National Water Quality Management Strategy

Australian Guidelines for Sewerage Systems

Effluent Management

1997

Agriculture and Resource Management Council of Australia and New Zealand

Australian and New Zealand Environment and Conservation Council

Copies of this publication may be obtained from:

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ISBN 0 642 19557 9
ISSN 1038 7072

Printed on recycled paper.

front cover photo: Thanks to the ACTEW Corporation for the use of the Lower Molongo Water Quality Control Centre photo

Printed in Australia for the Agriculture and Resource Management Council of Australia and New Zealand, and the Australian and New Zealand Environment and Conservation Council.

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Introduction

Australian communities generate large volumes of wastewater with domestic water use alone producing about 70,000 litres per person per year. Wastewater also comes from industry and commerce. Treated wastewater, known as effluent, is normally discharged to the environment, requiring proper management to protect public health and the environment.

A sewerage system:

- receives domestic, commercial and industrial wastewater
- treats the wastewater to the required level
- discharges the resulting effluent and solids to the environment.

In providing this service, the sewerage system:

- manages the liquid waste produced by a community, to protect public health and the environment
- treats and disposes of the effluent at a location distant from an individual's property, enabling higher density development, with savings in other services such as water supply, energy and transport
- enables large scale treatment installations to be built and operated, resulting in considerable cost savings
- results in point source rather than diffuse source discharges, which are easier to manage, monitor and modify.

Purpose of Document

This document is one of a suite of documents forming the National Water Quality Management Strategy. Guidelines and documents forming part of the strategy are detailed in Appendix 1.

The series, *Guidelines for Sewerage Systems*, covers sewerage systems as a whole. Five separate documents deal with particular aspects of sewerage systems as set out in Figure 1. This document reviews the overall management of sewerage systems and specifically addresses effluent management. It has been developed as a basis for a common and national approach throughout Australia.

Guidelines for Sewerage Systems				
Acceptance of Trade Waste	Sewerage System Overflows	Use of Reclaimed Water	Effluent Management	Sludge (Biosolids) Management

Figure 1: Diagrammatic structure of the *Guidelines for Sewerage Systems*

These guidelines deal with effluent from wastewater treatment plants for domestic and industrial wastes. They do not cover effluent discharged directly to the environment from sources such as:

- septic tanks
- industries
- stormwater drains etc.

Nor do they apply to cases where raw sewage is applied to land as part of the treatment process (for example, at Werribee in Victoria).

Discharges from treatment plants for specific industries such as farm dairies and dairy processing, wool scouring, tanning, piggeries, wineries and distilleries are, or will be, covered in other guidelines of the strategy.

These guidelines are intended to apply until the next revision of this document. They describe the principles and practice for managing effluent, and help to identify and select appropriate methods. The effluent parameters of major concern, the minimum level of treatment and the commonly required level of treatment are nominated for each of the discharge options. The guidelines also cover assessments of existing effluent discharges, new schemes and proposals for effluent management.

Target Audience

These guidelines are intended to be used by :

- those responsible for decisions on the management of effluent

- organisations and people involved in the preparation of catchment management plans, such as government departments and agencies, water authorities, regulators or decision makers with similar powers, community groups and special interest groups

- those involved in the approval process, such as Commonwealth, State and local government, and major environmental and industry groups

- all others with an interest in the management of sewerage systems, such as customers of water authorities.

Management Framework

Aims and Objectives

The principal aim of effluent management is to return treated wastewater to the environment in a way which the community accepts after considering both environmental and cost factors. Objectives for effluent management include:

- avoiding risks to health
- maximising the reuse of effluent (for both the value of the water and the nutrients).
- minimising both adverse impacts to land and the contamination of surface and ground waters when used in land applications
- maintaining agreed water quality objectives for receiving waters when discharging to surface waters.

The water quality objectives will usually be decided after considering:

- existing ecosystems
- the environmental values or uses of the receiving water
- environmental flows
- other community objectives.

Philosophies

Australian Governments have endorsed the principles of ecologically sustainable development (ESD) and adopted integrated catchment management as an appropriate means to achieve sustainability. These concepts have been incorporated in the National Water Quality Management Strategy as follows.

Ecologically Sustainable Development (ESD)

Ecologically sustainable development provides the basis for water quality management.

The core objectives of ESD include the enhancement of individual and community well-being by following a path of economic development which balances ecological, social and economic demands and safeguards the welfare of future generations.

Water pollution, which adversely affects drinking water supplies, the rural environment and activities such as fishing, recreation and tourism, may limit future economic development. The decline in water quality and the natural and cultural amenity of some of our water bodies has already affected the productive use of the nation's water resources and resulted in degraded habitats. Solutions for the continued use of water resources will require changes within the water industry and by a wide range of organisations and individuals.

The concept of ecologically sustainable development provides a comprehensive philosophical umbrella under which to pursue the issue of water quality management. The National Strategy for Ecologically Sustainable Development sets out the objectives and guiding principles. Refer to *Policies and Principles - A Reference Document* for further information.

Integrated Catchment Management

Catchments are the most appropriate geographical area for the development of water management plans.

Sound catchment management embraces:

- a comprehensive approach to natural resource management within a catchment with water quality considered in relation to land and water uses, characteristics of aquatic and riparian ecosystems, and other natural resources

- co-ordination of all the agencies, levels of government and interest groups within the catchment

- extensive opportunity for community consultation and participation.

These principles are applied through the Integrated Catchment Management (ICM) or Total Catchment Management (TCM) programs in the States and Territories.

Authorities responsible for managing activities in a catchment need realistic and achievable water quality goals and objectives. The national guidelines and management process offer a framework within which catchment managers can participate in the selection of environmental values and subsequent achievement of water quality goals. State regulations and policies may also play a part in meeting these goals. The *Implementation Guidelines* provide further information.

Principles

Waste management can be approached through one or more actions. In decreasing order of preference these are:

- waste minimisation
- recycling
- reuse
- treatment to reduce potential degrading impacts
- discharge to the environment.

Traditionally, governments have tended to implement policies to protect water quality through direct command-and-control type regulation, coupled with monitoring systems and non-compliance sanctions. This approach provides relatively guaranteed outcomes where monitoring and enforcement processes are good.

Market-based approaches seek to influence behaviour by changing the relative returns of environmentally benign and damaging activities. They attempt to ensure that resource-use decisions take into account all the relevant social costs and benefits.

A comprehensive strategy for achieving sustainable water quality management should build on the strengths of both regulatory and market based approaches.

Control Mechanisms

Options for controlling the discharge of wastes to the environment and affording protection of the environment are as follows.

Regulations

Regulation of water in Australia varies within the States and Territories. However, there is a national trend for government to clearly identify and separate the roles of:

- water resource management
- regulation
- operation.

The States and Territories are responsible for:

- setting clear water quality goals which integrate environmental and economic considerations, with the full participation of stakeholders and consideration for community views
- addressing duplication and gaps in government responsibility for water and wastewater regulation
- putting in place clear accountabilities and establishing a steward for water resources
- meeting the community's legitimate demands for input into decision making processes
- monitoring management practices and water quality against objectives.

Discharges should comply with regulations such as:

- Health Department regulations
- planning regulations
- catchment regulations
- environment authority works approvals
- environment authority discharge licences
- pollution control statutes.

Economic tools

By and large, the regulatory mechanisms are already in place. Economic tools to manage water quality will be introduced progressively. Where the traditional form of regulation is not already strongly established, there is added incentive to initiate innovative approaches exploiting the potential of market based instruments.

Examples of economic tools might include point source and diffuse source trading licences and unit charges for significant pollutant concentrations.

