Draft Environmental Guidelines

Composting and Related Organics Processing Facilities

February 2002

For community consultation

NSW EPA

ENVIRONMENT PROTECTION AUTHORITY

This draft document was prepared by the Waste Policy Section of the NSW Environment Protection Authority for community consultation.

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Who should read these DRAFT guidelines?

These composting guidelines are being developed to provide:

- a clear outline of environmental issues that need to be managed for composting facilities
- a clear system for regulating composting facilities and activities
- information on some of the techniques available to manage environmental issues.

They are being developed to help:

- occupiers of existing composting and related organics processing facilities, such as mulching, fermentation and digestion facilities
- individuals, companies, local government bodies, regional waste boards and communities planning such facilities
- individuals or groups wishing to find out what management measures they can use to avoid or minimise the negative impacts of composting and related organics processing and its products on local amenity, health and the environment
- suppliers or developers of individual items of equipment or entire turnkey processes for such facilities
- environmental consultants
- existing or intending users of the products of these facilities, which include composts, soil conditioners and mulches.

Consultation and feedback on draft guidelines

The draft guidelines are being released for an extended consultation period to enable all key players to thoroughly review them.

The EPA will accept feedback on the draft guidelines until 30 August 2002. However, there will be an opportunity to provide early feedback and participate in stakeholder discussions on key issues in the period from 12 April 2002 to 30 August 2002.

The key dates and process are as follows:

(i) Preliminary review period for guidelines from release date until 12 April 2002.

(ii) Forward any initial feedback (if desired) to the EPA by 12 April 2002.

(iii) EPA will review this early feedback and establish stakeholder groups to discuss any key issues with a view to exploring options.

(iv) By 12 July 2002, distribute any alternative approaches/options developed by stakeholder groups to all key stakeholders who received the initial draft guideline.

(v) Final feedback on draft guideline (including any alternatives circulated) by 30 August 2002.

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ACRONYMS AND ABBREVIATIONS

ANZECC	Australia and New Zealand Environment Conservation Council
APHA	American Public Health Association
AS	Australian standard
BOD	Biological oxygen demand
C:N	Carbon to nitrogen ratio
DA	Development application
DC	Development consent
DLWC	Department of Land and Water Conservation (NSW)
DUAP	Department of Urban Affairs and Planning (NSW)
EIS	Environmental impact statement
EMP	Environmental management plan
EMS	Environmental management system
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	New South Wales Environment Protection Authority
ESD	Ecologically sustainable development
FML	Flexible membrane liner
HDPE	High density polyethylene
IDA	Integrated development assessment
ISO	International Standards Organisation
LEP	Local environmental plan
m/m	Mass per mass
MSW	Municipal solid waste
NMOC	Non-methane organic compounds
NZS	New Zealand standard
PET	Polyethylene terephthalate
REP	Regional environmental plan
RPD	Relative per cent difference
SEPP	State environmental planning policy
USEPA	United States Environment Protection Agency
v/v	Volume per volume
WMMA	*Waste Minimisation and Management Act 1995*

1 INTRODUCTION

The reprocessing of organic waste has important environmental benefits, including the recovery and conservation of resources and a reduction in the amount of waste going to landfills. These benefits come from turning organic waste into useful and safe products, without causing harm to the environment. If commercial composting facilities are not well managed they can have serious environmental impacts. Modern composting operations tend to reprocess much greater quantities of organic wastes than traditional processes. Consequently, the generation of by-products, such as water-soluble nutrients, can become greater than the capacity of natural processes to cope with them adequately. Even relatively simple tasks in composting and related organics processing—such as mulching, grinding and chopping—can have environmental impacts.

The New South Wales Environment Protection Authority (EPA) is developing guidelines to set out environmental objectives and performance requirements for composting and related organics processing activities. They are intended to give the managers of existing and potential facilities the tools for choosing processes that achieve the required environmental outcomes for processing particular mixes of organic waste types.

These draft guidelines cover the reprocessing of the following types of organic waste:

- garden waste
- untreated wood waste
- natural organic fibrous wastes
- biosolids[1]
- manures
- food waste (for example, meat, fish and fatty and oily sludges of vegetable and animal origin, including grease trap sludges)
- mixed residual waste containing organic matter.

For the purposes of these draft guidelines, 'reprocessing' includes composting, digestion, mulching, fermentation and similar processes that involve biological organisms in the processing of organic waste materials. Facilities that employ biological digestion to produce methane or other fuels are covered by these guidelines. Facilities that produce fuels from organic waste by non-biological processes such as pyrolysis, hydrogenation or gasification are not covered.

These draft guidelines use a performance-based approach. This means that they:

- define clear environmental issues that affect the management of composting and related organics processing facilities, and
- identify objectives, performance requirements and performance measures for dealing with each issue.

By setting objectives and not prescribing particular environmental techniques that must be used, the EPA encourages facilities to develop cost-effective solutions that not only achieve the right environmental outcome but also are appropriate to particular operations. The EPA also encourages facilities to develop their own monitoring techniques and performance measures.

Once these guidelines are finalised following this consultation process, they will have a practical effect in terms of operation on composting and related organics processing facilities that are required to hold environment protection licences. Composters or other organic waste reprocessors who are not required to be licensed may, however, find useful information in this document

[1] Note that the product quality criteria in these guidelines **do not** apply to materials containing biosolids—such materials are subject to the *Environmental Guidelines: Use and Disposal of Biosolids Products* (EPA 1997)

relating to the management of such processes and the quality that will be necessary for products to be considered non-wastes.

EPA licensing requirements

Composting facilities are listed in a schedule of the *Protection of the Environment Operations Act 1997* that triggers licensing requirements because they are over a certain size or are located near sensitive receptors like schools or hospitals. Persons who process organic waste materials on the premises on which they arose, such as farmers and other businesses, do not require an environment protection licence for that activity. Only those premises which receive organic waste materials generated elsewhere require a licence. Schedule 1 of the *Protection of the Environment Operations Act 1997* determines which specific composting and related organics processing facilities (identified as 'Composting and related reprocessing or treatment facilities' in the Schedule) require environment protection licences. For information about licensing and associated costs see *Guide to Licensing under the Protection of the Environment Operations Act 1997*, published by the EPA.

Environment protection licence conditions will be reviewed and developed or updated, as required, once the final composting guidelines are published following the consultation period, and will include:

- performance requirements and performance measures for each environmental objective listed in section 3 of these guidelines, or
- the performance requirements shown in these guidelines and any alternative performance measures proposed by the applicant and approved by the EPA for a particular environmental objective.

These guidelines can also be used to assist occupiers of facilities that do not have to be licensed.

In the spirit of its performance-based approach, the EPA encourages environment protection licence applicants to develop their own site-specific monitoring techniques and ways of measuring performance. Applicants must show that their methods are suitable for assessing compliance with the performance requirements. If these alternative methods are approved, the EPA will include them as conditions of a facility's environment protection licence. If facility occupiers want to use alternative or modified performance measures, they must note them on information provided to support their environment protection licence applications or in negotiations on amendments to their existing environment protection licences. Applicants will need to provide documentation that either:

- identifies the extent to which the system is used successfully elsewhere and certifies that:
  —the conditions are comparable
  —the system has been operating long enough for its possible consequences to be known
  —the prospective occupier can duplicate the system that is used
  —it can be demonstrated why the system works
  —there is no opposing evidence
  —the proposal is compatible with other aspects of the composting and related organics processing facility operation
  —the technique is benign to the environment with respect to all other environmental objectives

or

- demonstrates:
  —the soundness of the proposal in field or laboratory tests
  —the fact that the conditions simulate the proper operating conditions
  —why the system works
  —that there is no opposing evidence

—how the EPA can replicate the test results produced by the applicant, if desired

—that the proposal is compatible with other operational aspects of the proposed composting and related organics processing facility

—that the technique is benign to the environment with respect to all other environmental objectives.

If, in the opinion of the EPA, the proposed alternative performance measurement methods represent an increased risk of serious or irreversible harm to the environment, the EPA may request an independent expert assessment.

Classification of incoming organic wastes

Environment protection licences use a three-class system to specify the wastes that facilities can receive. (See Table 1 on next page.)

The main factors that determine the classes are:

- potential to generate unpleasant odours
- potential to attract vermin and vectors
- potential to generate harmful leachate, which can contaminate surface water, ground water and soil.

Class 1 organic wastes have the lowest potential environmental impact. Class 2 wastes have a greater impact. Class 3 organic wastes have the greatest potential to affect the environment and amenity seriously. These include meat, fish, fatty foods and fatty or oily sludges. Facility occupiers need to take special care when handling and reprocessing Class 3 wastes.

This classification system corresponds to the Department of Urban Affairs and Planning's *EIS Practice Guideline: Composting and Related Facilities* (DUAP 1996). Consent and concurrence authorities use DUAP's guidelines when they are evaluating development applications. Development consents indicate the classes of organic waste that are allowed to be reprocessed at particular facilities. The EPA ensures that the conditions it puts in environment protection licences are consistent with these.

EPA environment protection licences allow facilities to receive wastes classified as having a lesser environmental impact but not wastes classified as having a greater potential impact. For example, facilities licensed to receive Class 2 wastes may receive materials from Class 1 but not from Class 3. Facilities holding or seeking environment protection licences will need to demonstrate to the EPA that they have an incoming material screening procedure that prevents them from receiving wastes other than those allowed by their environment protection licences. Facilities holding or proposing to hold environment protection licences to receive and reprocess organic waste need to demonstrate that they have in place appropriate handling and storage arrangements for any unreprocessed Class 2 wastes, in order to reduce the impacts of odour and leachate.[2] Alternatively, occupiers should demonstrate that they have appropriate alternative controls for odour and leachate.

[2] The EPA recommends that the odour and leachate be minimised by either:

—mixing the Class 2 wastes into windrows containing a large proportion of actively composting Class 1 wastes (typically at a ratio of 25:1 Class 1: Class 2 (w/w) or greater), or

—using an enclosed or actively ventilated composting process with odour collection and treatment during the initial period of composting.

Facilities holding or proposing to hold environment protection licences to receive and reprocess Class 3 wastes will need to demonstrate that they have in place appropriate handling and storage arrangements for any unprocessed Class 2 and 3 wastes. These wastes are best reprocessed in enclosed facilities incorporating odour and leachate collection and/or treatment components, unless occupiers can demonstrate that they have appropriate alternative controls for preventing odour and leachate impacts.

Under wet conditions, when grass clippings alone are reprocessed, or whenever the percentage of grass clippings in a mixture exceeds 15% (m/m), severe odour and leachate problems can occur unless facilities use appropriate environmental controls. Applicants seeking environment protection licences for Class 1 waste reprocessing will need to demonstrate that they will reprocess material containing less than 15% grass clippings, or that they will have additional leachate and odour controls in place.

Table 1. Classifications of organic waste

Waste class and threshold	Types of organic waste material permitted in classification[1] (Classes with larger numbers may contain types from classes with smaller numbers.)	
	Category	**Examples of organic material**
Class 1 (5000 tonnes a year)	**Garden and landscaping material**	Grass[2]; leaves; plants; loppings; branches; tree trunks and stumps.
	Untreated timber	Sawdust; shavings; timber offcuts; crates; pallets; wood packaging.
	Natural organic fibrous material	Peat; seed hulls/husks; straw; bagasse and other natural organic fibrous materials.
	Processed fibrous material	Paper; cardboard; paper processing sludge; non-synthetic textiles.
Class 2 (200 tonnes a year)	**Other natural or processed vegetable material**	Vegetables; fruit and seeds and processing sludges and wastes; winery, brewery and distillery wastes; non-fatty food waste.
	Biosolids[3] and manures	Sewage biosolids, animal manure and mixtures of manure and biodegradable animal bedding materials.
Class 3 (200 tonnes a year)	**Meat, fish and fatty foods**	Carcasses and parts of carcasses; blood; bone; fish waste; fatty processing or food wastes.
	Fatty and oily sludges and wastes of animal and vegetable origin	Dewatered grease trap wastes; fatty and oily sludges of animal and vegetable origin.
	Mixed residual waste containing putrescible organic matter	Wastes containing putrescible organic matter, including household domestic waste that is set aside for kerb side collection or delivered by the householder directly to a waste facility, and waste from commerce and industry.

Notes:

1. These classifications are used only to facilitate reference to these groupings of waste (with different potential environmental impacts) in these guidelines and in environment protection licences: they are **not** used in waste legislation.
2. Particular care should be taken if grass clippings are present at more than 15% mass/mass (m/m) in a mixture.
3. Conditions applying to processing and use can be found in *Environmental Guidelines: Use and Disposal of Biosolids Products* (EPA 1997).

Environmental management techniques

The onus is on the occupiers of the facility to select the best mix of techniques for site development and management for their particular location to meet the required environmental objectives. To help environment protection licence applicants with this task, these guidelines provide information on established environmental techniques. (See section 5.) These sample techniques will often need modifying to meet the specific environmental issues of the site.

