline value, fortnightly inspection is also recommended for the absence of tarry residues and floating materials such as wood, plastic articles, glass containers, plastic, rubber, waste, splinters or any other substances. It is difficult to establish criteria for oil and grease, as the mixtures are very complex.

Table 10. Examples of aesthetic parameters considered in recreational water standards/guidelines

Directive/standard	Parameters considered
EC bathing water Directive (CEC, 1976)	Clarity Presence of toxic substances or oil Taste Odour Colour
Canadian Water Quality Guidelines (MNHW, 1992)	Materials that will settle to form objectionable deposits Floating debris, oil, scum, and other matter Substances producing objectionable colour, odour, taste or turbidity. Substances and conditions in concentrations that produce undesirable aquatic life.
WHO Guidelines (WHO, 1998)	Clarity, colour Oil and grease Litter Odour Noise

The Environment Agency/National Aquatic Litter Group (EA/NALG) have developed a monitoring protocol and classification scheme for the assessment of aesthetic quality of coastal and bathing beaches (EA/NALG, 2000). In summary, beach litter is counted over a 100 m stretch, and the beach is graded based on the number of items of seven categories of litter. The final overall grade defaults to the worst category found (Table 11).

Table 11. Environment Agency/National Aquatic Litter Group categories for grading a beach according to number of aesthetic items (EA/NALG, 2000)

Category	Sub category	Grade			
		A	B	C	D
Sewage-related debris	General	0	1-5	6-14	15+
	Cotton buds	0-9	10-49	50-99	100+
Gross litter		0	1-5	6-14	15+
General litter		0-49	50-499	500-999	1000+
Potentially harmful litter	Broken glass	0	1-5	6-24	25+
	Other	0	1-4	5-9	10+
Accumulations	Number	0	1-4	5-9	10+
	Continuous strip	-	-	-	Grade D
Oil		Absent	Trace	Nuisance	Objectionable
Faeces		0	1-5	6-24	25+

The primary weakness with this classification is that it is based on a small sample area (100m). Whilst this saves both time and money, a true reflection of the aesthetic condition of the recreational water use area is not given.

Aesthetic factors play an important part in the economy of communities reliant on recreational water use areas. Cleaning recreational water use areas costs the responsible authorities huge amounts of money each year. In the UK, Suffolk District Council estimated that £50,000 was spent each year cleaning the coastline; authorities in Kent have estimated direct and indirect costs of over £11 million to deal with litter along the Kent coastline (Williams *et al.,* 2000). In extreme cases people may avoid visiting an area if it is littered with potentially hazardous and unasesthetic items. Such effects were experienced in New Jersey, USA in 1987 and Long Island, USA in 1988 where the reporting of medical waste along the coastline resulted in an estimated loss of between US$ 1.3×10^9 and 5.4×10^9 in tourism-related expenditure (Valle-Levinson and Swanson, 1991).

5.1.2 Physical hazards

These include drowning and near drowning, major impact injuries, slip, trip and fall accidents, cuts, lesions and punctures.

Drowning and near-drowning may be associated with recreational water uses with both low and high water contact. The use of boats, canoes, yachts and fishing have been associated with drowning (Plueckahn, 1972; Steensberg, 1998). In the UK drowning is the third most common cause of accidental death in the under 16s. In 1999 there were 569 drownings, with the majority (248 or 44%) occurring in rivers and streams (RoSPA, 2000). Some of the contributory factors of these outcomes relate to the water body and others to the behaviour of the participants (Table 12).

Table 12. Principal contributory factors to physical hazards relevant to the recreational water body and the behaviour of the participants (WHO, 1998)

Physical hazards	**Contributory factors**	
	Relevant to the water body (marine and freshwater)	**Attributable to behaviour of the participants**
Drowning/near-drowning	Current	Alcohol consumption
	Offshore winds	Lack of supervision of children
	Objects under the surface leading to entanglement	Awareness of hazards
	Wave height	Wearing of lifejackets
	Water temperature	
	Water transparency	
	Impeded visibility	
Impact injuries	Water depth	Awareness of water depth
	Water clarity	Safe diving techniques
	Presence of hazards under the water	
	Bottom surface type	
	Conflicting uses in one area	
Slip/trip and fall accidents	Water depth	Awareness of hazards
	Objects under the water surface	
	Water clarity	
	Adjacent surface type	
Cuts, lesions, punctures	Presence of hazardous objects under the water or on the adjacent surface	Walking barefoot Awareness of litter control

Table 13 shows a breakdown of the locations of drownings in the UK in 1999 and the activities/behaviour which has contributed to those deaths.

Table 13. Causes of drowning in the UK 1999.

Location	Total number of drownings	Percentage of total	Activity/ behaviour	Total number
Rivers, streams	248	44	Angling from boat	14
Coastal	112	20	Angling from land	10
Lakes and reservoirs	84	15	Fell in	81
Canals	43	8	Alcohol	78
Home baths	31	5	Boating	25
Docks and harbours	19	3	In vehicles	14
Garden ponds	18	3	Playing	11
Swimming pools	14	2	Sub aqua	7
			Canoeing	5
			Cycling	3

Source: Royal Society for the Prevention of Accidents (RoSPA), 2000

Guidelines/standards considering physical hazards

The WHO Guidelines for safe recreational waters appears to be the only current guidelines protecting the health of recreational water users to consider physical hazards. The Guidelines consider drowning and near-drowning, spinal injury, impact injuries and cuts and lesion injuries. Preventive and management actions such as development of user awareness, provision of local hazard notices etc are also suggested.

5.1.3 Naturally occurring hazards

Naturally occurring hazards may be encountered during recreational use of freshwater and marine environments and should be considered in the risk classification of waters.

Leptospirosis

Water becomes contaminated with leptospires from the urine of infected domestic animals, primarily rodents. The detection of pathogenic leptospires in water is difficult. They are relatively slow growing in culture and do not compete well against other more rapid growing organisms.

The risk of leptospirosis can be reduced by informing users about the risks of using water that is accessible to domestic and wild animals. Outbreaks of leptospirosis are not common although an outbreak was reported in the United States after a triathlon (CDC Update, August 21 1998).

Schistosomes

The major form of schistosomiasis are caused by five species of water borne flatworms called schistosomes. Schistosomes enter the body through contact with infested surface water. Schistosomes eggs are evacuated from the human body via faeces or urine. They hatch into swimming larvae called miracidia. These swim about until they locate a snail and bore into its body. Over a period of 3 to 4 weeks, miracidia develop into sporocysts, which each produce thousands of cercariae, the next infective stage. A single snail can shed thousands of cercariae each day.

Although the majority of cases of schistosomiasis are in tropical countries, many outbreaks of the disease have been reported in western countries. During July 1987 more than 65 people developed an itchy rash with fever, nausea and vomiting after attending a water sports park in Suffolk, UK (Eastcott, 1988). It was discovered that snails from the lake were emitting cercariae.

In the summers of 1985 and 1986, 118 people contracted cercarial dermatitis after swimming in a reservoir in central Bohemia, Czechoslovakia (Kolarova *et al.,* 1989). Surveys of the reservoirs found many infected snails.

Naegleria fowleri

Naegleria fowleri are free living amoeboflagellates that normally live in warm freshwaters and hot springs, unchlorinated swimming pools, and in warm wastewater pools from power plants. The ameoba survive by feeding off bacteria. *Naegleria fowleri* is found worldwide.

Infected water is inhaled through the nose and the pathogen penetrates the nasal membranes and enters the cerebrospinal fluid by following the nasal nerves. The ameoba then penetrate and feed on brain tissue (Hunter, 1998). *N. fowleri* have been isolated from lakes, rivers, swimming pools, sewage sludge, thermal effluents and drinking waters (Fewtrell, 1994a). The optimum temperature for growth is found to be 37-45^{o}C. Despite *N. fowleri* being commonly found in many surface waters, human disease is quite rare. Visvesvara and Stehr-Green (1990) recorded only 144 cases worldwide. Cases have been reported from the United States, South America, Europe, Australia, and New Zealand in persons swimming in freshwaters, lakes, and ponds, and even in indoor pools filled with chlorinated heated river water, as the ameoba are very resistant to chlorine. The UK has had three cases. Cain *et al.,* (1981) report the case of a young girl who died as a result of primary ameobic meningoencephalitis after swimming in a thermal pool in Britain.

Toxic algae and cyanobacteria

There is a lack of scientific evidence for effects of toxic algae on recreational users of marine waters – although there are many reports of human health impacts after consumption of shellfish and fish. The primary concern for human health focuses on toxic cyanobacteria which cause scums in freshwaters. Although there is considerable evidence for potentially severe health effects associated with scums caused by toxic cyanobacteria, no human fatalities have been attributed to oral ingestion of scum, even though many animal deaths have been reported – probably due to the larger volumes of water that the animals would ingest. Studies by Philipp (1992), Philipp and Bates (1992) and Philipp *et al.,* (1992) into human health risk assessment amongst dinghy sailors, recreational fishermen, and windsurfers exposed to

Microcystis and *Gloeotrichia* blooms did not identify any adverse health risks. However, adverse health outcomes resulting from contact with and/or ingestion of cyanobacterial cells and toxins is now recognised. These include skin irritations, allergic responses, and mucosa blistering, muscular and joint pains, gastroenteritis, pulmonary consolidation, liver and kidney damage and a range of neurological effects (Codd, 2000). There are three potential routes of exposure of recreational users to cyanotoxins – direct contact of exposed parts of the body, and the areas covered by a bathing suit (Pilotto *et al.,* 1997); accidental swallowing (Turner *et al.,* 1990); and inhalation of water.

There are not many reports of bathing sites having been closed due to mass occurrences of toxic algae. Cronberg *et al.,* (1988) describe how a number of Swedish lakes used for bathing were closed due to mass occurrence of the flagellate *Gonyostomum semen* which causes skin irritations and allergies. Surface aggregations of planktonic cyanobacteria occur more often. The high density of cells containing toxins may reach concentrations likely to cause health effects.

Surface aggregations of planktonic cyanobacteria occur because of their capability to regulate their buoyancy allowing them to reach optimal water depths for their growth. Scum formation is influenced by the morphological conditions of the water body, such as the water depth from which the cyanobacteria can reach the surface and the wind which pushes surface aggregations together from shoreline scums. The characteristics of the water body will determine how fast accumulated scum material disperses. In shallow bays this will be a longer time. The risk to recreational users occurs where clumps of filaments are broken off after storms or where cyanobacterial mats naturally detach from the sediment and are accumulated on the shore (Edwards *et al.,* 1992). It is difficult to define a 'safe' concentration of cyanobacteria in recreational water in relation to allergenic effects or skin reactions, since individual sensitivities vary. Dermal reactions may be aggravated where cyanobacterial cells are disrupted under bathing suits or wet suits. WHO have produced guidelines for safe practice in managing bathing waters which may produce or contain cyanobacterial cells and/or toxins (Table 14).

