

**NATIONAL WATER QUALITY
MANAGEMENT STRATEGY**

**EFFLUENT MANAGEMENT
GUIDELINES FOR
DAIRY SHEDS IN AUSTRALIA**

June 1999

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PREAMBLE

This document is one of a suite of documents forming the National Water Quality Management Strategy (NWQMS). This Strategy aims to achieve the sustainable use of the nation's water resources by protecting and enhancing their quality, while maintaining economic and social development.

The Effluent Management Guidelines series, covers guidelines for specific industries. Six separate documents deal with specific industries as set out in Figure 1. This document provides national Effluent Management Guidelines for Dairy Sheds. It sets out principles that can form the basis for a common and national approach to effluent management for the dairy industry throughout Australia.

Effluent Management Guidelines					
Dairy Sheds and Dairy Processing Plants in Australia		Intensive Piggeries in Australia	Aqueous Wool Scouring and Carbonising in Australia	Tanning and Related Industries in Australia	Australian Wineries and Distilleries
a) Dairy Sheds in Australia	b) Dairy Processing Plants in Australia				

Figure 1: Structure of the Effluent Management Guidelines for specific industries

Further information on the National Water Quality Management Strategy is given in Appendix A.

While prepared by a joint ANZECC/ARMCANZ working group these guidelines are designed primarily for the Australian situation, in recognition of the different legislative framework in New Zealand. However they could serve as a basis for discussion in New Zealand on the issues addressed in the guidelines.

1 INTRODUCTION

The dairy farm industry is Australia's fourth largest rural industry in terms of gross value of production. Its annual sales, ex farm gate, total more than \$ 2.6 billion, and it directly employs some 50,000 people. The industry operates in all States, with Victoria accounting for more than 60 per cent of the national output. In 1995/96 there were 1.9 million cows on 13,720 registered dairy farms, with most farms being family owned and operated. Additional information on the industry is provided in Appendix B.

1.1 Objective of the guidelines

The objective in developing the *Effluent Management Guidelines for Dairy Sheds* (hereafter referred to as 'the Guidelines') is to ensure a nationally consistent approach to effluent management for the dairy farm industry throughout Australia.

The Guidelines can serve as a basis for sustainable resource development extension programs and for negotiations between regulatory authorities, local government and the industry on conditions for the managing, monitoring and reporting for effluent management that should apply at the regional level. They are sufficiently flexible to serve as a framework for developing both codes of practice and general industry agreements, as well as the range of legislative controls that apply around Australia. It is not practicable to produce guidelines which will be immediately applicable to licensing in all jurisdictions without adaptation to, and discussion of, local needs and conditions.

As the Guidelines deal with dairy shed effluent and associated solid components including sludges, and not total site management, the document would be one of a number that may need to be used for the overall environmental management of dairy sheds.

The Guidelines will be reviewed as appropriate, but it could be reasonably expected that this would be within three years.

1.2 Environmental objectives

The Guidelines' main environmental objectives are that the proper siting, establishment and operation of dairy sheds should:

- maintain the environmental values of surface and groundwaters, including their ecology, by minimising the discharges of effluents containing organic matter, nutrients, salts or chemical constituents;
- minimise the effect of effluent addition to land, which may lead to the degradation of soil structure, salinisation, waterlogging, chemical contamination or erosion; and
- avoid off-site nuisance or interference with amenity, such as odours associated with inappropriate or poorly-operated waste treatment processes.

Achievement of these environmental objectives requires that dairy shed operations throughout Australia should be managed to protect:

- surface waters
- groundwaters
- soils
- vegetation
- public amenity.

The main emphasis of these Guidelines is water quality protection. Achievement of these environmental objectives, and the specific objectives in Section 4, should help ensure that dairy shed operations are ecologically sustainable both in the short and long term.

1.3 Application of guidelines

These Guidelines are intended for use by dairy farmers (including consultants, extension officers and farmer organisations), regulators, planning agencies and the broader community.

Dairy farmers

The Guidelines aim to:

- assist operators of dairy sheds to minimise and as far as possible use the effluent they produce
- prevent the unacceptable degradation of water, land and environmental quality.

The Guidelines should be consulted in conjunction with existing regulations, where extensions or new developments are planned, or where environmental protection at existing operations is to be enhanced.

Regulators and planning agencies

Effluent Management Guidelines for Dairy Sheds in Australia should provide the framework where guidelines or codes of practice are to be developed to assist with the regulation of dairy sheds. Any such State or local guidelines should be consistent with the Guidelines. Existing codes of practice or regulations should be consistent with, and at least as stringent as, these Guidelines.

In general, State, Territory, regional and local government guidelines, laws and regulations will be more detailed than these Guidelines to take account of the specific circumstances of the dairy farm industry in different areas. Local knowledge and data specific to individual dairy farms are essential to manage dairy farms responsibly.

The broader community

Integrated catchment management is increasingly becoming the "umbrella" for sustainable natural resource management. It provides the framework for the community, industry and government to work together to manage environmental and resource management problems. This document provides information which will help communities to participate in an informed manner in integrated catchment management, including decisions on new or existing dairy farm developments and local resource management issues. Development of catchment-based plans and strategies is central to integrated catchment management.

Further information

The development of detailed guidelines and environmental codes of practice is the responsibility of relevant State and Territory authorities. Proponents are thus encouraged to seek advice from the relevant State and Territory authorities about current regulations and codes of practice when new developments are being contemplated, or when the effluent management system of existing operations is to be upgraded.

Where further information is required to assist decisions relating to the management of effluent, reference should be made as appropriate to other National Water Quality Management Strategy documents (Appendix A) or the sources listed in Appendices C and D.

2 PRINCIPLES OF ENVIRONMENTAL MANAGEMENT

The main principles of effective environmental management of effluent, in order of importance, are:

- avoidance or elimination of excessive waste generation through improved planning
- minimisation of waste generation
- effective recycling and reuse of effluent where feasible
- disposal, where its use is not practicable, in a manner that will not cause adverse short or long term environmental impact.

The development and implementation of a whole farm plan is a fundamental consideration for sustainable management of dairy shed effluent. The plan should be based on:

- identifying land suitable for each part of the farm operation
- selecting site and layout for the most efficient operation
- total quality management, including setting objectives, risk management, financial management and forward planning.

The plan provides the management, administrative and monitoring framework for the environmental aspects of an operation and should include environmental management principles and pay attention to animal health and human occupational health and safety.

Information on the development of whole farm plans can be obtained from State and Territory agricultural and soil conservation agencies, Landcare facilitators and consultants.

Effective effluent management should be seen as an important part of a dairy farm operation, and allocated an appropriate share of management effort and funding.

To achieve the objectives of these Guidelines, the following need to be considered:

- possible future expansion for both existing operations and new developments
- other land uses and activities in the catchment or local area.

There should be consultation with all the relevant State and Territory authorities including regulators and planning agencies. The plan should be updated regularly to adapt to changing technology and economic and market conditions.

3 GENERAL CHARACTERISTICS OF DAIRY SHED EFFLUENT

Dairy shed effluent generally includes manure, urine, pathogens, gravel, sand, soil, waste feed, milk spillages, detergent and disinfectant residues, and on occasions minor amounts of veterinary chemicals. The concentrations of the effluent components and the volumes of effluent generated vary widely and depend very much on the amount of water used in washing down bails and yards. It should be noted that the characterisation of the effluent(s) of a particular enterprise is fundamental to the operation and management of that enterprise, and for adequate assessment for any land application program. Collection of data by dairy farm operators for the purposes of characterisation of the effluent is encouraged. The following data shows values for a study carried out in north-eastern Victoria. However, this data is indicative only. Site specific information on the particular effluent stream should be obtained for modelling purposes when developing effluent processes.

