

**NATIONAL WATER QUALITY  
MANAGEMENT STRATEGY**

**EFFLUENT MANAGEMENT  
GUIDELINES FOR  
TANNING AND RELATED INDUSTRIES  
IN AUSTRALIA**

**June 1999**

**AGRICULTURE AND RESOURCE  
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# TABLE OF CONTENTS

<b>PREAMBLE</b>	<b>VI</b>
<b>1 INTRODUCTION</b>	<b>1</b>
1.1 Objective of the guidelines	1
1.2 Environmental objectives	1
1.3 Application of effluent management guidelines	2
The industry	2
Regulators and planning authorities	2
The broader community	2
Further information	2
<b>2 PRINCIPLES OF ENVIRONMENTAL MANAGEMENT</b>	<b>3</b>
<b>3 GENERAL CHARACTERISTICS OF TANNERY WASTE</b>	<b>5</b>
<b>4 GUIDELINES</b>	<b>8</b>
4.1 Site suitability assessment	8
Objectives	8
Guidelines	8
4.1.1 Existing operations	8
4.1.2 New developments	9
Performance assessment options	9
Existing sites	9
New sites	10
New and existing sites	10
4.2 Design of the effluent management system	11
Objectives	12
Guidelines	12
4.2.1 Separating stormwater from tannery effluent	12
4.2.2 Optimising the volume of effluent generated, and enhancing water recycling	12
4.2.3 Minimising the load of effluent components	12
4.2.4 Separating the various waste streams	13
4.2.5 Effluent treatment systems	13
4.2.6 Effective effluent containment and storage	13
4.2.7 Controlling spillages	13
4.2.8 Preventing contamination of water supplies	13
4.2.9 Odour control	13
4.2.10. Land application of effluent	14
Performance assessment options	14
4.3 Treatment of tannery effluent	15
Objective	15
Guidelines	15
4.3.1 Options for treating effluents	15
Physical and chemical treatment	15
Biological treatment	16
4.3.2 Siting and design of treatment lagoons	16
Lagoon siting and soils	16
Lagoon design and sizing	16
4.3.3 Capacity of the effluent management system	16
Performance assessment options	17

<b>4.4 Use of tannery effluent</b>	<b>17</b>
Objective	17
Guidelines	17
4.4.1 Land requirement	18
The nature of the soils	18
Land application rates	19
Water budgets	19
Surface runoff/soil erosion	19
Groundwater	20
Surface waters	20
Climatic conditions	20
Agricultural and horticultural practices	20
4.4.2 Characteristics of the effluent	21
Biochemical Oxygen Demand (BOD)	21
Total dissolved solids or salinity	21
Salt management plan	22
Sodium Adsorption Ratio (SAR)	22
Nutrients	23
4.4.3 Irrigation Management	23
Control of stormwater and irrigation tailwater	24
Performance assessment options	24
<b>4.5 Use of sludge</b>	<b>24</b>
Objective	24
Guidelines	24
Performance assessment options	25
<b>4.6 Disposal of tannery effluent</b>	<b>25</b>
Objective	25
Guidelines	25
Performance assessment options	25
<b>4.7 Monitoring and reporting</b>	<b>26</b>
Objective	26
Guidelines	26
Performance assessment options	27
<b>4.8 Contingency measures</b>	<b>27</b>
Objective	27
Guidelines	27
Performance assessment options	27
<b>APPENDICES</b>	<b>28</b>
<b>Appendix A: The National Water Quality Management Strategy (NWQMS)</b>	<b>28</b>
<b>Appendix B: Sources of further advice</b>	<b>30</b>
<b>Appendix C: Sewer discharge</b>	<b>31</b>
<b>Appendix D: Further information</b>	<b>34</b>
<b>Appendix E: Glossary</b>	<b>35</b>

## FIGURES

Figure 1: Structure of the Effluent Management Guidelines for Specific Industries.	vi
Figure 2: Tannery Processes: Woolskins	5
Figure 3: Tannery Processes: Hides, Kangaroo and Fellmongery	6
Figure 4: Tannery Effluent Management and Treatment Options	11
Figure A1: National Water Quality Management Strategy	28

## TABLE

Table 1: Environmentally Significant Components Of Tannery Effluents	7
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# PREAMBLE

This document is one of a suite of documents forming the National Water Quality Management Strategy. 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 Tanning and Related Industries in Australia. It sets out principles that can form the basis for a common and national approach to effluent management for the tanning and related industries 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

Tanneries and related industries are located in all Australian states. Australia produces 30 million woolskins and seven million cattle hides a year, of which 20 per cent and 50 per cent respectively are processed in Australia. The hide, skin and leather industry has expanded substantially in recent years, due largely to an increased focus on export markets. Exports of bovine leather increased from \$233 million in 1992-93 to \$355 million in 1995-96 and exports of sheepskin leather increased from \$4.3 million in 1992-93 to \$18.7 million in 1995-96. In 1995-96, the industry achieved combined export earnings of \$961 million.

## 1.1 Objective of the guidelines

The objective in developing the *Effluent Management Guidelines for Tanning and Related Industries in Australia* is to ensure a nationally consistent approach to effluent management for the tanning 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 allow adaptation to 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.

These Guidelines would be one of a number of documents that may need to be used for the overall environmental management of a particular tannery, since they deal with effluents, and associated solid components including sludge, not total site management.

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 tanneries and related industries 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 tannery 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 tannery operations are ecologically sustainable both in the short and long term.

### **1.3 Application of effluent management guidelines**

These Guidelines are intended for use by the tanning industry (including consultants), regulators, planning authorities and the broader community.

#### **The industry**

The Guidelines aim to assist operators of tanneries to:

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

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

#### **Regulators and planning authorities**

*Effluent Management Guidelines for Tanning and Related Industries in Australia* should provide the framework where guidelines or codes of practice are to be developed for the regulation of tanneries. 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 site specific circumstances of the tanning industry. Local knowledge and data specific to individual tanneries are essential to manage tanneries 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 overcome 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 tanneries and local resource management issues. Development of catchment-based plans and strategies is central to integrated catchment management.

#### **Further information**

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 Appendix B.

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.

These Guidelines should apply immediately to any expansion and new developments, and be phased in for existing facilities to timetables agreed with State and local government authorities.



## 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 better planning
- optimisation of waste management processes
- effective and feasible recycling and reuse of waste
- disposal of waste where its use is not practicable, in a manner that will not cause short or long term adverse environmental impact.

A fundamental consideration for sustainable management of tannery effluent should be the development of an Environmental Management Plan through the implementation of an Environmental Management System. In some States an operator can be required to produce an Environmental Management Plan as a stand alone document, not as part of an Environmental Management System. The amount of detail provided in the plan will depend on the size of the enterprise, siting considerations in relation to neighbouring communities and the environmental sensitivity of the location such as proximity to surface and groundwater. The Environmental Management System provides the management, administration and monitoring framework for the environmental aspects of an operation. It includes the principles of Total Quality Management and should incorporate the principles of risk management.