The increasing understanding of the health hazards associated with toxins and their occurrence in natural and controlled waterbodies supports the need for eutrophication control measures such as those suggested by the Environment Agency (NRA, 1990b) to provide long-term contributions to the reduction of health risks due to cyanobacterial toxins in recreational water.

Table 14. WHO Guidelines for safe practice in managing bathing waters which may contain or produce cyanobacterial cells and/or toxins (adapted from WHO, 1999a)

Guidance level or situation	**Health risks**	**Recommended action**
Cyanobacterial scum formation in bathing area	Potential for acute poisoning. Potential for long-term illness with some cyanobacterial species Short-term adverse health outcomes e.g. skin irritations/ gastrointestinal illness	Immediate action to prevent contact with scums; possible prohibition of swimming and other water-related activities. Public health follow-up investigation Inform relevant authorities
100,000 cells cyanobacteria per ml or 50 ug chlorophyll a per litre with dominance of cyanobacteria	Potential for long-term illness with some cyanobacterial species Short-term adverse health outcomes e.g. skin irritations/ gastrointestinal illness	Watch for scums Restrict bathing and further investigate hazard Post on-site risk advisory signs Inform relevant health authorities
20,000 cells cyanobacteria per ml or 10 ug chlorophyll a per litre with dominance of cyanobacteria	Short-term adverse health outcomes e.g. skin irritations/ gastrointestinal illness, probably at low frequency	Post on-site risk advisory signs Inform relevant authorities

The health impairments from cyanobacteria in recreational waters should differentiate between the irritative symptoms caused by unknown cyanobacterial substances and the more hazardous exposure to high concentrations of known cyanotoxins, particularly microcystins. WHO therefore advocate a series of guidelines associated with increasing severity and probability of adverse affects (Table 15). As with microbiological hazards the level of risk that recreational water users expose themselves to will be dependent on the duration of exposure and quantity of water ingested.

The WHO Guidelines for drinking water quality has derived a guideline value of 1 µg/l microcystin-LR (provisional) (WHO, 1997b) which is already being used in Australia and the UK in the day to day management of water supply from sources affected by cyanobacterial blooms (Codd, 2000). Once further data are available for other cyanobacterial toxins other than microcystin, targets for eutrophication control can be set according to waterbody use.

Table 15. WHO Guidelines associated with incremental severity and probability of adverse effects from cyanobacteria and cyanotoxins in recreational waters (adapted from WHO, 1999a).

Level of severity of adverse health effect	Guideline levels
Relatively mild and /or low probabilities of adverse health effects	For protection from irritative or allergenic effects of cyanobacterial compounds Density of 20,000 cyanobacterial cells / ml 2-4 µg l^{-1} microcystins
Moderate probability of adverse health effect	Density of 100,000 cyanobacterial cells per ml 20 µg l^{-1} microcystins. This is based on the WHO drinking water Guidelines and assumes that an adult of 60 kg consumes 100 ml water whilst swimming.
High risk of adverse health effects	For a child of 10 kg ingestion of 2 mg microcystins or less could be expected to cause liver injury.

Guidelines / standards considering naturally occurring hazards

The WHO Guidelines for safe recreational water environments (WHO, 1998) consider cyanobacteria and algae as well as ‘dangerous aquatic organisms’. No limits are set for these parameters.

The Guidelines for Canadian recreational water quality (MNHW, 1992) consider protozoa – *Giardia*, *Cryptosporidium*, *Naegleria* and *Entamoeba histolytica* and the helminth *Schistosoma*. Toxic phytoplankton and vector organisms are also mentioned.

5.1.4 Physical and Chemical Parameters

pH

The pH of the water may have a direct impact on recreational water users where it is excessively high or low. Of particular concern would be skin or eye irritations although very little evidence of either of these has been recorded in recreational water users.

Guidelines/standards considering pH

The Canadian recreational water quality guidelines (MNHW, 1992) specify that the pH of waters used for total body contact recreation should be in the range of 6.5-8.5. If the water has very low buffering capacity, pH values between 5.0 and 9.0 should be acceptable. This was derived from the work of Mood (1968) and Basu *et al.*, (1984).

WHO (1998) considers pH but has not set guideline standards. The EC bathing water Directive (unrevised; CEC, 1976) specify an imperative pH standard of 6-9.

Turbidity

Safety hazards associated with turbid or unclear water are dependent on the intrinsic quality of the water itself. However, lifeguards and other persons near the water should be able to see and distinguish people in distress. In addition, swimmers should be able to see while under water.

Guidelines/standards considering turbidity

The Canadian recreational water quality guidelines (MNHW, 1992) set a maximum limit of 50 nephelometric turbidity units (NTU).

Clarity – light penetration

Bathing and swimming areas must be clear enough for users to estimate the depth, to see subsurface hazards easily, and detect submerged bodies of users easily. As well as the safety factors, clear waters facilitate the enjoyment of the aquatic environment.

Guidelines/standards considering clarity

For primary contact recreation the Canadian recreational water guidelines suggest a Secchi disc should be visible at a minimum depth of 1.2m (MNHW, 1992).

The EC bathing water Directive (CEC, 1976) set an imperative standard of 1 metre measured by Secchi disc and a guideline standard of 2 metres to measure clarity.

6. REVIEW OF PROGRESS TO RECREATIONAL WATER QUALITY STANDARDS

A number of countries/organisations are in the process of reviewing their recreational water quality standards or guidelines:

6.1 European Community bathing water Directive

The EC bathing water Directive (CEC, 1976) is 25 years old and it is generally accepted that its revision is long overdue. The revision has begun with the adoption of a Communication to the European Parliament and the Council entitled '‘Developing a new bathing water policy’.

The proposal was discussed at length during a bathing water conference held in Brussels 24-28 April 2001 attended by around 125 participants from Member States. The outcome of the discussions will be considered during the drafting of the revised bathing water Directive, which will be tabled towards the end of 2001.

There has been considerable debate about the shortcomings of the bathing water Directive (76/160/EEC). The primary issues are: the retrospective nature of the monitoring and reporting system associated with the Directive which could lead to the public being exposed to health risks; the appropriateness of the microbial indicators on which compliance is based; the inadequacy of the reporting system of the results of the microbiological monitoring – for example, bathing waters are classified as either pass or fail, whereas in reality the poor or good water quality could be localised and the water could be graded. The Directive fails to recognise the inherent problems associated with microbiological monitoring – in particular the spatial and temporal factors affecting bacterial survival, the problems associated with comparing results nationally and internationally due to analytical reproducibility and inter-laboratory comparability, the costs involved in data collection and subsequently in treating waters to meet compliance with the Directive, and the problems associated with interpretation and presentation of results.

In addition, the current bathing water Directive does not consider the source of pollution affecting the quality of the water. There is currently debate concerning the level of risk to public health from faeces derived from animal sources as opposed to human sources. This may be significant in the choice of the most appropriate indicator.

The scope of the EC bathing water Directive is an issue of particular relevance to this report. A major shortfall with the 1976 EC bathing water Directive is that activities other than bathing are not specified. The coastal and freshwater environment is used for a variety of recreational water activities which vary from ‘no contact’ with the water environment to ‘extensive direct contact’ resulting in full body immersion. The trend is that the coastal and freshwater environments are used by an increasing number of people throughout Europe for recreational activities and this has enormous financial implications for the tourism industry. The protection afforded by the EC bathing water Directive should logically then protect all these user groups. With the proposed definition of bathing for the revised Directive – any direct body contact with water involving head submersion and/or risk of ingestion of water – arguably water sports involving risk of ingestion of water such as windsurfing, surfing, jet skiing etc will be included in the proposed revision. This may have considerable implications for the definitions of bathing areas.

The Communication indicates that the revised Directive will take a new approach towards the protection of bathing waters through a combination of water quality assessment and management actions where the water is shown to have problems rather than on monitoring requirements, and there will be a greater emphasis on provision of information to the public and raising awareness. There will be a greater significance on clarifying the relationship of the bathing water Directive with other directives, such as the Water Framework Directive and the Urban Waste Water Directive. The costs and benefits of the proposed measures will need to be analysed.

6.2 WHO Guidelines for Safe Recreational Water Environments

The WHO has been concerned with the health of bathers and tourists for many years. In 1994 it was decided to initiate development of guidelines concerning recreational use of water. The process took around five years.

The draft WHO guidelines for safe recreational water quality were released in 1998 and considered a variety of hazards affecting recreational water users with a focus on the derivation of guidelines for recreational water quality assessment. There were subsequent expressions of concern that a regulatory approach based principally on the monitoring of faecal pollution of recreational waters was too limiting. The concept of combining water quality assessment with a form of sanitary inspection, taking into account environmental hazards impacting on recreational water quality and resulting in a classification scheme, was developed by a WHO expert consultation that met in Annapolis, USA in 1999 (WHO, 1999b). This concept was further refined by a WHO consultation meeting held in Farnham, UK in 2001 (WHO, 2001).

The scheme focuses on faecal contamination from humans, with less importance being placed on faecal contamination from other sources, such as drainage from areas of animal pasture and intensive livestock rearing, the presence of gulls or the use of beaches for horses or dogs. The rationale for this is that the pathogens transmitted by this route are fewer, and most of them have relatively higher infectious doses, thus posing less risk of transmission from animal excreta than human excreta. As a result, the use of faecal indicator bacteria alone as an index of risk to human health may significantly overestimate risks where the indicators derive from sources other than human excreta.

In 2001 WHO reviewed the evidence concerning health effects of faecal pollution of recreational waters that had become available since the release of the draft Guidelines in 1998 and further developed a monitoring protocol for recreational waters which aims to:

- Move away from the sole reliance on ‘guideline values of faecal indicator bacteria’ to the use of qualitative ranking of faecal loading in recreational water environments, supported by direct measurement of appropriate faecal indicators; and
- Account for the impact of actions to discourage water use during periods or in areas of higher risk.

- Classify recreational waters

The criteria for assessing and classifying beaches and other recreational water environments, are based on microbiological characteristics of human health significance. The guidelines apply to recreational and sporting activities in which there is whole body immersion, such as swimming, diving, waterskiing, windsurfing, kayak rolling etc, i.e. primary contact recreation.

For activities in which whole body immersion is rare or absent, such as paddling, boating, rafting (secondary contact recreation), WHO recommend that the corresponding criteria relating to microbial indicators should be set at least an order of magnitude higher than those recommended for primary contact recreation.