Table 1a Amount of Dairy Shed Effluent (Indicative values only)
(North-Eastern Victoria)*

Amount :	(L/cow/yr)
Dung and urine	750
Effluent-Pit & milk room	1840
Effluent-Yard wash down	5840
Uncontaminated water (coolers, roofs)	15400

Table 1b Characteristics of Dairy Shed Effluent (Indicative values only)
(North-Eastern Victoria)*

Component in wastewater:	(mg/L)
Biochemical oxygen demand (BOD)	3200
Suspended solids	2400
Total nitrogen	187
Ammonia	84
Total phosphorus	26
Sodium	119
Potassium	200
Magnesium	27
Chloride	180
Carbonate/Bicarbonate	155
pH	8
Veterinary chemicals	+
Cleaning materials and disinfectants	++
Bacteria, viruses, helminths	++
Salt (as EC)	1.12 dS/m
Sodium Adsorption Ratio (SAR)	4.3

Source: Wrigley, 1994

*typical dairy shed run-off

+ *may be present in significant concentrations*; ++ *concentrations variable*.

The amount of dung and urine deposited at the dairy shed and yards during milking varies considerably from farm to farm but generally ranges from 5 - 8 per cent of the total daily excretion. It is unlikely that this amount of waste can be reduced substantially, although it differs according to season, herd size, and duration of milking.

The major effluent components that have implications for the environment are the high levels of organic matter, measured as BOD, nitrogen, phosphorus, salt and bacteria from the faeces and urine. In particular, spilt milk and water used to clean vats and other equipment contain high levels of BOD. The salt measured in dairy farm effluents may come from the farm's primary water supply.

The growth in cow numbers per farm, and reduction in the number of dairy farms, has led to much greater volumes of effluent being generated at a smaller number of dairy sheds and an intensification of potential environmental pollution.

A diagrammatic representation of dairy shed effluent, and its management, is given in Figure 2.

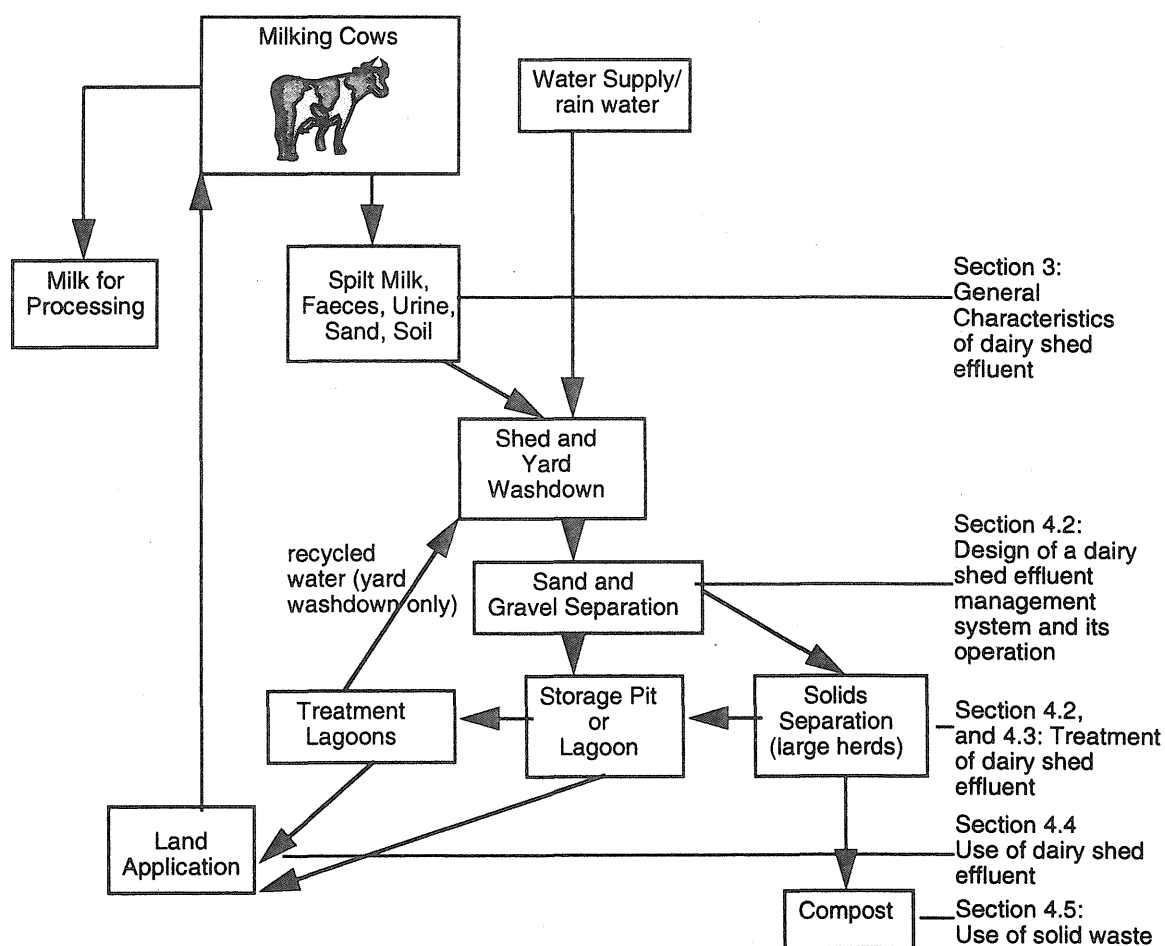


Figure 2: Diagrammatic Representation of Dairy Shed Effluent and its Overall Management

4 GUIDELINES

The Guidelines which follow are designed to provide general principles for nationally consistent environmental management of dairy shed operations to protect water quality. They are not intended to provide detailed prescriptive standards.

The principles can be adapted by State and Territory regulatory agencies to take account of their own legislative and environmental requirements for the approval of new projects, setting licensing conditions and the general environmental management of dairy shed operations.

The important factors in managing dairy sheds are:

- site suitability
- effluent management system design
- effluent use and reuse
- effluent treatment
- effluent disposal in circumstances where use is not practicable
- monitoring and reporting
- contingency measures.

4.1 Site suitability assessment

Siting has a significant impact on the complexity and cost of effluent treatment, and the management which would be required to protect water quality. Carefully planned siting of facilities, particularly the effluent utilisation areas facilitates the environmental management of an operation. Where possible, the site selected should be one which avoids the need for costly environmental protection measures and which ensures preservation of community amenity.

Objectives

For existing operations to:

- identify site constraints which can result in adverse environmental impacts
- manage the dairy shed operations through effective use of appropriate practices, techniques and technologies to allow for these constraints
- enhance or maintain the water quality of relevant water resources based on their agreed environmental values.

For new dairy shed developments to:

- avoid unacceptable environmental impacts on water resources, soils and amenity
- enhance or maintain the water quality of relevant water resources based on the agreed environmental values for the resources.

Guidelines

The following factors should be taken into account when choosing a site.

4.1.1. Existing operations

For existing operations, site constraints can be minimised through:

- considering the site's limitations and problems, eg high watertable, particular soil characteristics, topography, presence of incompatible land uses, size of site, availability of services, proximity to surface and groundwaters, amount of land available for effluent application
- liaison with regional planning/zoning agencies
- appropriate modification of the dairy
- adopting effective housekeeping and best management practices
- updating the operator's knowledge
- replacement of obsolete technology by proven and more cost-effective technology.

If the operation cannot overcome the constraints, its scale should be reduced to a manageable level, be re-established in a suitable location, or closed.

4.1.2. New developments

Siting of new operations or substantial expansions to existing operations should consider:

- the amount of land required for establishing the enterprise, taking into account:
 - estimation of quality and quantity of the effluent and solid wastes/sludges produced at all stages of the process (ie, raw, post treatment, post storage etc)
 - land suitability (including topography, slope, surface soil type and previous landuse practices)
 - characterisation of the soil to determine its suitability for the storage, treatment and application of effluent and other solid wastes
 - type of effluent storage and treatment system to be used
 - future expansions
- climate (including rainfall, prevailing winds, katabatic wind/ drainage, evaporation)
- type of effluent storage and treatment system to be used
- neighbouring landuse, including residential, commercial, industrial and agricultural
- proximity to sensitive sites, including to surface and groundwaters, areas of scientific value, areas of Aboriginal significance and areas containing unique, uncommon or endangered fauna and flora
- the proximity of services and amenities including water supply
- the need for appropriate buffer zones between the enterprise and sensitive areas including waters and residences
- potential beneficial uses of groundwater
- the requirements of the sewerage service provider for industrial waste disposal, if disposal to sewer is planned for plants in urban areas
- other factors outlined in Section 4.3 Use of dairy shed effluent, eg surface runoff/soil erosion.