Appropriate environmental techniques to meet the environmental objectives for any given site should be chosen in the light of three points:

- Management, design and construction techniques will all depend on early decisions on facility location, the selection of the proposed reprocessing technology, and the types of wastes received.
- Not all techniques will be appropriate to a given facility.
- A combination of design and construction, operations management, monitoring and remediation measures is generally required to deal with the range of potential environmental impacts for a given site and facility.

The EPA encourages occupiers to use operational, monitoring or design techniques appropriate to their proposed facility. However, these must meet the environmental objectives, which may require additional measures to prevent unacceptable impacts from occurring.

If the EPA approves environmental techniques other than the sample techniques, these alternative techniques will be set out in the facility's environment protection licence.

Documenting environmental management

Environment protection licences aim to specify environmental outcomes and minimum performance requirements that need to be achieved.

The EPA requires proponents to provide information with their environment protection licence application on their proposed facility in order to understand the likely impacts the facility could have on the environment, and the measures proposed to mitigate those impacts and protect the environment. Details of the information required will be provided when you receive your environment protection licence application form from the EPA.

The EPA encourages the development and use of environmental management plans (EMPs) and environmental management systems (EMSs) because these can be very useful framework documents to assist the operator in detailing the processes, procedures and management practices for their facility. However, because these environmental management plans usually cover issues outside EPA licensing requirements, such as energy and resource conservation, the EPA does not require EMPs or EMSs to be developed as a condition of the licence.

An outline EMP is often required under the integrated development approval process, if your facility needs an EIS. If you need to prepare an outline EMP, it is recommended that it addresses all of the performance requirements and performance measures (including monitoring strategies) in these guidelines. The Appendix contains a complete list of items that could be included in an EMP for composting or related activities.

Planning issues

The *Environmental Planning and Assessment Act 1979* and the *Environmental Planning and Assessment Regulation 2000* require proponents of new facilities to lodge development applications to the appropriate consent authority (usually the local council).

This first part of the process is likely to require the preparation of an environmental impact statement (EIS). The requirements are set out in the Department of Urban Affairs and Planning's *EIS Practice Guideline: Composting and Related Facilities* (DUAP 1996). For applications that involve an EIS, the EPA can require specific information to be included in the EIS.

If the facility requires an environment protection licence from the EPA, under integrated development assessment (IDA) the EPA will be involved in the approval process. The EPA provides general terms of approval (GTAs) to the consent authority and can request further information from the applicant to support the development application. The development consent must incorporate the EPA's general terms of approval. The EPA then must issue its licence to be consistent with the development consent.

It is important that the proponent can demonstrate in the EIS that they can meet the relevant environmental outcomes specified in the guidelines.

Financial provisions and closure plans for the facility during operation or closure

Financial assurance

The facility will need to demonstrate that it has the ability to cover the cost of site remediation when the composting and related organics processing ceases. To determine the appropriate type and amount of financial assurance that may be needed, an independent consultant needs to prepare a well-documented assessment of the potential cost. An independent contractor can then complete the necessary remediation of the site in order to make it suitable for the future use planned for the site.

Under Part 9.4 of the *Protection of the Environment Operations Act 1997,* the EPA can **require** a financial assurance to secure or guarantee funding for remediation or pollution reduction programs from the occupier of a scheduled premises. The EPA (or other appropriate regulatory body) cannot require a financial assurance unless it is satisfied that it is justified with regards to:

- the degree of risk of environmental harm associated with the activities to be carried out
- any site remediation work that may be required because of activities to be carried out under the environment protection licence
- the environmental record of the holder of the environment protection licence
- any other matter referred to in regulations under the Act.

If the EPA invokes this section and requires a financial assurance, it will liaise with the facility to establish the amount and form of the financial guarantee.

Facility closure

Under Section 76 of the *Protection of the Environment Operations Act 1997*, the environment protection licence conditions may require the person who holds the environment protection licence immediately before the facility is to cease operation to submit to the EPA a closure plan before the facility ceases operation. This plan must:

- specify the steps that have been or are to be taken in closing and stabilising the facility, and the time-frame for doing so
- provide for a post-closure monitoring and maintenance program

- identify any proposed future uses of the facility site
- comply with any other specified requirements relating to the plan.

The EPA may approve the submitted closure plan or vary it before approval. To make the closure plan enforceable on the facility after the suspension, revocation or surrender of the environment protection licence under section 81 of the *Protection of the Environment Operations Act 1997*, the notice of suspension, revocation or surrender of environment protection licence will attach a condition requiring the last licensee to comply with the requirements of the closure plan.

2 OVERVIEW OF ENVIRONMENTAL ISSUES

The types and quantities of organic waste received at a reprocessing facility determine the nature of potential pollutants that can be generated and the severity of the potential environmental risks, as well as the quality of the end-products.

Poor environmental management of composting facilities can result in one or more of the following problems:

- release of unpleasant odours
- presence of vermin in excessive numbers
- pollution of surface water, ground water and soil
- excessive releases of greenhouse gases and/or harmful airborne organisms, such as spores of the fungus *Aspergillus fumigatus*
- excessive noise levels from equipment, such as shredders and traffic.

The principal environmental issues of concern to the community and the EPA in relation to composting and related organics processing are water and air pollution, production of contaminated compost, loss of amenity, and potential hazards.

Water pollution

Organic wastes have a tendency to generate leachates that need careful management. Whereas garden, wood and fibrous wastes form leachates only when additional water is introduced, food, meat, fish wastes and fatty or oily sludges usually contain sufficient quantities of moisture to generate leachate without extra water. Leachate generation is at its greatest when the waste contains excessive moisture (for example, when too much rain falls on to the waste); this means that the composting biomass will tend to become anaerobic.

Leachates can be acidic, especially when they are generated under anaerobic conditions. They can cause the dissolution of metals and metallic compounds that may be present in organic wastes. Alkaline leachates can also be formed from wastes with low carbon to nitrogen ratios, such as food and animal wastes under normal aerobic conditions.

Leachates from composting and related organics processing facilities have the potential to pollute ground and surface waters. They are high in nutrients; this makes them favourable host media for bacteria and other micro-organisms and gives them a high biological oxygen demand (BOD).

Surface water run-off from an composting and related organics processing facility can cause, in particular, unacceptable sediment loads in receiving waters, while surface water run-on can lead to excessive generation of leachate.

Air pollution

Composting and related organics processing can cause the atmospheric emission of greenhouse gases, such as methane.

Under aerobic conditions the main gaseous product of composting and mulching is carbon dioxide, and the materials are characterised by an earthy or woody odour.

Under anaerobic conditions—when the biodegrading waste does not receive sufficient air—methane is generated, and this is accompanied invariably by the production of strong and foul odours. These odours are caused by the generation of ammonia, volatile amines (when the degrading material has a high nitrogen content), hydrogen sulfide and volatile organic compounds. These gases can be toxic, although in open-air aerobic composting situations they are not present in high enough concentrations to be considered dangerous.

The presence of foul odours is a good indicator that methane is being produced by the degradation process—that is, that the process has turned anaerobic. The absence of odours does not necessarily indicate that methane is not present: odours may be diminished or removed during diffusion of the biogas mixture through fresh compost, odour scrubbers or soil containing biological organisms, but the odourless methane is unaffected by these processes.

Anaerobic fermentation processes yield methane as the main gaseous product of biodegradation. Unmanaged methane emissions from these processes represent a lost opportunity to recover energy or fuel from such facilities, and uncontrolled emission may also create an explosion risk. It is better to design facilities to use or avoid such emissions rather than to attempt to mitigate their impacts once they occur.

Global warming

In improperly managed composting processes organic materials become anaerobic. In an oxygen poor environment, bacteria that generate methane gas tend to flourish. Methane has more than 20 times the greenhouse warming potential than carbon dioxide, which is the normal by-product of aerobic composting. So poorly managed composting processes can contribute to an increase in global warming.

The well managed composting of organic materials can contribute to a reduction of global warming by keeping these materials out of landfill. Landfills are usually oxygen poor, so methane is generally produced from the decomposition of organic materials in landfills. The capture of methane from landfills, even if it is included during the design phase, is never 100% efficient, so the landfilling of organic materials will always release greenhouse gases into the environment.

Contamination of organic wastes and products

Consistent with the Government's *Green Waste Action Plan*, the EPA advocates source separation of organic wastes **at the point of generation**. By separating organic wastes, generators help to reduce reprocessing costs and improve the quality of the reprocessed organic products delivered to the market.

Poor product quality is an environmental issue as well. This is because contaminated organic materials used in the environment as composts, soil conditioners or mulches can potentially lead to the pollution of surface water and/or soil and/or groundwater and in turn may also pose health risks via the food chain. Such contaminated materials would still be classified as wastes in spite of the processing. In order to produce the highest possible quality and minimise potential environmental and human health impacts and operating costs, it is preferable to process organic materials that are streamed at source and are kept separate from other wastes.

Ample evidence shows that mixing of organic wastes with other wastes in municipal, commercial and industrial waste collections may expose composting facilities' feedstock and their reprocessed products to physical contamination and to irreversible chemical contamination.

Excessive levels of contaminants, pathogens or toxins in the products of composting and related organics processing will degrade their quality and limit or prevent their usefulness. Toxic organic chemicals and metals present in organic wastes can have the following properties and effects:

- The contaminants do not degrade during reprocessing and are, therefore, concentrated in the final products.
- Metals that tend to accumulate (such as cadmium, chromium, copper, mercury, lead, nickel and zinc) can have short-term and/or long-term toxic effects on organisms in the environment.
- Soil contamination by heavy metals can necessitate costly remediation or even require storage of intractably contaminated soil.

- Significant health hazards can arise if contaminated composts are applied to agricultural and residential land and if these chemicals enter the food chain.
- The presence of contaminants can endanger domestic animals, wildlife, plants and other living organisms and may have serious ecological consequences.

Europe and North America have had some negative experiences with post-collection separation systems and mixed waste collection and processing systems involving the composting of unseparated municipal solid waste (de Bertoldi 1998; Barth and Stöppler-Zimmer 1998; Glenn 1998). These experiences have demonstrated that the markets for composts produced by some of these systems can be extremely limited owing to the high level of contaminants present. In many cases, no beneficial use could be found for contaminated composts produced from mixed organic wastes, and they were either stockpiled, used as landfill cover or landfilled.

Physical contaminants, such as shredded plastic and broken glass, also pose problems. Their removal, either at the start or end of the composting process, is expensive. Complete elimination cannot be assured.

Recyclable materials, such as polyethylene terephthalate (PET), glass, high-density polyethylene (HDPE) and other plastics separated from the mixture after processing, will be heavily soiled, perhaps even contaminated. It may no longer be viable to reprocess the mixture. Such contaminated materials are likely to have to go to solid waste class 1 landfills (municipal waste landfills) if they contain or are contaminated with putrescible waste.

Efforts to avoid contamination need to begin with the organic waste collection. Generators and suppliers of wastes to composting facilities need appropriate advice from composting facilities. This includes having agreed material specifications and being aware of on-site management practices.

Reprocessing should also ensure that the organic products meet the quality requirements of end-users. For example, organic wastes that are not fully biodegraded (that is, that have a low carbon to nitrogen ratio) will continue to biodegrade, producing ammonia. Such alkaline conditions can cause temporary soil damage and, therefore, harm to vegetation and other organisms present in the soil.

Processed organic materials (for example, unsatisfactory compost) that do not meet the relevant product quality standards can be reprocessed into high-energy compounds or chemical feedstocks by processes such as anaerobic fermentation. Failing this, the material would remain classified as a waste and would need to be disposed of in a landfill that was either licensed to accept that type of waste or may otherwise lawfully accept it.

Amenity issues, including odour and potential hazards

The potential negative impacts on local amenity from inappropriately managed composting and related organics processing activities include odour, dust, pests, vermin, birds, litter, fire and noise from equipment or traffic. These impacts may occur on and off-site.

The most common issue is the release of foul odours from the anaerobic biodegradation processes occurring in putrescible organic wastes.

3 GUIDELINES FOR MEETING ENVIRONMENTAL OBJECTIVES

Facility environmental management revolves around the facility occupier finding answers to five fundamental questions:

1. What are the key environmental issues associated with the facility?
2. What is the required level of environmental performance for these issues?
3. What environmental controls are proposed to address these issues to the required level of environmental performance?
4. How can these controls be monitored to achieve the required level of environmental performance?
5. What remedial action is proposed should the monitoring show the controls not to be meeting the required level of environmental performance?

In relation to question 1, 10 key environmental issues have been identified for composting and related organics processing facilities and are described below. Composting and related organics processing facilities should work to achieve the objectives for each issue. EPA environment protection licences will be developed to ensure that these issues are effectively managed.

Each environmental issue has three parts:

1. an **objective,** which describes the desired environmental outcome
2. **performance requirements**, which describe what is necessary to satisfy the objective
3. **performance measures,** which describe ways of measuring the performance requirements to see whether the objective is being achieved.

The performance requirements address question 2 above, and the performance measures address question 4 and in some circumstances question 5. The choice of environmental controls (question 3) is not mandated, but is left up to the occupier to determine on the basis of the specific circumstances of the facility.

Issue 1: Water pollution

Objective

Prevent water pollution. Surface or underground discharges of leachate and water from the facility must not pollute ground water and/or surface waters.