In August 1995, the International Standards Organisation (ISO) released the draft international standard ISO 14001 on *Environmental Management Systems: Specification with guidance for use*. In late 1995 ISO 14001 was published as an interim standard within Australia and New Zealand by Standards Australia. This standard can be used to provide guidance when implementing an Environmental Management System.

The Environmental Management System should incorporate the principles of cleaner production to minimise the adverse environmental impacts of the production process. In the context of these Guidelines, cleaner production involves the use of:

- better housekeeping
- improved management practices
- state-of-the-art in-plant production processes
- the concept of management of all aspects of the entire production process, from the raw materials to finished product including any associated waste.

Effective effluent management is an important part of a tannery operation, and should be allocated an appropriate share of management effort and expenditure. Good communication within the operation is important for increasing the operation's overall efficiency, including effective environmental management, and for ensuring that problems are identified early and rectified before they become significant.

To achieve the objectives of these Guidelines, it is important the operation's Environmental Management System considers:

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

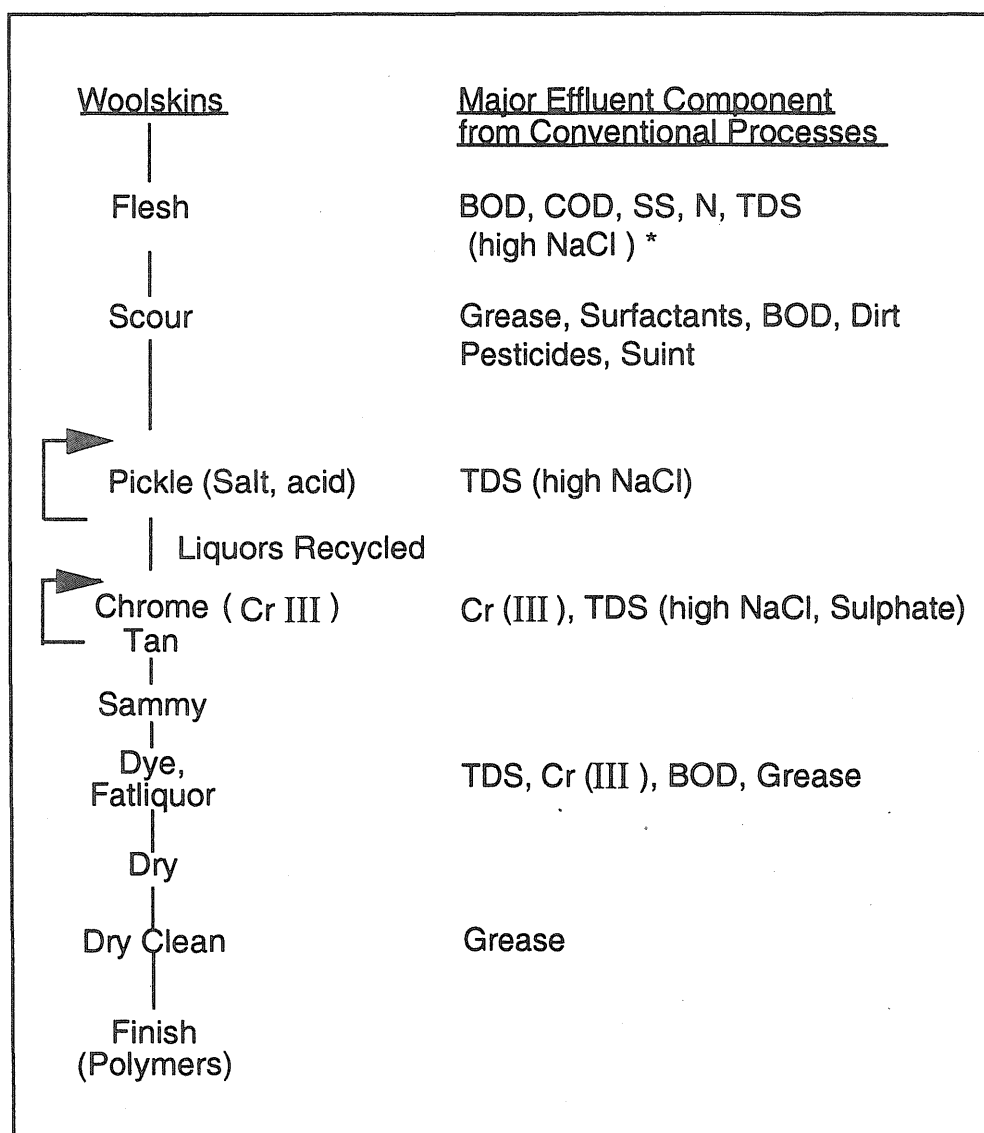
Development of the Environmental Management System/s and/or Plan/s should involve consultation with regulators, planning authorities and the broader community. State and Territory environment protection authorities can provide information on the development of Environmental Management System and/or Plans.

It is strongly recommended that professional consultancy advice be sought in the development and implementation of an Environmental Management System, and that all applications for a new or expanded tannery operation should be accompanied by a plan for such a System.

### 3 GENERAL CHARACTERISTICS OF TANNERY WASTE

Tanneries use a range of chemical compounds to preserve, unhair and tan hides and skins. Chrome tanning is the major form of tannage world-wide. Tannery processes for chrome tanned leather are summarised in Figures 2 and 3.

Tannery processes produce effluents containing dirt and biological materials in addition to surplus, spent or washed-out chemicals (including salt, chrome, nitrogen, ammonia, and sulphur compounds). Untreated tannery effluent is high in total dissolved solids (TDS), suspended solids (SS) and biochemical oxygen demand (BOD). The major contaminants in the effluent stream produced at a particular stage of the tanning process are also indicated in Figures 2 and 3 (refer to Glossary for explanation of terminology).