Once the site has been chosen, it should be benchmarked to:

- develop siting, operational and management systems that ensure the facility is managed to minimise environmental impact
- compare benchmark information with subsequent monitoring information to assess environmental performance.

Performance assessment options

Performance Indicators for site suitability could include whether:

Existing sites

- appropriate practices, techniques and technologies have been developed and used on site
- an acceptable Whole Farm Plan is in place
- public amenity has been maintained by odour control
- a monitoring program is in place for water and odour (for monitoring of water resources, see the NWQMS documents: *Australian Water Quality Guidelines for Fresh and Marine Waters*, and *Guidelines for Water Quality Monitoring and Reporting*).

New sites

- Best Available Technology has been implemented, where possible at reasonable cost, to ensure environmental protection measures specific to the site have been undertaken.

New and existing sites

- risk management assessment of the site has been undertaken
- assessment has been made of the suitability of the soil and hydrology at the site
- protection measures specific to the site have been established
- adverse impacts on water resources, land and amenity have been minimised
- adequate safeguards for possible system failure are in place.

The proponent's past environmental performance should be considered where approval is to be given for the development of a new dairy shed, or for extensions to existing operations.

4.2 Design of a dairy shed effluent management system and its operation

It is recognised that good effluent quality is not necessarily dependent on high technology and may often involve simple, innovative solutions. The installation of effluent management systems according to these Guidelines and appropriate technical specifications does not guarantee the effective operation of an effluent management system. Any system requires proper management to operate effectively.

Objective

To design the dairy shed and its operation to effectively manage effluent, including controlling effluent volume, quality and treatment.

Guidelines

4.2.1 Separating stormwater from dairy shed effluent

Uncontaminated stormwater should be separated from the effluent system, and collected for use within the shed, or directed to watercourses to maintain environmental flows and recharge aquifers. Separating stormwater from the effluent will reduce the effluent volume.

Contaminated stormwater should be directed to effluent collection ponds, provided the ponds have the capacity to handle the extra volumes that may be involved. If the effluent system cannot handle the volume, then the shed should be designed to allow for the separate collection and containment of contaminated stormwater.

Stormwater, contaminated and uncontaminated, should be minimised by the construction of stormwater diversion systems to minimise runoff to the milking site, effluent application sites and other sensitive areas.

4.2.2 Optimising the volume of effluent generated, and enhancing water recycling

The shed must be designed to optimise the overall operation. This can be achieved by ensuring the various components of the dairy, including the effluent management systems, are mutually compatible and well integrated.

Dung and urine production in the shed can be minimised by attention to practices such as efficient cow flow and animal waiting, low cow stress, improved feed formulation and optimising the time needed for milking.

Efficient water use, including recycling of plate cooling water and the removal of solid wastes before washing down, will minimise the volume of effluent generated and the consumption of clean water, and should also reduce premature filling of ponds. Water use for washing down the shed should also be minimised. Water from the treatment ponds should not be used for shed washdown because of potential disease and odour problems. Adequately treated, recycled water is suitable for washing down exterior yards and is increasingly being used for the flood washing of yards. Yards are generally only washed once a day where flood washdown is practised.

Operators should be aware of potential animal/human health and dairy hygiene problems when using recycled water. There can also be problems associated with salt and nutrient buildup with continuously recycled water. A balance must be found between the advantages to operators of flood washing and the need to manage larger effluent volumes.

4.2.3 Separating the various waste streams

Separating the solid component from the dairy shed effluent with the use of solids/sediment traps can improve effluent handling. Sand and gravel should be separated to protect the effluent handling equipment. The life of treatment or storage ponds is increased by preventing sediments from reaching the ponds.

4.2.4 Effluent treatment systems

The selection of an effluent treatment process will depend mainly on the components of the effluent and their concentrations, available accepted technologies, the desired final quality of the effluent, solid wastes/sludges and cost. The range of available treatment options is discussed in section 4.4.

4.2.5 Effective effluent containment and storage

Effluent management systems should provide storage for the effluents until they can be disposed of or used. The possibility of odour control needs to be addressed.

Storage tanks, and storage and treatment ponds should be designed to safely contain their maximum operational load and comply with local regulations. This should take into account the maximum volumes of effluent to be stored during seasons when land application may not be possible, as well as increased effluent volumes resulting from above average rainfall (relevant authorities should be consulted on conditions required to satisfy local requirements). A generally accepted standard is to design any system to cope with the wettest year in ten. Storage systems should also incorporate a spillway to prevent damage during any overtopping under extreme conditions.

The base should be constructed with low permeability materials or lined with such materials to minimise the leakage of effluent to groundwater resources. In addition, lagoons should be designed and constructed to prevent potential pollution of surface water through runoff.

Surface water runoff may be harvested, stored separately and added to effluent, where extra water is needed for irrigation. Increasingly waste management facilities are being integrated with other components of the dairy farm rather than deal with waste as a separate issue. For example, storages are now being used both for wastewater and the harvesting and impounding of catchment runoff.

Permission from water agencies may be needed if the additional fresh water required has to be taken from groundwater, streams or rivers.

4.2.6 Controlling spillages

Areas where accidental spillage of milk, effluent or chemicals could occur, should be adequately bunded or sloped to drains and directed to storage, or to effluent treatment areas.

4.2.7 Preventing contamination of water supplies

When water supply is from a reticulated source, surface water impoundment or direct from groundwater bores, backflow prevention devices which meet relevant Australian Standards should be installed. Water authorities should be contacted to ascertain any controls on establishing and operating dairy sheds within declared drinking water source areas.

4.2.8 Buffer zones for odour control

Dairy operations should be adequately separated from the rest of the community and from residential areas. However, buffer zones should not be used to compensate for poor design or management. The effectiveness of buffer zones in controlling odours depends on:

- the quality of effluent discharge
- the type of effluent storage and treatment systems
- methods used to minimise and treat odours generated from effluent treatment, storage and disposal

- whether effective buffer zones have been considered at all stages of the planning process for the operation, including
 - the distance between sites on the property where operations are undertaken and the surrounding amenities
 - physical barriers, including topography and vegetation
 - climatic conditions, including wind direction, speed and turbulence (eg by plume modelling).
- community consultation and involvement.

By themselves, buffer zones do not protect the community from odour. Most odour problems may be alleviated if the effluent management practices recommended elsewhere in these Guidelines are adopted. Proponents, as well as operators of existing dairies, are encouraged to discuss separation distances for buffer zones, and other related requirements, with the relevant State or Territory agencies or authorities who may have specific requirements, as well as the local community.

4.2.9. Land application of effluent

The ultimate aim of any effluent management system is to sustainably use and assimilate the nutrients, salts, organic matter and water contained in dairy shed effluent and solids into the environment by employing crops, pastures and soils. For further details refer to Section 4.3, Use of dairy shed effluent.

Performance assessment options

Management systems are in place which:

- promote an awareness of potential problems, regular observation of the operation, and the regular assessment of effluent quality and volumes, spillages, and odour
- minimise the volumes of effluent produced, and the amount of fresh water used.
- optimise the use of recycled water.

4.3 Use of dairy shed effluent

Objective

To encourage the use of the nutrient, organic matter and water values of the solid waste/sludge and dairy shed effluents, where this use is not precluded by other components of the effluents such as salts, in a manner which protects water quality consistent with the environmental objectives.

Guidelines

Generally, land application provides the most efficient means of recycling valuable water, along with the effluent's nutrient and organic components. Suitable treatment in a properly constructed and maintained treatment system may be required.

Issues relating to groundwater protection, soil structure, land contamination, salinity and eutrophication of surface waters will need to be carefully considered on a local/regional basis. Local conditions may limit or preclude the application of effluent via irrigation because of the particular sensitivity of the site with respect to these issues. These issues are considered in the following sections.

Further information on the utilisation of effluent by irrigation is available from relevant State and Territory Environment authorities, including the Victorian and NSW Environment Protection Authorities (EPA (Victoria) (1992) and EPA - NSW (1995)).

Note that application of the guidelines alone does not assure adequate protection of groundwater quality.