Performance requirements

Surface water. For some facilities the most probable surface water emission from the facility is suspended sediment from exposed areas. In such cases the occupier should use the design and operating requirements of the NSW Department of Housing guideline *Managing Urban Stormwater: Soils and Construction* (NSW Department of Housing 1998), also known as the 'blue book', to prevent pollution. For large exposed facilities the occupier is encouraged to contact the EPA regarding the application of the Department of Housing guideline to their particular facility.

At facilities where surface water emissions are likely to contain dissolved contaminants, suitable management systems for leachate and waste water should be designed to ensure that discharges to surface waters are avoided. Each system should be designed to meet the performance criteria negotiated with the EPA. Options for waste water and leachate management include on-site reuse, evaporation and discharge to sewer.

For sites where these options are not possible, stringent quality and discharge conditions are likely to be attached to the environment protection licence. Where such licensed discharges occur, discharge limits on the environment protection licence will be negotiated on a site-by-site basis. These negotiations will take into account the nature of the waste water, the available treatment options and the available ambient water quality and flow objectives, such as the *Water Quality and River Flow Interim Environmental Objectives* for that catchment. (Copies of the *Water Quality and River Flow Interim Environmental Objectives* for each catchment can be obtained from the EPA internet site on www.epa.gov.au/ieo/index.html or by calling the EPA pollution line on 151 555.)

Ground water. The occupier must assess the vulnerability of the ground water underneath and adjacent to the facility, and if necessary must install appropriate systems to prevent groundwater pollution.

Unless it has been established that the facility poses minimal risk to the ground water, the occupier must monitor the ground water. Monitoring results should compare the quality of the ground water down-gradient from the facility and at a representative background point(s) located up-gradient from the facility. If statistically significant variations are detected, action must be undertaken to restore the groundwater quality. Facilities will need to nominate representative indicators for this monitoring, based on the contaminants found in the leachate from the facility.

Performance measures

Water monitoring data assessment. When the operation of a facility results in a statistically significant (90% confidence level) change in the value of one or more indicator values at a monitoring point, the occupier will need to investigate and remedy the causes of the changes, unless the environment protection licence permits such changes. Occupiers must notify the EPA if any of the above changes are confirmed to a statistically more significant (95% confidence level) in the ensuing investigation.

The appropriate methods contained in the EPA's *Approved Methods for Sampling and Analysis of Water Pollutants in NSW* (EPA 1998) must be used for sampling or analysing surface water or ground water, unless the EPA has approved other methods.

Issue 2: Methane gas emissions and explosion hazards

Objective

Minimise emissions of methane to air and ground and the risk of explosions.

Performance requirement

Facilities must avoid generating methane in aerobic processes. In anaerobic fermentation processes, facilities must collect and use all the methane or chemicals produced. In all processes, methane concentration levels must be below 1.25% volume/volume (v/v) inside buildings, within the facility's boundary, and outside the facility.

Performance measure

Biogas monitoring devices used to establish methane emission concentrations must be capable of quantifying methane at concentrations of 0.5% volume/volume (v/v) to ± 0.1% (v/v).

Issue 3: Emissions of nitrogen oxide and non-methane organic compounds

Objective

Minimise emissions of nitrogen oxides and non-methane organic compounds whenever using biogas combustion processes.

Performance requirement

If a facility is proposing to use gas flare or electricity-generating equipment, the air quality impact assessment should demonstrate that the facility will not be the cause of extra exceedances of the following ambient air quality goals (taking into account existing background concentrations in addition to the incremental increase in impacts caused by the facility):

- one-hour average maximum ground level NO_2 concentration of 0.12 ppm, and
- annual average reading NO_2 concentration of 0.03 ppm.

Gas flare or electricity-generating equipment must ensure a non-methane organic compound (NMOC) destruction efficiency of at least 98%.

Exhaust gas emission concentrations must comply with the limits prescribed in the Clean Air (Plant and Equipment) Regulation 1997. However, if the facility uses internal combustion engines to generate electricity, it must also comply with an NO_x (as NO_2) exhaust gas emission concentration limit of 1.12 g/kW/h (1.5 g/brake horsepower/h) under all operating conditions.

If the electricity-generating capacity exceeds 12 MW at any one site, the facility may need to carry out a photochemical smog impact assessment. The EPA often seeks such assessments in support of EISs, environment protection licence applications or pollution reduction programs.

Performance measure

The EPA's preferred dispersion models, AUSPLUME or ISCST3, should be applied as part of the air quality impact assessment to support EISs, environment protection licence applications or pollution reduction programs. Other dispersion models may be substituted, but facilities must demonstrate that the selected model performs as well as or better than the preferred models for a specific application.

Annual emission testing will determine the NMOC destruction efficiency and the NO_x emissions to determine compliance with the exhaust-gas emission concentration limits. The EPA sets these limits for all scheduled activities as prescribed by the Clean Air (Plant and Equipment) Regulation 1997 or by specific environment protection licence conditions. To determine compliance exhaust gas emission concentration limits, facilities should use the methods for sampling and analysis in *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (EPA 1999b).

Issue 4: Odour

Objective

Minimise odour emissions.

Performance requirement

Irrespective of whether an composting and related organics processing facility is sited in an industrial, rural or residential area, the following odour design criteria should be applied at the nearest off-site sensitive receptor:

- The predicted incremental increase in odour level at the nearest off-site sensitive receptor located in a residential area should not exceed the background odour levels by more than 2 odour units (50% recognition) (the recognition threshold).
- The predicted incremental increase in odour level at the nearest off-site sensitive receptor located in an industrial or rural area should not exceed the background odour levels by more than 7 odour units (50% recognition) (recognition threshold).

An averaging period of nose-response time (approximately one second) must be complied with 99% of the time, using site-representative, hourly average meteorological data covering at least one year. (A sensitive receptor is any location where people are likely to work or reside. These include residential dwellings, schools, hospitals, offices and public recreation areas.)

Section 129 of the POEO Act makes it clear that scheduled activities must not cause the emission of offensive odours. However, the Act does allow the EPA to provide a defence for the emission of offensive odours via licence conditions, provided such conditions are directed at minimising the odours.

The EPA will consider providing such odour defence conditions only where a licensee provides sufficient justification that offensive odour emissions cannot be prevented despite the use of best management practices, and after all practicable control options and avenues have been exhausted.

The Act defines offensive odours as: '**Offensive odour** means an odour:

(a) that, by reason of its strength, nature, duration, character or quality, or the time at which it is emitted, or any other circumstances:

  (i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or

  (ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a strength, nature, duration, character or quality prescribed by the regulations or that is emitted at a time, or in other circumstances, prescribed by the regulations.'

Any application to the EPA for an odour defence condition would need to be supported by the following information:

- verification that the offensive odour is generated from within the premises
- the circumstances under which the offensive odours are emitted
- a description of the strength, nature, character or quantity of the offensive odour
- details of any community complaints about odours from the premises
- any practicable measures that have been adopted or could be adopted to prevent or minimise the offensive odour
- any ongoing investigations that could be undertaken to assess options for reducing the offensive odour

The EPA will review requests for a defence against offensive odours on a case-by-case basis.

Performance measures

To predict the likely incremental increase in odour impacts, the EPA proposes that facilities follow these methodologies.

- Odour emissions should be sampled and measured by the methods prescribed in the EPA's *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (EPA 1999b).
- The EPA's preferred dispersion models, the Victorian EPA's AUSPLUME or the USEPA's Industrial Source Complex Short Term Version 3 (ISCST3), should be used to undertake an air

quality impact assessment to support an EIS, a environment protection licence application, or a pollution reduction program. Other dispersion models may be substituted for AUSPLUME or ISCST3. However, the facility must show that the selected model performs as well as or better than the preferred models for a specific application.

- Facilities should use hourly average, site-representative meteorological data covering at least one year to determine the statistical compliance with the odour design criteria described above.
- A 'screening' level odour impact assessment should use 'synthetic' worst-case meteorological data.
- For refined odour impact assessments, a facility should use at least one year's site-specific meteorological data. A one-year site-specific data set must be correlated against a longer duration, site-representative, meteorological database of at least five years (preferably consecutive).
- If site-specific meteorological data are not available for a refined odour impact assessment, the EPA requires the use of at least one year's site-representative meteorological data. A one-year site-representative data set must be correlated against a longer duration, site-representative meteorological database of at least five years (consecutive preferable).
- Conversion of one-hour average dispersion model predictions to nose-response-time peak odour concentrations should be carried out using peak-to-mean ratios prescribed by the EPA.
- The reference methods for odour level determination are either:

  —Draft Australian Standard Air Quality–Determination of Odour Concentration by Dynamic Olfactometry (unpublished), or

  —*European Standard—Air Quality—Determination of Odour Concentration by Dynamic Olfactometry* (CEN—European Standard for Standardisation 1997).

Note: The EPA has recently released drafts of an odour policy and supporting technical notes for all types of facilities in NSW, and when this policy is finalised the composting guidelines will be updated to be consistent with the final odour policy.

Issue 5: Suitability of incoming organic waste

Objective

Ensure that incoming organic wastes do not have negative environmental or amenity impacts.

Performance requirement

Facilities must ensure that they receive only those classes of waste that are suitable for both the reprocessing techniques and the environmental controls available there. They must receive only the classes of organic waste set out in their licenses. (See Table 1.)

Facilities must not receive the following categories of organic wastes:

- materials seized by the Australian Quarantine Inspection Service, or NSW Agriculture, or agricultural agencies from other States or Territories
- any organic wastes containing contaminants classified as **hazardous wastes** or **industrial wastes** in any statutory instruments. (See: *Protection of the Environment Operations Act 1997* and *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (EPA 1999a).
- organic waste that is contaminated by industrial chemicals and/or pathogens that will not be rendered harmless by the process or that may constitute a health or environmental risk, including clinical waste and other related wastes of clinical origin and diseased carcasses.

Performance measure

The EPA will assess compliance with the performance requirement by the presence in the storage, preparation and reprocessing areas, within the bounds of due diligence, of only those types of suitable organic waste that belong to the classes of waste specified on the facility's environment protection licence.

Issue 6: Environmental quality of reprocessed products and stabilised wastes

Objective

Ensure that the output of products from the facility can be beneficially and sustainably used, and that any stabilised wastes are suitable for disposal at the facility that receives the waste.

Performance requirement

The occupier must ensure that:

- reprocessed organic products that are intended to be used as a compost, soil conditioner or mulch must meet the physical, chemical and biological requirements specified in section 4 of these guidelines in order to be classified as a reprocessed material, and
- materials that do not meet the requirements of section 4 may:
  - —be applied to land at facilities that hold environment protection licences or that may otherwise lawfully receive such wastes, or
  - —be sent to premises (for example, landfills and reprocessing facilities) that are licensed to accept or may otherwise lawfully accept that type of waste following the assessment and classification of such waste materials in accordance with section 3 and Technical Appendix 1 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines; EPA 1999a).

Performance measure

The occupier of the facility must be able to demonstrate by means of laboratory test results retained at the facility that:

- products classified as non-waste reprocessed products meet all of the requirements of section 4 of these guidelines for beneficial land application, or
- waste products meet the requirements for lawful application or disposal at the premises to which they have been sent.

Issue 7: Safe storage and disposal of residual wastes and contaminated materials

Objective

Ensure that process residues and contaminated products are stored appropriately and disposed of lawfully.

Performance requirement

The facility must securely store all contaminated products, wastes, materials and process residues that cannot be beneficially reprocessed at the facility, until they can be lawfully disposed of at the facility or transferred to another facility.

Contaminated products and residues must be classified or assessed in accordance with the Waste Guidelines before being sent to waste facilities that are licensed to receive them or to premises that may otherwise lawfully receive them.

For wastes classified or assessed as hazardous waste, industrial waste or Group A waste, the facility occupier must comply with the waste-tracking requirements of the environment protection licence.

Performance measure

Compliance is measured by the following criteria:

- There are no contaminated wastes, materials or residues outside the secure storage areas provided for them at the facility.
- There is documented evidence that the facility has lawfully disposed of any contaminated products or residues that it has generated.

Issue 8: Noise

Objective

Minimise noise emissions.

Performance requirement

The noise generated during the operation of the facility must be managed so that the requirements of the NSW Industrial Noise Policy (EPA 2000a) are met.

Performance measure

The site-specific noise level determined for a particular facility will depend on the receiver's land-use type, the existing background and ambient noise levels, and the nature, level and characteristics of the source noise. The general objectives of the NSW Industrial Noise Policy are that:

- the existing acoustical environment should be measured in accordance with the policy
- a site-specific noise level should be determined from either the intrusive criteria or amenity criteria for the site, whichever is the more stringent
- any prediction of the characteristics of the noise source should include an assessment of tones, impulses and other annoying characteristics where they occur, and should take into account any adverse weather conditions
- reasonable and feasible mitigation measures should be proposed where impacts are identified
- negotiations should be initiated if unresolved impacts are identified.

The NSW Industrial Noise Policy must be consulted for further details on noise limits and treatment.

Issue 9: Dust

Objective

Minimise dust emissions from the facility.