For passive recreational use of water bodies, e.g. walking, aesthetic enjoyment of the water, the criteria relating to microbial indicators are recommended to be at least another order of magnitude higher again.

The WHO guidelines recommend the use of faecal streptococci or enterococci as the primary microbial indicators for temperate waters (WHO, 1998). These are considered superior to thermotolerant coliforms and *E. coli* as predictors of human health risk at bathing beaches, due to their slower die-off in seawater, chlorinated wastewaters and in response to solar radiation.

Based on the microbiological assessment of the water four categories of quality are suggested (Table 16).

Table 16. World Health Organisation proposed microbiological assessment categories for faecal streptococci/enterococci in recreational waters (WHO, 2001)

Microbiological category label	Recreational water quality	95th percentile (faecal streptococci per 100 mL)
A	Favourable	40
B	Satisfactory	41-200
C	Passing	201-500
D	Unacceptable	>500

It is recommended that recreational water environments should also be subject to an annual sanitary inspection to determine whether pollution sources have changed (WHO, 2001). The three most important sources of human faecal contamination of recreational water environments for public health purposes are identified as:

- Sewage
- Riverine discharges, where the river is a receiving water for sewage discharges and either is used directly for recreation or discharges near a coastal or lake area used for recreation; and
- Bather contamination, including excreta.

In addition to these, other sources of human faecal contamination include septic tanks near the shore, leaching directly into groundwater seeping into the recreational water environment, shipping and local boating, including moorings and special events such as regattas etc. It is recognised that the degree of flushing of the bathing area also needs to be taken into account.

Additional information that should be considered in assessing the safety of recreational waters and in controlling associated risks include:

- Rainfall (duration and quantity) – increased flushing into recreational waters can raise indicator densities to high levels, through for example animal wastes washed from urban or agricultural land. Resuspension of pathogens trapped in sediment is another factor influenced by rainfall, and is a particular issue for freshwater catchments. In all cases the effect of rainfall on recreational water quality can be highly variable, and characteristic for each recreational water area.
- Wind (speed and direction)
- Tides and currents
- Physiography of the bathing area.

The WHO (2001) report recommends a primary classification scheme for coastal and other recreational water environments based on a matrix of five sanitary inspection categories (very low to very high in susceptibility to faecal influence) and the four microbiological assessment categories (A-D; Table 16). This scheme will be discussed in section 7 of this report.

6.2.1 Epidemiological basis of the criteria for WHO Guidelines for microbiological quality of recreational waters

UK epidemiological studies (Kay *et al.,* 1994; Fleisher *et al.,* 1996) form the key studies for the derivation of the WHO Guideline values since they provided a stronger relationship with faecal streptococci/enterococci than other epidemiological studies, and produced higher estimates of gastrointestinal symptoms. However, these studies are primarily indicative for adult populations in marine waters in temperate climates and do not take into account the lesser degree of protection that children have. In addition, these Guidelines were derived from studies where the 'exposure' was a minimum of ten minutes bathing involving three immersions. They may therefore underestimate risks for activities involving higher risks of water ingestion or longer periods of water contact (although water users spending longer periods of time in the water may build up higher immunity levels). The experimental protocol used by Kay *et al.,* 1994 required self-reporting of symptoms. However, one week after exposure all volunteers returned for interview and medical examinations to validate the symptoms and three weeks after exposure they completed a final postal questionnaire.
In order to derive Guideline values for activities other than swimming, information on typical users (e.g. age, frequency of the activity per season/month or annum) is required. The local authorities can then adapt the Guideline values to the circumstances (taking into account physicochemical conditions), expressing health risk in terms of the rate of illness affecting a 'typical' bather over a fixed period of time.

The principal of risk assessment can be adapted to any human health effect and could therefore be adapted for other parameters other than pathogens affecting the quality of recreational waters. Constraints to the application of risk assessment to recreational water include the current lack of specific data for many pathogens and other health risks to users.

6.3 New Zealand Recreational Water Quality Guidelines

The Ministry for the Environment for New Zealand has revised the 1998 Bacteriological Water Quality Guidelines for Marine and Fresh Water and renamed them as the Recreational Water Quality Guidelines (Ministry for the Environment, 1999). The Guidelines cover three categories of water use:

- Marine bathing and other contact recreation activities
- Fresh water bathing and other contact recreation activities (although due to lack of research into health implications from freshwater bathing these are interim guidelines)
- Recreational shellfish gathering in marine waters (but not commercial shellfish harvesting)

The Guidelines cover the interpretation of monitoring results from surveys of bacteriological indicators of faecal contamination but do not cover other impacts on water uses, such as water clarity or marine biotoxins from algal blooms.

The Guidelines promote a three tier system:

- Clean: 'safe for bathing' (green), requiring water managers to continue routine monitoring (weekly).
- Potentially contaminated: 'Potentially unsafe' (amber), requiring water managers to undertake further investigation to assess the safety.
- Highly likely to be contaminated: 'highly likely to be unsafe' (red), requiring urgent action from water managers, such as closing a beach.

The 1992 Guidelines set upper limits based upon the intensity of beach use (following US EPA), with the idea of minimising community risk. Under this scheme the limits for an infrequently used beach were higher than those for popular beaches. Designation of beaches according to the level of use is not now considered practical for application in New Zealand due to public concern that they were exposed to a higher risk when using more remote beaches. The current approach is to minimise individual risk. Beaches are either 'contact recreation areas', i.e. well–used or are not considered 'contact recreation areas' i.e. are not well used. However, indexing classifications to catchment use and susceptibility to faecal influence is now being considered (G. Mcbride, personal communication, 2001).

6.4 Australian Recreational Water Quality Guidelines

In Australia the National Health and Medical Research Council (NHMRC), Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) all recognise the need for a single guideline document to supersede the current Australian guidelines for recreational water quality which date back to 1990 (NHMRC, 1990). The current guidelines are based on thermotolerant coliforms as the universal indicator in fresh and marine waters. It is intended that the proposed revised guidelines should be largely based on recommendations from the WHO guidelines (WHO, 1998 and WHO, 2001).

There is also a second set of national guidelines which were put out by the Environmental Protection Agency of Australia in 1992 and recently (2000) reissued in the environmental guidelines publication. However, this is an interim document and is waiting endorsement by relevant government stakeholders. These guidelines are based on both enterococci and thermotolerant coliforms.

States chose which of these guidelines to follow. However, this has lead to a situation where for example in Western Australia the Health department applies the NHMRC guidelines and the Department of Environmental Protection applies the other set.

Both sets of guidelines distinguish between primary and secondary contact recreation, and tertiary contact, aesthetic or visual use. However, almost all interest and effort is focused on primary contact recreation in Australia (R. Lugg, personal communication, 2001).

6.5 Water Protocol

Of direct relevance to recreational waters is the Water Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes adopted at the Third Interministerial Conference on Environment and Health, London 1999. The provisions of this Protocol apply to: (a) surface freshwater; (b) groundwater; (c) estuaries; (d) coastal waters which are used for recreation or for the production of fish by aquaculture or for the production or harvesting of shellfish; (e) enclosed waters generally available for bathing.

The objective of this Protocol is to promote at all appropriate levels, nationally as well as in transboundary and international contexts, the protection of human health and well-being, both individual and collective, within a framework of sustainable development, through improving water management, including the protection of water ecosystems, and through preventing, controlling and reducing water-related disease.

The Protocol is not only relevant to diseases affecting the skin, and ear and eye problems, but also draws special attention to the health problems which can result from the use of semi-enclosed waters or completely closed waters for recreational purposes, where concentrations of pollutants may occur.

7. POSSIBLE APPROACHES FOR CLASSIFYING RECREATIONAL WATERS

This review of the literature has shown that, in general, standards for recreational waters focus on bacteriological criteria and are adopted for primary contact recreation uses (as defined by US EPA, 1986). This definition also covers the activities of children. Current approaches to the elaboration and setting of water quality objectives differ internationally (Tables 7 and 8).

The classification of waters according to use does not seem to be common. A review of the literature revealed some examples of interest: the US EPA, 1986 ambient water quality criteria for bacteria; the recently published WHO classification scheme (WHO, 2001; and the Black Sea environmental quality objectives (BSEP, 2001). All these were designed for use in coastal waters but could be potentially adapted for freshwaters and to protect the health of participants other than bathers.

The approach of establishing water quality objectives for individual water bodies takes into account site-specific characteristics of a given water body. This is being applied for instance in North America in the Great Lakes and in some river basins in Europe. Its application requires the identification of all current reasonable potential water uses. Designated uses of or "assets" to be protected in marine waters may include: fish spawning and nursery grounds, economically important fishing areas, shellfish cultivation, bathing and water-sports, and ports and harbours.

In this approach, generally a limited number of existing water quality standards are selected as water-quality objectives for a water body. The water-quality objectives frequently follow the most stringent standard among water uses. In adopting water-quality objectives for a given water, site-specific physical, chemical and hydrological conditions are taken into consideration. These may be related to the overall chemical composition (salinity, pH. dissolved oxygen), physical characteristics (turbidity, temperature, mixing regime), type of indigenous aquatic species and biological community structure and natural concentrations of certain substances (e.g. metals or nutrients).

The following sections describe some examples of generic classification schemes devised by US EPA, WHO and the Black Sea Environment Programme (BSEP).

7.1 US Environmental Protection Agency (EPA, 2000)

While most recreational waters are designated for primary contact recreation in the United States there are some waters where a recreational use with less stringent water quality criteria may be justified. These uses can include the designation of intermittent, secondary, or seasonal recreation uses. In some cases, recreational uses may be removed altogether, for example, waters that are irreversibly impacted by wet weather events or where climate allows primary contact recreation to occur on a seasonal basis only. In these cases meeting the primary contact recreation use at all times would result in considerable social and economic impact.

However, the EPA's recommended water quality criteria (Dufour and Ballentine, 1986) do not suggest water quality criteria for recreation uses other than primary contact recreation. Some States have adopted seasonal and secondary contact recreation uses for waterbodies, even though EPA recommend that States adopt water quality criteria to support primary contact recreation use wherever feasible to ensure protection of human health from gastrointestinal illness. Although conditions such as the location of the waterbody, high or low flows, safety concerns, or other physical conditions of the waterbody may make it unlikely that primary contact recreation would occur, EPA believes that people, particularly children, may swim or make other use of waterbodies regardless of the physical conditions, such that ingestion may occur. Other activities such as kayaking or surfing may encourage participants to use high flow or unsafe waters.

Where States wish to adopt a subcategory of recreation uses with less stringent water quality criteria that are less protective than the EPA's recommended criteria for primary contact recreation, they must demonstrate (and attain approval from EPA) that primary contact recreation is not an existing use and the water quality necessary to support the use is not attainable based on chemical, physical and biological analyses, as well as economic considerations.