Effluent Quality

Two procedures have been used to identify appropriate levels for effluent quality:

- Effluent management and environmental values
- Technology based guidelines

Effluent management and environmental values

The underlying principle of managing effluent discharges maintaining the environmental values of waterways and for land application, the sustainable use of the land. Environmental values are values or uses that promote public benefit, welfare, safety or health, and ecosystem protection and are in need of protection from the effects of pollution, waste discharge and deposits. The declaration of environmental values within a catchment is ultimately the responsibility of State and Territory governments and involves the balancing of social, environmental and economic benefits and costs.

The adoption of environmental values and hence the balancing of costs and benefits should be based on consideration of factors such as urbanisation, growth and development, waste management practices. Only by optimising these factors can the principles of ESD be achieved.

Application of water quality based effluent standards should take into account the relative contributions of diffuse sources and background waterway conditions to ensure meaningful improvements are achieved.

Environmental values for aquatic ecosystems are listed in Appendix 5. They have been taken from *Australian Water Quality Guidelines for Fresh and Marine Waters*.

Technology based guidelines

Effluent guidelines are to be based on the application of accepted modern technology which:

- has demonstrated consistent achievement of the acceptable contaminant levels in the environment while maintaining economically viable operations
- takes into account engineering and scientific developments in wastewater treatment

- pursues opportunities for waste minimisation
- takes into account the potential of new and emerging technologies to economically achieve higher levels of performance.

Where technology based guidelines can produce ambient water quality above the stated objectives, these guidelines may still be necessary to reserve capacity for other present and future discharges.

Determining effluent quality

Initially, it is intended that technology based guidelines would be applied progressively to existing installations. New installations would generally comply at start up while existing discharges would be expected to adopt phase-down programs to progressively come into compliance.

Where scientifically derived ambient water quality objectives would not be met by a proposed or existing discharge, which complied with technology based effluent criteria, then more stringent water quality criteria based on environmental values may need to be placed on the discharge. Alternative means of effluent management also should be explored, as well as economic instruments and catchment-wide approaches to the reduction of contaminants at source.

This approach should be applied at the design stage of new installations and used as the target for any planned major augmentation of an existing discharge.

There must be a regular review and statement of what constitutes accepted modern technology over time.

Stakeholders

Stakeholders in the field of effluent management include:

- Governments - set standards and regulations, provide sewerage agencies with authority, and respond to the community
- Sewerage authorities - manage sewerage systems
- Community - provide input to the process and may be affected by the decisions of government and of the sewerage authorities.

The Role of the Sewerage Authority

The sewerage authority acts for its shareholders, customers and the community it serves. Its roles include:

- managing the sewerage system effectively and efficiently
- encouraging community participation in determining broad approaches
- informing the community about the impact of its decisions
- participating in a comprehensive catchment management approach

- identifying the financial, environmental and social costs of decisions for the community
- advising government on technical issues and the options available
- maintaining close liaison with government on the performance of the sewerage system
- providing a return for its shareholders.

Community Consultation

For many years, the responsibility for environmental decisions was taken on behalf of the government by sewerage authorities and other agencies. The community now expects to be involved in the decision making process.

The policy making process must provide the community with:

- information on the benefits, costs and environmental and public health impacts of alternative methods of effluent management
- opportunities to participate in decision making.

Making information widely available and providing opportunities for public involvement in decision making will encourage the community to consider effluent and waste management options in a broader water resource management context. For example, the process can be used to ensure that communities consider and comment on options in a broad catchment context rather than on more narrow grounds.

Australia's water and wastewater service providers are typically public owned monopolies. The cost of pursuing higher water quality is often very substantial in both capital and recurrent terms and must either be passed on as higher charges or absorbed as lower returns. There is a role for the local community to have a say about balancing the costs and benefits to achieve improvements in water quality or reductions in the environmental impacts of wastewater flows, at the least cost to society and a maximum value to consumers.

As the costs of effluent management proposals can run into expenditure in the order of billions of dollars, the process must be open to systematic community scrutiny to ensure benefits justify the costs.

The ultimate decision on the discharge quality to be met, lies with governments in their roles as standard setters and regulators. The aim is to achieve waste management solutions which reflect the community preference on its use of resources.

While a comprehensive cost benefit analysis approach has substantial merits in determining standards, the benefits of improved environmental amenity are notoriously difficult to quantify in monetary or other terms. In particular, it is often difficult to reflect the benefits of long-term environmental sustainability in traditional cost-benefit analyses.

This means that scope needs to be provided for the application of a wide range of assessment techniques which ensure that informed decisions are made. Some of the approaches which should be used to explain and make transparent the costs and benefits of various options include:

- reporting the views expressed via community input processes
- presenting evidence about the nature and scope of the identified problem (e.g. scientific evidence, evidence of recreational and commercial use of receiving waters, etc.)
- providing the context within which the proposed options have been developed (e.g. relationship to the sewerage authority's capital investment program, description of previous attempts to minimise the environmental effects of existing regulatory regimes, etc)
- providing information on relevant trends and options (e.g. overseas developments in wastewater management, the range of available waste management options, etc)
- risk assessment/sensitivity analysis
- calculating the total capital and recurrent cost of pursuing various levels of environmental enhancements and equating these to an annual cost or rate that the individual must meet
- identifying the range of possible environmental and other benefits that might flow, quantifying these where possible
- consulting the community on which level of enhancement that it wishes to accept.

By using this wide range of approaches as a basis for community consultation, a sound understanding of community preferences can be generated. Failure to undertake such a process can result in:

- adoption of solutions that the community does not support
- excessive exploitation of the environment
- communities incurring high costs for what may be low priority environmental gains.

Options for Effluent Management

The options are based on the philosophy, objectives and principles outlined in the Management Framework.

The options should address the management of the sewerage system as a whole and each of the aspects individually. The aspects are:

- waste minimisation
- managing the collection system
- managing the treatment system - including efficient process control within the treatment plant and proper sludge handling
- effluent reuse
- discharge of the remaining effluent to:
    - land
    - coastal waters
    - inland waters.

Each aspect is elaborated below.

The choice of a preferred option is made after considering:

- social needs and community expectations
- feasibility
- public health and environmental impacts
- cost of the scheme
- available and feasible technology.

Waste Minimisation (domestic, commercial and industrial)

The application of good waste minimisation practices will keep the volume of water and potential pollutants to a minimum.

It is the first aspect which should be addressed.

Major areas for consideration are:

- the reduction of contaminants in industrial wastes discharged to the sewerage system
- minimisation of wastewater flows by applying water conservation and demand management principles to industrial, commercial and domestic customers

- management of domestic products that may add contaminants to the wastewater flow
- management of sewerage systems to exclude infiltration and stormwater.

Reducing the quantity of water and/or pollutants being discharged to the sewerage system has a positive affect on other aspects of the system.

Waste minimisation can be brought about by a combination of national, state and local actions in the areas of:

- rules, such as requiring all new toilets to be dual flush (6 litre/3 litre)
- incentives, such as quantity and quality based charges for major industrial dischargers and user pays for domestic sewage
- education, such as providing information on the use of water efficient appliances and environmentally friendly products and practices.

Table 1 identifies typical measures which can be employed in domestic, commercial and industrial situations to achieve waste minimisation.