\* If skins have been salted

Figure 2: Tannery Processes: Woolskins

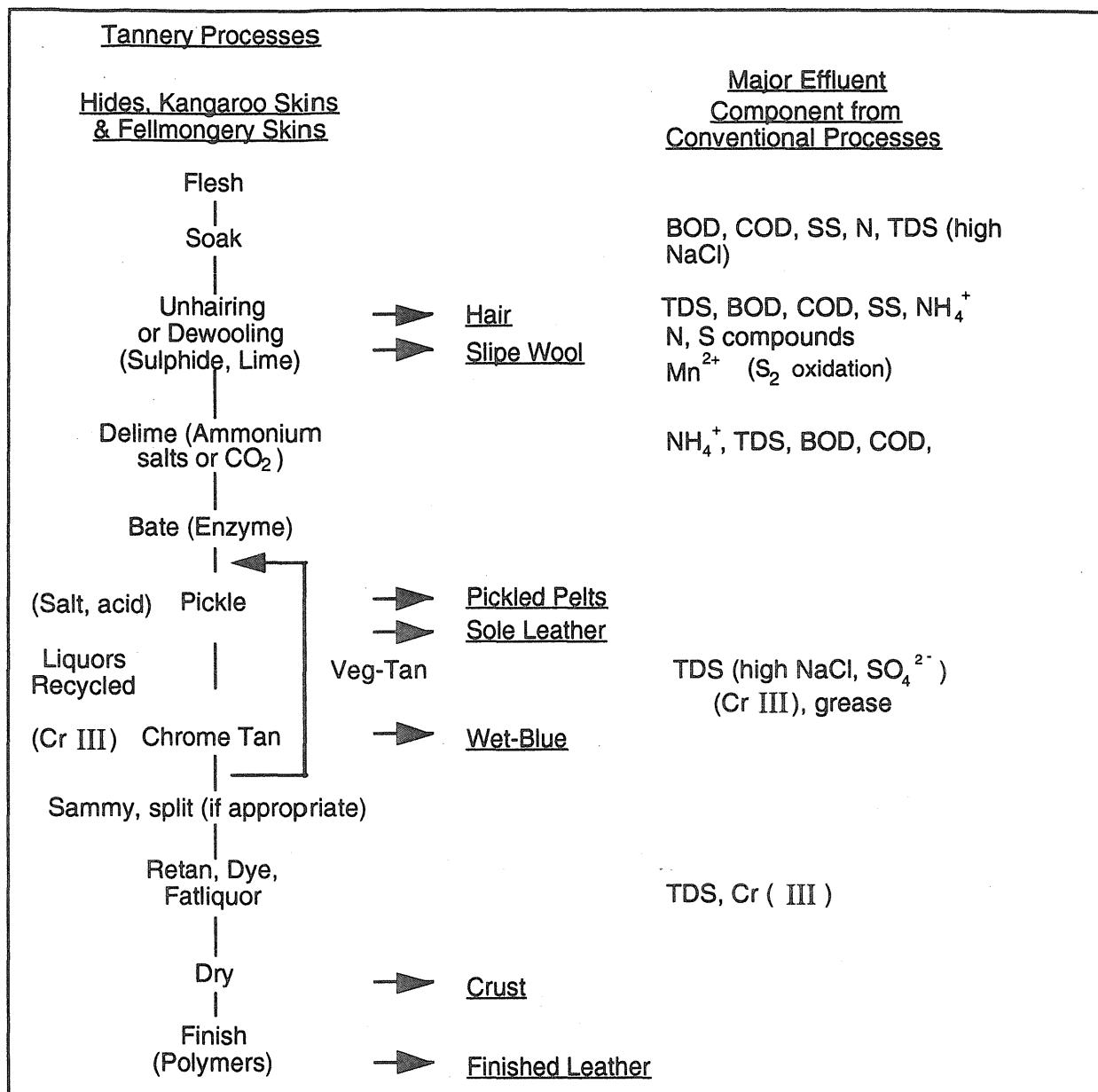


Figure 3: Tannery Processes: Hides, Kangaroo and Fellmongery

Tannery processes vary according to the type of leather produced:

- wet blue from hides
- dewoolled or fellmongered pickled-pelts from sheepskins
- woolskins
- finished leather
- sole leather.

Consequently, the composition of tannery effluents depends on the types of processes in use at the time as well as the level of water consumption. Table 1 lists the effluent components of environmental significance.

**Table 1: Environmentally Significant Components Of Tannery Effluents**

<b>Components</b>		
Total Dissolved Solids		(TDS)
Nitrogen		(N)
Ammonia		(NH <sub>3</sub> )
Sulphide		(S <sup>-</sup> )
Sulphate/Total Oxidised Sulphur		(SO <sub>4</sub> <sup>2-</sup> )/(TOS)
Biochemical Oxygen Demand		(BOD)
Chemical Oxygen Demand		(COD)
Grease		
Suspended solids		(SS)
Chromium		(Cr)
Manganese		(Mn)
Surfactants		(Wetting agents)
<b>Other Pollutants</b>		
Solvents	degreasing, drycleaning	
	finishing	
Solid Wastes	sludges	
	fleshings	
	untanned trimmings	
	tanned waste	

Tanning also uses large volumes of water. Conventional woolskin processes use about 400 litres per skin. A typical range for wet-blue production would be 10-30 litres per kg of hide.

The major components of tannery effluent which need to be considered in relation to environmental protection are effluent volume, content and concentration of dissolved salts (including sodium chloride), nutrients (especially nitrogen in various forms), other chemicals and biochemical oxygen demand. Other concerns are odours and solvent vapours, gas and particulate emissions and noise emissions. Site specific information on the particular effluent stream should be obtained for modelling purposes when developing effluent management processes.

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 operators of tanneries and related industries for the purposes of characterisation of the effluent is essential.

## 4 GUIDELINES

The Guidelines are designed to provide general principles for the nationally consistent environmental management of tanneries to protect water quality. The principles can be adapted by jurisdictions 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 tanneries. They are not intended to provide detailed prescriptive standards.

The important factors in planning, developing and managing tanneries to ensure that they are both economically and ecologically sustainable are:

- site suitability
- effluent management system design
- effluent treatment
- use of effluent
- effluent disposal in circumstances where re-use is not practicable
- use of sludge
- 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 required to protect water quality. Carefully planned siting of facilities, particularly the effluent utilisation areas facilitates the environmental management of the 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 tannery 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 tannery 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

Existing operations with site constraints (eg high watertable, particular soil characteristics, topography, presence of incompatible land uses, size of site, availability of services) should implement the following:

- innovative and effective technologies to minimise effluent and allow for its reuse
- effective design of the plant

- effective housekeeping and best management practices
- an effective monitoring system to enable potential problems to be detected early
- replacement of obsolete technology by proven and more cost-effective technology
- liaison with regional planning/zoning authorities.

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 following:

- 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 )
- neighbouring landuse, including residential, commercial, industrial and agricultural
- proximity to sensitive sites, including 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 4.4, Use of Tannery 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:

##### ***Existing sites***

- appropriate practices, techniques and technologies have been developed and used on site
- an acceptable Environmental Management System and/or 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
- an acceptable Environmental Management System/Plan has been developed.

***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 for a tannery
- 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 new tanneries or for extensions to existing operations.



## 4.2 Design of the effluent management system

Tanneries should incorporate modern technologies and processes. This involves adopting technology which has consistently achieved the desired effluent quality levels in economically viable operations. It should also take into account state-of-the-art engineering and scientific developments in effluent treatment, as well as opportunities for waste minimisation. It is recognised that good effluent quality is not necessarily dependent on sophisticated technology and may often involve simple, innovative solutions. Tannery effluent management options are represented diagrammatically in Figure 4.