An **intermittent** recreation use may be appropriate where the water quality criteria associated with primary contact recreation are not attainable for all wet weather events, even with well-designed and operated systems. In this case the standards for primary contact recreation would be suspended during defined periods of time, usually after a specified hydrologic or climatic event.

Where primary contact recreation is not an existing use, a **secondary contact recreation** use with less stringent water quality criteria may be appropriate in some circumstances.

A **seasonal recreation** use may be appropriate where primary contact recreation is only possible a few months out of the year. Determining the length of time the recreation use should be suspended and what water quality criteria will apply during this time should be determined on a case-by-case basis taking into account the proximity of outfalls to sensitive areas, the amount of rainfall, time of year etc.

Where subcategories of primary contact recreation are adopted or where a primary contact recreation use is removed States should conduct a use-attainability analyses for recreation uses. This may include:

- Physical analyses considering the actual use, public access to the waterbody, facilities, proximity to residential areas, safety considerations, and substrate, width etc of a waterbody.
- Chemical analysis of existing water quality

- Potential for water quality improvements including an assessment of nutrients and bacteriological contaminants; and
- Economic /affordability analyses.

7.2 WHO Classification Scheme (WHO, 1999b; 2001)

The approach suggested by WHO to classify recreational waters addresses some of the concerns and constraints which are evident in the current standards and guidelines. The proposed WHO approach does not have exclusive reliance on microbiological criteria, but rather a focus on broader data collection for management options to reduce user risk.

The approach leads to a classification scheme through which a recreational water used for contact recreation would be assigned a class (very poor, poor, fair, good, or excellent), based upon health risk. The classification scheme provides a generic statement of risk and indicates the principal management and monitoring actions likely to be appropriate to the water body.

The classification is compiled of three principal components:

- Primary classification based upon the combination of evidence for the degree of influence of human faecal material (by a sanitary inspection of the water catchment) together with counts of faecal indicator bacteria (a microbiological quality assessment).
- Identification of factors likely to influence faecal contamination such as nearby rivers, or storm water outlets that may be influenced by rainfall events or sewer overflows.
- The possibility of reclassifying a beach class if a significant change in the catchment management reduces or increases human exposure to microbial risk.

In the WHO guidelines, health risk is expressed in terms of the rate of illness affecting a ‘typical’ bather over a fixed period of time (WHO, 1998; Table 6). A ‘typical’ bather is considered to be a person receiving 20 exposures throughout the bathing season, each of which might involve three instances of head immersion and approximately ten minutes in the water. This could be during a 10-day holiday in which the bather entered the water twice a day, or through a person visiting a local beach one day every two weeks during a 20 week bathing season and entering the water twice per visit.

The scheme does not therefore address users experiencing long periods of immersion or people participating in sports where immersion and ingestion of water may be very fast, e.g. surfing. As discussed earlier in this report (section 4) the majority of epidemiological studies have not addressed activities other than bathing or activities in freshwaters. It is acknowledged by WHO that epidemiological data on freshwaters or exposures other than bathing are currently inadequate to present a parallel analysis for defined reference risk (WHO, 2001 page 20). It is clear that suitable microbiological standards need to be developed to protect users (other than bathers) of recreational waters – fresh and marine waters.

The WHO classification scheme requires an environmental hazard assessment (see for example Figueras *et al.*, 2000; WHO, 2001) and microbiological water quality assessment to be performed. The three most important sources of human faecal contamination of recreational-water environments for public health purposes are identified as sewage; riverine discharges, where the river is a receiving water for sewage discharges and either is used directly for recreation or discharges near a coastal or lake area used for recreation; and bather contamination, including excreta. WHO has ranked the relative risks to human health from these sources taking into account the pollution load, using population as an index. Information on local circumstances needs to be taken into account – for example, a river discharging into an enclosed bay can be considered of higher risk than one discharging directly into the open sea (Table 17).

Table 17. Relative risk potential to human health through exposure to sewage through outfalls (WHO, 2001)

Treatment	**Discharge Type**		
	Directly on beach	**Short outfall**[a]	**Effective outfall**[b]
None[c]	Very high	High	NA
Preliminary	Very high	High	Low
Primary (incl. Septic tanks)	Very high	High	Low
Secondary	High	High	Low
Secondary plus disinfection	Moderate	Moderate	Very low
Tertiary	Moderate	Moderate	Very low
Tertiary plus disinfection	Very low	Very low	Very low
Lagoons	High	High	Low

[a] The relative risk is modified by population size. Relative risk is increased for discharges from large populations and decreased for discharges from small populations.
[b] This assumes that the design capacity has not been exceeded and that climatic and oceanic extreme conditions are considered in the design objective (i.e. no sewage on the beach zone)
[c] includes combined sewer overflows

Rivers discharging in coastal areas may carry a heavy load of microorganisms from a variety of sources, including municipal sewage and animal husbandry. Following rainfall, microbial loads may be significantly increased due to surface run-off, urban stormwater overflows and resuspension of sediments.

Recreational areas on rivers will be subjected to similar influences. In addition, where water flow is managed, either for recreation or for other purposes, the act of impoundment and discharge itself may lead to elevated microbial levels through resuspension of sediment. Much lower levels of effluent dilution may occur in riverine environments than in coastal equivalents, and differential pathogen-indicator organism relationship may exist in saline and non-saline waters. Riverine discharges may be categorised with respect to the sewage effluent load and degree of dilution in a way similar to that presented in Table 18.

Table 18. Relative risk potential to human health through exposure to sewage through riverine flow and discharge (WHO, 2001)

Dilution effect[ab]	Treatment level				
	None	Primary	Secondary	Secondary plus disinfection	Lagoon
High population with low river flow	Very high	Very high	High	Low	Moderate
Low population with low river flow	Very high	High	Moderate	Very low	Moderate
Medium population with medium river flow	High	Moderate	Low	Very low	Low
High population with high river flow	High	Moderate	Low	Very low	Low
Low population with high river flow	High	Moderate	Very low	Very low	Very low

[a]The population factor includes all the population upstream from the recreational-water environment to be classified and assumes no in-stream reduction in hazard factor to classify the recreational-water environment

[b]Stream flow is the 10% flow during the period of active beach use. Stream flow assumes no dispersion plug flow conditions to the beach.

Sheltered recreational water use areas often attract a higher number of recreational water-users and may present particular problems. Small volume, low circulation and low water exchange rates often occur in such bodies of water (section 4.3). The indicator and pathogen concentrations in the water may be strongly influenced by slow exchange rates, and the sewage effluent may be effectively trapped for long periods of time.

Bather-derived faecal pollution may present a significant health risk, and microbial build-up can occur during the day, such that peak levels are reached by the afternoon. The two important factors in relation to bathers are bather/user density and degree of dilution (Table 19). Low dilution or no water movement may occur in lakes, lagoons and coastal embayments which are often the sites for novice watersport enthusiasts. The likelihood of bathers defecating or urinating into the water is substantially increased if toilet facilities are not readily available.

Table 19. Relative risk potential to human health through exposure to sewage from bathers (WHO, 2001)

Bather shedding	Category
High bather density, high dilution[a]	Low
Low bather density, high dilution	Very low
High bather density, low dilution[a,b]	Moderate
Low bather density, low dilution[b]	Low

[a]move to next higher category if no sanitary facilities available at site
[b]If no water movement

Sheltered coastal areas and shallow lakes may also be subject to accumulation of sediments, which may be associated with high microbial loads that may be resuspended by water users/rainfall events.

The classification of the recreational water use area is calculated from the results of the sanitary inspection and microbiological assessment (Table 20).

Table 20. Classification scheme for recreational waters based on combined sanitary and microbiological assessment under new WHO Guidelines (WHO, 2001)

Microbiological assessment category (faecal stretptococci/enterococci indicator counts)						
		A **40**	**B** **41-200**	**C** **201-500**	**D** **>500**	**Exceptional circumstances**
Sanitary inspection category Susceptib ility to faecal influence)	Very low	Very good	Very good	Follow up	Follow up	
	Low	Very good	Good	Fair	Follow up	
	Moderate	Follow up	Good	Fair	Poor	
	High	Follow up	Follow up	Poor	Very poor	
	Very high	Follow up	Follow up	Poor	Very poor	
	Exceptional circumstances*					

*Such as risk of transmission of pathogens associated with more severe health effects

In many circumstances several contamination sources would be significant at a single location, and therefore a recreational water should be categorised according to the single most significant source of pollution. The water can then be reclassified if appropriate and effective management actions are implemented, or should the water be affected by pollution events.

7.3 Black Sea (BSEP, 2001)

The GEF BSEP was established in June 1993 with three primary objectives:

- to strengthen and create regional capacities for managing the Black Sea ecosystem;
- to develop and implement an appropriate policy and legal framework for the assessment, control and prevention of pollution and the maintenance and enhancement of biodiversity; and
- to facilitate the preparation of sound environmental investments

The BSEP is being implemented through a network of national coordinators, thematic regional activity centres and focal point institutions targeting: emergency response, routine pollution monitoring, special monitoring, biodiversity protection, coastal zone management, environmental legislation and economics, data management and GIS, and fisheries. The overall programme coordination is conducted by a Project Coordination Unit, based in Istanbul.

Pilot studies completed by WHO within the BSEP have shown a relatively large percentage of samples indicating unacceptable quality of Black Sea bathing water (WHO, 1995). Data on beach and bathing water quality is rarely revealed to the public and the methodological approaches are not harmonized. A number of heavily polluting land-based point sources within coastal areas of each Black Sea coastal country have severe impacts on human health, beach tourism, commercial fisheries and biodiversity. Economic valuation of the effects of pollution from these 'hot spots' and other polluting sites indicate that, in the case of beach tourism alone, actions leading to a 20% improvement in Black Sea water quality could generate $550 million in annual economic benefits to coastal economies. This estimate does not include expected benefits to human health and fisheries (http://www.unep.org/search/unep.asp?q=BSEP).

The BSEP has recently developed a series of Environmental Quality Objectives (EQOs) for water and sediment quality for recreational activities, ports and harbours, protected areas, bottom sediment and the general ecosystem. The approach for the application of EQOs within the Black Sea region represents a combination of methods, i.e. water or sediment quality standards proposed for a variety of human uses and for general ecosystem protection, in combination with a classification scheme to determine actual quality. The EQO approach has been proposed as the basis of a management framework with two essential elements: the principal one being the assessment of compliance to standards for a specific use, and the secondary consideration being the distance from compliance in cases where water bodies are classified as below an acceptable quality class. The designation of a particular area of water for a specific use will therefore depend on both the relative compliance with specified standards and the overall adjudged water and sediment quality. The designation of a quality class together with the compliance to specified standards is also an important requirement for the relocation of dredged sediment. Such a system is currently in practice within Ukrainian territorial waters.