Type	Measures
Domestic	minimise water usage and discharge through legislation and public education. e.g. : dual flush (6/3) toilets, low flow shower heads, low water use washing machines and dishwashers
	bans on the use of sewerage systems for the disposal of drainage water
	detect and remove illegal connections, such as roof drainage
	minimise pollutant loads via public education on not using the sewer system as a rubbish disposal system, limiting the amount of oil and grease going down the sink, minimising the amount of soaps and detergents used, including possible alternatives; and regulation of product constituents (for example, phosphorus in detergents).
	supporting and enforcing restrictions or bans on the use of in sink garbage grinders
	minimising the amount of household chemicals in wastewater by educating the community on their proper disposal and by having proper disposal available, e.g. programs aimed at cultural change, such as Waterwise and phosphorus action programs.
Commercial and Industrial	minimise water usage, discharges and pollutant loads through a combination of legislation, education and financial incentives (for example, a charge for service based on the strength and volume of trade waste). For further information on the discharge of Trade Waste (Industrial Waste) to sewer, refer to *Guidelines for Sewerage Systems - Acceptance of Trade Waste (Industrial Waste).*

Table 1: Waste minimisation measures in domestic, commercial and industrial situations

Managing the Collection Systems

A properly managed system will:

- minimise potential for overflows and restrict occurrences to situations where they cause least problems
- minimise odour emissions
- minimise infiltration (leakage of groundwater into the pipes) and illegal discharges of stormwater to keep wastewater volumes to a minimum
- deliver wastewater as fresh as possible to the treatment plant so that it is easy to treat
- minimise energy usage
- avoid deposition and blockage in the sewer
- minimise exfiltration.

Further information is found in *Guidelines for Sewerage Systems - Sewerage System Overflows*.

Managing the Treatment Systems

The plant's operation should be environmentally responsible. In designing and operating the plant to meet the effluent and sludge management requirements, the following must be considered:

- balancing energy usage and performance through use of systems such as ponds, energy efficient aeration systems, use of methane for heating or energy recovery etc.
- recycling effluent for filling tanks, washing down, etc.
- minimising odours and noise
- judicious use of chemicals
- minimising overflows
- removing solids to maintain the quality of the effluent
- developing effluent and sludge (biosolids) as resources.

Further information on the management of sludge is found in *Guidelines for Sewerage Systems - Sludge (Biosolids) Management*.

Effluent Reuse

Reuse is the application of effluent in a way that provides income, reduces costs or leads to some other benefit. It could result in economic, social or environmental benefits either directly or indirectly.

Reuse can produce an obvious benefit if it reduces the demand for water from other sources and systems. In times of water shortage, it provides a scarce resource. However, by not returning effluent to natural inland water bodies, the flow in rivers is reduced.

While the nutrient content of treated wastewater may have some economic value, the presence of pollutants should be recognised. Less obvious characteristics, such as elevated levels of dissolved solids and changes in water chemistry can be significant in both industrial and agricultural systems. In the latter, serious consequences relating to salinity, soil structure and soil permeability can occur.

Costs of distribution and irrigation systems for effluent reuse can be significant, requiring detailed financial analysis to ensure stakeholders are aware of cost implications. Ideally, analysis should include the costs and benefits of any change in environmental values or amenity. The costs and benefits of reuse should be compared with the costs of using alternative water sources. Such a comparison should take account of any costs needed to achieve the desired sustainable water quality in the receiving waters if the effluent is not reused.

The positive and negative aspects of each reuse practice must be assessed. The effects on public health and on the environment should be evaluated. The legal implications and the risk management aspects of reuse schemes are likely to become more significant in future. Reuse of effluent is already recognised as a major due diligence issue.

Indirect and environmental reuse options may include reuse via surface waters and groundwater.

The options are:

- irrigation
- direct potable
- indirect potable
- non-potable urban
- municipal
- agricultural
- aquaculture
- tree growing
- recreational
- environmental
- industrial.

For the larger effluent discharges, reuse options reduce the total discharge but rarely totally eliminate the need for discharge. Total reuse is feasible in the more arid parts of Australia, particularly where there are suitable land and storage facilities near a treatment plant.

While only a small percentage of effluent is reused in Australia, there is increasing interest in using this resource mainly for land application and to a lesser extent for industrial purposes or for the augmentation of domestic supplies. Reuse in large urban areas is limited by the cost of either transporting large volumes of effluent to irrigation areas or sophisticated treatment for quality water supply systems within the urban area..

For more information, refer to the Strategy paper, *Guidelines for Sewerage Systems - Reclaimed Water* which replaces *Guidelines for Use of Reclaimed Water in Australia*, NHMRC/AWRC 1987.

Effluent management strategies should evaluate reuse options and implement options that are practical, economic and environmentally beneficial. Surplus effluent should be managed through one of the following options.

Land Application

Land application includes evaporation ponds, irrigation and soakage systems. Land application by irrigation is similar to the reuse of effluent for irrigation. While reuse has the aim of maximising crop production, the aim of land application is to maximise the discharge of water and its return to the water cycle by evapotranspiration and evaporation, or infiltration.

Land application, in most instances, involves the irrigation of land owned by the sewerage authority. Where effluent is used to irrigate crops on land owned by others, the *Guidelines for Sewerage Systems - Reclaimed Water* should be consulted. The principles in that document should also be considered when sewerage authorities adopt land application of effluent.

Land application aims to utilise the water and nutrient components in a sustainable way with minimum impacts on:

- soil;
- surface waters;
- groundwater; and
- ecosystems at or near the application site.

Land application of effluent is significantly influenced by the availability of land, climate, topography, groundwater and soil properties.

In parts of Australia, there is an increasing trend towards sustainable land application due to environmental constraints and community concern about discharges to sensitive water bodies. Many small communities use land application as the effluent management option.

Discharge to Coastal Waters

Where effluent is discharged to coastal waters, the aim is to maintain a water quality that protects the water body's environmental values. Usually, a mixing zone around the discharge point will be specified beyond which the environmental values are maintained.

Factors which influence the impact of effluent on a specific water body include:

- quality of the water body before effluent is mixed
- quality and quantity of the effluent
- dilution in the mixing zone
- hydrodynamics of the water body
- interactions between the effluent and the receiving environment
- sensitivity of the receiving environment.

Effluent discharge to oceans, bays and estuaries is common in Australia, particularly from the larger coastal communities.

More than 50 per cent of the Australian population lives in the State and Territory capital cities, all of which, with the exception of Canberra, are located on the coast and discharge effluent directly or indirectly to the ocean. There are more than 50 ocean outfalls from these cities and other coastal communities. The discharges vary from about 500 megalitres per day from outfalls in Sydney and Melbourne to less than one megalitre per day in some small communities.

The level of treatment before discharge varies from minimal to secondary treatment with nutrient removal. The treatment level and the location and design of the outfall depend on many factors such as:

- the environmental values of the ocean, estuary or bay
- the total effluent flow
- oceanographic aspects
- dilution, oxidation and dispersion characteristics of the receiving waters
- engineering constraints
- community desires.

Many discharges are designed to take account of naturally occurring dilution and disinfection processes at the discharge site, thus providing further protection of the environmental values of the adjoining waters without costly treatment.

Discharge to Inland Waters

Effluent discharge to inland waters is usually from smaller communities with a few exceptions such as the larger regional inland cities. With very few exceptions, the effluent has been treated to at least secondary level.

Disinfection is commonly required. Nutrient reduction is an increasing need especially where the effluent is a significant proportion of the total flow. The effect on the quality and the ecology of the stream and subsequent impact on coastal waters must also be considered.

Treatment Processes

Wastewater treatment involves various processes used individually or in series to obtain the required effluent quality. In normal sequence, the principal processes are:

- pre-treatment which removes gross solids, coarse suspended and floating matter
- primary treatment which removes readily settleable solids, usually by sedimentation
- secondary treatment which removes most of the remaining contaminants including fine suspended solids, colloidal and dissolved organic matter usually by biological aerobic processes or chemical treatment (where chemical treatment produces an effluent of similar quality to that achieved by biological processes)
- nutrient removal which further reduces the levels of nitrogen and phosphorus following secondary treatment
- disinfection of effluent which reduces pathogens to levels acceptable for the reuse or discharge of the treated wastewater
- advanced wastewater treatment which further improves the quality of effluent by processes such as sand filtration, ion exchange and microfiltration.