Performance requirement

Dust deposition criteria. The facility should be designed and operated so that the maximum increase over the background dust deposition levels, caused by the facility and its operations, conforms with the limits in Table 2. These limits are an annual mean value of the total solids at the most affected sensitive receptors, and do not generally apply within the boundaries of the facility.

Table 2. Dust deposition criteria (total solids)

Existing dust level g/m^2/month (annual average)	Maximum acceptable increase over existing dust level g/m^2/month (annual average)	
	Residential suburban	Other areas
2	2	2
3	1	2
4	0	1

Facility planning. Dust deposition criteria should be used to determine whether a proposed development is likely to have an adverse dust impact. Approaches for assessing the potential dust impacts of a proposed facility are as follows.

- Background dust deposition monitoring is conducted to determine the existing dust deposition levels.
- Dust emissions are estimated by the appropriate application of emission factors.
- Dispersion modelling is conducted to determine the increase in dust deposition over the existing background levels.
- The predicted increase in dust deposition is added to the existing background levels and compared with the appropriate criteria.

Facility operation. Dust deposition criteria should be used to help evaluate the effectiveness of dust controls at a facility. However, as it is not generally possible to determine accurately the relative contribution of a source to the measured dust deposition rates (that is, from the premises concerned, a nearby premises, or elevated background levels), it is not appropriate to use the dust deposition criteria as enforceable limits on environment protection licences or approvals.

Nevertheless, it can be useful to operate a background-monitoring site that is not affected by dust emissions from the premises. Such a site can be used to determine whether elevated background levels (rather than impacts from the premises) are the major contributors to any exceedances of the criteria.

Monitoring results should be reported against dust deposition criteria and should be used as triggers for further investigation. Use the following approach:

- Monitoring results are compared against the appropriate criteria.
- Any exceedances of the criteria at nearby sensitive receptors are identified.
- The causes of any exceedances are investigated and reported.
- Actions are identified and implemented to ensure that impacts will be minimised in the future.

Performance measure

In general, monitoring sites should be selected to reflect the dust deposition rates at nearby sensitive receptors. Monitoring sites should be selected according to *Australian Standard AS2922–1987 Ambient Air—Guide for Siting of Sampling Units* (Standards Association of Australia 1987).

Dust deposition monitoring and analysis should be conducted according to *Australian Standard AS3580.10.1–1991 Deposited Matter—Gravimetric Method* (Standards Association of Australia 1991).

Issue 10: Litter

Objective

Control litter and site materials effectively and keep them on site.

Performance requirement

Following a period of windy weather, the facility occupier must clean up wind-blown litter on and near the facility as soon as practicable (preferably within one working day). Vehicles that leave the facility must not distribute mud, litter or site materials outside the facility.

Performance measure

Compliance is measured by:

- absence of mud and other types of dirt, wastes and litter being carried by vehicles from the facility that could be deposited on roads outside the facility and on nearby streets
- inspection of the facility and nearby areas to confirm that effective steps are being taken to keep the facility free of litter, as shown by the absence of wind-blown litter and site materials within one working day after windy weather.

4 PRODUCT QUALITY STANDARDS FOR REPROCESSED ORGANIC WASTES

Legislative framework

This section describes what a facility must do to demonstrate that it has reprocessed organic waste to a standard that makes it acceptable to apply to land without an environment protection licence.

Product quality standards

A comparison between the specifications for composts made with biosolids and composts made without biosolids is shown later in this chapter in Figure 1.

Composts and other non-waste products (made without *any* biosolids content)

Standards have been developed for composts and other reprocessed organic materials produced from wastes without any biosolids content. These are similar to the standards established for biosolids and are in part taken from the 'Unrestricted Use' and 'Restricted Use 1' criteria in the Biosolids Guidelines. The requirements for composts and other products made without any biosolids content are set out below in Tables 3 (physical, chemical and biological requirements), 4 (contaminant acceptance concentration thresholds) and 5 (stabilisation grade criteria).

The management options for products that do not satisfy the requirements in Tables 3, 4 and 5 are set out at the end of this section.

Table 3 lists the physical, chemical and biological requirements for composts, soil conditioners and mulches.

Table 3. Physical, chemical and biological requirements for composts, soil conditioners and mulches

Type of permitted beneficial use	Allowable *contaminant acceptance concentration thresholds*[1] in products	Allowable *stabilisation grade*[2, 3] in products	Minimum moisture content[4]	Maximum content of contaminants[4]: glass, metal and hard plastics > 2 mm (on a dry weight basis)	Maximum content of contaminants[4]: plastic film > 5 mm (on a dry weight basis)
Unrestricted Use	Grade A	Grade A	25% (minimum)	0.5% (maximum)	0.05% (maximum)
All uses except home lawns and gardens	Grades A & B	Grade A	25% (minimum)	0 .5% (maximum)	0.05% (maximum)

Notes:

1. Refer to Table 4.
2. Refer to Table 5. Note that stabilisation involves reductions in the levels of both pathogens and vector attraction.
3. For test methods refer to *Environmental Guidelines: Use and Disposal of Biosolids Products* (EPA 1997).
4. For test methods refer to Appendix H of *Australian Standard AS4454–1999*: *Composts, Soil Conditioners and Mulches* (Standards Australia 1999).

Table 4 shows the contaminant acceptance concentration thresholds referred to in Table 3.

Table 4. Contaminant acceptance concentration thresholds

Contaminant	**Grade A**[2] **(mg/kg)**[4]	**Grade B**[3] **(mg/kg)**[4]
	Note: contaminant acceptance concentrations are **not** mean values (Refer to Schedule 2 in reference[1])	
Arsenic	20	20
Cadmium	3	5
Chromium (total)	100	250
Copper	100	375
Lead	150	150
Mercury	1	4
Nickel	60	125
Selenium	5	8
Zinc	200	700
DDT/DDD/DDE[5]	0.5	0.5
Aldrin	0.02	0.2
Dieldrin	0.02	0.2
Chlordane	0.02	0.2
Heptachlor	0.02	0.2
Hexachlorobenzene (HCB)	0.02	0.2
Lindane	0.02	0.2
Benzene hexachloride (BHC)	0.02	0.2
PCBs	ND[6]	0.3

Notes:

1. Source: *Environmental Guidelines: Use and Disposal of Biosolids Products* (EPA 1997)
2. The Grade A threshold for cadmium is under review and will be revised. Subject to the outcome of this review, the standard for cadmium would be revised and would then become the same as the maximum allowable soil concentration for agricultural land, *viz* 1 mg/kg.
3. The Grade B threshold levels are under review and will be revised in two years.
4. Values are expressed on a dry weight basis.
5. Value of each contaminant should be less than the value indicated.
6. No detected PCBs at a limit of detection of 0.2 mg PCBs/kg product.

Table 5 shows the stabilisation grade criteria referred to in Table 3.

Table 5. Stabilisation of composts, soil conditioners and mulches[1]

Pathogen reduction process	Vector attraction reduction requirements
For Stabilisation Grade A:	
1. For composting and mulching processes with a temperature of at least 50°C, the time temperature requirement is: $D = (131{,}700{,}000)/(10^{0.14t})$ Where: D = time required in days t = temperature in °C This option includes: • pasteurisation at 70°C for 30 minutes • composting at 55°C for 3 consecutive days 2. For other processes, consult the Biosolids Guidelines[1].	1. Mass of volatile solids in the organic waste or biosolids must be reduced by a minimum of 38%, or 2. Specific oxygen uptake for organic waste or biosolids treated by an aerobic process must be less than 1.5 mg O_2 /h/g total solids at 20°C, or 3. Treated in an aerobic process for at least 14 days, during which time the temperature of the material must be > 40°C and the average temperature > 45°C, or 4. For other processes, consult the Biosolids Guidelines[1].
Note: 1. Source (adapted from): *Environmental Guidelines: Use and Disposal of Biosolids Products* (EPA 1997).	

Reprocessed material containing biosolids

The *Environmental Guidelines: Use and Disposal of Biosolids Products* (Biosolids Guidelines: EPA 1997) establish minimum product quality and application guidelines for products produced from or containing biosolids (so-called 'biosolids products'). Materials containing biosolids are **not** covered by the product quality criteria in these guidelines and are subject to the criteria in the Biosolids Guidelines.

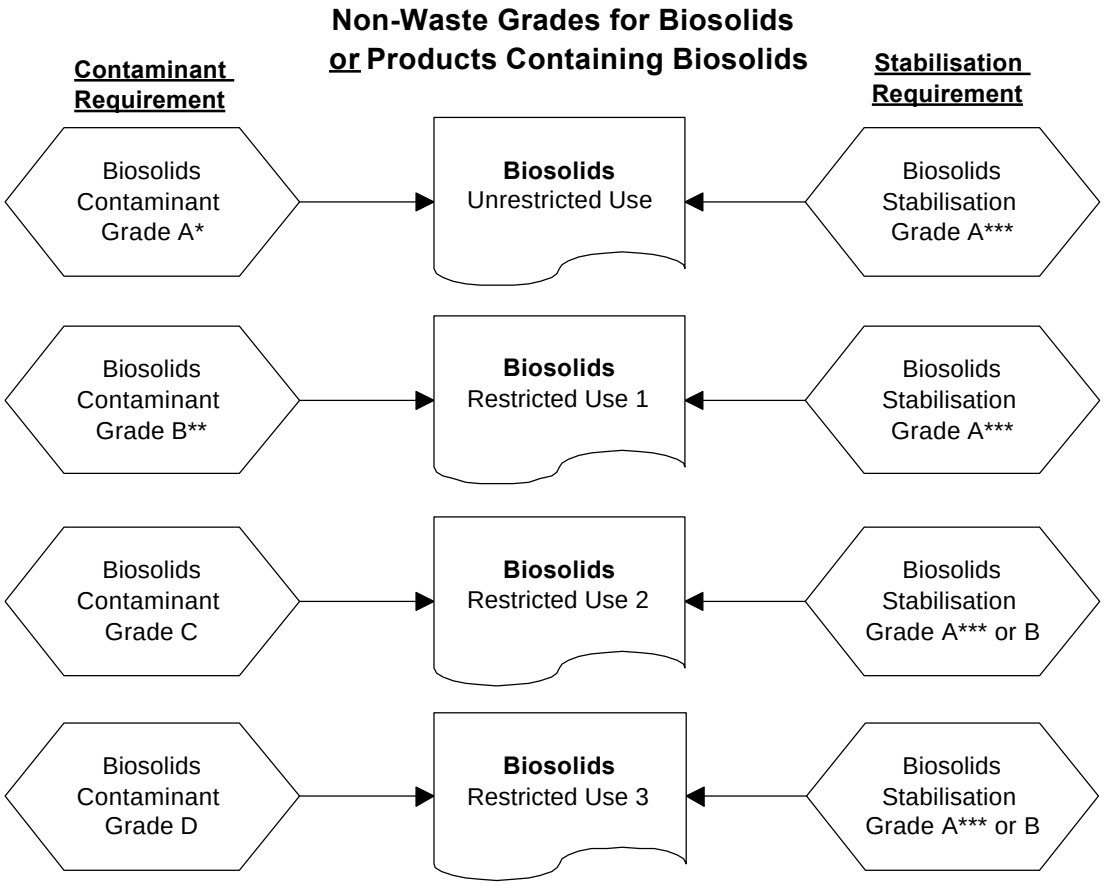
Under the provisions specified in the Biosolids Guidelines, reprocessed materials containing biosolids ('biosolids products') may, depending on their classification, be (in accordance with the provisions in those guidelines):

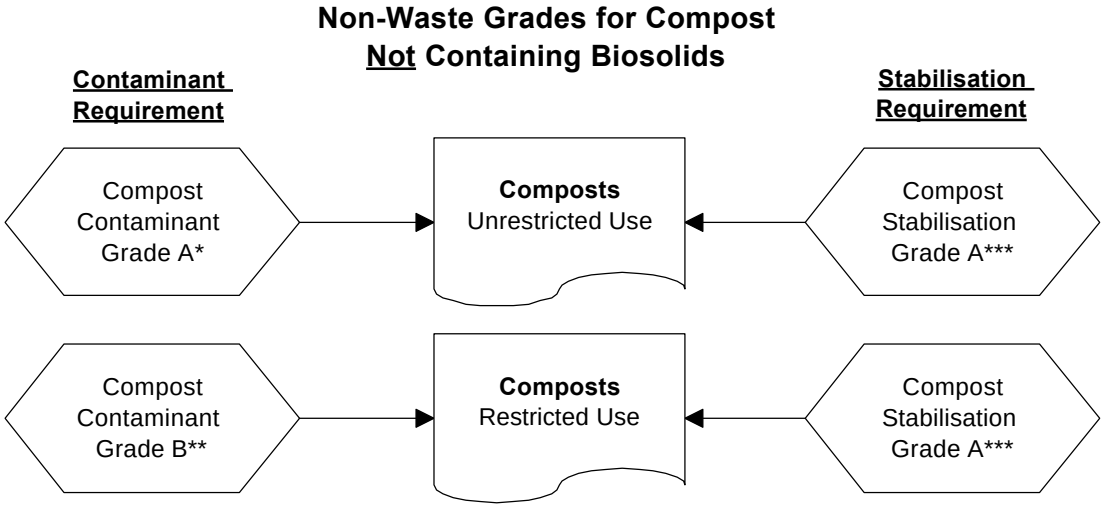
- used domestically without restriction (Unrestricted Use)
- used on public contact sites and for urban landscaping (Restricted Use 1)
- applied to land for agricultural and forestry purposes (Restricted Use 2)
- used for soil and site rehabilitation purposes (Restricted Use 3), or
- disposed of on site without a environment protection licence or to a landfill under an environment protection licence (Unsuitable for Use).