To develop a management framework for compliance with water and sediment quality standards for all parameters of some relevance to aquatic ecosystems and water uses, national authorities are faced with an excessive and costly monitoring burden. In order to avoid this, a two tier system was suggested for each component of the framework (i.e. ecosystem protection and each water use), with parameters being defined as either 'Tier 1' or 'Tier 2', depending on their relative importance in terms of ensuring protection of that use. Generally, Tier 1 parameters should always be monitored to ensure the most important standards are set for the ecosystem protection compliance and specific water uses. Compliance with standards set for the additional Tier 2 parameters, however, is only required where these are known be present and where ecosystems and human uses of a waterbody may be compromised. In this way the ecosystem protection component and specific water uses receive an appropriate level of safeguard while not entailing excessive cost. Since the objective underlying each water use is very different, the justification for assigning different parameters to Tiers 1 and 2 is also very different.

In terms of the BSEP recreational waters are defined as those used primarily for sports in which the user comes into frequent contact with the water, either as part of the activity or incidental to the activity. Other recreational uses, which have less frequent direct contact with the water, include boating, canoeing and fishing. A third category concerns passive recreational use of surface waters, mainly as pleasant places to be near and involves no body contact. The importance of the different water quality parameters varies depending on the category of recreational use (Table 21).

Due to the short exposure of swimmers, recreational water quality standards for hazardous substances such as heavy metals and/or organic micropollutants are not included. Standards for these substances would be less stringent than those established for other water uses.

Some standards have been established in UN/ECE countries aimed at the protection of the aesthetic properties of water. These standards are primarily oriented towards the visual aspect. They are usually non-quantifiable because of the varying acuteness of sensory perception and because of the variability of local conditions and may specify, for example, that waters must be free of floating oil or other immiscible liquids, floating debris, excessive turbidity, and objectionable odours. For primary contact, the parameters in Tier 1, are based on those listed in the EC Bathing Water Directive (76/160/EEC; CEC, 1976), and relate to microbiological and aesthetic quality. These latter parameters include hydrocarbons, phenolic compounds and surfactants which cause aesthetic rather than toxicological problems (e.g. oily films, odours and foaming) (Table 8). Such parameters can be "monitored" by a simple visual inspection. For secondary contact and non-contact activity, only aesthetic parameters are required for classification as Tier 1 since it is not considered necessary to monitor microbiological quality for these activities as the risk of exposure is minimal or non-existent. The selection of microbiological and/or aesthetic parameters is therefore dependent on the recreation use and as such negates the need for Tier 2 parameters.

Table 21. Water quality parameters relevant to different recreational uses (source: Black Sea Environment Programme consultation document)

Characteristics	Primary contact[1]	Secondary contact[2]	Visual use[3]
Microbiological	X	X	
Nuisance organisms (e.g. algae, jellyfish)	X	X	X
Physical and chemical guidelines			
Aesthetics	X	X	X
Clarity	X	X	X
Colour	X	X	X
PH	X		
Temperature	X		
Toxic chemicals	X	X	
Oil, debris	X	X	X

[1]Primary contact sports Include: swimming, scuba diving, water skiing, canoeing, dinghy sailing.

[2]Secondary contact activities include: rowing, yachting.

[3]No contact activity but water essential to enjoyment. e.g. walking, sun-bathing, picnics, bird-watching

In the 'Black Sea scheme' recommended Tier 1 parameters for recreational waters are given in Table 22.

Table 22. Mandatory (Tier 1 indicated by 1) and Guide (Tier 2, indicated by 2) parameters for monitoring for recreational activities in the Black Sea. Other uses of the water body are provided for comparison although additional parameters exist for these other uses (BSEP, 2001).

Parameter	**General Ecosystem**[1] Water column	**Bottom Sediment**[2]	**Protected Areas**[3] Water column	**Ports and Harbours**[4] Water column	**Recreational Activities**[5] Water column
General variables					
Colour			1		1
Odour			1		1
PH	1		1	1	1
Transparency					1
Tarry residues, debris					1
Organic compounds					
Hydrocarbons (total)	1		1	1	1
Phenols (total)	2	1	2	2	1
Surfactants – anionic	2		2	2	1
Microbiological parameters					
E. coli			1		1
Total coliforms			1		1
Enteroviruses			1		1
Faecal streptococci					1
Salmonella			1		1
Blue-Green algae					1
Intestinal parasites					1
Pathogens					1

1 – Tier 1 parameters. These should always be monitored to ensure the most important standards are set for the protection of water users and the ecosystem.

2 – Tier 2 parameters – compliance with tier 2 parameters is only required when these are known to be present and where ecosystem and human uses of a waterbody may be compromised.

[1]General ecosystem includes all parameters for non-protected areas of commercial fishing

[2]The use of sediment refers to the quality of dredged material. However, the same parameters are applied to sediment within general ecological zones, protected areas and ports/harbours. In the case of the ports/harbours, the standards are less stringent

[3]The designation and standards for protected zones will be qualified on a national level.

[4]Ports and harbours include passenger terminals, industrial terminals, fishing ports, navy ports and multi-use facilities

[5]The assessment of recreational water does not include the measurement of parameters within the sediment

The next stage in the development of the protection framework based on EQOs is the establishment of a hierarchical, 5-point classification schemes, for the ecosystem protection component and each specific use category, that describes the physical, chemical and microbiological quality of the water or sediment in relation to compliance/non-compliance with appropriate standards, in addition to the distance from compliance/non-compliance. Therefore, in general terms, the quality of water (or sediment) required to sustain ecosystem and intended human uses, may be classified as either: (1) 'High' quality; (2)'Good' quality; (3) 'Fair' quality; (4)'Poor' quality; (5) "Bad' quality.

The regional standards are intended to protect human health and safety during immersion activities. Water which does not meet the standards specified for the Black Sea waters for microbiological parameters could still be used for other recreational sports which are unlikely to involve immersion e.g. boating, fishing, etc. For these type of activities or for those which do not involve contact with water, maintenance and improvement of aesthetic quality is of greater importance.

It was therefore considered that the Black Sea classification of water for recreational uses should involve monitoring for microbiological and aesthetic quality. The latter is very subjective and it is difficult to define specific standards other than to suggest that quality should be acceptable on the basis of visual inspection. For marine waters used for recreational uses involving no contact, microbiological quality is of lesser importance.

A five-point classification scheme has been developed (after regional consultation) to describe the water quality required for different recreational uses (Tables 23 and 24). Waters which are less than one-fifth of the specified microbiological standards (i.e. less than 0.2 x specified standards) and meet the aesthetic standards are considered to be of 'High' quality. Waters which are less than the microbiological standard, but not more than by a factor of five, and meet aesthetic requirements are considered to be 'Good' quality. Both 'High' and 'Good' quality waters are suitable for all recreational uses.

Additional arbitrary factors of 5 have been applied to the microbiological standards, in order to set the bandings for 'Fair', 'Poor' and 'Bad' quality. The setting of a banding value of five times the standard has been used to broadly approximate the spread of microbiological quality of waters within the region. 'Fair' and 'Poor' quality waters are only recommended for recreational uses other than immersion activities. 'Bad' quality waters are deemed unacceptable for any contact activities. Standards set for long-term protection have been used as a starting point to describe waters of 'High' and 'Good' quality in terms of parameter concentrations. Waters classified as 'Fair', 'Poor' and 'Bad' quality therefore indicate a gradual move away from compliance with standards and a position of worsening water quality. In this way, it will be possible to classify the quality of individual areas of water (and sediment) in the Black Sea region with separate regard to ecosystem protection and each intended human use of the water. This will allow relevant and realistic objectives to be set in terms of water or sediment quality improvement. The proposed scheme will therefore provide a tool for setting objectives for quality improvement that are compatible with a level of quality that a given area of water can realistically support.

Table 23. Basis of 5-point classification scheme for recreational activity – developed for the Black Sea (BSEP, 2001)

Class	Definition of band
'High' quality	<0.2 x specified standards for *E. coli* .
	Meeting the standards for microbiological and aesthetic parameters
	Suitable for all recreational uses
'Good' quality	Meeting the standards for all microbiological and aesthetic parameters
	Suitable for all recreational uses
'Fair' quality	5 x greater than the microbiological standards for either *E.coli*, total coliforms or faecal streptococci.
	Meeting all other standards for microbiology.
	Aesthetic quality acceptable.
	Suitable for recreational uses other than immersion activities (e.g. boating, fishing, etc.)
'Poor' quality	25 x greater than the standards for either *E. coli,* total coliforms or faecal streptococci.
	Meeting all other standards for microbiology.
	Aesthetic quality acceptable.
	Suitable for recreational uses other than immersion activities (e.g. boating, fishing, etc.)
'Bad' quality	25 x greater than the standards for either *E. coli,* total coliforms or faecal streptococci.
	Not meeting one or other standards for microbiology.
	Aesthetic quality unacceptable.
	Not suitable for contact or immersion recreational activities

Table 24. Classification scheme for marine recreation quality requirements – developed for the Black Sea (BSEP, 2001)

Parameter	1 ('High')	2 ('Good')	3 ('Fair')	4 ('Poor')	5 ('Bad')	Critical level for action
Tier 1 Parameters						
Microbiological parameters – quality standards and critical action levels to be decided on a national basis						
E.coli	<0.2 x standard	<standard	>5 x standard	>25 x standard	>25 x standard	Above standard
Total coliforms	<0.2 x standard	<standard	>5 x standard	>25 x standard	>25 x standard	Above standard
Faecal streptococci	<0.2 x standard	<standard	>5 x standard	>25 x standard	>25 x standard	Above standard
Enteroviruses	Absence	Absence	Absence	Presence	Presence	Presence
Salmonella	Absence	Absence	Absence	Presence	Presence	Presence
Blue-green algae	Absence	Absence	Absence	Presence	Presence	Presence
Intestinal parasites	Absence	Absence	Absence	Presence	Presence	Presence
Pathogens (total)	Absence	Absence	Absence	Presence	Presence	Presence
Aesthetic parameters						
Transparency	Visually acceptable (>1m)	Visually acceptable (>1m)	Visually acceptable (>1m)	Visually acceptable (>1m)	Visually unacceptable (<1m)	Visually unacceptable (<1m)
PH	6-9				Outside range	Outside range
Colour	Visually acceptable	Visually acceptable	Visually acceptable	Visually acceptable	Visually unacceptable	Visually unacceptable
Hydrocarbons ($\mu g\ l^{-1}$)	<25	<50	>50	>50	>50	>50
Phenols ($\mu g\ l^{-1}$ as C_6H_5OH)	Organoleptic Satisfactory < 5	Organoleptic Satisfactory < 5	Organoleptic Satisfactory < 5	Organoleptic not satisfactory <25	Organoleptic not satisfactory > 25	Organoleptic not satisfactory >5
Surfactants (mg l^{-1} as lauryl sulphate)	Visually acceptable <0.1	Visually acceptable <0.3	Visually acceptable <0.4	Visually acceptable <0.5	Visually unacceptable >0.5	Visually unacceptable >0.5
Tarry residue and floating waste	Visually acceptable	Visually acceptable	Visually acceptable	Visually acceptable	Visually unacceptable	Visually unacceptable

8. QUALITY AWARD SCHEMES

There are a number of award schemes in place to assess the quality of bathing beaches. The primary objective of these schemes is to inform the public and act as an incentive for improvement of quality. The two major schemes applicable to the UK are the European Blue Flag and the Seaside Award.