Secondary treatment usually includes the first three treatments in series or combined in varying configurations. Secondary treatment is normally a prerequisite for advanced wastewater treatment and disinfection. Advanced wastewater treatment is generally associated with discharge to sensitive environmental areas or for effluent reuse where health considerations are paramount.

Tables 3 to 6 define the minimum and commonly required level of treatment for various effluent management practices. These guideline levels of treatment are intended to apply until the next revision of this document. Treatment requirements beyond this time frame depend on the long-term water quality objectives for receiving waters and sustainability of the particular operation. Appendix 6 - Table 7 lists typical effluent quality following various levels of treatment.

Public Health and the Environment

While effluent management now enables treatment to a level where the risk of human disease is minimised, public health issues need to remain a priority. Environmental aspects are also vital. The discharge of poorly treated effluent can cause severe and even irreparable damage to receiving waters and land environments. If not properly managed, contaminants such as phosphorus, nitrogen, heavy metals, suspended solids, and those with high oxygen demand can cause undesirable changes in both aquatic ecosystems and land vegetation.

Aesthetics

Protection of aesthetic environmental values needs to be considered to avoid unacceptable visual, odour and taste problems, including those detailed in Table 2 below.

Category	Description
Floatables	Presence of gross solids, plastics, foam or excessive oil and grease that will remain on the surface of receiving waters or on the shoreline.
Suspended Solids	Effluent that results in receiving waters turbidity, or accumulation of potentially odorous organic sediments.
Colour	Discharge of an effluent resulting in an unacceptable increase or change in background colour.
Odour	Objectionable odour emissions.
Taste	Where swimmers may be affected, discharges that cause objectionable tastes are unacceptable. Where marine biota are harvested, tastes may influence the acceptability of the product.
Oil and grease	Effluent should not result in swimmers noticing a greasy feel to the water.
Spray drift and aerosols	Spray drift to adjoining land when spraying effluent on vegetation.

Table 2: Aesthetic factors to be avoided

Pathogens

Faecal wastes from humans and other animals contain micro-organisms capable of producing illness. Pathogens include viruses, bacteria, fungi, and protozoan and metazoan parasites.

Raw wastewater contains many species of micro-organisms making it impractical, if not impossible, to monitor them all. The presence of faecal contamination and the likely presence of pathogens is detected by looking for indicator organisms. Faecal coliforms are the most widely used indicators, selected because of their ability to indicate the presence of fresh faecal material and thus the possibility of pathogenic organisms from that source. However, there may be better indicators of bacterial pathogens, viral pathogens or other infecting organisms. Other indicator organisms have been proposed as more representative but are not yet used widely because of difficulties with practical methods of identification and their low correlation with disease.

It is important to establish the potential for pathogens so as to determine the potential health risks associated with the recreational use of receiving waters or consumption of seafood. The levels to which pathogens must be reduced to protect public health are well documented. Discharge licences for treatment plants include microbiological requirements. Compliance with these requirements has led to a low incidence of water-borne disease in Australia.

Nutrients

Despite nutrients such as nitrogen and phosphorus being essential for plant growth, small increases in levels can alter natural ecosystems. The Australian environment is relatively fragile and generally nutrient deficient.

As populations have grown, nutrients from urban and rural developments have entered the waterways. Increasingly, waterways are showing the effects of these nutrients. The development of undesirable species of algae is dependent upon a range of factors including the nitrogen to phosphorus ratio, with excess phosphorus encouraging the growth of cyanobacteria (blue-green algae). These can produce biotoxins that can kill animals which drink affected waters.

Acceptable levels of nutrients vary widely and must be assessed on a case by case basis. Often this is difficult, time consuming and expensive, but knowledge of the effects of nutrient variations is gradually increasing. The Australian environment's special characteristics preclude the straight forward application of research results and management techniques developed overseas. The *Australian Water Quality Guidelines for Fresh and Marine Waters* provides further details on nutrient levels in ambient waters. The discharge of effluent should be managed to avoid excessive nutrient levels.

Toxicants

Toxicants in effluents can influence human health, either as acute or chronic effects. Levels sufficient to produce acute effects are not normally encountered. Where this could happen, controls to avoid it must be in place. Toxicants are a chronic risk to human health when they are:

- persistent in the aquatic environment
- bioconcentrated several thousand fold
- exerting a toxic effect after prolonged exposure to low concentrations of the toxic constituent.

Toxicants, such as heavy metals and chlorinated organics, are of concern in all environments. Toxicants are removed from wastewater through biodegradation or are retained in the sludge.

Where large volumes of industrial wastes may contribute toxicants, the toxicants must be controlled at the source. The *Guidelines for Sewerage Systems - Acceptance of Trade Waste (Industrial Waste)* should be consulted.

Toxicants in effluent can also have acute and chronic effects on aquatic species and should not compromise the receiving waters' environmental values. The *Australian Water Quality Guidelines for Fresh and Marine Waters* identify the environmental values and their associated maximum toxicant levels for water bodies. The levels required to protect ecosystems are almost always more stringent than those required to protect human health. Toxicant concentrations in effluent used for land application should not have a detrimental impact on crops and vegetation.

The use of chlorine as a disinfectant is of special concern if the discharge is to a waterway, as the levels present can be harmful to aquatic life. Where the discharge is to a waterway, treatment techniques that do not add to the aquatic toxicity of the effluent are preferred. Where chlorine is the only practical disinfection option, the need for dechlorination of the effluent should be considered in cases where there is not sufficient dilution through dispersion to ensure that chlorine concentrations are below toxic levels.

Dissolved solids

The concentration and nature of soluble salts in treated effluent are important considerations in land applications and the discharge of effluent to fresh water. Effluent discharges to fresh water may alter the salinity of the water and affect the existing aquatic flora and fauna, as well as riparian ecosystems.

Land application without proper controls for dissolved solids may create serious environmental problems particularly in association with high water tables. The hazards and issues associated with irrigation and complex soil-water relationships require specialist knowledge even if the concentrations of dissolved salts are low. Those of concern include:

- water and soil salinities
- leaching of salts
- soil permeability
- specific ions such as chloride and sodium
- trace contaminants
- plant sensitivity.

Other considerations

Parameters such as temperature and biochemical oxygen demand must be considered in the review of each discharge. The review should assess the parameters' impact on the ecosystems associated with receiving waters or land.

Guidelines for Land Application

Land application is the discharge of effluent on an area of land with the primary aim of returning the water to the water cycle by evaporation, evapotranspiration or infiltration.

The application of raw sewage to land is not covered by these guidelines as this application is considered to be part of the treatment process rather than management of the effluent. This document deals with the effluent from the wastewater treatment process.

These guidelines describe the levels of treatment required for effluent prior to land application. The *Guidelines for Sewerage Systems - Reclaimed Water* provides further detail for a range of reuse options.

Generally, water quality limits are set for effluent before application. They are set to minimise potential health risks and effects on the receiving environment, and are monitored to determine compliance.

The basic principles for land application are:

- the build up of any substance in the soil should not preclude sustainable use of the land in the long term
- the effluent is not detrimental to the vegetative cover
- any change to the soil structure should not preclude the use of the land in the long term
- any runoff to surface waters or percolation to groundwater should not compromise the agreed environmental values
- no gaseous emissions to cause nuisance odour.

Land application may be the best practical option for inland communities. Total disposal is likely to be feasible in semi arid or arid regions and for small communities in other areas.