Provided that organic materials containing biosolids meet the requirements of the Biosolids Guidelines, they will be regarded as non-waste products under the *Protection of the Environment Operations Act 1997.*

A comparison between the specifications for composts made with biosolids and composts made without biosolids is shown in Figure 1.

Figure 1. Comparison of classifications of biosolids and compost





Notes:

* Requirements for Biosolids Contaminant Grade A are the same as for Compost Contaminant Grade A

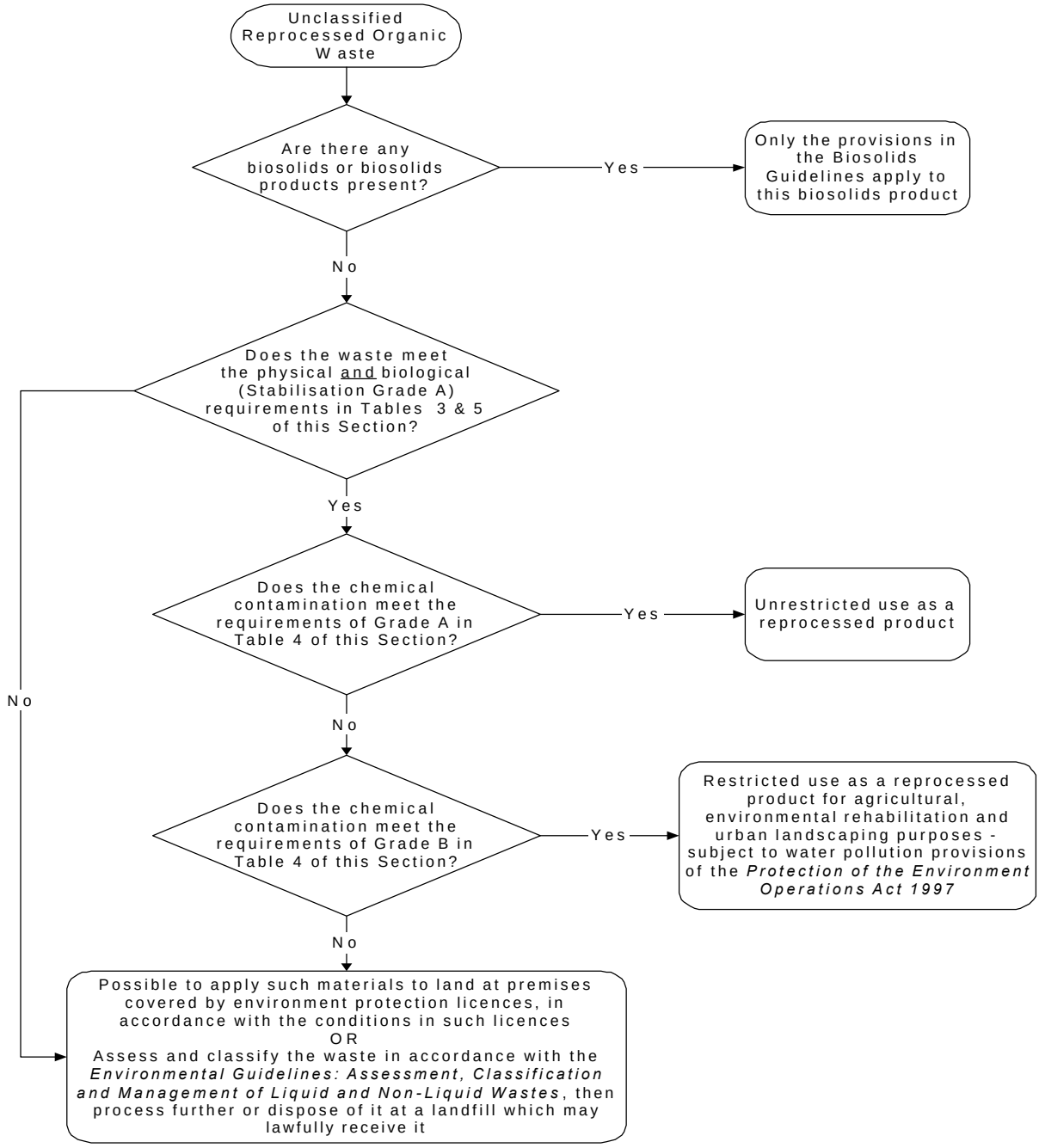
** Requirements for Biosolids Contaminant Grade B are the same as for Compost Contaminant Grade B

*** Requirements for Biosolids Stabilisation Grade A are the same as for Compost Stabilisation Grade A

Management options for reprocessed material not satisfying prescribed standards

If a facility is producing products that do not meet the requirements set out above, it is still possible to apply such materials to land at premises covered by environment protection licences and in accordance with the conditions in such licences. Otherwise, the occupier must assess and classify the processed wastes as specified in section 3 and Technical Appendix 1 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (EPA 1999a) and send them to a waste facility that is licensed to receive those wastes or that may otherwise lawfully receive them. Figure 2 outlines how reprocessed organic waste should be classified and managed.

Figure 2. Classification and management of reprocessed organic waste



5 PROVEN TECHNIQUES FOR DEALING WITH ENVIRONMENTAL ISSUES

The techniques set out here have been shown to be effective in dealing with the environmental issues identified in Part 3. They are not necessarily required for licensing, but the EPA recommends that you use them as a basis for developing operational controls to suit your own facility. Some of them are specific to open-air composting of organic wastes by windrowing or static pile methodologies. Although open-air composting methodologies tend to require the most intensive environmental management, their management is well documented. By contrast, many different types of proprietary enclosed or in-vessel reprocessing methodologies are available with environmental controls supplied as part of the package. Such technologies are not well documented in publicly available technical literature, as they form part of the intellectual property purchased from the supplier.

Issue 1: Water pollution

Each facility should develop an integrated strategy for water monitoring, assessment and remediation that enables the occupier to detect any water pollution from the premises and to take appropriate action to prevent pollution of waters. This section sets out a number of components that the occupier can place in this program. As a minimum, water quality should be monitored regularly to ensure that any pollution of waters under or near the facility is detected early.

Location and design of monitoring wells

The parameters for establishing an effective groundwater and subsoil monitoring network should generally include:

- If only one thin (less than 5 m thick) aquifer is identified on site, then single, fully slotted bores are sufficiently reliable indicator bores for pollutants. If multiple aquifers are identified on site, or an aquifer of a thickness greater than 5 m is identified, the monitoring bores should be:
  —a nest of bores, slotted over different intervals, or
  —a multi-port bore, or
  —an appropriate combination of both.
- A minimum of one monitoring bore per aquifer located down the hydraulic gradient from the reprocessing area is needed for adequate monitoring. It is advisable, however, to locate one monitoring bore per aquifer up the hydraulic gradient from the processing area in order to be able to establish whether any change in water quality detected down-gradient has been caused during the passage of the water under the processing area.
- Monitoring bores should generally have a minimum internal diameter of 50 mm and adequate sampling ports.
- The selected monitoring bore design should include pipe of suitable strength with slotted sections, gravel packed and with adequate cement/bentonite seals between the sections. The standpipe should be adequately sealed near ground level with cement-based grout, and the top of the standpipe should be covered by a security cover. The standpipe should be constructed in such a way to prevent the ingress of surface water and to prevent extraneous material (such as insects) from getting into the well.
- Make sure the porous media surrounding the monitoring bores and the lysimeter cup are composed of material that does not affect the composition of the sample.
- For installation and well maintenance, follow the standard references such as:
  —*Handbook: Groundwater. Volume II: Methodology* (USEPA 1991)
  —*Guidelines for Groundwater Monitoring at Municipal Landfill Sites* (Hirschberg K-J 1993)

—*Minimum Construction Requirements for Water Bores in Australia* (ARMCANZ 1997).

- Your water management strategy should clearly identify the number of wells, the drilling method, the material used in well construction, and the procedures used for well development and well security. The quality system established for the facility should be applied to the establishment and operation of the groundwater monitoring system.
- Groundwater monitoring may include the installation of suction lysimeters to monitor the vadose zone beneath the composting and related organics processing facility and at suitable locations surrounding the facility when there is no evidence of ground water. A suction lysimeter is used to extract pore water when ground water is absent. These devices will indicate the presence and quality of leachate in the geological formation.

Water monitoring

Your water-monitoring strategy should be effective in monitoring and reporting of ground water and surface water characteristics and early detection and reporting of possible pollution of ground water and/or surface water.

A comprehensive hydrological investigation of both the site and the surrounding groundwater regime will or should have been conducted before site establishment. The technique used should take into consideration the Department of Urban Affairs and Planning's *EIS Practice Guideline: Composting and Related Facilities* (DUAP 1996). The groundwater flow and flow pathways for all aquifers on site should be identified with a high degree of certainty in the water monitoring program.

A minimum of one monitoring point per surface water body located downstream from (for flowing or perennial waters) or near (for still waters) the reprocessing area is needed for adequate monitoring. It is advisable, however, to locate one reference monitoring point per surface waterbody—upstream (for flowing waters) or distant (for still waters) from the processing area—in order to be able to establish whether any detectable change in water quality has been caused by the reprocessing activities.

The water-monitoring strategy should generally include:

- a plan of the proposed location and depth of the groundwater monitoring wells for all aquifers that are placed at risk by the composting and related organics processing activities. This plan should be supported by adequate documentation outlining the groundwater hydraulics. When it is not possible to locate hydraulically up-gradient wells, there will be a need to have a sufficient number of samples taken at compliance-point wells before composting and related organics processing activities start, in order to characterise the background characteristics of the ground water.
- a plan of the monitoring points for all surface waterbodies that are placed at risk by the composting and related organics processing activities. This plan should be supported by adequate documentation outlining surface water dynamics. When it is not possible to locate reference monitoring points, before composting and related organics processing activities start you will need to have enough samples taken at compliance points to characterise the background characteristics of the surface water before composting and related organics processing activities start.

The indicator parameters recommended for routine monitoring of waters are listed under the 'Water pollution remediation strategy' heading below. Indicators of all water-soluble inorganic compounds used as feedstock amendments (such as fertilisers) should be monitored specifically. On the basis of the water assessment of the site, occupiers may vary the indicators chosen. In the water management strategy, include justification of why you have selected the indicator parameters. The strategy should give details of how the limits for the specific indicators adopted will provide an indication of all the possible types of pollution that may occur. The regular monitoring of electrical conductivity (sometimes written as EC) may be used for preliminary indication of changes in water

quality. This is because EC is a measure of the ability of water to conduct an electric current and is sensitive to variations in dissolved solids, mostly mineral salts. Increases in the measured values of EC for waterbodies are often good warnings that pollution events may have occurred and that a more detailed investigation of the values of the abovementioned indicator parameters should be undertaken. Any increases in values of these indicators will be taken as evidence that leachate has been in contact with ground water, and that a water assessment program should be implemented.

Generally, all groundwater detection monitoring wells, lysimeters and surface-water monitoring points should be sampled quarterly by a suitably qualified person. This frequency can be relaxed if it can be demonstrated that there are no seasonal effects after data have been collected for five consecutive years.

Water samples should be taken, preserved and analysed in accordance with the appropriate procedure outlined in *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (EPA 1998)*.

Use statistical procedures for all analytical results in order to determine whether there has been a significant change in concentration for the indicator parameters. Analysis of variance or other suitable statistical techniques, as outlined in the water management strategy, can be used to perform this assessment. For a discussion of the statistical analysis of groundwater data see *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities* (USEPA 1989). The occupier may need expert help in order to obtain reliable water monitoring data and/or to interpret it correctly. Helpful information concerning water quality investigation can also be found in *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (EPA 1998).

Assessment of water monitoring results

If water monitoring detects a possible failure of the leachate containment system, an investigation should be established to determine the extent of that failure.

If the sampling of groundwater monitoring bores and/or lysimeters or surface-water monitoring points indicates levels for any chosen indicator exceeding the limits specified in the water management strategy, the affected groundwater monitoring bores and/or lysimeters or surface water bodies should be resampled as soon as possible.

Note that if the anomaly is verified in resampling:

- the EPA should be notified immediately by phone and in writing within 14 days of verification of the increase in levels of the water pollutant indicator, or as specified in the environment protection licence
- within 28 days of the notification or as specified in the environment protection licence, the applicant should prepare a water assessment plan that identifies the specific contaminants and extent of the pollution to the water
- the water assessment plan should include submission to the EPA of a list of proposed analytes for the evaluation, and a monitoring program for sampling the groundwater wells, lysimeters or surface waterbodies
- the list of analytes should be based on the detection of monitoring variations and the contaminant content of the leachate, and would need to be supported by a justification for the selection of analytes
- the information obtained during this assessment should be used to prepare a water pollution remediation strategy.