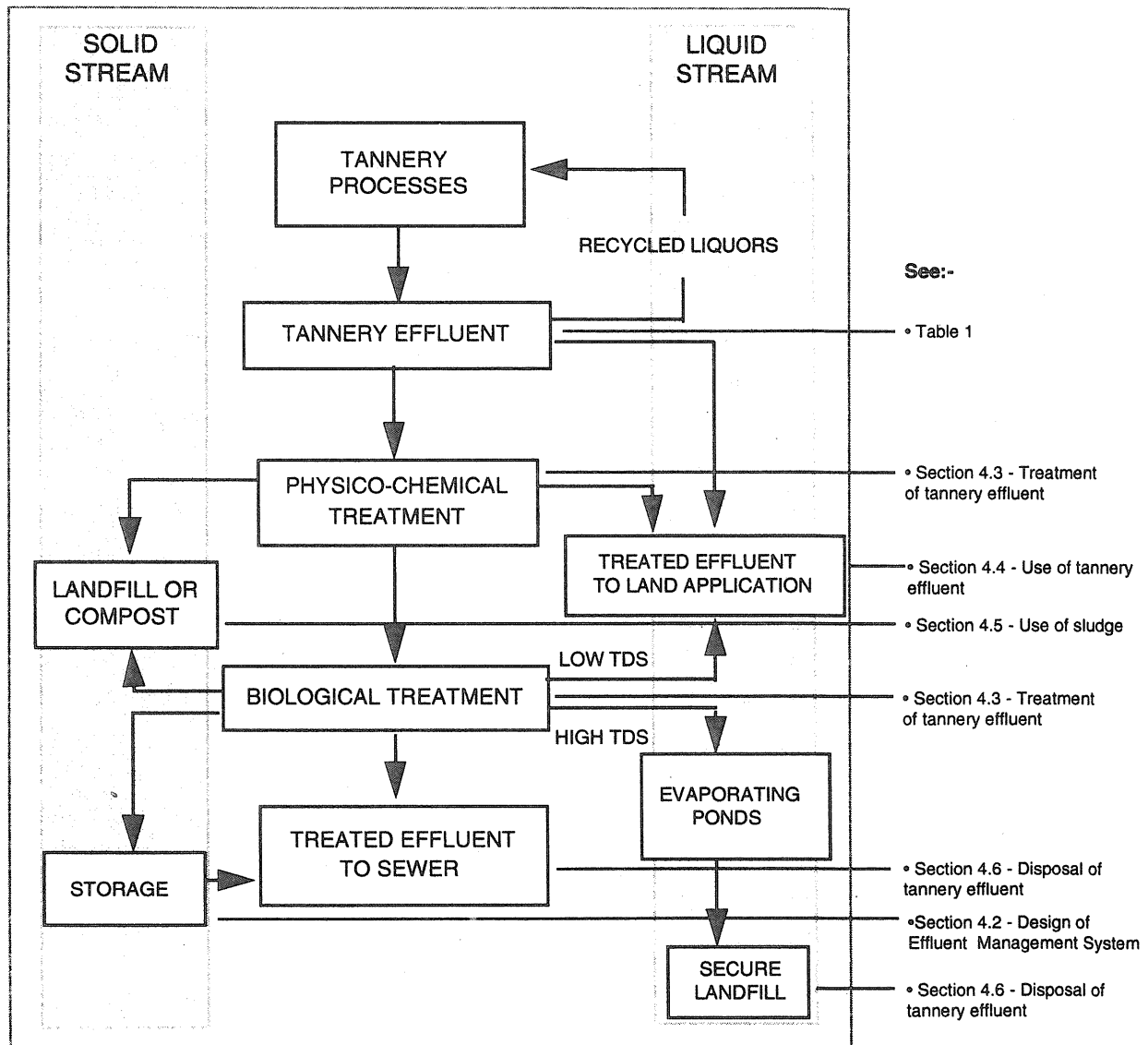


Figure 4: Tannery Effluent Management and Treatment Options

## Objectives

These are to:

- optimise the quantity and quality of effluent, given the expected use of the effluent
- produce effluent of a quality which will enhance its use
- meet regulatory requirements
- design an effluent treatment and management system which includes zero discharge to surface waters and aims at zero discharge to groundwaters. It is recognised that a leaching fraction may be needed to flush salts beyond the root zone.
- ensure that the various components of the tannery, including the effluent management and treatment systems, are mutually compatible and well-integrated.

## Guidelines

### ***4.2.1 Separating stormwater from tannery effluent***

Uncontaminated stormwater flows should be separated from the effluent system and either collected for use within the plant or directed to watercourses to maintain environmental flows. Separating stormwater flows from the effluent will reduce the volume generated and will improve treatment performance due to more even hydraulic loading.

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 plant should be designed to allow for the separate collection of contaminated stormwater.

In urban areas where tanneries discharge to the sewer, some authorities may require the operation to have the capacity to store all polluted stormwater for discharge after heavy rain. Where the first downpour of rain will flush an open area clean, the relevant authority may accept this polluted water with the discharger being required to divert the following rainfall to stormwater, on the grounds that it is no longer polluted.

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

The plant should be designed to optimise the overall operation. Efficient use of water including recycling of process liquors and treated effluent will minimise the volumes of effluent generated and the consumption of clean water. This can be achieved by ensuring the plant's various components, including the effluent management systems, are mutually compatible and well-integrated.

### ***4.2.3 Minimising the load of effluent components***

Minimising the load of components in the effluent stream should reduce the need for costly treatment, and also enhance opportunities for utilisation. Examples of load minimisation include:

- removal of potential sources of load (eg hair removal)
- chemical substitution (changing the chemical additives in the tanning process)
- electro/mechanical process control through updated engineering techniques enabling the optimum amount of buffering chemicals and other consumables to be added at the various process stages.

#### ***4.2.4 Separating the various waste streams***

Attention should be given to separating the waste stream components according to their characteristics and specific treatment needs to improve the resultant effluent quality. This would obviate the need for costly treatment and enhance opportunities for reuse. The main components which should be considered for separation are:

- high and low salinity effluent
- sulphide and non-sulphide containing liquors
- chrome and non-chrome containing liquors.

#### ***4.2.5 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 solid and liquid effluents and cost. The range of available treatment options is discussed in section 4.3.

#### ***4.2.6 Effective effluent containment and storage***

Storage and treatment tanks and lagoons, should be designed to contain their maximum operational load safely 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 because of climatic conditions, as well as increased effluent volumes resulting from unusually heavy rainfall events (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.

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.

#### ***4.2.7 Controlling spillages***

Areas where accidental spillage of effluent or products could occur should be adequately bunded or sloped to drains and directed to storage for recycling or to effluent treatment areas. Effective alarm systems should be installed throughout the tannery, particularly in areas where equipment malfunction or the spillage of material would cause pollution, to enable accidents to be detected immediately and remedial action instituted without delay.

#### ***4.2.8 Preventing contamination of water supplies***

When water is from a reticulated supply, 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 tanneries within declared drinking water source areas.

#### ***4.2.9 Odour control***

Odours from the site of the tannery operation can occasionally result in the loss of public amenity. These odours arise from poor design and management of the tannery. Protecting the community from odours depends on several factors, including:

- the quality of effluent discharge, eg effluents containing concentrated sulphur compounds may yield odour problems
- the type of effluent 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 will be alleviated if the effluent management practices recommended elsewhere in these Guidelines are adopted for new and existing tanneries. Proponents, as well as operators of existing tanneries, 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.

When new activities are proposed for sites near established tanneries, it is important to recognise the existence of agreed buffer zones.

#### ***4.2.10. 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 tannery effluent and solids into the environment by employing crops, pastures and soils. For further details refer to Section 4.4, Use of tannery effluent.