Where discharge to surface water or groundwater is not permitted, application and loading rates need to be carefully calculated and monitored to prevent effluent percolation or runoff beyond the land application area or diversion to adjacent water bodies or land. Infiltration occurs on highly permeable soils and most of the flow is to groundwater resulting in aquifer recharge. In particular situations, land discharge may rely solely on evaporation. The quality of any discharge to surface waters should be sufficient to protect the environmental values of the receiving waters.

There should be storage capacity for times when climatic conditions halt operations or require reduced loading rates. Storage may also be needed for flow equalisation, system backup, reliability and management. These requirements are site specific and depend on climatic conditions, topography, soil depth, permeability and chemical characteristics of the soil, and land use. The cost of providing storage can be significant, often influencing the economic viability of land application schemes.

Where spray irrigation is used, the potential health risk from aerosol spray drift should be evaluated. The proximity of the operation to communities and access by the public during and after irrigation are factors that may place limitations on spray irrigation.

Planning ideally requires multi-disciplinary inputs to assess the effect of proposed effluent discharge as schemes are constrained by a variety of local factors. The appropriate State Government Authority should be approached for advice on site specific details. The objective should be to minimise the build up of toxicants in the soil and the vegetation through appropriate management of hydraulic systems and treatment processes.

Table 3 lists discharge options, guideline treatment levels, the limiting factors for each land application option, and associated parameters likely to be of concern. These factors should be considered in detail before adopting a particular option. The "minimum level of treatment" is usually the lowest that will be practical for the particular discharge option. It sets the lower end of the spectrum for treatment for each land application option. The commonly required level of treatment is the level most likely to be specified by the environment protection agency in the licence to discharge the effluent. The type of land application and local conditions will determine the level of treatment required.

LAND APPLICATION OPTIONS	LIMITING FACTORS FOR DIFFERENT SEGMENTS OF THE ENVIRONMENT	EFFLUENT PARAMETERS OF MAJOR CONCERN	MINIMUM LEVEL OF TREATMENT	COMMONLY REQUIRED LEVEL OF TREATMENT
Evaporation ponds	Air - aesthetic enjoyment (odours). Water - seepage, run-off.	Odour emission, toxicants, organics (BOD), pathogens.	**Nil**	**C**
Evapotranspiration (Irrigation) agricultural landscape	Air - odours. Land - potential for long-term soil contamination and adverse impacts on vegetation and soil structure.	Odours, dissolved solids, toxicants, pH, pathogens, nutrients.	**B** **C**	**C and E** **C and E**
Infiltration - natural - ground artificially conditioned - aquifer recharge	Groundwater - existing and potential environmental values. Aquifer clogging. Land - potential for long-term degradation of land and/or crops and vegetation.	Solids, BOD, nutrients, pathogens, toxicants, dissolved solids, pH.	**C**	**C and D**

Table 3: Land discharge options and treatment levels

NOTES: PLANT TYPE - TYPICAL TREATMENT PROCESSES

Treatment Process Category	Parameters to be removed	Examples of Treatment Processes
A Pre Treatment	Gross solids (for fine screens, some readily settleable solids)	Screening
B Primary Treatment	Gross solids plus readily settleable solids	Primary sedimentation
C Secondary Treatment	Most solids and BOD	Biological treatment, chemically assisted treatment, lagoons
D Nutrient removal	Nutrients after removal of solids	Biological, chemical precipitation.
E Disinfection	Bacteria and viruses	Lagooning, ultraviolet, chlorination.

ABBREVIATION **BOD** = Biochemical Oxygen Demand

Guidelines for Coastal Waters

Marine waters have a very important intrinsic value. They are used for both pleasure and commercial gain by tourists and local communities. The maintenance of acceptable water quality is a priority.

In Australia, effluent is discharged to a range of coastal waters, including:

- open ocean
- estuaries
- bays.

There may be a high or small tidal range. The discharge may be close to populated centres or in an unpopulated area. The ocean receives effluent directly via long ocean outfalls or nearshore discharge sites, and indirectly via discharge into adjoining rivers, estuaries and groundwater.

As most of Australia's population is concentrated around the seaboard, the larger volumes of effluent are discharged to coastal waters and the ocean. Dilution and dispersion are valuable processes for reducing the impacts of many non-toxic and non-accumulative pollutants. The effects of most ocean discharges are statistically insignificant when compared to total loads in the ocean. However, there may be locally significant effects, particularly for large quantities of discharge. These effects include:

- bacterial - may be unfit for swimming or shellfish harvesting
- aesthetics - may be unsightly due to oil, grease, plastics, litter or odour
- nutrients - near shore productivity may be increased
  - nuisance algal growths, which are a particular problem in estuaries
- toxicants - may impact on biota and have the potential for making produce unacceptable for use.

Marine ecosystems need to be maintained to ensure:

- the abundance, genetic diversity and evolutionary development potential of marine species
- maintenance of the food chain which provides an important source of protein including that for human consumption.

Bioaccumulation is a critical factor in assessing long-term impacts of effluent discharge. The potential for bioaccumulation of heavy metals, pesticides and other organics and pesticides should be controlled to minimise chronic effects on the environment and possibly human health. Limiting mass loadings at the source is preferred. The *Guidelines for Sewerage Systems - Acceptance of Trade Waste (Industrial Waste)* provide more detailed information.

Ambient conditions such as water quality, biological communities and characterisation of sediments can be measured. Where possible, predischarge monitoring should be undertaken as early as practicable before discharge starts to obtain a baseline for comparing outfall performance. The baseline should be obtained before urbanisation and should cover areas adjacent to stormwater drainage as well as the outfall.

Treatment up to a secondary level typically reduces pathogens in effluent by two orders of magnitude. Disinfection of effluent by filtration or detention lagoons can improve removal rates even further. Dilution also effectively reduces levels of pathogens, augmented by dispersion by ocean currents and tidal action. Predators and the antagonistic effects of oxygen, salt water and ultraviolet radiation in the marine environment contribute to the reduction and ultimate destruction of pathogens.

Table 4 lists the various categories of discharge to coastal waters and indicates the related environmental values, issues and guideline treatment levels that apply. These categories are dependent upon the mixing processes that dominate the discharge.

Extended outfalls depend predominantly on buoyancy generated turbulence to achieve initial dilution. Subsequent dispersion will then occur as ocean and wind generated currents move the effluent/sea water mix away from the discharge site. An extended outfall will normally have an initial dilution of 50:1 or better.

Where the depth and hence the buoyancy generated turbulence is insufficient on its own to achieve adequate dilution, additional mixing can result from :

- higher velocity discharges where the energy of the discharge enhances the mixing
- tidal energy.

These processes, combined with subsequent dispersion in the ocean and with higher treatment levels, can be used with discharges into coastal and nearshore waters.

Bays and estuaries are generally shallow and there is little buoyancy mixing. In addition, because of the proximity of the shoreline, there is little opportunity for subsequent dispersion. In such cases, a satisfactory discharge is dependent upon the velocity of the discharge, tidal mixing and a high level of treatment.

The presence of reefs or bathing beaches near outfalls in tropical or sub-tropical waters can impose a need for a level of treatment significantly better than that commonly required in less sensitive coastal waters.

Tidal movement in the open ocean provides little mixing energy. Near the coastline and particularly in bays and estuaries, tidal movement provides much greater mixing energy but the movement is cyclical. In estuaries, unless the effluent reaches the open ocean within a reasonable number of cycles, it may not readily disperse. In this event, (and depending on the mass of the nutrients discharged and the dilution/dispersion ratio achieved) a reduction in the nutrients in the effluent may be desirable. Nitrogen is usually the limiting nutrient for coastal waters. The limiting factors for coastal discharges and parameters likely to be of concern for a given option are also listed. These should be considered in detail before adopting a particular option.