4.3.1 Land requirement

The amount of land required depends on a number of factors including:

- susceptibility to waterlogging surface runoff and soil erosion
- potential effect on groundwater depth and quality, and surface water
- climatic conditions (rainfall, wind speed, evapotranspiration)
- the nature of pasture or crop grown
- pastoral, agricultural and horticultural practices (eg grazing prior to application, young stock off for a year, older stock off for at least 2 weeks)
- the properties of soils (infiltration rate, phosphorus sorption capacity, moisture storage capacity in the root zone, physical characteristics and other chemical properties including Electrical Conductivity, Sodium Absorption Ratio (see p16), Exchangeable Sodium Percentage)
- the quality and quantity of the effluent
- maximum operational life of the application site determined by phosphorus sorption capacity of the site and predicted salt accumulation

The nature of the soils

Long term application of dairy shed effluent at excessive levels could damage soils. To select land for irrigation, it is important to ensure that the soils have the following characteristics:

- a structure that permits air movement and water penetration
- sufficient depth to permit optimum root development by the crop
- adequate natural drainage, or suitable artificial drainage
- sufficient capacity to hold water for shed use between successive irrigations
- nutrients in sufficient quantities for adequate plant growth
- moderate pH, ie it should be neither too acid nor too alkaline
 - neutral to slightly acid soils are best for most irrigated crops
- ease of cultivation.

It is not always possible to have all of these qualities and the relative importance of each will depend to some extent on the type of crop to be grown, as well as the characteristics of the effluent.

The most satisfactory soils for efficient irrigation are deep, well structured, well drained soils that range in texture from loam to clay loam. They are generally preferred to sandy soils, which are very permeable, and heavy clay soils, although the range of soils that are satisfactory for crop production under irrigation is quite wide. Soils suitable for effluent irrigation are those suitable for irrigated pasture or crop production. Soils for solid wastes/sludge application should be suitable for improving pasture or dryland cropping, able to withstand cultivation without incurring significant erosion or major structural decline and not prone to waterlogging.

Soils generally considered unsuitable for irrigation include:

- poorly structured clays
- shallow soils with rock, gravel or impeding clay close to the surface
- soils with poor drainage
- soils with a high salt content and low permeability.

A soil survey is the most satisfactory way of determining the suitability of different soils for the application of effluent to land for pasture and crop production.

Land application rates

Before and during land application, scheduling and application rates based on the properties of the effluent including its salinity and nutrient content, pH and BOD need to be considered. This should be assessed seasonally.

While maximum application rates for land treatment of effluent will depend on site-specific conditions, in general they will be limited by one or more of the following:

- hydraulic loading
- nutrient loading/balance (N, P, K)
- salt loading.

Guidelines which aim to maintain effluent loading at a rate which, after accounting for rainfall, is balanced by evapotranspiration, are inadequate to protect groundwater. This is especially so in areas where rainfall can exceed evapotranspiration over periods which are sufficiently long that excess water (and solutes, such as nitrates and salts) can leach beneath the root zone.

As rainfall cannot be controlled, the only effective way of preventing excessive contamination of groundwater is to ensure that concentrations of nutrients and salt below the root zone remain at an acceptable level. This may require land application of effluent to be suspended during wet periods or seasons.

A nutrient balance can be developed, where the losses from the system are:

- the uptake of nutrient by plants which are removed
- gaseous losses of nitrogen
- and net accumulation of nutrients in the soil.

Such balances should be calculated to account for within-season variations in components of the nutrient budget (particularly plant uptake, net mineralisation and leaching) when determining application rates. Long term nutrient monitoring of the soil solution below the root zone would provide feedback on sustainable application rates and site management, and complement groundwater sampling at the watertable.

Water budgets

Water budget studies are an important tool for quantifying land requirements and the volume of effluent which may be applied.

Surface runoff/soil erosion

To minimise surface runoff and soil erosion, effluent should not be used on land which is:

- immediately adjacent to streams and water courses
- subject to flooding (flood risk analysis should be undertaken)
- waterlogged or saline
- sloping with inadequate ground cover
- rocky, slaking and highly erodible
- of highly impermeable soil type.

Irrigation runoff should be contained on site. Irrigating onto areas receiving surface run-off from higher land increases the risk of effluent moving offsite. Protection by diversion banks located upslope of the irrigated area is advisable.

Groundwater

Important factors to consider are:

- groundwater quality
- the depth to groundwater - including perched and seasonal watertables, and soil type - which can influence infiltration rates
- the location, characteristics, and current and potential use of groundwater.

A small increase in infiltration of water from the surface to the groundwater can cause a rise in the level of the watertable. As the watertable rises, it carries the salts in the soil towards the surface, increasing salt levels in the root zone and possibly causing waterlogging. It is unlikely to occur where dairy shed effluent is applied to dryland crops and pastures (in permeable soils with a substantial separation between surface and watertable).

Measures to protect groundwater quality will be more onerous where the ambient groundwater quality is capable of providing drinking water supplies or sustains ecosystems. Once contaminated, groundwater is expensive to clean up.

Hydrogeological expertise will be required to evaluate the characteristics of the groundwater beneath the land application area. This will include evaluation of mixing and dilution, travel times, direction of groundwater flow, and the possibility of denitrification occurring. Consideration may also need to be given to the construction of monitoring wells which can provide valuable information for the design of effluent irrigation.

The NWQMS document *Guidelines for Groundwater Protection* should be consulted when considering groundwater issues.

Surface waters

The following should be taken into account:

- general features - distances of various waterbodies and water uses from proposed dairy shed and /or land application site
- hydrological features - catchment area and drainage patterns.

Climatic conditions

Factors include the following, all of which affect evapotranspiration rates, and any tendency to flooding or waterlogging:

- regional climate - rainfall, temperatures, humidity, winds, evaporation
- local microclimate - diurnal pressure and associated air movement patterns.

Effluent should only be applied during conditions which will minimise polluted run-off, groundwater contamination or surface ponding. Application is generally better in hot weather due to higher UV exposure which kills pathogens such as *Leptospirosis*, Jones disease and worm eggs.

Agricultural and horticultural practices

The decision to use crops, trees or pasture or a combination of these, and the selection of species should be based on the other factors discussed in this section (4.3). It should be noted that effluent is used as a fertiliser substitute as well as irrigation water.

The vegetation, which has stored nutrients taken up from the effluent, needs to be removed from the site of application to prevent these nutrients being re-released into the soil (by decaying vegetation or as livestock wastes). Leaching of nutrients to groundwater is a particular concern but can be controlled by careful design of effluent irrigation rates and attention to harvesting and removing vegetation from the site of application, for example as fodder or crop. Where livestock are used to harvest the vegetation through grazing, the size of the reuse area will need to be increased to accommodate the nutrients returned in their manure.

4.3.2 Characteristics of the effluent

The characterisation of the effluent for a particular enterprise is fundamental to the operation and management of that enterprise and for the adequate assessment for any land application program. Collection of data by operators is encouraged and some or all of the following may be required for initial characterisation and ongoing monitoring:

- total dissolved solids (TDS)
- suspended solids (SS)
- Biochemical Oxygen Demand (BOD)
- Carbon Oxygen Demand (COD)
- organic carbon
- electrical conductivity (EC)
- exchangeable cations (sodium, magnesium, calcium)
- Sodium Adsorption Ratio (SAR)
- pH
- total Kjeldahl nitrogen (TKN)
- ammonia nitrogen (NH₃)
- phosphorus (P)
- potassium (K⁺)
- sulphate (SO₄²⁻)

Concentrations of nutrients, total dissolved solids or salinity, organic matter, BOD, and suspended solids (non-filterable residue) should be regularly tested in dairy effluent and solids at least on an annual basis. This is particularly important just prior to land application to calculate and determine appropriate application rates.

Biochemical Oxygen Demand (BOD)

Over-application of high BOD effluent can create anaerobic conditions in the soil. Prolonged oxygen depletion will reduce the capability of the soil micro-organisms to break down the organic matter in the effluent and may ultimately lead to odour generation and surface and/or groundwater pollution. It is therefore essential to apply effluent at rates that will not cause the development of anaerobic conditions. Resting periods between applications may be required to permit re-aeration of the soil. However, the quantity of oxygen which can be held in different types of soil varies according to soil texture and structure.