#### **Performance assessment options**

Monitor:

- the volume and characteristics of treated and untreated effluent so that they are kept within sustainable and manageable limits
- quantities of recycled and reused process liquors and effluent
- spillages; ensure they are contained and deal with sources of spillages
- any odours.
- effluent and solids application areas, for possible degradation of soil structure, salinisation, waterlogging, chemical contamination or erosion and impacts on groundwater.

Assess the tannery's overall performance in consultation with the community and relevant government authorities.

## 4.3 Treatment of tannery effluent

Suitable treatment in a properly constructed and maintained treatment system will be required prior to utilisation of the effluent.

### Objective

To treat tannery effluent to allow for its use in an environmentally sustainable manner for a particular site.

### Guidelines

The treatment systems should permit safe, effective and sustainable land application of liquids and separated solids. For disposal to sewer, the treatment should achieve the quality required by the treatment plant for trade waste. Selection of an effluent treatment system could be based on the factors outlined in Section 4.4 Use of tannery effluent.

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

- total suspended solids
- BOD
- nutrients
- salts
- chromium
- other components that may be present in the effluent such as ammonia and sulphide odour
- surfactants
- wool wax (fell mongering operations)

Options for effective treatment and management of tannery effluent are summarised in Figure 4.

While treatment methods will vary between tanneries, 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, maintenance periods, storm events.

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 management expertise for efficient effluent treatment is available at all times.

### 4.3.1 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 equipment and separation methods such as coarse screening, sedimentation, dissolved air flotation (DAF), or centrifuging.

This type of treatment will not only reduce the rate of sludge build up in lagoons 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 (eg coagulation, flocculation), and to improve treatment performance or suitability for land application.

### ***Biological treatment***

Aerobic/facultative lagoons are generally seen as a suitable form of biological treatment to enhance the breakdown of pollutants. Lagoon 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.

### ***4.3.2 Siting and design of treatment lagoons***

Lagoon 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 lagoons to prevent surface and groundwater contamination.

#### ***Lagoon siting and soils***

Lagoons may be installed where the slope of the land is not too steep to cause problems with their construction and where soils are sufficiently impermeable to retain effluents in the lagoon. Impervious liners should be used in lagoon construction where underlying soil permeability is suspect and there is a potential to contaminate groundwater. Great attention must be paid to their installation. Lagoons should not be constructed where overflows can enter surface waters or natural wetlands. They should not be installed across watercourses. Adjacent surface water runoff should be prevented from entering the lagoon.

#### ***Lagoon design and sizing***

Lagoons should be designed to cater for maximum hydraulic and waste load and to allow for a tannery's future expansion. Lagoon systems should be large enough to retain the total volume of wastewater where soils may be saturated for a period, as in areas with a prolonged wet season. Allowance needs to be made for primary lagoons to be taken out of service, solar dried and desludged after about 5 - 10 years of service. Allowance should be made for any runoff from the catchment of the lagoon and any contaminated stormwater flows from the tannery.

### ***4.3.3 Capacity of the effluent management system***

Planning for any increase in tannery production needs to consider the capacity of the effluent treatment system to accommodate the possible production increase. An augmentation of treatment capacity can be accomplished in several different ways, including:

- load reduction due to improved housekeeping and/or effluent stream segregation
- physical pre-treatment processes
- enhanced aeration of lagoons
- expansion of the lagoon capacity
- new effluent treatment facilities
- chemical or microbiological supplements.

## Performance assessment options

These include:

- the characteristics of the effluent are monitored before and after treatment to gauge the effectiveness of any treatment
- tannery effluent is used for land application, eg irrigating crops, pastures and trees
- all polluted runoff has been contained
- surface and groundwater is monitored for ambient levels of salt, BOD, nitrogen, chromium, phosphorus, potassium (trace amounts) and pH (refer to recommended levels for environmental values in *Australian Water Quality Guidelines for Fresh and Marine Waters* as a guide)
- soils are monitored for the effect of effluent application, including physical, chemical and biological characteristics
- the effects on public amenity are evaluated by observing buffer zones and noting any public complaints
- crops, trees and pasture are monitored for yield and foliar symptoms, growth rates and health
- records are maintained from which the history of loading of water, nutrients, salts and contaminants can be calculated for all areas where effluent is applied.

## 4.4 Use of tannery effluent

### Objective

To encourage the use of

- nutrients
- trace elements
- organic matter
- water values of the solid waste/sludge and liquid effluents

where this use is not precluded by other components of the effluents, such as salts, metals and pesticides (woolskins), 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 will 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 use of treated 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.

#### **4.4.1 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, evapotranspiration)
- the nature of pasture or crop grown
- pastoral, agricultural and horticultural practices
- 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 p.22), 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 tannery effluent at excessive levels could damage soils and lead to site contamination from components such as chromium. To select land for irrigation with tannery effluent, 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 plant use between successive irrigations
- nutrients in sufficient but not excessive 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
- no salinity problems.

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 and well drained, ranging 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. For effluent irrigation such soils are those that are suitable for irrigated pasture and crop production. For solid waste/sludge application soils should be suitable for improved 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
- coarse silica sand soils (without iron or aluminium-rich fines).



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 the maximum application rate will be limited by one or more of the following:

- hydraulic loading
- nutrient loading/balance (N, P, K)
- salt loading
- metals loads
- oil and grease loads.

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.

Bunding should be constructed to control accidental irrigation runoff and to recover effluent runoff for reapplication.

### *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 tannery 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 tannery 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 and 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.

### *Agricultural and horticultural practices*

The decision to use either crops, trees or pasture, and the selection of species should take account of the fact that tannery effluent is rich in nutrients and salts. Particular types of vegetation may accumulate nutrients more than others.

The vegetation which accumulates nutrients contained in the effluent needs to be harvested from the application site 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. 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. Operators should comply with appropriate health regulations and guidelines concerning human and animal consumption of irrigated crops.

If plant water requirements exceed the nutrient-limited effluent land treatment rate, the shortfall in water will need to be met from another source.

#### ***4.4.2 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 solids
- suspended solids
- BOD
- COD
- organic carbon
- electrical conductivity (EC)
- exchangeable cations (sodium, magnesium, calcium)
- sodium adsorption ratio
- pH
- total Kjeldahl nitrogen
- ammonia nitrogen
- phosphorus
- oil and grease
- chromium
- potassium
- sulphate.

Concentrations of nutrients (NPK), total dissolved solids or salinity, organic matter, BOD, sodium adsorption ratio (SAR) and suspended solids (non-filterable residue) should be tested for regularly in liquid effluent and solid wastes/sludges. 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 soil micro-organisms' capability 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 allow sufficient time between irrigations for the soil to become aerobic. 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 causes an increase in the osmotic pressure of the soil solution, resulting in a reduced availability of water for plant consumption and possible retardation of plant growth. Recommended guidelines for irrigation water quality are given in the NWQMS document *Australian Water Quality Guidelines for Fresh and Marine Waters* and cover a number of parameters including salts (TDS), sodium adsorption ratio (SAR) and chromium. These guidelines also take into account soil characteristics, crop tolerance, climate, and irrigation practices which can influence soil loadings for particular contaminants.