8.1 European Blue Flag Awards

The European Blue Flag Award is owned and run by the independent non-profit organisation Foundation for Environmental Education (FEE). The Blue Flag Campaign includes environmental education and information for the public, decision makers and tourism operators.

The award of the Blue Flag is presently based on 27 specific criteria for beaches (Table 25) and 16 specific criteria for marinas. Although the specific requirements are different for the two types of sites, they cover the same subject areas:

- Water Quality
- Environmental Education and Information
- Environmental Management
- Safety and Services

All Blue Flags are awarded for one season at a time. If a beach fails to meet the imperative criteria at any time the Flag should be removed until the criteria are met.
The beaches are judged by a panel in each country consisting of:

- Ministry of Environment
- Environmental organisations
- Association of local authorities
- National lifesaving federation
- Education experts
- Marina experts

There is also a European Jury consisting of:

- 3 representatives from FEE
- 1 representative from United Nations Environment Programme
- 1 representative from European Union for Coastal Conservation
- 1 representative from the European Parliament Environmental Committee

The approved applications and the special cases (dispensations) are sent to the European Jury, which finally decides which beaches and marinas to be awarded the Blue Flag for the season.

During the season the bathing water quality data are controlled by the national environmental protection agency. In-season control visits are made by the national

Table 25. Summary of criteria to achieve a European Blue Flag Award for beaches

Water Quality		Environmental management		Safety and services		Environmental education	
Guideline	**Imperative**	**Guideline**	**Imperative**	**Guideline**	**Imperative**	**Guideline**	**Imperative**
No algal accumulations	Compliance with EC bathing water Directive standards	Facilities for recycling waste	Landuse and development plans in use	Shielded source of drinking water	Beach guards during bathing season	Environmental interpretation centre	Prompt public warning of gross pollution
	No industrial or sewage-related debris on beach	Promote sustainable transportation	Adequate number of litter bins	Easy access to telephone	First aid facilities		Public display of information on flora and fauna in sensitive areas
	Local and regional emergency plans for pollution accidents		Daily beach clean when necessary		Enforcement of national laws concerning animals		Display of updated information about water quality
	Compliance with EU Urban wastewater Treatment Directive		Safe access		Disabled access to beach and toilets		Display of information about the Blue Flag
			Management of different users and uses		Buildings and equipment properly maintained		Removal of Blue Flag if criteria is not met
			Conform with EC Urban wastewater treatment directive				Demonstration of 5 environmental education activities
							Code of conduct for the beach

Source: FEE 2001 http://www.blueflag.org/criteria/beachc.htm organisation and the Blue Flag Co-ordination. If some of the imperative criteria are not fulfilled during the season or the conditions change, the Blue Flag is withdrawn. In 2001 a total of 2041 beaches were awarded a Blue Flag (55 in the UK) and 713 marinas (26 in the UK).

The European Blue Flag Award has now been accepted in South Africa and is being considered in the Caribbean.

8.2 UK Seaside Awards

In addition to the Blue Flag Awards, the UK Tidy Britain group organises The Seaside Award which recognises two categories of beach: 'resort' and 'rural'. A Seaside Award is given to a beach, which complies with all appropriate legislation, including the Bathing Water Directive 76/160/EEC, and fulfils 28 land-based criteria, in the case of a resort, and 12 in the case of a rural beach (http://www.seasideawards.org.uk/). In 2001 55 beaches received a Seaside Award and 26 marinas.

A comparison of the criteria required by the UK Seaside Awards and European Blue Flag Awards are provided in Table 26.

Table 26. Comparison of the criteria required for UK Seaside Awards and European Blue Flag Awards (2001)

Criteria	Blue Flag	Seaside Award
Region	European	UK
Flag	Blue with white circle	Yellow and blue
Water Quality	EC bathing water Directive Guideline standards for microbiological and physico-chemical parameters. Urban waste water treatment Directive	EC bathing water directive mandatory standard for microbiological parameters
Beach type	Resort	Resort and rural
Dogs	Banned from beach	Banned from beach* Seafront dogs on leads*
Public telephones	Available if no lifeguards	Available* Within 5 minutes walk* Checked daily*
Toilets	Provided Adequate for numbers of visitors and disabled Cleaned and regularly maintained	Provided Adequate for numbers of visitors and disabled Cleaned and regularly maintained
Litter bins	Adequately provided Emptied and maintained regularly	Adequately provided Every 25m Appropriate style

Criteria	Blue Flag	Seaside Award
		Emptied and maintained regularly
Bathing safety	Lifesaving equipment Lifeguards recommended Zoning from different users	Lifesaving equipment Lifeguards recommended* Patrolled areas defined* Zoning from different users
Supervision		Daily (10.00am-6.00pm)*
Cleansing	Daily	Daily up to EPA standards
Drinking water	Provided	Provided
Access	Safe for all including disabled	Safe for all including disabled No unauthorised vehicles, camping or dumping
First Aid	Provided	Provided and attended with times displayed
Incidents	Public warning of pollution	Public warnings of pollution Records must be kept and made available for inspection*
Information displayed	Current water quality Award criteria Environmental initiatives Byelaws and codes of conduct Beach management and award administration contact details	Current and previous 5 years water quality Award criteria Map of award area Car parks Sampling points Beach management and award administration contact details Managing local authority Safety information Defined award area Environmental initiatives Byelaws and codes of conduct
Environmental care	Recycling facilities Promote sustainable transport Provide/promote 5 environmental initiatives	Promote environmental care

*Not required for rural beaches
Source: http://www.seasideawards.org.uk/

8.3 Ireland Beach Guardian Awards

"Beach Guardian Awards" are to be launched in 2001 in Ireland to highlight the importance of community involvement in caring for the environment. The theme of the 2001 Irish Blue Flag Campaign is "Beach security". The awards will be a focus on issues such as: new legislation for control of motorised craft, how to minimise vandalism, the signage, control of driving on beaches, zoning of different activities, enforcement of bye-laws, etc. Local authorities will be encouraged to carry out Safety Risk Assessments, which will take all aspects of beach security into account.

8.4 Green Coast Awards

The Green Coast Award is an environmental award which recognises rural beaches of high environmental quality but don't qualify for Seaside Awards or Blue Flags because they have few facilities. The scheme was created by Welsh Water but will be extended to the rest of the UK in 2000 via the Tidy Britain Group. In order to receive the award, beaches must meet EC guideline water quality standards and have effective and appropriate management to ensure that the natural environment is protected.

8.5 Marine Conservation Good Beach Guide

This is an annual guide to beaches in the UK. There are three classes of beach according to this guide: A 'recommended beach' where 100% of the water samples taken have quality has passed the EC Mandatory standards. 80% or more of the samples pass the EC Guideline total and faecal coliform standard and 90% or more of the samples pass the EC Guideline faecal streptococci standard. The beach is also unaffected by sewage from non-satisfactory discharges (any sewage affecting beaches is treated to secondary standards) according to the Marine Conservation Society (MCS).

An MCS Guideline Pass corresponds to a beach where 100% of the water samples pass the EC Mandatory Standard; 80% or more of the samples pass the EC Guideline total and faecal coliform standard; 90% or more of the samples pass the EC Guideline faecal streptococci standard. The MCS is satisfied that these beaches pose a minimum risk from sewage contamination from continuous discharges, and recommends these beaches for bathing.

A Mandatory pass is a beach in which 95% or more of the water samples pass the EC Mandatory standard. These beaches pass the minimum legal requirements for water quality. There are sewage-derived bacteria present in quantities known to cause illness

A beach fails where less than 95% of the samples pass the EC Mandatory Standard. The water at these beaches is contaminated by sewage and MCS advises against swimming and other immersion water sports.

As seen from Table 26, many of the criteria for the two major award schemes in place in the UK are identical, which questions the need for both. Evidence from research has shown that the public are generally unaware of the meaning of flags on a beach (Williams and Morgan, 1995).

9. CONCLUSIONS

1. In general, current standards for recreational waters only focus on bacteriological criteria and are adopted for primary contact recreation uses (Section 5 and 6; Recommendations 1, 4 and 5).

2. Usage-derived standards are very much in their infancy and there is currently a lack of data regarding the actual frequency of use of recreational waters. In relation to this there is no formal method for collecting this data (Sections 2, 5 and 6; Recommendation 2).

3. Any classification of recreational waters which is designed to protect public health must be based on reliable, comparable and scientifically sound data in order to be effective (Section 4; relates to all recommendations)

4. The main body of epidemiological evidence relevant to recreational waters addresses the health risks associated with bathing in marine waters. There is a lack of epidemiological evidence which can be used for setting scientifically based bacteriological standards for bathers in freshwaters or for setting scientifically based standards which adequately protect the health of recreators other than bathers in both marine and freshwaters (Sections 3 and 4; Recommendation 3).

5. There remains a need to obtain adequate data to assess health risks, other than bacteriological, to recreational water users, both in freshwaters and marine. This includes physical, chemical, naturally-occurring and aesthetic risks (Sections 3 and 4; Recommendations 3, 4 and 5).

6. For each type of recreational activity more than one hazard will be encountered. In order to devise a classification system based on recreational use of water, the parameters of significance for each activity or class of activity must be decided. It is therefore important to consider the recreational activities for which each water will be used, the degree of exposure of the participants to the hazards, the quality of the water environment which will be required and the hazards that the users will be exposed to (Section 3; Recommendations 3, 4, 5, 6 and 7).

7. Issues arise where there is more than one activity being conducted on a given body of water. In this case the standards should relate to the activity which involved the greatest risk. Accidental immersion should also be considered when setting standards (Section 3; Recommendations 3, 4, 5 and 6).

8. Aesthetic factors are especially important where there is passive recreation or activities not involving contact with water. Perception by the general public of the beach aesthetic appearance and water quality has become increasingly important for both the physical and psychological well-being of users (Section 5.1.1; Recommendation 7).