Water pollution remediation strategy

A water pollution remediation strategy should be developed if groundwater, surface water or subsoil pollution is confirmed in the water assessment strategy or identified by external monitoring. The water pollution remediation strategy should identify why the pollution occurred, describe the

process to be used to protect the water resource from further pollution, and assess practicable ways of returning the water to the original quality. The strategy should also consider identification and remediation of contaminated sediments, where relevant.

Occupiers of composting and related organics processing facilities should be aware that the costs associated with groundwater remediation are significant and the remediation work may take several years.

Note that if water pollution is detected, the facility occupier should take immediate action to contain the pollution. They must report the incident to the EPA in accordance with the EPA environment protection licence conditions, giving details of the nature and source of the pollution, any actions taken, and any future actions that will be carried out to prevent recurrence. If the EPA directs the future actions, these must be commenced as soon as practicable.

The following indicator parameters may be used in identifying and assessing the clean-up of pollution incidents:

- alkalinity, ammonia, calcium, chloride, fluoride, iron, magnesium, manganese, nitrate, organochlorine pesticides, organophosphate pesticides, pH, total phenolics, polycyclic aromatic hydrocarbons, potassium, sodium, sulfate and total organic carbon (TOC).

When you are sampling and analysing you should use the appropriate methods in *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (EPA 1998), unless the EPA specifies other methods in the environment protection licence.

Working surfaces

Active composting surfaces, material and compost storage areas and associated access roads should be constructed to minimise leachate pollution and to allow all-weather access to any utilised part of the reprocessing site for any required vehicles or plant.

The working surfaces, including the incoming material storage areas, the active composting pad (for open composting) and the compost storage area should:

- be curbed and graded sufficiently to prevent both run-on and run-off
- contain one or more catch basins capable of collecting all leachate generated from the design 1-in-10-year storm event without overflowing
- be designed and constructed from an inert low-permeability material such as compacted clay, modified soil, asphalt or concrete over a compacted base able to support the load of material on it, and any machinery used in the composting facility, without sustained damage.

Working surfaces made from such materials should be able to support all structures, machinery and vehicles as applicable and allow access to any utilised part of the reprocessing site, irrespective of the weather conditions. Vehicles may include:

- transport vehicles used for the delivery of organic waste and the transport of finished products
- mobile equipment used in all phases of all the processes operated on the site
- fire-fighting vehicles and equipment.

Access is especially important for machinery used in moving feedstock material and in the turning and aeration of material in the 'active state', since in wet weather the chances of materials becoming anaerobic and the likelihood of serious odour emissions are very high.

It should be noted that 'active state' in the above paragraph means undergoing or capable of undergoing rapid biological decomposition; it usually means that the material is emitting or is capable of emitting heat in the presence of an adequate supply of oxygen and moisture.

Leachate barrier

It is possible that the working surfaces of the site or building, together with the leachate drainage and collection system, will act as an adequate leachate barrier, so that a separate leachate barrier may not be required. In such a situation, you should clearly document in the water management strategy the reason for not fitting a separate leachate barrier.

A specially designed leachate barrier may be required for processes that:

- process Class 2 and 3 wastes, and/or
- are operated in troughs, trenches or pits that are below ground level, and/or
- are set up on a terrain of highly permeable soil, and/or
- are set up over or near vulnerable ground water and/or surface resource(s) requiring protection. Where the Department of Land and Water Conservation has prepared groundwater vulnerability maps, the areas of concern are those mapped 'high' or 'very high' vulnerability.

When fitted, a barrier system should be designed to prevent the pollution by leachate of ground, ground water and surface waters over the period of time that raw materials or products remain on the site.

Since the collected leachate is usually rich in nutrients, the recommended practice is to recover these nutrients by using the leachate for the wetting of new organic waste material or actively composting organic material that requires the additional moisture.

In-vessel facilities should incorporate features to allow for the drainage and removal of leachate.

The recommended technique for a leachate barrier is a liner system that forms a secure barrier between the ground water, soil and substrata and the composting waste.

The design requirements for a leachate barrier depend upon the head of liquid (leachate) acting upon it. The basis of the design adopted for the leachate barrier should be documented in the water management strategy. Presented below are the characteristics of a leachate barrier that has been found to be suitable for some overseas composting facilities:

- a clay or modified soil liner consisting of at least 600 mm of recompacted clay with an in-situ permeability (K) of less than 10^{-7} ms^{-1}. Placed in successive layers up to 300 mm uncompacted thickness, they should be of compatible material and each underlying layer should be scoured to prevent excessive permeability due to laminations.
- a concrete or asphalt cement pad of a thickness of at least 100 mm, designed to withstand the loads from all machines, vehicles and equipment that are required to operate the facility.

Leachate drainage and collection

All leachate drainage in excess of the absorbent capacity of the degrading biomass and/or curing materials and/or cured products should be allowed to drain readily in a manner that avoids the generation of strong odours and methane. This liquid should be collected in a leachate collection system and prevented from escaping from the composting and related organics processing facility into ground water, surface water or subsoil.

The leachate collection system should be designed and installed in accordance with the quality requirements specified in the appropriate standards.

Acceptable techniques include:

- conducting all feedstock storage, active composting and mature compost storage on a specially prepared low-permeability pad. (See 'Working surfaces' and 'Leachate barrier' in this section.)
- installing a drainage layer underneath the composting material to provide adequate leachate drainage from composting material. This may consist of a bed of coarse material such as wood

chips, or alternatively the processing platform may permanently incorporate a drainage layer designed to withstand the loading, working and removal of compost.

- for small-scale facilities or facilities in drier areas, incorporating absorbent material in compost and at the base of the pile
- running windrows down a minimum slope of 1% to allow for free drainage of leachate to a collection drain
- shaping the piles and windrows to maximise run-off and hence reduce infiltration
- enclosing leachate drains to reduce the emission of odours.

Leachate storage

Leachate should be collected and stored in either a dam that is lined or in above-ground storage tanks. Above-ground tanks are the preferred option for leachate storage, and they should be surrounded by a bund with a capacity of 110% or greater than that of the tanks within the bund.

Leachate dams or tanks should have high-level alarms that are interlocked to the discharge pump or line, so that they cannot be overfilled. If the leachate dam or tanks are open at the top, they should generally be capable of accepting the run-off or leachate generated by any 1-in-10-year storm event without overflowing.

Characteristics of a suitable leachate-dam liner include:

- a clay or modified soil liner consisting of at least 90 cm of recompacted clay with an in-situ permeability (K) of less than 10^{-9} ms^{-1}. Successive layers should be of compatible material, and each underlying layer should be scoured to prevent excessive permeability due to laminations. The sides should generally have a slope not exceeding a gradient of one vertical to three horizontal, in order to allow suitable compaction of the barrier and to facilitate subsequent testing.
- If the leachate dam is located in an area of poor hydrological conditions or otherwise poses a significant potential threat to surface or ground waters, the clay or modified soil liner should be overlaid with a flexible membrane liner (FML) of permeability (K) for water of less than 10^{-14} ms^{-1}. The FML will have material properties that will ensure that it can maintain this permeability for a period at least equivalent to the desired working life of the leachate dam. The FML should have a minimum thickness of 1.5 mm and should be laid following procedures in an approved construction quality assurance program. All joins and repairs should be fully tested to ensure liner integrity is not breached at these locations, and the FML should be protected against load-induced damage.

Leachate monitoring

A leachate monitoring strategy is needed to assess the effect leachate may have if it is recirculated in an composting and related organics processing facility, irrigated on the surface of an composting and related organics processing facility, stored, or treated on site.

Leachate needs to be tested before it is released to disposal. The analysis should be conducted in accordance with the provisions in the water management strategy. (There will be individual requirements in relation to the concentration of pollutants, depending on the site's soil chemistry and specific operating conditions.)

Initial characterisation testing should be conducted for aromatics, volatiles, halocarbons, and the base, neutral and acid extractable organic contaminants that could be detected by Methods 8260 and 8270 (USEPA 1992). Ongoing quarterly or batch testing of a representative sample for all contaminants is recommended.

Surface water controls

Surface water controls should be implemented in order to prevent any surface water from mixing with the waste, and to prevent any sediment or pollutants from being carried off the composting and related organics processing facility.

In order to avoid the generation of excessive leachate or the erosion of organic waste, material being processed, or reprocessed material from the composting and related organics processing facility, the surface water controls should generally conform to the following principles:

- the facility should be designed to prevent surface water from mixing with the organic waste, the materials being processed and the final products
- all water that has entered processing and storage areas and water that has been contaminated by leachate should be handled and treated in the same manner as leachate
- all surface water that has been collected from cleared or non-vegetated surfaces should be treated in accordance with *Managing Urban Stormwater: Soils and Construction* (NSW Department of Housing 1998)
- exposed areas at the composting and related organics processing facility site should be minimised; only the minimum area needed should be cleared.

An effective surface-water monitoring strategy should be able to demonstrate that surface water is not being polluted by run-off from the facility.

A surveyed monitoring point should be established at all of the facility's discharge locations, upstream and downstream, and in the receiving waters. Procedures for obtaining a representative sample should be outlined in the water management strategy.

Quarterly sampling is recommended when surface water is present. Tests should be conducted with a representative sample for all the indicators selected for the groundwater monitoring strategy. Testing should also be conducted for total suspended solids. This sampling and analysis strategy should use the same quality controls as those used in the groundwater monitoring strategy.

Issue 2: Methane gas emissions and explosion hazards

For **composting (aerobic) processes**, subsurface diffusion of biogas generated as an unwanted by-product during composting and related organics processing can be reduced by the good barrier properties of an effective compost pad and leachate barrier system. Such containment is especially important for processes that are operated in troughs, trenches or pits that are below ground level. Another technique for preventing subsurface diffusion is to construct slightly raised processing platforms or surfaces. No additional containment is required if an adequate aeration program is maintained whilst the material is in an active state of decomposition.

For **fermentation (anaerobic) processes,** the applicant should be able to demonstrate that adequate measures are in place for the containment, extraction and treatment of any biogas (or odour) that is generated. The requirements for containment will depend greatly on the design of the overall process.

Gas monitoring

If there is a likelihood of **subsurface biogas** migration, a subsurface biogas monitoring strategy should be implemented to demonstrate that biogas is not migrating off the site. Gas monitoring wells would need to be installed around the perimeter of either the site or the reprocessing area where biogas is generated. They should be placed to the depth of the minimum groundwater level; to the greatest depth of the fermenting organic material; or 10 metres below underground utilities or manholes within 50 metres of the composting and related organics processing facility—whichever is the greatest. These wells need to be placed at intervals that are small enough for potential off-site migration to be detected.

The spacing and design of these wells will need to be determined by a site investigation, and the details given in the gas management strategy. If the occupier's site investigation identifies distinct lithological units that could act as conduits for biogas, either multiport wells that can monitor the distinct lithological units separately, or separate wells for every distinct unit, will need to be installed.

If specified in the environment protection licence, well construction details should be submitted to the EPA for approval before installation of wells. Generally the EPA will require individual slotted probes with bentonite seals between monitoring zones, with the monitoring zones backfilled with pea gravel to facilitate movement of gas.

The occupier should conduct quarterly monitoring. If methane above 1.25% v/v was detected in a site perimeter-monitoring well, then the EPA would have to be notified as specified in the environment protection licence, and the frequency of monitoring would need to be increased. Procedures for sampling should include the flushing of one probe casing volume before the reading is taken.

Where biogas odours are of concern, the hydrogen sulfide (H_2S) gas concentration will also need to be measured under non-oxidising conditions as a precaution.

The testing should be conducted in situ with a properly maintained, zeroed and calibrated field instrument.

If there is a likelihood of the presence of **surface biogas**, a surface-biogas-monitoring program should be implemented to demonstrate that biogas is not creating a hazard.

Estimates of surface gas concentration can be achieved by testing the atmosphere 5 cm above the ground surface near areas where composting material is in the active state. A field technician would start at a point 5 metres from the perimeter of the organic waste material processing area. Readings should be taken 5 metres from the perimeter and around the entire boundary of the organic waste processing area. This monitoring should be performed on calm days (winds below 10 kilometres per hour).

This monitoring should be conducted monthly with a zeroed and calibrated methane gas detector. The threshold concentration for closer investigation and action is 500 parts per million (v/v) of methane at any point on the composting and related organics processing facility surface. Corrective action is needed if this threshold is exceeded.

If there is a likelihood of the presence of methane, monitoring should be able to confirm that methane is not accumulating in buildings and posing a danger of explosion.

Areas and buildings identified in the gas management strategy as having the potential to have methane concentrations of greater than 1.25% in the soil subsurface should be tested on a monthly frequency with a tested and calibrated methane detector. If any buildings are to be built within this area they should be designed not to accumulate methane gas.

Buildings should not have gas concentrations exceeding 1.25% (v/v) methane. If methane is detected above this threshold, daily testing is recommended until ventilation or other measures control the methane build-up.