With adequate drainage, salt accumulation in the soil can be controlled to an extent by the application rate of water. If the sum of applied irrigation water and rainfall is lower than evaporation and plant consumption, accumulation of salts in the main root zone will result. Proper irrigation management will allow application of sufficient excess water (leaching fraction) to move a portion of the salts out of the root zone, without causing excessive increases in the groundwater table. (NWQMS - *Australian Water Quality Guidelines for Fresh and Marine Waters*, p 5-7)

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 ((NWQMS - *Australian Water Quality Guidelines for Fresh and Marine Waters*, p 5-5).

Where possible, application to land of tannery effluent with an SAR 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 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. 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.

### **4.4.3 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 which result 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.

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.

Other nutrient-intensive activities incompatible with environmental objectives (such as animal holding) should be excluded from irrigated areas.

### ***Control of stormwater and irrigation tailwater***

Upslope stormwater may need to be diverted to prevent it from entering the effluent utilisation areas. The use of earth bunds and contour drains to direct runoff from irrigated areas to storage and recovery dams for re-use should be considered, particularly in areas with long dry summers. Runoff from the solid waste/sludge and effluent utilisation areas should be managed to minimise discharge directly to waters by the use of buffers zones, recycle/reuse systems 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**

These include:

- tannery effluent is used for land application, eg irrigating crops, pastures and trees
- all polluted runoff has been contained
- surface and groundwater is monitored for ambient levels of salt, BOD, nitrogen, chromium, phosphorus, potassium (trace amounts) and pH (refer to recommended levels for environmental values in *Australian Water Quality Guidelines for Fresh and Marine Waters* as a guide)
- soils are monitored for the effect of effluent application, including physical, chemical and biological characteristics
- the effects on public amenity are evaluated by observing buffer zones and noting any public complaints
- crops, trees and pasture are monitored for yield and foliar symptoms, growth rates and health.
- records are maintained from which the history of loading of water nutrients, salts and contaminants can be calculated for all areas where effluent is applied.

## **4.5 Use of sludge**

### **Objective**

To ensure sludge is utilised in an environmentally sustainable manner.

### **Guidelines**

Before sludge can be used as a soil conditioner, all components of the material need to be identified and the origin of the sludge(s) defined. The value of sludge products and the range of options for beneficial use may be restricted by the presence of contaminants such as metals (eg chromium). Allowable levels of contaminants in sludge products used as soil conditioners are regulated by either state environment protection or agriculture authorities which should be consulted in planning sludge reuse schemes.

Before and during land application, scheduling and application rates based on the properties of the sludge including its salinity and nutrient content, toxicant concentrations, pH and BOD need to be considered. This should be assessed seasonally. Maximum application rates for land treatment of sludge and solid waste will depend on site-specific conditions.

The issues discussed in Sections 4.4 need to be considered when applying sludges to land.

### **Performance assessment options**

These include:

- all polluted runoff has been contained
- surface and groundwater is monitored for ambient levels of salt, BOD, nitrogen, chromium, phosphorus, potassium (trace amounts) and pH (refer to recommended levels for environmental values in *Australian Water Quality Guidelines for Fresh and Marine Waters* as a guide)
- soils are monitored for the effect of effluent application, including physical, chemical and biological characteristics
- the effects on public amenity are evaluated by observing buffer zones and noting any public complaints
- pastures, crops or trees are monitored for yield and foliar symptoms, growth rates and health
- records are maintained from which the history of loading of nutrients, salts and contaminants can be calculated for all areas where solid waste is applied
- solids are handled and utilised in an effective and environmentally sustainable manner
- contaminant concentrations (mg/kg) are measured.

## **4.6 Disposal of tannery effluent**

### **Objective**

To dispose of tannery effluent in an environmentally sustainable 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, or the relevant guidelines of the licensing agency. Ambient water quality immediately downstream of the plant should remain within the limits for parameters set for the most sensitive environmental value to be protected in the receiving water body. This may require tertiary treatment (viz. nutrient removal, filtration and disinfection) of the effluent prior to discharge. 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*.

Where salinity is a problem, highly saline effluents should be separated and directed to evaporating basins for collection of the salts. In some jurisdictions, particularly in inland areas, disposal of salt to landfills may be rejected. Alternative, secure landfills will need to be found. Treated effluents may be discharged to sewer (where applicable), provided the effluents meet the local sewerage service provider's criteria. Additional information on the management of industrial effluent is contained in the NWQMS document *Sewerage Systems - Acceptance of Trade Waste*.

### **Performance assessment options**

These include:

- the effluent quality of any discharge is monitored
- the environmental values of relevant water bodies are monitored
- if discharge to sewer is permitted, the requirements of the relevant authority are monitored to ensure they are being achieved

- compliance with both a regional catchment plan and the relevant guidelines of the licensing agency or agriculture department regarding effluent disposal, including by sewer
- 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

Monitoring is an essential part of any Environmental Management System and/or Plan. The extent of monitoring required should be determined on the basis of the tannery and property size, and the location's environmental sensitivity. Monitoring of effluent quality and volumes discharged at land treatment areas is needed to effectively manage an effluent land treatment system. Monitoring of groundwater levels and quality, and soil water concentrations below rooting depths is essential.

### Objective

To ensure the on-going efficient operation of the plant and for regulatory purposes To ensure the tannery operation is meeting its Environmental Management System and/or Plan objectives.

### Guidelines

- Include monitoring and reporting on the plant's performance as an integral part of the operation's Environmental Management System.
- Maintain records of monitoring data, which should be made available for review by relevant authorities on request.
- Review procedures and data periodically with regulatory authorities to ascertain its usefulness and to effectively monitor performance.
- Develop a Quality Assurance system and use accredited procedures and laboratories to analyse samples to ensure the integrity of monitoring data (eg NATA accredited).
- Conduct regular inspections of facilities, in particular pumps and waste storage reservoirs.
- Undertake regular monitoring of land to which effluent has been applied. The soil should be monitored for nutrient levels, particularly phosphorus adsorption as well as for salt levels. Visual assessment should be made for waterlogging, sealing, erosion etc. Harvested crops should also be sampled and analysed to monitor nutrient removal from the site.
- Regularly monitor surface waters liable to be affected by a tannery. Groundwater may be monitored depending on the sensitivity of the site to groundwater.
- Maintain records of each effluent irrigation area as separate management units including effluent volumes, dates of application, and any pasture/crop management information (eg bales of hay cut and removed).
- Supplement regular reporting with "exception" reporting to alert supervisors to unusual variations in plant performance .
- Pollution events should be reported to relevant regulatory authorities.
- Provide plant managers with up-to-date information on their plant's environmental performance to enable problems to be detected early and remedial action implemented.
- Provide operators 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.
- Analysis of certain characteristics of the effluent may be required for initial characterisation and ongoing monitoring

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.

### **Performance assessment options**

These include:

- adequate operational planning, consultation, recording, monitoring, reporting, and education and training of staff in place
- consistent adherence to licence conditions
- no environment related complaints
- regular reporting to management and staff, including feedback on performance, changes to the system, and an internal audit system with relevant documentation and reporting.

## **4.8 Contingency measures**

### **Objective**

As part of a good overall strategic plan for the tannery, to have in place effective procedures enabling plant managers to respond effectively to all emergencies and contingencies.