9. It is recognised that the commitment required to make significant further advances in improving bathing water quality and protect the health of all users, not just bathers, is considerable in terms of both time and money and there is a need to

quantify amount of effort required and the benefits to be gained (Recommendation 8).

10. RECOMMENDATIONS

A number of recommendations are given below arising from the conclusions identified in section 9 of this report. In order to utilise the expertise and data held by specialist groups and agencies associated with recreational waters, it is suggested that a working group should be established to discuss the logistics of implementing these recommendations and to utilise existing data held by user groups.

1. There is a need to have an improved approach to the regulation of recreational waters that better reflects health risk and provides enhanced scoping for management interventions. WHO have proposed one such approach which provides a quality classification for bathers. The examples provided by the BSEP and the USEPA suggests two systems that begin to consider the health of recreational water users other than bathers. However, there are some issues relating to the setting of appropriate standards that need to be addressed if a classification system will truly protect the health of recreational water users.

2. It is recommended that accurate information on the intensity of participation in different activities is gathered in order to quantitatively or qualitatively assess the risks faced by participants. In order to do this a formal method of data collection should be established. It is recommended that this is co-ordinated by a central organisation and utilises a network of specialist groups such as sports clubs, lifeguards and tourist boards.

3. It is recommended that epidemiological studies are undertaken to accurately assess the health risks to bathers in freshwaters and to user groups other than bathers in both marine and freshwaters. It is recommended that such studies compare the health risks between the various classes of recreational usage of recreational water, i.e. no contact; incidental/limited contact; meaningful direct contact; extensive direct contact.

4. In order to consider all the factors that can influence the condition of a recreational water use area it is recommended that each recreational water body is assessed individually through a sanitary inspection.

5. It is recommended that a risk assessment is undertaken to identify the main hazards to the participants undertaking various recreational activities at each site. The relative risk potential to human health for each activity on each recreational water body can then be assessed and the parameters of significance identified. A scoring system based on the relative risk could then be assigned to each hazard and a classification scheme for each type of activity could then be constructed. The scheme should be flexible, allowing managers and regulators to implement management actions.

6. Studies are needed to establish a better understanding of the exposure-effect process to assess health risks associated with swimming and other water-based activities. In order to do this there is a requirement to: (a) Characterise swimmer/user behavioural patterns that may affect risk characterisation activities and risk management practices with regard to recreational water safety; (b) Characterise typical exposures that may be experienced through various activities

associated with recreational water use and determine the exposure-response and condition of infection during these events; (c) Evaluate the relationship between water quality and diseases associated with bather/user load.

7. It is recommended that investigations into the public perception of quality are undertaken. In terms of aesthetic quality it may be appropriate to survey a variety of recreational water user groups undertaking different activities to assess what level of quality each group find acceptable. In addition there is currently little insight into what different water users consider to be a ‘tolerable level of risk’ with regards water quality.

8. In order to establish the benefits to be gained from introducing a classification system and to gain an insight into the amount of effort that would be required, it is recommended that pilot studies are undertaken in selected areas designed by the Environment Agency based on the most appropriate existing classification method or a combination of the methods described within this report.

11. ON-GOING RESEARCH/PROJECTS

Current research activities in the field of recreational waters include:

- The development of molecular methods to measure microbial marine pollution – being undertaken by several research groups around Europe
- Investigations into serious illnesses associated with swimming – WHO and USEPA project being undertaken by Robens Centre for Public and Environmental Health
- Alternative approaches to assessing the aesthetic quality of the environment - Phase 2 – Environment Agency project
- Investigation into enteric viruses in natural waters – Environment Agency project to update future policy and give the UK Government a basis on which to debate the revised EC Bathing Waters Directive.
- Investigation into the extent of bacterial contamination of watercourses and bathing waters as a result of farm waste disposal to land in order to assess the effectiveness of the Management Plans and Code in controlling bacterial pollution – Environment Agency project
- Water based recreation - a report that will provide a basis for consideration of future action by Government in order that it may fulfil its commitment to increasing access to the countryside, including water, for informal recreation and enjoyment Environment Agency project.
- Distinguishing *E. coli* of human and animal origin from environmentally occurring bacteria using molecular-based methods – being undertaken by the University of Wisconsin, including samples taken from Southsea, UK.
- A quantitative estimate of the global burden of disease is being undertaken by WHO.

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Appendix 1. Facilities available and watersports undertaken at a selection of undesignated bathing sites around the United Kingdom. Source: Surfers Against Sewage, 2001.

Type of water body	Name of water body	Location	Facilities	Watersports undertaken at the site
Beach-Estuarine	St.Dogmaels	Pembrokeshire	Toilet/Phone	SA/C/SR/S/SAL/WS
Rocky/Shingle beach	Ceibwr	Pembrokeshire		SA/C/SR
Estuarine, Rocks	Newport Parrog	Pembrokeshire	Parking	C/SR/SAL/WS/S
Harbour/Shingle Beach	Lower Fishguard	Pembrokeshire	Toilet	SA/C/SRSAL
Pebble, Sand beach with Cliff	Aberbach (St.Nicholas)	Pembrokeshire		SA
Rocky, Cliffed, Shingle Beach	Abercastle	Pembrokeshire	Toilet	SA/C/SAL
Shingle rocky beach	Aberfelin/Trefin	Pembrokeshire	Toilet	SA
Harbour with rocky outcrops	Porthgain	Pembrokeshire	Toilet	SA
Sand and rock beach	Porthmelgen	Pembrokeshire		
Rock and Sand Beach	Porthsele	Pembrokeshire		B/SA
Harbour,	Porthclais	Pembrokeshire	Toilet	SA/C/SAL
Harbour, stream, estuarine	Solva	Pembrokeshire	Toilet	SA/C/SR/SAL
Sandy Beach with Rocks	Lindsway Bay	Pembrokeshire		
Shingle and Mudflats	Hazelbeach	Pembrokeshire		moorings/b
Harbour, estuarine	Neyland	Pembrokeshire	Toilet	SA/C/SAL/WS/WSK
Estuarine, Shingle	Burton	Pembrokeshire	Toilet	C/SAL/WS/WSK
Estuary, shingle, mud flats	Llangwm/Blacktar	Pembrokeshire	Toilet	C/SAL/WS
Estuary	Lawrenny	Pembrokeshire	Toilet	C/SAL/WS
Rocky shingle and sand beach	Angle Bay	Pembrokeshire		C/SAL
Rocks	Stackpole Quay	Pembrokeshire	CAFE	SA/C/SAL/WS
Harbour, sandy beach	Tenby Harbour	Pembrokeshire	Toilet, cafe	B/C/SR/
Rock	Hartley Reef	Blythe, Newcastle on Tyne OS 346757		S
Rock reef	The Black Middens	Tynemouth, mouth of Tyne River OS 374869		S
Rock reef	The Gare	Mouth of River Tee OS 555275		S
Scar	Huntcliff	Saltburn by Sea		S
Scar	Skinningrove	Nr.Middlesbrough OS 714200		S
Beach	Primrose Valley	Nr.Bridlington		S
Rock reef	Skeleton Reef	Nr.Scarborough		S
Beach Sand and Shingle	East Runton	Sheringham, East Anglia OS 201429		S
Beach	Walcott	Nr.Cromer OS 360330		S
Shingle Beach	Happisburgh	nr.Cromer		S

Beach	Scratby	Nr.Great Yarmouth		S
Beach	Gorleston	Nr.Great Yarmouth OS 530030	Lifeguard in summer	S,B
Rock reef	Chapmans Pool	Nr.Poole		S
Beach	Southbourne	nr.Boscombe OS 143912	Toilets	S
Chalk reef	The Marina	Brighton Marina (east of harbour wall)		S
Beach	The Witterings	Nt.Chichester OS 770980 & 805964		S
Rock Reef	Gyllyngvase Reef	Nr.Falmouth OS 809316		S
Rock reef and Sand	Perranuthanoe	Nr.Praa Sands OS 540292	Cafe	S
Rock Reef	Porthleven	Porthleven,OS 625255		S/WS
Sand Bar	Hayle River Mouth	N.Cornwall, nr.Hayle		S,WS
Sandy beach	Chapel Porth	Nr.St.Agnes, N.Cornwall, OS 697497	Lifeguards in summer	S,B,WS
rock reef	The Cribber	Newquay, N.Cornwall,		S,WS
Sand Beach	Mother Iveys	nr.Wadebridge		S
Sand Beach	Lundy Bay	nr.Polzeath		S
sand beach	Trebarwith Strand	nr.Wadebridge, OS048876		S, WS
Sand and rock beach	Crackington Haven	nr.Bude, 140970	Lifeguards in summer	S,B,WS
Rock reef and Sand	Upton	nr.Bude		S
Sand Beach	Sandy Mouth	nr.Bude OS202099	Cafe, car park	S
Rock and Sand beach	Duckpool	nr.Bude OS 200116	Cafe, Car Park	S/WS
Rock Reef	Bucks Mill	nr.Bideford OS 350243		S
Tidal Bore	Severn Bore	River Severn between Fretherne and Maisemore		S/C
Rock Reef	Llantwit Major	Between Barry and Cardiff OS 955675	Lifeguards in summer	S,B
River mouth, sand bar	Ogmore by Sea	nr.Bridgend OS 860750	Lifeguards in summer	S,B
Sand Beach	Aberavon	next to Port Talbot OS 740900	Shops, Pubs, Lifeguards (summer)	S,B
Rock reef and Sand	Hunts Bay	Gower OS 563867		S
Sand Beach	Threecliff bay	Gower OS 535877		S
Rock Reef	Slade Bay	Gower OS 487854		S
Sand Beach	Horton	Gower OS 478855		S/WS
Rock Reef	Sumpters	Gower OS 463846		S
Rock Reef	Boiler Reef	Gower OS 444853		S
Rock Reef	Pete's Reef	Gower OS 437857		S
Sand Beach	Fall Bay	Gower OS 413873		S
Sand Bay	Broughton Bay	Gower Peninsular OS 413933		S
Rock ledge	Llwyngwril	N.Wales, nr Dolgellau		S
Sand/Rock Ledge	Porth Ceiriad	Lleyn Penisular OS 310250		S