State authorities may be able to advise on loading rates which do not cause environmental effects under various climatic conditions.

Total dissolved solids or salinity

The salinity or total dissolved solids (TDS) concentration of irrigation water (measured as electrical conductivity (EC)) is an extremely important water quality consideration. An increase in salinity or EC levels causes an increase in the osmotic pressure of the soil solution resulting in reduced availability of water for plant consumption and possible retardation of plant growth. If salt levels are high, evaporation should be considered as an option. Recommended guidelines for saline irrigation water are available in the NWQMS document *Australian Water Quality Guidelines for Fresh and Marine Waters*. These Guidelines take into account soil characteristics, crop tolerances, climate, and irrigation practices.

With adequate drainage, salt accumulation in the soil can be controlled to an extent by the rate of application of water. Salts will accumulate in the root zone if the sum of applied irrigation water and rainfall is lower than evaporation and plant consumption. Proper irrigation management will allow application of sufficient excess water (leaching fraction) to move a portion of the salts out of the root zone, while not causing excessive increases in the groundwater table, (NWQMS - *Australian Water Quality Guidelines for Fresh and Marine Waters*, p 5-7).

Where the dairy shed effluent is moderately saline, potential irrigation areas should have free draining soils. They may need to be planted with salt tolerant species and be managed to drain excess salt to surface and/or groundwater at a rate which will not be detrimental to existing and potential future water users. Sites should not be irrigated with effluent if sub-surface drainage is likely to cause both rising groundwater tables and land salinisation in the direction of groundwater flow.

It is important to distinguish between salinity due to sodium chloride from that due to other dissolved solids, some of which may be beneficial to soil.

Salt management plan

A salt management plan that takes into account the issues discussed in the previous section, and which will consequently adequately manage salt in a land application program, should be developed. The decision to apply saline effluent will need to be dealt with on a case by case basis. Unless a detailed salt management plan can be developed to adequately manage the salt in a land application program, alternative methods of reuse/disposal of effluents should be considered.

Sodium Adsorption Ratio (SAR)

Excessive sodium in irrigation water relative to calcium and magnesium can adversely affect soil structure and reduce the rate at which water moves into and through the soil. Problems of soil permeability increase when SAR approaches 10. (*Australian Water Quality Guidelines for Fresh and Marine Waters* p 5-5)

Where possible application of dairy shed effluent to land with an Sodium Adsorption Ratio greater than 10 should be avoided to minimise the risk of soil waterlogging and destabilising soil structure. The SAR can be expressed as:

$$S. A. R = \frac{Na^+}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

Na = sodium concentration (meq/L)
= (mg/L in effluent) / (22.99)

Ca = calcium concentration (meq/L)
= (mg/L in effluent) / (40.08 x 0.5)

Mg = magnesium concentration (meq/L)
= (mg/L in effluent) / (24.32 x 0.5)

Where effluent with a high SAR poses a problem, consideration could be given to blending it with better quality water. Dilution of effluent streams with high quality water is not recommended practice in areas where water resources are scarce. Evaporative disposal may be an alternative worth considering. Alternating irrigation with high quality water is not recommended unless soil amelioration is also made. Alternating low salinity water after using high salinity water must be monitored to avoid crusting and sealing which can lead to an appreciably reduced infiltration rate. As with all other parameters in the design of a land irrigation system, the actual suitable SAR of the effluent will depend on the soil characteristics of the site. Sodium is required in limited amounts for most plant growth. However, some plants are sodium-sensitive and can be affected by low concentrations of exchangeable sodium. It has been reported that sodium toxicity can occur in sensitive fruit crops when SAR is as low as 5.5 (Bernstien (1962) p5-6 NWQMS - *Australian Water Quality Guidelines for Fresh and Marine Waters*).

Nutrients

The nutrients in effluent most likely to be utilised by plants are nitrogen, phosphorus and potassium. The availability of these nutrients for plant uptake is spread over a number of years. Nitrogen, for example is present as ammonium, ammonia, organic nitrogen, nitrate and nitrite, however plants only take up nitrogen in the ammonium and nitrate forms from the soil. The other forms can become available through the processes of the nitrogen cycle so that for example the organic nitrogen (proteins) is slowly mineralised into plant available forms over a number of years. Phosphorus is also released for plant uptake over time although some of it is quickly bound up by the soil and not available for plant use.

Optimum use of nutrients will depend on soil type, moisture availability, crop type and land management.

4.3.3 Irrigation Management

An irrigation management plan should be developed detailing the following:

- irrigation methods
- crop, water and nutrient requirements
- application rates
- scheduling
- design for the collection
- storage
- utilisation and management of stormwater and tailwater
- a salt management plan.

The intensity and depth of irrigation should be adapted to the soil and vegetation to prevent excessive leaching of effluent beneath the root zone. This can be determined by appropriate monitoring of soil moisture and salinity profiles.

Caution should be exercised when spraying effluent as it may contain micro-organisms and pathogens and can drift from the site. Aerosols from spraying should be contained on site and surrounded by a non-irrigated vegetation buffer zone. Local authorities should be consulted when determining the size of the buffer zone. Operators should take care that they do not inhale aerosols, and should comply with appropriate health regulations and guidelines concerning human and animal consumption of irrigated crops.

An irrigation system should take into account the drainage characteristics of the soils. Better drained soils would enable removal of salt and prevent long-term accumulation around the root zones.

Applications should be scheduled, based on a water deficit. When the soil is saturated in periods where rainfall exceeds evaporation, irrigation waters will need to be stored until the soil is suitable for irrigation.

Adequate storage will be required to retain effluent during wet periods or seasons. A generally accepted standard is to design any system to cope with the wettest year in ten. Hydrological expertise should be engaged to design this capacity and to provide guidance on local constraints on effluent irrigation.

It is important that properly trained personnel are available on site to manage the irrigation.

Control of stormwater and irrigation tailwater

Upslope stormwater should be diverted to prevent it from entering the solid and effluent utilisation areas. Runoff from the solid waste/sludge and effluent utilisation areas should be managed to minimise discharge to waters by the use of buffers zones, recycle/reuse systems terminal ponds etc. If irrigation runoff occurs, it should be contained.

Wastewater irrigation may yield a tailwater discharge which will ultimately need to be disposed of in an environmentally sensitive way. Management of tailwater must be a key consideration of every wastewater irrigation project, as it is often this issue which provides a major impediment to the sustainability of wastewater irrigation.

Performance assessment options

Indicators include:

- dairy shed effluent is being applied to land (eg irrigating crops, pastures and trees), and the productivity of the distribution area is comparable to, or better than that elsewhere on the farm
 - crops, trees and pasture are monitored for foliar symptoms, yield, growth rates and health
- unacceptable off-site impacts on water, land, air or vegetation are minimised by a regular assessment of the condition of the soil and surface and groundwater.

4.4 Treatment of dairy shed effluent

Where there is insufficient land to sustainably use the effluent, then the effluent will need to be treated. Suitable treatment in a properly constructed and maintained treatment system will be required prior to utilisation of the effluent.

Objective

To treat dairy shed effluent to allow for its use in an environmentally acceptable manner for a particular site.

Guidelines

Effective treatment systems should permit safe, effective and sustainable land application of liquids and separated solids. They should also provide storage for the effluents until they can be disposed of or used.

Any treatment system will need to be able to either reduce, or deal with:

- total suspended solids
- BOD
- nutrients
- odour generation potential
- pathogens

Processes for effective treatment and management of dairy shed effluent are summarised diagrammatically in Figure 3.

While treatment methods will vary between dairy farms, methods should be the best available considering:

- the required level of treatment
- cost
- technical capabilities and backup
- ability to handle extreme events, eg shock loadings.

After treatment, the effluent can be applied to the land at a managed rate which ensures long term sustainable application. Any treatment system needs to be carefully managed and regularly maintained. It is important to ensure that the expertise required for efficient effluent treatment is available at all times.