The "minimum level of treatment" is usually the lowest that will be practical for the particular discharge option. It sets the lower end of the spectrum for treatment for each coastal discharge. The commonly required level of treatment is the level most likely to be specified by the environment protection agency in the licence to discharge the effluent. Local conditions will determine the treatment level.

DISCHARGE OPTIONS	LIMITING ENVIRONMENTAL VALUES APPLYING TO EACH DISCHARGE OPTION	EFFLUENT PARAMETERS OF MAJOR CONCERN	MINIMUM LEVEL OF TREATMENT	COMMONLY REQUIRED LEVEL OF TREATMENT
coastal waters via extended outfall	maintenance of aquatic ecosystems.	toxicants, pathogens floatables, oil and grease, suspended solids	**A**	**B**
coastal waters high tidal range	maintenance of aquatic ecosystems, recreation – primary & secondary contact	pathogens, toxicants, floatables, oil and grease, suspended solids.	**B**	**B**
coastal waters nearshore (other than bays and estuaries)	maintenance of aquatic ecosystems recreation – primary contact aesthetic enjoyment	pathogens, toxicants, floatables, oil and grease, suspended solids nutrient impact, surfactants.	**C**	**C**
bays and estuaries	maintenance of aquatic ecosystems recreation – primary & secondary contact, aesthetic enjoyment,	Oil and grease, nutrients, pathogens, toxicants, floatables colour, suspended solids, BOD, surfactants	**C**	**C and D** for medium to large discharges (> 3 megalitres per day)

Table 4: Coastal waters discharge options and treatment levels

NOTES: PLANT TYPE – TYPICAL TREATMENT PROCESSES

Treatment Process Category	**Parameters to be removed**	**Examples of Treatment Processes**
A Pre Treatment	Gross solids (for fine screens, some readily settleable solids)	Screening
B Primary Treatment	Gross solids plus readily settleable solids	Primary sedimentation
C Secondary Treatment	Most solids and BOD	Biological treatment, chemically assisted treatment, lagoons
D Nutrient removal	Nutrients after removal of solids	Biological, chemical precipitation
E Disinfection	Bacteria and viruses	Lagooning, ultraviolet, chlorination

ABBREVIATION **BOD** = Biological Oxygen Demand

Guidelines for Inland Waters

The ability of inland waters to maintain environmental values is increasingly being threatened by steady growth in population, urbanisation and use of catchments. In many catchments, waterways have been seriously degraded, leaving the costly and difficult task of environmental restoration to this and future generations. These issues highlight the need for sewerage systems to manage the impact of urbanisation on inland waters and the need for increasingly more stringent controls.

In addition, the community needs to consider the costs associated with sustaining the existing environment in light of continued urban growth. This includes the costs associated with managing effluent from the growing community. It should be accepted in such a debate that the community may accept a changed environment provided that this change is sustainable.

Waste management principles are crucial in managing effluent discharge to inland waters.

Issues to be considered in discharging effluent to inland waters include:

- avoiding or reducing the amount of contaminants in the effluent through appropriate trade waste controls and customer education
- reusing or recycling treated effluent where practical
- returning effluent to a stream to provide environmental flows **only** where effluent quality is at least commensurate with ambient water quality objectives
- adopting accepted modern treatment technology with the aim of improvement over time
- applying environmental quality guidelines for effluent where the discharge is a major determinant of the receiving stream quality
- avoiding discharges entering potable water supply off-takes and stretches of streams having high environmental value by optimal location of the discharge pipes.

Where the effluent causes ambient water quality objectives to be exceeded, the mixing zone associated with the discharge should be clearly designated in a waste discharge licence. The aim must be to progressively reduce the declared mixing zone size until the discharge no longer impairs water quality objectives. The impact of effluent on waterways, including mixing zones, should be monitored.

Although deterioration of an aquatic system may be reversible, restoring a system to its former state is usually far more costly than prevention.

A wide range of environmental values can be attributed to inland water bodies. Table 5 sets out the effluent parameters of concern and the guideline treatment levels for discharge to inland waters. The minimum treatment level defines the lower end of the spectrum for each discharge to inland waters. The most commonly required treatment level is that most likely to be specified by the environment protection agency in the licence to discharge the effluent. While local conditions will determine the treatment level, the demonstrable effect of nutrients on many Australia's inland waters means that in many regions there is an expectation that effluent will be subject to secondary treatment plus nutrient removal prior to discharge, unless it is established by the proponent that site specific circumstances would allow secondary treatment only to protect the agreed environmental values of the inland waters. It should be noted that proponents should not assume that because a discharge meets a treatment standard the discharge will be permitted. It will need to be further demonstrated that any such discharge, and its assoicated mixing zone, would not prejudice the environmental values of the waterway.

INLAND WATERS OPTIONS	LIMITING ENVIRONMENTAL VALUES APPLYING TO RECEIVING WATERS	EFFLUENT PARAMETERS OF MAJOR CONCERN	MINIMUM LEVEL OF TREATMENT	COMMONLY REQUIRED LEVEL OF TREATMENT
rivers, streams and lakes	ecosystem protection	dissolved solids, toxicants, floatables, colour, turbidity, TSS, nutrients, BOD, pH.	**C**	**C and D**
	recreation and aesthetics	toxicants, floatables, colour, turbidity, TSS, nutrients, BOD, pathogens, odour, oil and grease.	**C**	**C and D** **(E for primary contact)**
	raw water for drinking water supply	dissolved solids, toxicants, floatables, colour, turbidity, TSS including algae, nutrients, BOD, pH, pathogens, taste & odour producing compounds.	**C**	**C, D and E**
	agricultural water	dissolved solids, toxicants, floatables, TSS, pH, pathogens.	**C**	**C**
	industrial water	dissolved solids, toxicants, floatables, colour, turbidity, TSS, nutrients, BOD, pH.	**C**	**C**

Table 5: Inland waters discharge options & treatment levels

NOTES: PLANT TYPE - TYPICAL TREATMENT PROCESSES

Treatment Process Category		Parameters to be removed	Examples of Treatment Processes
A	Pre Treatment	Gross solids (for fine screens, some readily settleable solids)	Screening
B	Primary Treatment	Gross solids plus readily settleable solids	Primary sedimentation
C	Secondary Treatment	Most solids and BOD	Biological treatment, chemically assisted treatment, lagoons
D	Nutrient removal	Nutrients after removal of solids	Biological, chemical precipitation.
E	Disinfection	Bacteria and viruses	Lagooning, ultraviolet, chlorination.

ABBREVIATIONS **BOD** = Biochemical Oxygen Demand **TSS** = Total Suspended Solids

Sampling and Monitoring

Sampling and monitoring of the environment and effluent are needed to determine whether:

- predicted effluent quality is achieved
- level of impact or change caused by the management system is as predicted
- agreed environmental values are met.

The Environment

A sampling program for the environment is usually based on output from a detailed site study and consideration of the discharge's nature and volume. Impact monitoring generally aims at determining long-term changes and may be fairly infrequent.

A broad range of aspects needs to be considered when assessing the impact on the environment including:

For water,

- the current background quality of the water body
- status of ecosystems, both pre and post discharge
- modelling the effects on the receiving environment, including the effects from all other discharges to the water body
- sampling the water in and beyond the mixing zone and sampling of sediments and fauna
- establishing control sites beyond the influence of the discharge to identify changes unrelated to it
- biological monitoring e.g. macro invertebrates
- evaluating the biological impact of the discharge.

Setting water quality objectives for the receiving waters and sampling of these waters are covered in other documents of the strategy.