### **Guidelines**

Tanneries should be prepared for:

- disruption to power supplies which may affect the plant's effluent management system
- extreme rainfall events
- disruption to tannery operation or effluent treatment by storms, flooding, fire, etc
- plant breakdowns
- overloading of aerobic treatment plants or lagoons, or unusually low effluent inputs which can affect the system's biological treatment activity
- accidental discharge of hazardous materials into the effluent stream
- plant spillages
- clean up of site contamination (eg soil removal or treatment)
- changes in the physico-chemical environment which can disrupt the effectiveness of the effluent treatment system's biological activity
- 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. The plan should be regularly rehearsed and updated

### **Performance assessment options**

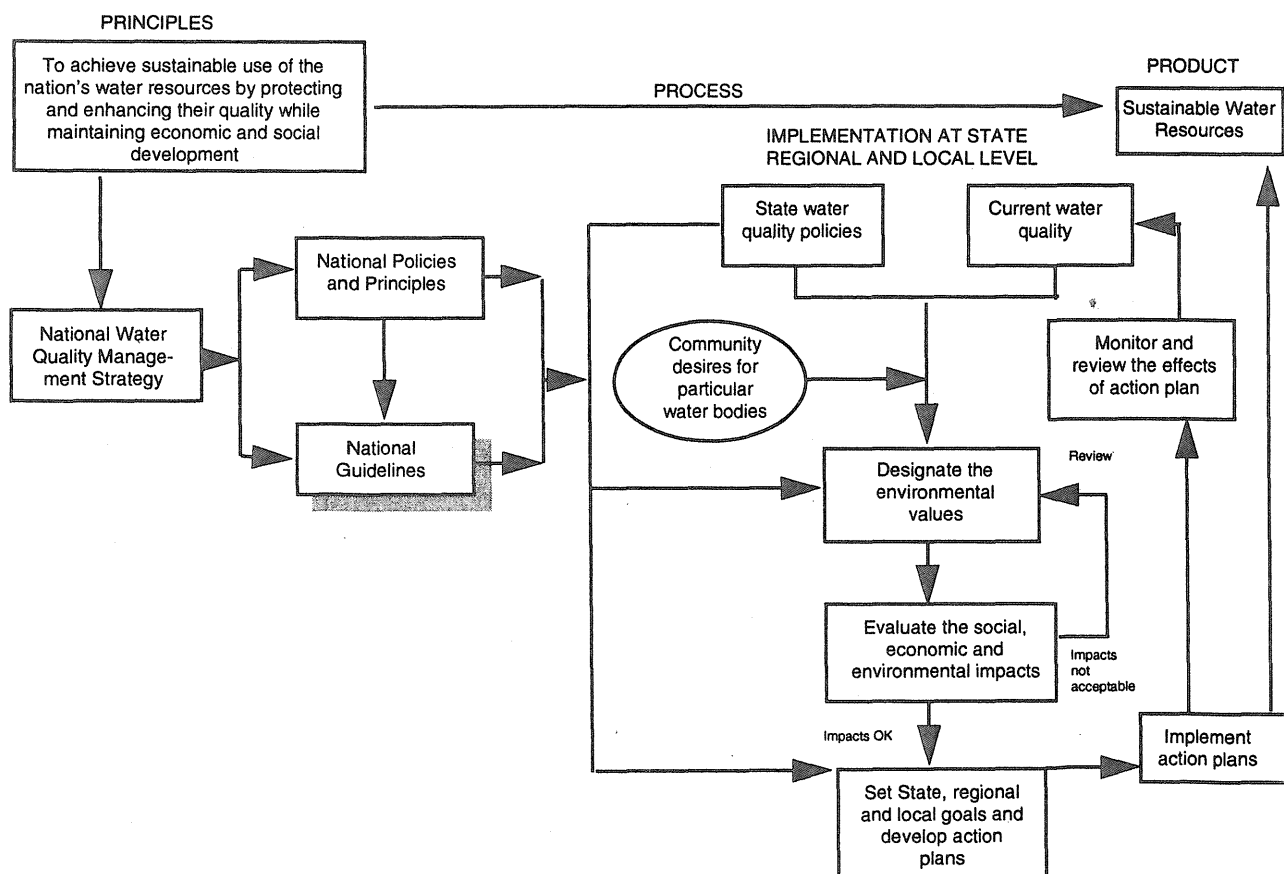
- An up-to-date contingency plan is disseminated to staff and regularly inspected and trialed.
- Record and regularly analyse the operations response to specific contingencies which have arisen.

## Appendix A: The 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: Sources of further advice**

CSIRO Leather Research Centre (Melbourne)

CSIRO Division of Water Resources (DWR)

State and Territory Environment Protection Authorities

State and Territory Authorities responsible for:

- Agriculture and Primary Industries
- Conservation and Land Management
- Water

Local Government Authorities

Regional Tertiary Institutions

Industry Consultants

## Appendix C: Sewer discharge

Effluent from tanneries and related industries contains the following components of concern when discharging to a sewerage system:

- pH
- chromium
- sulphide
- BOD
- suspended solids
- ammonia and organic nitrogen (TKN)
- total dissolved solids
- sulphate
- oil and grease.

The current treatment options to meet sewer discharge acceptance limits are as follows:

### pH

If necessary, pH adjustment of effluent must occur to ensure that pickle liquors are neutralised. A low pH can corrode the concrete pipes in sewers. A high pH can result in the release of ammonia from the waste due to sewer turbulence which may cause Occupational Health & Safety concerns due to odour generation.

### Chromium

Trivalent chromium, Cr(III) is used as a tanning agent to produce leather. Cr(III), in contrast to Cr(VI), is lower in toxicity. One of the current technologies for reducing Cr(III) discharge to sewer is direct recycling of chrome tanning liquors. For direct chrome recycling in wet blue production, the spent chrome liquor is used as the next pickle liquor, after adding acids and salts. Any excess liquors are collected for chrome recovery by precipitation. The recovered chrome can be redissolved in acid and added to the chrome recycle liquors. In woolskin processing, the chrome liquor can be re-used for prolonged periods.

The chrome sent to wastewater treatment must be treated by chrome precipitation, usually followed by solids removal by processes such as dissolved air flotation and the use of a belt filter press, before discharge to sewer.

### BOD

The unhairing process creates the most significant portion of the BOD<sub>5</sub> produced in tanning processes due to the degradation of hair that takes place in conventional unhairing treatments. The CSIRO has developed the Sirolime process which removes hair from hides in such a way that it can be filtered and recovered from process liquors, allowing process liquors to be recycled. The recovered hair can also be used in the manufacture of slow release nitrogen fertiliser. A range of hair-saving processes are now available.

Another source of BOD is contributed during the fleshing stage of the tanning process due to contamination of the wastewater by fat and some blood. Large quantities of fleshings can be utilised by rendering and can become a useful product. The processing of sheep skins can contribute to BOD because of the presence of lanolin in the wool.