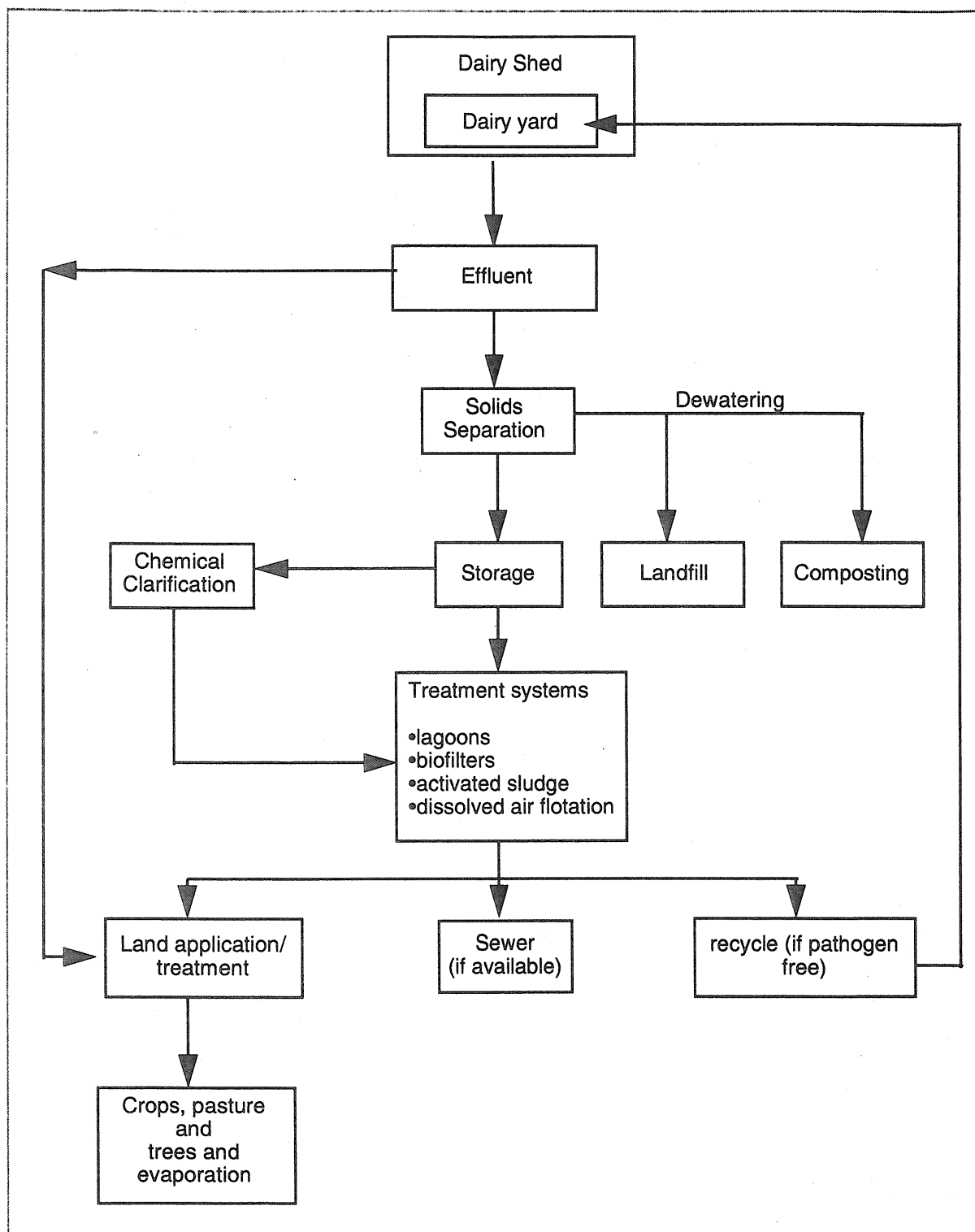


Figure 3: Diagrammatic Representation of Effluent Treatment and Utilisation Processes

4.4.1 Options for treating effluents

Methods which can be used in an appropriate combination to achieve the effluent treatment objectives are:

Physical and chemical treatment

Solids and suspended matter can be separated from the effluent stream by use of coarse screening equipment and sediment traps. This type of treatment will not only reduce the rate of

sludge build up in ponds and wear on pumps, but should also be a rapid way of reducing the BOD concentration in effluent prior to disposal or reuse.

Chemicals can be used to enhance treatment characteristics, such as settling of solids and to improve treatment performance or suitability for land application. Care should be taken to ensure any trace elements such as copper or cadmium which may be present as impurities do not have adverse residual impact on organisms in the treatment and disposal systems and in the general environment.

Biological treatment.

The most common form of biological treatment to enhance the breakdown of volatile organic pollutants is the use of anaerobic and/or aerobic ponds. Pond systems should be designed to take account of quantity, quality and intermittent generation of effluents, the likelihood of odours affecting nearby landowners, and the ultimate disposal/reuse method to be adopted. Some general information on siting and design is included in Section 4.4.2.

4.4.2 Siting and design of storages

Pond systems are suitable for effluent treatment where topography and soil conditions favour their installation. Some State regulatory authorities may have information on the siting and design of treatment ponds to prevent surface and groundwater contamination.

Storage siting and soils

Storage installation should take account of the soil characteristics, slope of the land, odour management potential, and catchment hydrology. Low permeability clay and/or liners should be used in lagoon construction to minimise effluent leaching to groundwater. It should also conform to and be part of a whole farm plan.

Storage design and sizing

Storages should be designed to cater for maximum hydraulic and waste load and future farm expansion. Storage systems should be large enough to retain the total volume of effluent produced during periods when soils may be saturated or during periods of prolonged or heavy rainfall. Allowance should be made for any runoff from the catchment of the pond and any contaminated stormwater flows from the dairy sheds.

4.4.3 Capacity of the effluent management system

Planning for any increase in dairy shed production needs to consider the capacity of the effluent treatment system to accommodate the possible production increase. Treatment capacity can be augmented in several different ways, including:

- load reduction due to improved dairy shed operation
- chemical or microbiological supplements
- physical pre-treatment processes
- artificial aeration of ponds
- anaerobic pre-treatment processes with appropriate controls on gases generated
- expansion of the pond capacity
- new wastewater treatment facilities.

Performance assessment options

These include:

- treated dairy shed effluent is being applied to land (eg irrigating crops, pastures and trees), and the productivity of the distribution area is comparable to, or better than that elsewhere on the farm
 - crops, trees and pasture are monitored for foliar symptoms, yield, growth rates and health.
- unacceptable off-site impacts on water, land, air or vegetation are minimised by a regular assessment of the condition of the soil, and surface and groundwater.

4.5 Use of solid waste

Objective

To make effective and environmentally sound use of solid dairy shed wastes.

Guidelines

The solid components of dairy shed effluent comprise gravel and sand, manure, and treatment pond sludges. Each of these may be managed and used differently. Use of the solids from dairy shed effluent should be encouraged provided it is feasible and economic. Sand and gravel should generally be returned directly to the tracks. Pond sludges should be considered as a stable, high strength fertiliser.

Ponds should be desludged once the sludge volume takes up one third of total volume (or half depth) of the pond. This typically represents 5 to 7 years and 10 to 12 years use for primary ponds receiving unscreened and screened effluent respectively. Secondary ponds rarely need desludging. When sludges are dewatered, the supernatant waters should be drained back to the pond system.

Manure or sludge can be composted and used as a soil conditioner, either on farms or in gardens. Some sludges, especially those from anaerobic ponds, are high in plant nutrients and can be applied immediately to soils without composting.

Professional advice should be sought on both sludge removal from the pond and application rates to soil. Sufficient sludge should be retained in the pond after desludging to ensure its activity is regained upon recommissioning.

Sludge should be stored with bunding and adequate drainage to prevent leaching to susceptible groundwaters, with any discharge from the stored sludge being directed to the effluent system. Stored sludges, if not adequately treated, can be a significant source of odour and attract flies and rodents. They should not be allowed to become anaerobic.

Provision for desludging and the effect of application to land should be considered in the Whole Farm Plan. As for dairy shed effluents, the issues discussed in Section 4.3 of this document should be taken into consideration when applying solid wastes and sludges to land.