For land,

- the soil type and structure
- vegetation cover
- potential for runoff

- proximity to streams and lakes
- evaluating the impact of the discharge
- sampling of groundwater, nearby surface waters, soil and crops.

Monitoring the environmental changes that may occur as a result of effluent discharges is complex. Soil samples and groundwaters can be analysed for contaminants. Similarly, fish and flora can be checked for bioaccumulation of contaminants. For large projects, an assessment of ecosystems with comparison against control sites can be justified.

The frequency and scope of environmental monitoring needs to be considered on a case by case basis. In particular, for most projects, the scope should be discussed with the environmental authority and community input sought.

Refer to *Monitoring and Reporting Water Quality* for additional information.

The Effluent

Monitoring of effluent quality may be undertaken to:

- assess treatment plant performance
- meet a regulatory requirement
- detect changes in effluent quality that could have an impact on the environment
- provide data for long term planning and to confirm design criteria
- meet research needs.

The nature and frequency of sampling required will depend on a large number of factors. These include the:

- sensitivity of the environment
- nature of the treatment process
- risks to the environment
- quantity of the discharge
- variability of the inflow
- composition and variability of the inflow's industrial waste component
- reliability of the treatment process
- competence of the operating staff
- effectiveness of the plant's maintenance and supervision
- remoteness of the plant.

It is recommended that sampling be at two levels:

- a small number of critical parameters such as indicators of general plant performance and those most likely to vary and have the greatest potential for short term impact on the environment
- a broad suite of parameters covering all those with identified potential for impact on the environment including suspended solids, BOD, temperature, pH, oil and grease, nutrients, dissolved solids, pathogens and toxicants.

The sampling frequency is largely dependent on plant size and the robustness of the treatment process. In cases where there may be a significant impact on the environment, more frequent sampling may be required.

The potential variability of effluent quality is also taken into account in determining sampling frequencies and is largely dependent on the type of treatment process. For example, lagoons relying on biological processes and with long detention times (>30 days) are far less likely to have sudden changes in effluent quality than are plants with very short detention times. Most treatment systems other than lagoons can be regarded as having short detention times.

Sampling at a frequency that shows any cyclical variation has advantages when assessing overall treatment plant performance. Table 6 gives the recommended sampling frequencies for different plant types. Two sampling frequencies are nominated for each plant size. In very small, remote communities (especially in the outback regions) sampling may be both logistically difficult and prohibitively expensive. In these cases, processes used should be selected to be robust and reliable. Then, sampling frequencies may be lower than that indicated.

Grab samples can usually be representative if sampling occurs within two hours of the normal time of maximum daily flow for short detention time systems. Small plants may exhibit larger variation in the quality of the incoming wastewater if the upstream system includes non-continuous industrial waste discharges. Composite sampling may be justified in some instances, particularly for the larger plants, where both total mass and peak pollutant loading on the receiving environment are important.

Details on the storage, transportation and testing of samples can be found in the relevant Australian Standards listed in appendix 4. Advice from analytical laboratories should be sought on sampling procedures generally and particularly where special needs exist as for microbiological and toxicant monitoring. Appendix 6 - Table 7 specifies typical effluent quality following various levels of treatment.

Plant Type (See notes below)	Principal Process Parameters	Plant Detention Times	Plant Size Very Small <0.5 MLD	 Small 0.5-3 MLD	 Medium 3-20 MLD	 Large >20 MLD
A, B	TSS, BOD	all	Q	Q	W	2xW
C	TSS BOD	long detention short detention	Q M	Q W	M 2xW	W 2xW
D	TSS, N, P BOD	long detention short detention	Q M	Q W	M 2xW	W 2xW
E	E. coli	long detention short detention	Q M	Q M	M 2xW	W 2xW
F	any site specific needs	all	W	W	2xW	2xW
Comprehensive suite of parameters (see page 33)		all	T	T	Q	Q

Table 6: Recommended sampling frequencies for effluents

NOTES: PLANT TYPE - TYPICAL TREATMENT PROCESSES

Treatment Process Category	Parameters to be removed	Examples of Treatment Processes
A Pre Treatment	Gross solids (for fine screens, some readily settleable solids)	Screening
B Primary Treatment	Gross solids plus readily settleable solids	Primary sedimentation
C Secondary Treatment	Most solids and BOD	Biological treatment, chemically assisted treatment, lagoons
D Nutrient removal	Nutrients after removal of solids	Biological, chemical precipitation.
E Disinfection	Bacteria and viruses	Lagooning, ultraviolet, chlorination.
F Advanced wastewater treatment	Treatment to further reduce selected parameters	Sand filtration, microfiltration.

ABBREVIATIONS

BOD = Biochemical Oxygen Demand **P** = Phosphorus **MLD** = Megalitres per day **2xW** = Twice weekly **M** = Monthly **T** = Twice yearly
TSS = Total Suspended Solids **N** = Nitrogen **W** = Weekly **Q** = Quarterly

Sampling frequency in very small remote communities may be lower than that indicated above.

Appendices

Appendix 1: Guidelines and documents

Paper No.	Title
	Policies and Process for Water Quality Management
1	Water Quality Management - An Outline of the Policies
2	Policies and Principles - A Reference Document
3	Implementation Guidelines
	Water Quality Benchmarks
4	Australian Water Quality Guidelines for Fresh and Marine Waters
5	Australian Drinking Water Guidelines - Summary
6	Australian Drinking Water Guidelines
7	Guidelines for Water Quality Monitoring and Reporting
	Groundwater Management
8	Guidelines for Groundwater Protection in Australia
	Guidelines for Diffuse and Point Sources
9	Rural Land Uses and Water Quality - A Community Resource Document
10	Guidelines for Urban Stormwater Management
11	Guidelines for Sewerage Systems - Effluent Management
12	Guidelines for Sewerage Systems - Acceptance of Trade Waste (Industrial Waste)
13	Guidelines for Sewerage Systems - Sludge (Biosolids) Management
14	Guidelines for Sewerage Systems - Reclaimed Water
15	Guidelines for Sewerage Systems - Sewerage System Overflows
16a	Effluent Management Guidelines for Dairy Sheds
16b	Effluent Management Guidelines for Dairy Processing Plants
17	Effluent Management Guidelines for Intensive Piggeries
18	Effluent Management Guidelines for Aqueous Wool Scouring and Carbonising
19	Effluent Management Guidelines for Tanning and Related Industries
20	Effluent Management Guidelines for Australian Wineries and Distilleries

Appendix 2: Glossary

Advanced wastewater treatment:

The application of multiple unit processes beyond secondary treatment.

Beneficial use: A beneficial use is any use or value of the environment that promotes public benefit, welfare, safety, health or aesthetic enjoyment.

Biochemical Oxygen Demand:

A measure of the amount of oxygen used in the biochemical oxidation of organic matter, over a given time and at a given temperature; it is determined entirely by the availability of the material as a biological food and by the amount of oxygen used by the micro-organisms during oxidation.

Chlorination: The application of chlorine to water, wastewater, or industrial waste generally for disinfection.

Conventional filtration:

The process of passing wastewater through a bed of granular material, e.g. sand and anthracite, to remove particulate matter.

Criterion: A qualitative or quantitative value or concentration of a constituent, based on scientific data, from which a decision or judgement may be made about suitability of water for a designated use.

Diffuse source: A source of pollution that has no single place of origin (for example, runoff of rainwater containing sediment, fertilisers and pesticides from land used for agriculture).

Disinfection: A process that destroys, inactivates or removes pathogenic micro-organisms.

Effluent: The water discharged following a wastewater treatment process, e.g. secondary effluent.