Sand Beach	Hells Mouth-Duckboards	Lleyn Peninsular OS 285265		S
Rock Reef	Hellsmouth-The Reef	Lleyn Peninsular OS 285265		S
Beach and Rock Reef	Hellsmouth-The Corner	Lleyn Peninsular OS 285265		S
Boulder reef	Fisherman's/Rhiw	Lleyn Peninsular 0S 285265		S
Rock Ledge, beach	Aberdaron	Lleyn Peninsular OS 172264	Small town services	S
Sand Beach	Whistling Sands	Lleyn Peninsular OS 166300	Cafe, Toilets, Carpark	S
Sand Beach and Rock Reef	Dunaverty Beach and Reef	Scotland; Mull of Kintyre OS 685078	None	S
Sand and rock	Westport	Mull of Kintyre, OS 655263	None	S
Sand Beach	Machrihanish	Mull of Kintyre, south of Westport	None	S
Rock and Sand reef	Graveyards	Mull of Kintyre, north of Westport	None	S
Sand Beach	Saligo Bay	Islay, Inner Hebrides, OS 207665	None	S
Sand Beach	Machir Bay	Islay, Inner Hebrides; OS 207630	None	S
Sand Beach	Laggan Bay	Islay, Inner Hebrides; near Machir Bay (78)	None	S
Sand Beach	Balnakiel Bay	North Coast, Scotland; OS 393690	None	S
Sand Beach	Sango Bay	North Coast, Scotland; OS 408677	None	S
Sand bar	Torrisdale	North Coast Scotland, OS 695620	None	S
Beach	Farr Bay	nr.Bettyhill, N.Scotland; OS 714626	None	S
Sand Beach	Armadale Bay	Armadale, N.Scotland; OS 795647	None	S
Beach with rivermouth	Strathy Bay	Strathy, N.Scotland; OS 835660	None	S
Sandbar formed by river	Melvich	Portskerra, N.Scotland; OS 880650	None	S
Rock ledge	Sandside Bay	Dounreay Nuclear Power Plant OS 960655	None	S
Rock Ledges	Brimm Ness (Graveyards)	N.Scotland; OS 04071	None	S
Rock Reef	Thurso Reef	Thurso, N.Scotland, OS 120690	None but Thurso town near	S
Rock Reef	Thurso East	Thurso, OS 125691	None but Thurso	S
Rock Reef	Murkle Point	Dunnet Bay, N.Scotland; OS 210690	Car park; nature reserve guide	S
Beach	Dunnet Bay	same Murkle Point(91), OS 210690	None	S
Rock Reef	Skarfskerry	nr.Dunnet, N.Scotland; OS 270745	None	S
Rock Reef	Skirza Harbour	Freswick, N.Scotland; OS 388680	None	S
Beach	Lossiemouth	Lossiemouth, NE Scotland; OS280680	None	S
Beach	Sandsend Bay	Sandend, NE Scotland; OS 554662	None but in Village	S
Sand and rock reef	Boyndie Bay	Banff, NE Scotland; OS 675646	None	S
Rock Reef	Phingask	Nr.Fraserburgh, NE Scotland OS 984675	None	S
Boulder Reef	Sandford	nr.Peterhead, NE Scotland; OS 124438	None	S
River mouth sand banks	Newburgh	nr.Balmedie, NE.Scotland; OS 006236	None	S

Rock Reef	Lunan Bay	Lunan, NE Scotaland; OS 690500	None	S
Beach	Pease Bay	Nr.Edinburgh; OS 795710	Carpark, Toilet, Caravan Park	S
Beach	Coldingham Bay	Nr.Edinburgh; OS 918665	Lifeguards in summer, Cafe,	S,B
beach	Brixham	nr.Torquay		SA
Natural Harbour	Scapa Flow	Orkney Isles		SA
	Blockships	Churchill Barriers, Orkney Isles		SA
Shingle Beach	Shakespeare Beach	Dover		SA
Beach	Sea Palling	Norfolk		SA
Beach	Trimingham	Norfolk		SA
Shingle bank	Weybourne	Norfolk		SA
Beach	Thornwick bay	Flamborough		SA
Beach	Bull Bay	Anglessey		SA
Rock	Old Harry Rock	Poole		SA
Estuary	Lepe Country Park	Edge of New Forest directly across from Cowes	Car Park, toilets	WS
Shingle Beach	Pagham	Pagham, SE England near Bognor Regis	Carpark	WS
Shingle/Sand beach	Pevensey Bay	Nr.Eastbourne	Carpark, toilets	WS
Natural Harbour-Sand Banks	Baiter Park	Poole Harbour	Carpark, toilets	WS
Natural Harbour	Hamworthy	Hamworthy, Poole	Carpark, toilets	WS
Bay, Natural Harbour	Bramblebush Bay	Poole Harbour Mouth	Carpark	WS
Man made inland lake	Rutland Water	Whitwell, near Oakham	Carpark, toilets, showers and changing rooms	WS
Shingle/sand beach	Shoreham by Sea	South Coast nr. Brighton	Carpark, toilets	WS
Single/Sand/Mud beach	Southsea	Portsmouth	Parking, toilets	WS
Shingle/rock beach	Stokes Bay	Gosport, Solent	Carpark, Toilets	WS
Shingle/sand beach	Amgmering-on-sea	nr. Bognor Regis	Toilets and carpark	WS
River Weir	Chertsey Weir	River Thames, London		C
River Weir	Hurley Weir	River Thames, London		C
River Weir	Sheppeston Weir	River Thames, London		C
Manmade Whitewater Course	Nene Whitwater Center	River Nene, Northampton	Carpark, Changing Rooms	C
River Weir	Hellesdon Mill	River Wensum, Norfolk		C
Man made Slalom Course	Nottingham Slalom Course	Nottingham		C
River Weir	Sawley Weir	River Trent, Nottingham		C

River	Washburn	River Washburn, Leeds		C
River	River Tay Playspots	River Tay, Perth Area		C
Rapids	Falls of Lora	Loch Etive, Oban, Scotland West Coast		C
Open Sea	Stanley	Stanley, Holyhead Island, North Wales		C
Rapid Course	Trweryn Centre	River Trweryn, North Wales		C
River Eddies	Eddylines	River Dee, North Wales		C
Tidal Race	The Bitches	Ramsey Island, Pembrokshire		C
Rocky Shingle Sand Bay	Lunderston Bay	Firth of CLyde, West Scotland	Carpark	WS
Natural Harbour/Loch/Bay	Largs	Firth of Clyde, West Coast of Scotland	Carpark	WS
Gently Sloping Sand Beach	Barassie	Troon, West Coast of Scotland	Toilets	WS
Sandy Bay	Benderloch	West of Scotland		WS
Sandy beach	Sands	Gairloch, W.Scotland	Campsite	WS
Large Sandy Beach	Burghead Bay	Elgin, NE Scotland		WS
Estuary	Newburgh	Ythan Estuary, N.of Aberdeen		WS
Beach, Sandbars	Aberdeen	Aberdeen	Carpark-Major City	WS
Shingle bay and Sandbars	Limekilns	Firth of Forth, East Scotland	Carpark	WS
Stony Beach	Duck Bay	Loch Lomond	Marina nearby	WS
Stoney Beach	Millarrochy	Loch Lomond	Carpark, Campsite	WS
Loch	Lochwinnoch	15 miles west of Glasgow	Carpark, Changing Facilities	WS
Man made Loch	Lochore Meadows	south of Loch Leven near M90	WS School	WS
Loch	Loch Morlich	Near Aviemore, Scotland	Carpark	WS
Loch	Loch Insh	South of Aviemore on old A9 road	Carpark, Changing Facilities, Bar, Hire	WS
River	Allen (Northumb'ld)NN	Northumb'ld		Canoe
River	Axe	Devon SW		Canoe
River	Balder	Middleton-In-Teesdale		Canoe
River	Barle	Taunton		Canoe
River	Blackwater	Tiptree	Canoe	Canoe
River	Brathay	Grasmere		Canoe
River	Congresbury Yeo	Western Super Mere		Canoe
River	Crake	Kirby	Kirby In furness	Canoe
River	Dart	Bideford		Canoe
River	Dee	Cheshire		Canoe
River	Derwent	Matlock		Canoe
River	Devils Water	Hexham		Canoe

River	Dove	Alrewas	Canoe
River	Duddon	Kirkby In Furness	Canoe
River	Eden	Carlisle, Cumbria	Canoe
River	Erme	Tavistock	Canoe
River	Exe	Crediton	Canoe
River	Fowey	St.Austell	Canoe
River	Frome	Trowbridge, Somerset	Canoe
River	Greta	Ambleside	Canoe
River	Lee Dobbs Weir	Cheshunt	Canoe
River	Leven	Ulverton, Cumbria	Canoe
River	Lyn	Oare Lynton	Canoe
River	Mole	South Norwood, Surrey	Canoe
River	North Tyne	Hexham	Canoe
River	Rede	Hexham	Canoe
River	South Tyne	Alsiton	Canoe
River	Stour	Ashford, Kent	Canoe
River	Tamar	Callington, Devon	Canoe
River	Tees High Force	Middleton-In-Teeside	Canoe
River	Torridge	Bideford	Canoe
River	Ure Masham to Ripon Yorks	Wakefield	Canoe
River	Washburn Yorks	Yorkshire	Canoe
River	Wensum Fakenham to Lenwade Mill	Fakenham	Canoe
River	Wharfe Linto-Barden	Otley, Yorkshire	Canoe
Harbour (natural)	Chichester	The Solent	WS
Beach	Red Wharf Bay	North Wales	WS
Semi-enclosed water	Menai Straits	North Wales	WS
Beach	Dale	Pembrokeshire	WS
Beach	Newton	Porthcawl, S Wales	WS
Reservoir	Llandegfedd	S.Wales	WS
Semi-enclosed Water, Estuary	Crow Point	Taw Estuary, Devon	WS
Reservoir	Roadford	Devon	WS
Beach	Rock	North Cornwall	WS
Beach	Marazion	South-West Cornwall	WS
Harbour	Falmouth	South-West Cornwall	WS

Reservoir	Stithians	Cornwall	WS
Beach	Overcombe Corner	South Coast	WS
Beach	Ringstead	South Coast	WS
Beach	Gosport	South Coast	WS
River	River Witham	Boston, Lincolnshire	WS
Beach	Climping Beach	Nr.Littlehampton	WS
Beach	Shoreham Beach	South Coast	WS
Beach	Minster Beach	Isle of Sheppey	WS
Beach	East Preston	Nr.Littlehampton	WS
Beach	Whistable	South Coast	WS
Beach	Broughty Ferry	Scotland	Canoe
Beach	Ashton Bay	Scotland	Canoe
Beach	Cardwell Bay	Scotland	Canoe
Beach	Helensburgh	Scotland	Canoe
Beach	Kinghorn	Scotland	Canoe
Beach	Loch Buie	Scotland	Canoe
Beach	Tobermory	Scotland	Canoe

Key:
SA-Sub Aqua
S-Surfing(including all craft)
WS-Wind Surfing
B-Bathing
SR-Sea Rowing
WSK-Water Skiing
SAL-Sailing
C-canoeing
OS-Ordanace Survey 6 figure Grid Reference