Performance assessment options

Indicators include:

- solid dairy shed effluent is being applied to land (eg irrigating crops, pastures and trees), and the productivity of the distribution area is comparable to, or better than that elsewhere on the farm
 - crops, trees and pasture are monitored for foliar symptoms, yield, growth rates and health
- minimal onsite and off-site impacts on water, land, air or vegetation, with a regular assessment of the condition of the soil, including salt and entrained nutrient content, and surface and groundwater.

4.6 Disposal of dairy shed effluent

Objective

To dispose of dairy shed effluent in an environmentally acceptable manner, only when effective use of the effluent is not feasible.

Guidelines

No effluent should be discharged to surface or groundwaters unless it can be demonstrated that it is consistent with the integrated catchment management strategy of the area, and the relevant guidelines of the licensing agency. Ambient water quality immediately downstream of the dairy shed operation should remain comfortably within the environmental value attributed to the receiving water body. This may require tertiary treatment (viz nutrient removal, filtration and disinfection) of the effluent prior to discharge, or alternatively all effluent should be returned to evaporative ponds where climatic factors permit. In some jurisdictions however, effective reuse means that direct discharge to water is not permitted.

Environmental values of water and the related ambient water quality parameters are described in the NWQMS document *Australian Water Quality Guidelines for Fresh and Marine Waters* which provides further information on this topic.

Performance assessment options

- compliance with both a regional catchment plan and the relevant guidelines of the licensing agency or agriculture department regarding effluent disposal
- regular assessment of soil condition, surface water, groundwater and odour
- minimisation of unacceptable off-site impacts on water, land, air or vegetation.

4.7 Monitoring and reporting

Objectives

To assess the on-going efficiency of the dairy shed's operation, its environmental performance and compliance with regulations.

Guidelines

The following actions may be taken :

- procedures should be reviewed periodically
- managers should regularly observe land to which effluent has been applied for the health of crop or pasture plants, soil sealing, waterlogging, surface runoff, soil water concentrations below rooting depths and the soil water balance
- dischargers should regularly monitor surface and groundwater bodies liable to be affected by a dairy shed, including biological and bacteriological assessments
- operators should be provided with adequate education and training, particularly in total quality management procedures, and risk management techniques, to assist in ensuring compliance with environmental regulations and requirements
- Relevant State/Territory and/or local authorities may require occasional or regular reporting depending on the site sensitivity or license arrangements. Establishments with a history of consistently poor environmental performance may be required to submit reports on their environmental performance more frequently.
- Analysis of certain characteristics of the effluent may be required for initial characterisation and ongoing monitoring.

Performance assessment option

Comprehensive and current records of operational planning, consultation, recording, monitoring, reporting, and education and training.

4.8 Contingency measures

Objective

To have in place effective procedures, preferably as part of a good overall strategic plan for the dairy shed, to enable managers to effectively respond to all emergencies and contingencies.

Guidelines

Dairy sheds should be prepared for:

- disruption to power supplies which may affect the dairy's effluent management system
- human error
- disruption to dairy shed operation or effluent treatment by storms, flooding, fire, etc.
- plant breakdowns, including drain blockages, pump failures, or disruption of power supplies
- overloading of aerobic or anaerobic treatment plants or ponds, or unusually low effluent inputs which can affect the biological treatment activity of the system
- accidental discharge of hazardous materials into the effluent stream
- temporary or permanent loss of access to effluent application and disposal facilities
- temporary or permanent loss of trained operators. All managers and staff should be aware of the plan and their individual responsibilities during emergencies
- clear and well defined reporting procedures

- disruption by processors
- potential leakage from ponds
- spillages of pesticides, disinfectants, veterinary chemicals etc. should be excluded from effluent systems as they may harm beneficial organisms and crops

Performance assessment option

- An up-to-date contingency plan is disseminated to staff and regularly inspected and trialed.
- Record and regularly analyse the operations response to specific contingencies which have arisen.

APPENDICES

Appendix A: The National Water Quality Management Strategy (NWQMS)

The Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) are working together to develop a National Water Quality Management Strategy (NWQMS).

The guiding principles for the National Water Quality Management Strategy are set out in *Policies and Principles - A Reference Document*, which emphasises the importance of:

- ecologically sustainable development
- integrated (or total) catchment management
- best management practices, including the use of acceptable modern technology, and waste minimisation and utilisation
- the role of economic measures, including user pays and polluter pays.

The process of implementing the National Water Quality Management Strategy involves the community working in concert with government in setting and achieving local environmental values, which are designed to maintain good water quality and to progressively improve poor water quality. It involves development of a plan for each catchment and aquifer, which takes account of all existing and proposed activities and developments, and which contains the agreed environmental values and feasible management options.

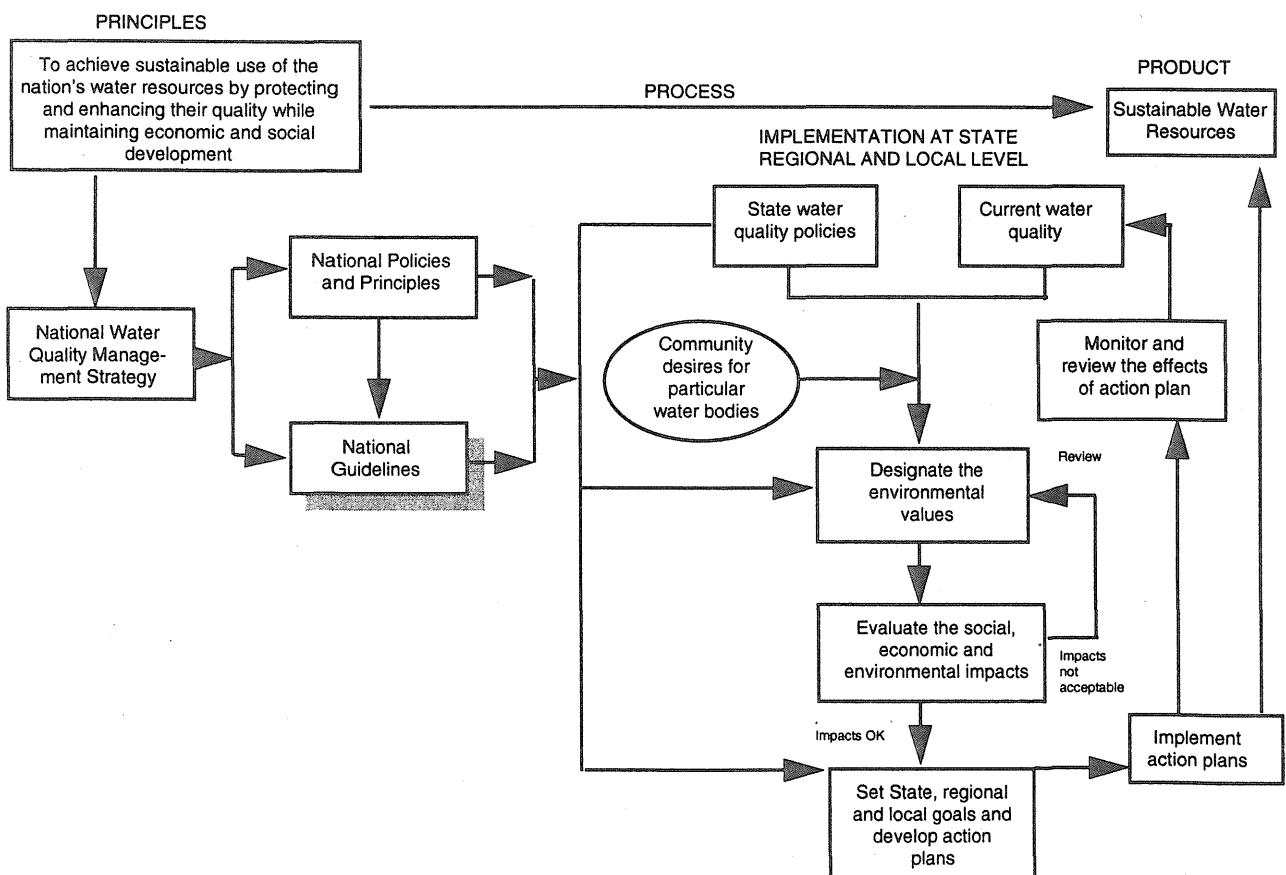


Figure A1: National Water Quality Management Strategy

BOX 1 DOCUMENTS OF THE NATIONAL WATER QUALITY MANAGEMENT STRATEGY

**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

Guidelines for Diffuse and Point Sources

9. Rural Land Uses and Water Quality
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 - Use of Reclaimed Water
15. Guidelines for Sewerage Systems - Sewerage System Overflows
- 16a Effluent Management Guidelines for Dairy Sheds in Australia
- 16b Effluent Management Guidelines for Dairy Processing Plants in Australia
17. Effluent Management Guidelines for Intensive Piggeries in Australia
18. Effluent Management Guidelines for Aqueous Wool Scouring and Carbonising in Australia
19. Effluent Management Guidelines for Tanning and Related Industries in Australia
20. Effluent Management Guidelines for Australian Wineries and Distilleries

The guidelines for diffuse and point sources are national guidelines which aim to ensure high levels of environmental protection that are broadly consistent across Australia.