Uncontrolled gas emission remediation strategy

A gas emission remediation strategy should be prepared and implemented in the event of detection of uncontrolled gas emissions.

The EPA should be notified as specified on the environment protection licence if methane is detected at concentrations greater than 1.25% (v/v) in the soil surface or subsurface or in building monitoring.

This notification should be followed within 14 days of the incident by a written assessment of the emissions and the management controls that are to be implemented or proposed to be implemented to prevent further emissions, or as specified in the environment protection licence.

Gas containment and extraction

An active gas containment and extraction system is recommended for composting and related organics processing facilities where:

- fermentation (anaerobic) processes are operated, and/or
- building monitoring or perimeter-well testing shows methane concentrations exceeding 1.25% (v/v), and other remediation measures have been found to be ineffective.

The best practice for handling any liquid that is condensed from the biogas is to treat it in the same manner as leachate, with the exception that it should not be spray irrigated because of its odour potential and low pH.

Issue 3: Emissions of nitrogen oxide and non-methane organic compounds

Biogas contains a large number of non-methane organic compounds (NMOC). Many of these compounds are toxic air contaminants that occur in the parts per million by volume (ppmv) concentration range or are highly odorous. When gas is extracted from within a fermentation vessel, care should be taken so that these gases are appropriately treated and not allowed to escape to the atmosphere.

The most common way of treating biogas is by oxidation, preferably with energy recovery. This energy recovery may be through the direct recovery of the calorific value of the biogas, the transmission of the cleaned gas through a gas distribution network, or the generation and sale of electricity. The EPA does not have any preferred energy recovery option, but leaves this decision to the site occupier.

Issue 4: Odour

Open-air compost facilities have the potential to generate significant odour impacts if they are not operated correctly. The main causes of odour generation from these facilities are (according to the Washington State Department of Ecology 1997):

- a porosity of less than 35% in the compost pile, inhibiting air circulation
- moisture levels greater than 60% in the compost pile, eliminating adequate free airspace
- initial carbon to nitrogen ratio (C:N) below 25:1, promoting ammonia volatilisation
- compost pile pH greater than 7.5, promoting hydrogen sulfide and mercaptan generation
- compost pile oxygen concentration below 16%, promoting volatile organic formation.

The measures described below deal largely with the controls needed to prevent these undesirable operating conditions and to store compost feedstock in a way that reduces odours.

Enclosed facilities, whether aerobic or anaerobic, are usually constructed with odour control equipment that is designed to treat the odours to acceptable levels (outlined in section 3, objective 4) before the gases are released to the atmosphere. However, the techniques described below are also applicable to enclosed facilities, since these facilities have to consider siting issues and often incorporate an open windrow 'maturation' phase after enclosed processing.

Another potential source of odour at composting and related organics processing facilities is the leachate storage area, especially when the leachate is allowed to become anaerobic. For leachate

storage tanks the extraction and treatment of odour is possible, but for ponds the use of aerators may be required to mix the ponds and keep them aerobic.

Location of the facility

The EPA recommends that composting works be located away from residences or other sensitive receptors. Unless they are designed, maintained and operated correctly, they can cause dust and odour nuisance. The impacts and necessary odour management approaches will depend upon:

- the size of the composting area
- the nature of the materials to be composted
- the composting technology employed
- whether the composting process is enclosed or open-air
- whether odour removal technology is employed
- the estimated odour emission rate
- the topography of the site
- the direction and frequency of winds.

If calm conditions are likely to occur frequently, drainage flows can have a profound effect on the dispersion of odours, the extent and intensity of odours and, consequently, the number of complaints. Calm conditions are most likely to occur in the morning and evening. Locations likely to cause least dispersion are those that have a predictable air drainage flow and no sea or other winds to disturb the stable wind conditions. In this regard, the worst times of the year for odour dispersion are likely to be late autumn and winter.

Site-specific meteorological data should be collected for a period of not less than 12 months. The parameters that need to be measured and electronically logged are wind speed, wind direction, ambient temperature and those parameters needed to determine the Pasquill-Gifford stability class—that is, either sigma theta or solar radiation and ambient temperature at two levels (2 metres and 10 metres). The meteorological station should be sited and operated in accordance with the methods prescribed in *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (EPA 1999). If specified in the environment protection licence, details of the proposed air quality monitoring should be submitted to the EPA for approval.

AUSPLUME, ISCST3 or any other approved dispersion computer-modelling package may be used to determine appropriate buffer distances for composting and related organics processing facilities.

Odour problems can arise when waste materials that are highly biodegradable are not treated appropriately and when improper gas management techniques are employed.

The following best practice measures may be applied in addition to those related to biogas emissions and process control:

- Enclosed storage and reprocessing facilities should be used, and there should be immediate attention to odorous organic waste loads. This will minimise the transmission of odours off site.
- Rapidly biodegradable organic waste material should be covered, and the amount of such material exposed to the atmosphere should be kept to a minimum. Rapidly biodegradable waste materials include grass clippings, food and animal wastes and organic sludges.
- Rapidly biodegradable waste materials of food and animal origin should be stored in moisture- and vermin-proof bins that are designed and constructed to resist the action of organic acids and facilitate washing. These bins should be located on a concrete- or bitumen-sealed and bunded washdown apron that is:

  —connected to the leachate collection system

  —protected to prevent the infiltration of rain into the leachate collection system.

- Composting and related organics processing facilities that have been identified by an odour dispersion modelling investigation (as required by Department of Urban Affairs and Planning siting criteria; DUAP 1996) as having a potential odour impact on neighbours should install and operate a meteorological station in accordance with AS 2923-1987 *Ambient Air—Guide for Measurement of Horizontal Wind for Air Quality Applications* (Standards Association of Australia 1987b) or later editions. This station should monitor and log at 10-minute averages the:

  —wind speed and direction

  —sigma theta (standard deviation of the horizontal fluctuation in the wind direction)

  —air temperature.
- Records of complaints about odours should be kept, and they should be correlated with weather conditions and deliveries of unusual wastes.

Managing storage times for feedstock

The storage times of organic waste feedstock should be controlled to avoid emissions of offensive odours.

Rapidly biodegradable organic wastes, such as grass clippings and food and animal wastes, may already be giving off odours when they are received; if not, they can start to do so soon after receipt.

If possible, rapidly degradable wastes should be prepared into processing feedstock as soon as they are received, or no later than by the end of the day of receipt. Biosolids should, however, be handled as specified in the *Environmental Guidelines: Use and Disposal of Biosolids Products* (EPA 1997).

If the more rapidly biodegradable wastes such as biosolids cannot be put into the process as soon as they are received at the site, they should be placed into either enclosed storage containers or sheds fitted with exhaust air purifiers, or covered with a 15-centimetre-thick layer of compost that is in the curing stage.

Other vegetation, natural fibrous material and wood materials may be stored for longer periods than the more rapidly biodegradable wastes. However, they should not be stored for more than 2 months unless adequate procedures are in place to control the threat of fire (See section 5, Other considerations) and vermin (See section 5, Other considerations). The storage limits specified in the environment protection licence must not be exceeded.

Covering of organic wastes

When rapidly biodegradable organic waste materials are in an 'active state' during open-air handling and/or processing, they should be covered in order to reduce odour emissions.

If open-air processing techniques are used, it has been found to be very useful to cover the piles or windrows with a 15-centimetre-thick layer of freshly made compost that is in the curing stage. The micro-organisms that are present in the fresh compost are able to reduce odour emissions by converting them to less volatile substances.

The covering affords other benefits by protecting the composting material from:

- losing too much valuable heat and moisture
- getting too wet in the event of rainfall.

Covering also makes it more difficult for vermin and vectors to get to the raw organic material.

The use of fresh compost in the curing stage or mulch as a cover material also has the following benefits:

- limits run-on and infiltration of water

- controls and minimises the risk of fire
- minimises emission of biogas
- reduces fly propagation and rodent attraction
- decreases litter generation.

The best source of this covering material is the previous batch of compost or mulch prepared in the same area.

Selection and mixing of ingredients for processing feedstock

Organic wastes and mixtures of wastes subjected to reprocessing in **non-enclosed** facilities should have a minimum angle of repose of 5 degrees and no free liquids.

Any liquid or semi-liquid amendments should be mixed with sufficient quantities of absorbent organic materials, such as sawdust or wood shavings or paper pulp, so that the resulting mixture meets the criteria for non-liquid wastes—that is, it should have a minimum angle of repose of 5 degrees and no free liquids. The resulting mixture should also have the appropriate carbon to nitrogen ratio for the intended biodegradation process. Note that the thorough mixing of components will enable biodegradation to take place more efficiently and, therefore, with a lower likelihood of odour problems.

The combinations of ingredients chosen for the feedstock used in composting processes should give efficient biodegradation of the organic wastes present, while minimising the emission of odours and greenhouse gases during the process.

The most commonly recommended values for the carbon to nitrogen (C:N) ratio for effective biodegradation are in the range of 25:1 to 30:1. Very few organic waste materials have C:N ratios that are in this range and, therefore, the common advice is to make mixtures for which the overall C:N ratios fall into this range. Organic waste materials with C:N ratios significantly outside the recommended range that are allowed to degrade are prone to give rise to significantly worse atmospheric emissions than those attained during normal controlled composting.

Note, however, that large pieces of ligneous material, such as wood pieces or chips, do not degrade much during the active period of composting. Therefore, when such material is present in significant quantities, overall C:N ratios of 40 or higher have been found to be advisable in order to have the carbon to nitrogen ratio of the actively degrading biomass in the desired range.

Food and animal waste materials, as well as fresh grass, have low C:N ratios. If they not mixed with high C:N materials for biodegradation, ammonia gas and odorous amines will be produced until the C:N ratio finally rises to a level at which the more beneficial types of processes take over. Also, such materials usually contain too much water, which limits the availability of oxygen; anaerobic processes tend to occur, leading to the release of methane and bad odours.

Wood and natural fibre materials (for example, paper) have very high C:N ratios. This leads not only to much slower degradation, but also to the loss of carbon as carbon dioxide and heat until the C:N ratio is right for the beneficial composting processes to take over. It may require several microbial cycles before the beneficial processes begin to take place at a substantial rate.

The presence of adequate amounts of water is crucial for beneficial degradation processes, but the presence of too much water leads to undesirable anaerobic reactions, as mentioned above. Water-absorbent and biodegradable additives (feedstock amendments or bulking agents) such as wood shavings, sawdust and paper pulp are used to get the moisture content of wet materials into the range of 50% to 65% (by weight). Such amendments or bulking agents can degrade without problems, even when their moisture content is as high as 75% to 85% (by weight).

Nitrogen-rich organic wastes, such as food waste, are good sources of additional nitrogen in the composting of high C:N materials such as garden wastes, and it is better to use them than inorganic fertilisers such as ammonium nitrate or phosphate.

Oxygen is a critical ingredient that can quickly get exhausted in rapidly degrading materials (in the 'active state'). (See below.)

Mixing and aeration

Steps should be taken to make sure composting materials in the active state have an adequate supply of oxygen. Biodegrading material in the active state is characterised by high levels of oxygen demand, which means that the internal oxygen levels can rapidly fall below what is optimum for the wellbeing of the aerobic organisms present. When the oxygen level drops too far, anaerobic organisms begin to predominate, resulting in undesirable odour and methane production.

It is important, therefore, to take steps to ensure that adequate oxygen levels are maintained either by a program of forced ventilation, or by turning or mixing the composting material at regular intervals. Portable equipment with long probes that can measure oxygen levels and temperature deep within composting material are recommended for monitoring oxygen levels in order to establish when turning is required. Turning or mixing also has the benefit of affording some cooling to the composting mix; cooling may be needed if the temperature starts to climb above 60°C to 65°C.

Issue 5: Suitability of incoming organic waste

The receipt and use of unsuitable waste may lead to product quality problems in the case of contaminated waste or to processing problems in the case of the wrong types of waste.

Best practice to avoid problems consists of:

- advising generators and transporters of the types of organic waste that the facility is prepared or licensed to accept and those that it will not
- being sure that facility staff can identify the different classes and categories of organic waste and also the potential outward signs of unacceptable contamination
- operating a comprehensive incoming materials inspection procedure before, during and after waste unloading
- implementing a random incoming materials sampling and testing protocol.

Remember that it is possible for a relatively small quantity of contaminated waste to ruin the quality of a much larger amount of product, owing to the mixing that occurs during processing and subsequent handling.

If a new waste type is to be accepted at a facility and the potential of the waste to produce odours or leachate during processing or the quality of the final product is unknown, a trial processing of the waste type is recommended. Areas that should be addressed in this trial are:

- collecting a representative sample of the waste to be processed
- determining the environmental impacts (such as leachate and odour) arising from the unprocessed waste and the processing of the waste
- putting into place operating procedures to control these environmental impacts
- assessing the quality of the compost generated from the waste.

If the new waste type is not among those permitted to be received on the environment protection licence, approval from the EPA must be obtained before the trial. The application for approval should include documentation on how the above issues will be addressed during the trial.