Environmental flows:

The flow in an inland stream needed to sustain the ecological values of aquatic ecosystems at a low level of risk.

Environmental value: See beneficial use above.

Evapotranspiration:

Water lost from soil by evaporation and/or plant transpiration.

Faecal coliforms: Thermotolerant coliform organisms mainly indicating faecal pollution. *Escherichia coli* is generally the dominant species.

Floatables: Gross solids, plastics, foam or excessive oil and grease present on the surface of the effluent.

Guideline treatment level:

A likely level of treatment for the particular set of discharge conditions. Actual treatment requirements should be determined in accordance with environmental value requirements and ongoing monitoring results.

Heavy metals: Metals of high atomic weight which in relatively high concentrations can exert a toxic effect. The main heavy metals include cadmium, chromium, copper, lead, mercury, nickel and zinc.

Lagoon: Any large pond or holding basin used to contain wastewater while sedimentation and biological oxidation occur.

Marine waters: Oceans and bays together with water in estuaries. These waters have dissolved inorganic ions greater than 30,000 mg/L.

Mixing zone: An area contiguous with an effluent discharge point and specified in the licence or permit, in which the water quality objectives applying to the water body are not required to be met.

Municipal wastewater treatment plant:

A plant treating wastewater of essentially domestic origins in which any industrial wastes are compatible with domestic wastewater.

Nutrients: Substances necessary for the growth and reproduction of organisms.

Nutrient removal: An additional wastewater treatment process to reduce the amount of nitrogen or phosphorus in the effluent below the levels achieved by secondary treatment.

Objectives: The desirable, short and/or long term goals of a water quality management program. Such objectives are often derived after consideration of water quality criteria in the light of economic, environmental, social or political factors.

Outfall: The pipe or conduit used to convey treated effluent to the point of discharge.

pH: An indicator of acidity or alkalinity.

Point source: A source of pollution from an identifiable place of origin (for example, an effluent discharge from a wastewater treatment plant or an effluent discharge from a rural industry).

Ponds: Treatment lagoons for purification of raw wastewater and for the additional treatment of primary or secondary treated effluent.

Potable water: Water suitable for human consumption whether used as drinking water or in the preparation of food, in showers etc.

Pre Treatment Wastewater treatment which involves the removal of gross solids and some of the readily settleable solids.

Primary treatment: Wastewater treatment which involves sedimentation (sometimes preceded by screening and grit removal) followed by sludge digestion or other means of sludge disposal.

Reuse: The application of appropriately treated wastewater to some beneficial purpose.

Secondary treatment:

Generally, a level of treatment that removes 85 per cent of BOD and suspended solids.

Sludge: The solids which are removed from wastewater by primary and secondary treatment.

Standards: Currently legally enforceable levels established by an authority.

Surfactants: A surface active agent found in detergents.

Tertiary treatment: Processes used to further improve secondary effluent quality prior to discharge or reuse. Such processes include sand filtration, oxidation pond retention, disinfection and the use of wetland filters.

Toxicant: A substance which, above a certain concentration, is poisonous to living things.

Turbidity: An expression of the optical property that causes light to be scattered or absorbed rather than transmitted in straight lines through water. Turbidity is caused by suspended matter such as clay, silt, finely divided organic and inorganic matter, plankton and microscopic organisms and gives the water a "cloudy" appearance.

Wastewater: Water which has been used, at least once, and has thereby been rendered unsuitable for reuse for that purpose without treatment and which is collected and transported through sewers. Wastewater normally includes water from both domestic and industrial sources.

Appendix 3: Bibliography

References

Australian Water Resources Council, *AWRC Strategy for Water Quality Management - A Discussion Paper,* March 1991.

Australian Water Resources Council, *Review of Effluent Disposal Practices,* Camp, Scott, Furphy, 1990.

Commonwealth of Australia, *National Strategy for Ecologically Sustainable Development*, December 1992.

EPA Victoria, *Environment Protection Act, 1970*

Guidelines

Australian Guidelines for Recreational Use of Water - NHMRC, 1990.

Recommended Water Quality Criteria, EPA of Victoria, 1983.

Water Quality Criteria for Marine and Estuarine Water Bulletin 103 - EPA WA

Draft National Water Quality Guidelines, ANZECC, October 1990.

Guidelines for Use of Reclaimed Water in Australia, NHMRC/AWRC, 1987.

Guidelines for the Disposal of Wastewaters by Land Application, SPCC.

Guidelines for Use of Treated Sewage for Agricultural Irrigation of Recreation Areas and Impoundments, Water Quality Committee, Queensland, 1977.

Guidelines for Wastewater Irrigation, EPA of Victoria, Publication No. 168, Revised April 1991.

NSW Guidelines for Urban and Residential Use of Reclaimed Water, NSW Recycled Water Co-ordination Committee, May 1993.

Appendix 4: Standards

References to Australian Standards (at October 1991) as published by Standards Australia.

- AS 1095 Microbiological Methods for the Dairy Industry
- AS 2031 Selection of containers and preservation of water samples for chemical and microbiological analysis
- 2031.1 - 1986 Chemical
- 2031.2 - 1987 Microbiological.
- AS 2051 Recommendations for the Sampling and Analysis of Waters for Heavy Metals
- with Special Reference to Mercury. 1977

Appendix 5: Environmental values

The *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC November 1992) nominates criteria for a range of environmental values. The environmental values are:

- Protection of aquatic ecosystems
    - Protection of freshwater ecosystems
    - Protection of marine ecosystems
    - Production of fish and shellfish for human consumption
    - Protection of wildlife
- Recreational water quality and aesthetics
    - Primary body contact (swimming, surfing etc.)
    - Secondary contact (boating, fishing etc.)
    - Visual use
- Raw water for drinking water supply
    - Raw water subjected to coarse screening only
    - Raw water subjected to coarse screening and disinfection

. Agricultural water uses

- Irrigation
- Stock watering
- Farmstead use. Industrial water quality
- Heating and cooling
- Hydro-electric power generation
- Textile industry
- Chemical and allied industry
- Food and beverage industry
- Iron and steel industry
- Tanning and leather industry
- Pulp and paper industry
- Petroleum industry

Appendix 6: Typical effluent quality following various levels of treatment

Treatment	BOD mg/l	Total Suspended Solids mg/l	Total Nitrogen mg/l	Total Phosphorus mg/l	*E coli* org/100 ml	Anionic Surfactants mg/l	Oil and Grease mg/l
Raw Wastewater	150-500	150-450	35-60	6-16	10^7-10^8	5-10	50-100
A	140-350	140-350					
B	120-250	80-200	30-55	6-14	10^6-10^7		30-70
C	20-30	25-40	20-50	6-12	10^5-10^6	< 5	< 10
D	5-20	5-20	10-20	< 2			< 5
E					$< 10^3$		
F	2-5	2-5	< 10	< 1	$< 10^2$		< 5

Table 7: Typical effluent quality for various levels of treatment

NOTES: PLANT TYPE - TYPICAL TREATMENT PROCESSES

	Treatment Process Category	Parameters to be removed	Examples of Treatment Processes
A	Pre Treatment	Gross solids, some of the readily settleable solids	Screening
B	Primary Treatment	Gross solids plus readily settleable solids	Primary sedimentation
C	Secondary Treatment	Most solids and BOD	Biological treatment, chemically assisted treatment, lagoons
D	Nutrient removal	Nutrients after removal of solids	Biological, chemical precipitation.
E	Disinfection	Bacteria and viruses	Lagooning, ultraviolet, chlorination.
F	Advanced wastewater treatment	Treatment to further reduce selected parameters	Sand filtration, microfiltration.

ABBREVIATIONS **BOD** = Biochemical Oxygen Demand