### **Suspended solids**

While these are produced in a variety of the processes, unhairing is again the most significant contribution to suspended solids. If the hair is separated from the wastewater, it will significantly reduce the suspended solids load and allow more efficient use of process liquors due to their ability to be recycled.

### **Ammonia**

One of the processes used to prepare hides for tanning is called deliming. This process uses high levels of ammonium salts, most commonly ammonium sulphate. Where there are charges or restrictions on sulphate in the effluent, ammonium chloride is often substituted. Deliming removes the lime from the hides used in unhairing and provides suitable conditions for the enzymatic bating process.

At present the most common method of ammonia removal to meet ammonia and Total Kjeldahl Nitrogen discharge limits involves air stripping of ammonia under alkaline conditions. As limits are placed on air emissions, this process becomes a less favourable option. An alternative which is gaining use is deliming with carbon dioxide. Carbon dioxide deliming can improve effluent quality and produce better leather products. It is applicable to the deliming of all types of raw material including kangaroo and fellmongered sheep skins.

### **Total dissolved solids**

Salt is a common preservative applied to hides and skins. Pickling also uses large amounts of salt solutions to prevent swelling of the hides at low pH. The effluent's salinity creates a few issues of concern. Salinity is a major concern especially as sewerage authorities are considering water reuse as part of waste minimisation. In rural areas the salinity is a problem due to degradation of land for agricultural and pastoral use.

The best ways of managing the total dissolved salt levels is to process unsalted often chilled (green) raw material, and to use CO<sub>2</sub> deliming and direct chrome liquor recycling.

### **Solvents**

Tanners should be encouraged to look at the products they use and where possible avoid those containing aromatic hydrocarbons as they cause occupational health and safety problems in the sewer environment. Where they are used, tanneries need to ensure effective treatment is installed to reduce the levels of these substances in the discharge to sewers.

### **Sulphates**

Sulphates and other oxidised sulphur compounds in combination with the degradation of organic waste by anaerobic bacteria produce hydrogen sulphide. This compound in turn can cause odour and corrosion problems in sewerage systems. For this reason the quantities of sulphate in effluents discharged to sewers may be limited by sewerage authorities.

### **Sulphide**

Sulphide containing liquors are usually treated via oxidation catalysed by manganese in the form of manganese sulphate. The sulphur is oxidised to thiosulphate and sulphate.

### Summary

The amount of effluent can be minimised by the processing of 'green' or unsalted hides and recycling of process liquors. Sulphide containing liquors are usually oxidised and excess chrome III can be removed by precipitation. If needed a flocculation and sedimentation step can be included to remove solids prior to discharge.

Additional information on general requirements for discharge to sewer are contained in the NWQMS document *Sewerage Systems - Acceptance of Trade Waste (Industrial Waste)*. Specific requirements should be obtained from the local sewerage authority.

## Appendix D: Further information

### Further reading

Australian Water Resources Council, *Review of Effluent Disposal Practices*, Water Management Series No. 20. 1991

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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



## 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	an underground layer of rock or sediment which holds water and allows water to percolate through.
Basification	the process of adding alkali during chrome tanning in order to bond the chromium to the collagen.
Bating	treatment of hides with enzymes to remove certain proteins to improve leather quality.
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 <sub>5</sub> 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.
Chromium [Cr (III), Cr (VI)]	Trivalent chromium, Cr(III) is used as a tanning agent to produce leather. Cr(III), is lower in toxicity than Cr(VI).
Chrome tanning	conversion of hide to leather using chromium salts.
Collagen	the principal protein of skin.
Deliming	the chemical removal of lime from hides after the unhairing process.
Denitrification	removal of nitrogen.

Effluent	is used here to refer to the liquid and associated solids (sludge) at all stages from production to utilisation or disposal. It does not include runoff from pastures or crops which have been irrigated with effluent, which is addressed in the NWQMS document <i>Rural Land Uses and Water Quality - A Community Resource Document</i> .
Environmental Management System	provides the management, administrative and monitoring framework which ensures that an organisation's environmental risk is minimised and that its environmental policy together with associated objectives and targets are achieved. Stages in an EMS, based on the ISO 14000 series comprise commitment to a policy, planning which includes evaluation of relevant regulatory framework, setting objectives and targets, establishing a management program (EMP), definition of personnel and responsibilities, identifying training needs, establishing and maintaining EMS documentation, emergency and preparedness and response procedures and establishing operational controls, and carrying out audits and reviews including monitoring and review.
Environmental values	<p>particular values or uses of the environment that are conducive to public benefit, welfare, safety or health and which 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:</p> <ul style="list-style-type: none"> <li>. ecosystem protection</li> <li>. recreation and aesthetics</li> <li>. drinking water</li> <li>. agricultural water</li> <li>. industrial water</li> </ul> <p>Refer to the NWQMS documents <i>Policies and Principles - A Reference Document</i>, and <i>Australian Water Quality Guidelines for Fresh and Marine Waters</i>.</p>
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.
Facultative	a condition where both the aerobic and anaerobic conditions occur. The surface of a pond may be aerobic and the bottom anaerobic. The term also refers to micro-organisms that can survive and reproduce under both aerobic and anaerobic conditions.
Fatliquor	an emulsion of oils which lubricates leather.

Fellmongered skin	sheepskin from which the wool is recovered.
Fleshing	removal of fat, muscle and subcutaneous tissue with a fleshing machine. The fleshings are recovered to produce tallow and protein for stockfeed.
Hydraulic loading	volume of water applied to an area of land.
Guideline	provides guidance on possible means of meeting desired environmental outcomes. Guidelines are not mandatory.
Ion exchange	purification of water by removal of ions.
Katabatic drainage/wind	a wind caused by cold air flowing downhill. When a sloping land surface cools by night time radiation, the cold air in contact with the ground flows downhill and 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.
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.
Phosphate Sorption Capacity	a measure of the inherent ability of soil particles to adsorb phosphorus from the soil solution.
Pathogens	disease-causing organisms.
Pickling	treatment of hides with salt and acid in preparation for tannage.
Retan	a modifying secondary tannage.
Risk management	is a decision-making process that entails considerations of political, social, economic and engineering information together 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.
Salt cured hides	hides preserved with salt.
Sammy	to remove water by wringing.
Sirolime	the restricted name of a novel process developed by CSIRO to remove intact hair from hides.
Slip wool	wool removed by fellmongering.
Standard	a standard is a quantifiable characteristic of the environment against which environmental quality is assessed. Standards are mandatory.
Suint	that portion of the sheep's fleece which is soluble in cold water after the wax has been removed. It is a complex mixture of metallic ions, organic acids, peptides, weak bases, neutral substances, and inorganic cations. Potassium salts of organic acids are a large component of suint. In Australian merino fleece, the amount of suint ranges from 2 to 13% with an average of 6.1%.
Suspended solids (SS)	matter in waste water that is in suspension.
Tanning/tannage:	the conversion of hides to leather.
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)	the amount of volatile and fixed suspended solids in waste water.
Vegetable tanning (Veg-tan)	conversion of hides to leather with tannins extracted from plants.
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.
Wet-blue tannery	a tannery processing hides from the raw state to, but not beyond, the chrome tanned stage.