Appendix B: Outline of the dairy industry

Dairying has developed from a small dairy herd brought to the colony of New South Wales with the First Fleet, to be Australia's fourth largest rural industry in terms of gross value of production. The dairy industry operates in all States, providing milk and manufactured products of the highest quality at world competitive prices.

Milk production continues to increase despite ongoing reductions in the number of cows and farms, through increases in both numbers of cows and yield per cow. In 1995-96, there was an estimated 1,924,000 cows on 13,720 registered dairy farms. Average milk production per cow is now 4,530 litres a year, up from 3,064 litres 12 years ago, and almost double the levels of 1970. The average Australian dairy herd comprises 130 milking cows, with a trend towards larger herds, and the average farm size is 199 hectares. Most are family owned and operated.

Total market milk production in 1995-96 was 1.83 billion litres (around 21 per cent of total milk production) with a value of more than \$880 million at the farm gate.

Appendix C: Further information

Further reading

Department of Primary Industry, Department of Environment and Land Management, Engineering and Water Supply Department, et al, (1993), *Guidelines for the management of milking shed wastewater and intensive stock use areas on dairy farms in the Mount Lofty Ranges*.

Dunford, P & Rose, K (1991): *Dairy effluent treatment and disposal*. In: Effluent control on Dairy Farms, Tasmanian Department of Primary Industry, pp. 13-22.

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Hubble, I (1991): *Dairy effluent - How much, what's in it and what value?* In: Effluent control on Dairy Farms, Tasmanian Department of Primary Industry, pp. 5-6.

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Klingberg, C M & Schrale, G (1985): *Guidelines for land application of effluent from intensive animal enterprises and related industries*. Department of Resources and Energy, Australian Water Resources Council, Report for Research Project 80/135

Lyons, B J, Wong, L P & Skerry, G P (1989): *Anaerobic treatment of dairy wastes*. Australian Water and Wastewater Association, 13th Federal Convention, Canberra 6-10 March 1989

Murray-Darling Basin Ministerial Council 1989, *Salinity and Drainage Strategy*, April 1989 AGPS, Canberra

Standards Australia 1995, *Environmental management systems - Specification with guidance for use*. Interim Australian/New Zealand Standard AS/NZ ISO 14001 (Int):1995, Standards Australia, Sydney

Standards Australia 1995, *Environmental management systems - General guidelines on principles, systems and supporting techniques*. Interim Australian/New Zealand Standard AS/NZ ISO 14004 (Int):1995, Standards Australia, Sydney

Wright, D & Bell, I (1991): *Land application of dairy effluent*. In: Effluent control on Dairy Farms, Tasmanian Department of Primary Industry, pp. 7-9.

Wrigley, R (1994): *Managing dairy-shed wastes*. Dairy Research and Development Corporation.

Appendix D: Sources of further advice

State and Territory Environment Protection Agencies

State and Territory Departments of Agriculture and Primary Industries

State and Territory Departments of Conservation and Land Management

State and Territory Water Agencies

Local Government Agencies

The CSIRO Division of Water Resources (DWR)

Regional Colleges

Industry Consultants

Appendix E: Glossary

Aerobic	a process where dissolved or free oxygen is present.
Anaerobic	a process or condition where there is no dissolved or free oxygen.
Aquifer	a layer of rock which holds water and allows water to percolate through it.
Biochemical Oxygen Demand (BOD)	the amount of oxygen required by aerobic organisms to carry out oxidative metabolism in water containing organic matter. It is determined by measuring the amount of oxygen gas absorbed during a particular laboratory analytical test (BOD test), in which components of a water sample are broken down by aerobic micro-organisms under specified conditions during a stated number of days. BOD ₅ denotes a 5-day BOD.
Catchment area	a natural drainage area, especially of a reservoir or river.
Chemical Oxygen Demand (COD)	a measure of the quantity of oxidisable (combinable with oxygen) components present in water. It is determined by measuring the amount of oxygen gas absorbed during a particular laboratory analytical test (COD test), in which components of a water sample are broken down by an inorganic chemical (an oxidising agent) under specified conditions during a certain number of hours.
Dairy shed	as used in these Guidelines, refers only to the milking shed, holding yards and feed pads, and not the whole dairy farm. In New Zealand dairy a dairy shed is called a 'milking parlour' or 'milking area'.
Denitrification	removal of nitrogen.
Effluent	is used here to refer to the liquid and associated solid waste produced at all stages from dairy sheds. It does not include runoff from pastures or crops which have been irrigated with dairy effluent.
Environmental values	particular values or uses of the environment that are conducive to public benefit, welfare, safety or health and that require protection from the effects of pollution, waste discharges and deposits. They are often called beneficial uses in the water quality literature. Five environmental values are:

- agricultural water
- drinking water
- ecosystem protection
- industrial water
- recreation and aesthetics

Refer to the NWQMS documents *Policies and Principles - A Reference Document*, and *Australian Water Quality Guidelines for Fresh and Marine Waters*.

evapotranspiration

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

Exchangeable Sodium Percentage (ESP) the amount of exchangeable sodium as a percentage of the cation exchange capacity. It is a measure of the sodicity of the soil. Sodicity relates to the likely dispersion on wetting and shrink/swell properties.

Groundwater recharge

the rate at which infiltrating water reaches the water table.

Guideline

provides guidance on possible means of meeting desired environmental outcomes. Guidelines are not mandatory.

Hydraulic loading

volume of water applied to an area of land.

Infiltration rate

rate of entry of water into the soil.

Katabatic drainage/wind

a wind caused by cold air flowing downhill when a sloping land surface cools by night time radiation. The along the valley bottom.

Leaching

the downward movement of a material in solution through soil.

Leaching fraction

The leaching fraction of soils refers to the ratio of deep drainage to the depth of rainfall plus irrigation over the same time period. The smaller the leaching fraction, the larger the water salt concentration within the root zone, or the higher the salt concentration experienced by plant roots.

Milking parlour

refer to dairy shed.

Phosphate sorption capacity

a measure of the inherent ability of soil particles to adsorb phosphorus from the soil solution.

perched watertable

upper surface of a zone of saturation where an impermeable stratum causes groundwater to accumulate above it over a limited lateral extent. It is situated above the main watertable.

risk management	is a decision-making process that entails considerations of political, social, economic, engineering information with risk-related information to develop, analyse and compare regulatory options and to select the appropriate regulatory response to a potential health or environmental hazard. The entire risk management process consists of eight steps. These are hazard identification, exposure assessment, effects assessment, risk characterisation, risk classification, risk benefit analysis, risk reduction, monitoring.
Specific Electrical conductivity	measure of salinity in water.
Standard	a standard is a quantifiable characteristic of the environment against which environmental quality is assessed. Standards are mandatory.
Tailwater	irrigation drainage water.
Total dissolved solids (TDS)	the amount of dissolved solids in waste water.
Total kjeldahl nitrogen (TKN)	is a determination of organic nitrogen and ammonia
Total solids (TS)	the sum of dissolved and undissolved solids in water or waste water, usually expressed in milligrams per litre.
Total suspended solids (TSS)	matter in wastewater that is in suspension.
Watertable	the level below which the pore space between sediments and fractures in rock are saturated with water. In an unconfined aquifer, the watertable is the level of the water standing in a well.