Issue 6: Environmental quality of reprocessed products and stabilised wastes

Destruction or inactivation of harmful organisms

The reprocessing conditions should be able to ensure a satisfactory reduction in the levels of human, animal and plant pathogens and the inactivation of noxious weeds, weed seeds and propagable shoots. The product should not contain harmful biodegradable contaminants. Products should meet the requirements of *Australian Standard AS 4454–1999: Composts, Soil Conditioners and Mulches* (Standards Australia 1999).

The times required to pasteurise the products depend on the mixing regime used and the prevailing temperatures attained in the biodegrading matter. The *Best Practice Guidelines for Composting Systems* in Appendix K of AS4454–1999 recommend pasteurisation regimes for the various types of processes that are currently being used. These regimes can be used as a guide to achieving a successful outcome.

The Standard describes the pasteurisation criteria to be achieved. For products that are derived from biosolids or organic waste mixtures with biosolids, the requirements laid down in *Environmental Guidelines: Use and Disposal of Biosolids Products* (EPA 1997) (including amendment, EPA 2000b) also apply.

Only materials that meet these pasteurisation requirements should be sold or used for soil amendment purposes.

Issue 7: Safe storage and disposal of residual wastes and contaminated materials

Contaminated products or waste-materials and process residues should not be stockpiled because they can:

- have negative impacts on the environment at or near the facility and disturb local amenity
- contaminate material in the process and/or the finished product.

Any plan for the handling of such contaminated wastes should indicate the maximum amounts intended to be stored and how they are going to be stored securely before disposal.

Contaminated products and residues that meet the acceptance criteria for waste as defined in *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (EPA 1999a) and *Environmental Guidelines: Solid Waste Landfills* (EPA 1996) can be disposed of in landfills that are licensed to accept them.

Consult the EPA or the relevant EPA guidelines for information on the treatment and/or disposal of waste that does not meet the above criteria for landfilling.

Whenever feasible, recyclable materials should be transported to appropriate collection centres or to recycling facilities.

Issue 8: Noise

Acceptable noise attenuation measures include siting noise-sensitive land uses away from the development, erecting acoustical barriers, treating equipment acoustically and limiting hours of operation. Particular attention should be paid to the design of items such as speed humps and vibration grids to prevent noise generation. Guidance on noise control techniques can be found in the *NSW Industrial Noise Policy* (EPA 2000a) , and in engineering noise control texts.

Issue 9: Dust

Dust controls should minimise the amounts of pollutants leaving the site as airborne dust, reduce the stormwater sediment load, and protect the local amenity.

The following best practice measures can be used to minimise generation of dust:

- Construct sealed or gravel roads from the public roadway to the gatehouse or waste reception section of the composting and related organics processing facility.
- Spray water to suppress dust on unsealed roads. Additional dust suppression methods may be required in areas with fine soils and in dry or windy conditions.

Issue 10: Litter

The local amenity should not be degraded by litter emanating from composting and related organics processing activities.

Wind-blown litter is a nuisance to the community, and can be controlled by the following techniques:

- The occupier should introduce procedures that prevent the unnecessary proliferation of litter. They should also consider the use of litter fences, and be responsible for ensuring that all wind-blown litter that leaves the site is retrieved.
- Clear all fences and gates of litter, preferably on a daily basis or as required.
- Exit signs need to advise transport operators and private vehicle drivers that they can be fined for any litter on public roads resulting from improper transport of wastes or materials.
- All litter that leaves the site should be retrieved on a daily basis.

Cleaning of vehicles

The occupier should ensure that vehicles leaving the reprocessing site do not track loose mud and litter outside the facility.

Vehicles that use composting and related organics processing facilities may inadvertently collect mud and litter on their wheels while on the site. It is essential that this be removed before the vehicle leaves the site, in order to minimise effects on both the local amenity and the quality of stormwater run-off.

The site occupier should provide a wheel washing or wheel cleaning facility for use by all vehicles. The site occupier is responsible for deciding what cleaning method is appropriate, considering the site traffic and local road conditions. Hand-held pressure-washing hoses, drive-through immersion bunds and vibration grids are all options that may suit different operations.

The site occupier should provide a truck body and tray cleaning and disinfecting facility for use by open-body vehicles delivering rapidly degradable (Classes 2 and 3) wastes. The site occupier is responsible for deciding what cleaning method is appropriate.

The reprocessing facility occupier should display signs advising all vehicle operators that it is the vehicle operator's responsibility to ensure that the remnants of their load or the waste stuck to the underside of the vehicle or the wheels does not litter public roads.

It is the responsibility of the facility occupier to keep access roads to the facility free of dirt and litter from customers and other facility users.

Other considerations

Select an appropriate site

Judicious location of the reprocessing site is, perhaps, the most effective way of dealing with the potential negative impacts on local amenity. Careful design and selection of process components and equipment, as well as good operating techniques, procedures and staff training, are other important ways of avoiding amenity problems.

An appropriate separation distance from any work or storage area of the site to the nearest residence, public building or business is crucial. The most suitable buffer distance will, however, depend on:

- the nature of the organic waste being reprocessed
- the nature of the processes being operated on the site
- the type of equipment, buildings and protective structures on the site
- the level of expertise and training of staff operating the processes
- the intensity of the around-the-clock supervision of the processes
- the prevailing meteorological conditions at the site.

Table 6 identifies the areas that are considered to be inappropriate by DUAP for composting and related organics processing facilities because of their environmental sensitivity. This list is not exhaustive, as an EIS-based assessment may indicate other inappropriate areas.

To ensure the environmental protection of these areas, and to provide certainty to developers seeking sites for composting and related organics processing facilities, the Department of Urban Affairs and Planning recommends in their *EIS Practice Guideline: Composting and Related Facilities* (DUAP 1996) that:

> proponents ensure that areas included in the Table [Table 6 here] are excluded from consideration for an composting and related organics processing facility early in the site selection process.

The DUAP guidelines also set out the steps to be taken in selecting an appropriate site, with heavy emphasis on conducting appropriate geological, hydrogeological, topographic and meteorological evaluations to establish the appropriateness of a site.

Schedule 3 of the Environmental Planning and Assessment Regulation 1994 requires an EIS for a number of designated developments. Clause 49, in particular, is relevant to composting and related organics processing.

The community has the opportunity to make inputs into the site assessment process irrespective of whether the plans are for a designated development or not:

- for designated development the community is able to make comments after the DA (Development Application and EIS) has been lodged, as specified within Part 4 of the *Environmental Planning and Assessment Act 1979*
- for facilities not requiring an EIS but still requiring planning consent, the consent authority should consider Section 90 of the *Environmental Planning and Assessment Act 1979* when determining the application. Although there is no formal requirement for the exhibition of such proposals, the consent authority may treat them as advertised development. This will provide opportunity for public notification and input into such proposals.

Consult *EIS Practice Guideline: Composting and Related Facilities* (DUAP 1996) for further details.

Table 6. List of environmentally inappropriate areas for composting and related organics processing facilities (from *EIS Practice Guideline: Composting and Related Facilities*, DUAP 1996, Table 1)

Area	Objective
A site located within an area of significant environmental or conservation value identified under relevant legislation or a planning instrument, including: • National Parks • historic and heritage areas, buildings or sites • any reserves for environmental protection, for example, aquatic, marine, nature, karsts • areas covered by a Conservation Agreement • Wilderness Areas identified or declared under the *Wilderness Act 1987* • other areas protected under the *National Parks and Wildlife Act 1974* • World Heritage Areas • areas on the Register of the National Estate • SEPP 14 wetlands, REP 20 wetlands, SEPP 26 Littoral Rainforests • areas zoned under an LEP or REP for environmental protection purposes, for example, high scenic, scientific, cultural or natural heritage.	To avoid the risk of damaging areas of high environmental value
Sites within an identified drinking water catchment (surface water or groundwater), for example, any lands nominated as 'Special or Protected Areas' by local water supply authorities (such as Sydney Water, Hunter Water, Council) or in the vicinity of a groundwater bore used as drinking water.	To avoid the risk of polluting drinking water
Sites located in an area overlying an aquifer that contains drinking-water-quality ground water that is vulnerable to pollution. (Consult DLWC for criteria to determine the vulnerability of ground water.)	To protect groundwater and surface water resources
Sites where the substrata are prone to landslip or subsidence.	To avoid sites that may have unsuitable substrata
Sites on floodplains that may be subject to washout during major flood events. (Consult councils for information about local flooding characteristics.)	To avoid washout risk if a significant flood event occurs

Select appropriate processing equipment

Processing equipment should be appropriate for the types and quantities of organic wastes that are to be processed. Occupiers of composting and related organics processing facilities should be able to demonstrate that they are minimising the levels of contaminants, such as heavy metals, other chemicals and inert contaminants, in the final products.

It is much easier to prevent atmospheric emissions in the early stages of the biodegradation processes when automated in-vessel bioreactors or enclosed areas fitted with exhaust air bio-filters or purifiers are used, rather than when the more simple and traditional open-air methods such as the turned pile, aerated static pile and windrow (with or without aeration) are used.

Nevertheless, it has been demonstrated using open-air methods of aerobic biodegradation (composting) that it is possible to avoid odorous emissions when processing the more difficult types of organic wastes. The process controls are, however, more demanding and labour intensive than for in-vessel processes.

In selecting a suitable processing system or methodology for the early stages of biological processing, consider:

- the type, nature and quantities of organic wastes to be reprocessed

- the anticipated levels of contaminants, pathogens, weeds, weed seeds and propagable shoots in the feedstock
- the location of the facility with respect to population and sensitive areas
- the ability of the occupier to monitor and maintain appropriate process conditions seven days a week all year round (mainly for rapidly biodegradable waste processing)
- the choice between:
  —higher up-front investment costs together with lower labour costs, or
  —lower up-front investment costs coupled with higher labour costs
- the desired time lapse between receipt of wastes and reaching the curing stage in the products
- the desired levels of quality and consistency in the products
- the projected revenues from the sale of the products and fees charged for acceptance of wastes.

In-vessel facilities have the advantage of being faster and more likely to produce a consistent and well-pasteurised product (while keeping odour impacts to a minimum) than the other available processes. There are a significant number of manufacturers and suppliers of in-vessel composting systems. For helpful guidance on selection criteria as well as a comparison with other methods of composting, see the following two publications:

- *Guidelines for Composting in Australia—Return it to the Earth* (Denlay 1993)
- *The Biocycle Guide to the Art and Science of Composting*, The JG Press Inc, Emmaus, Pennsylvania 1991.

For reprocessing Class 1 waste materials, the simpler open-air methods for composting have generally been found to be satisfactory, provided that the materials being processed (especially grass clippings, weeds and leaves) are not allowed to become anaerobic.

For reprocessing Class 2 waste materials, the likelihood of odorous emissions is much greater, although open-air methods for composting have been found to be satisfactory with adequate feedstock preparation and operating controls. For this reason, if the applicant intended to use an open-air facility to compost Class 2 waste materials, they would need to demonstrate clearly at the planning and community consultation stage that the location, design and operating methodology of the facility would prevent odorous emissions and the degradation of the local amenity.

For reprocessing Class 3 waste materials the likelihood of odorous emissions is much greater than for Class 2 waste materials, and open-air methods for composting have generally, but not invariably, been found to be unsatisfactory. It is most unlikely that the EPA would grant an environment protection licence for the open-air composting of Class 3 waste materials. As with Class 2 waste, the applicant would need to demonstrate clearly at the planning and community consultation stage that the location, design and operating methodology of the facility would prevent odorous emissions and the degradation of the local amenity.

The reprocessing of Class 3 waste materials by vermiculture is an exception to the above, because there is no need to turn the biomass and, therefore, the degradation of organic waste can take place in containers covered with layers of material such as curing compost, generally without significant odour-emission problems.

In the treatment of municipal solid waste (MSW), a very important consideration is the ability of the system to minimise contamination of the compost by heavy metals, other chemicals and inert contaminants. Processes that exert large forces on the waste mass, such as those experienced during shredding or vigorous tumbling, may result in the breaking-up of containers, bottles, batteries, and electronic components. This fragmentation can make it difficult and/or expensive to recover the 'inert contaminants' in a form that can be reprocessed. It will also release any heavy metals and other toxic chemicals that were previously contained.

Other equipment that can have significant (indirect) effects on reducing atmospheric emissions includes:

- equipment that can cut, shred, chop and grind vegetation small enough to enable it to mix with other organic wastes so that the less rapidly biodegradable materials can biodegrade faster. Note that wood from Australian native trees is generally much harder than the wood found in Europe or the USA, and this fact should be borne in mind when specifying/evaluating such equipment.
- equipment for the effective mixing of organic wastes and other materials from the different streams of feedstock in order to reach the desirable carbon to nitrogen ratio and moisture content before composting starts
- equipment for the effective turning, mixing and aeration of material that is in the active stage of degradation (except for certain in-vessel equipment types that achieve sufficient internal mixing). This equipment can vary from simple front-end loaders or bulldozers to purpose-built windrow-turning machines.

The sound power (noise) levels of the mobile and stationary processing equipment chosen need to be considered at the site-selection stage. Their suitability should be assessed with respect to:

- their proposed location on the site
- the natural characteristics of the site
- attenuation measures planned for the site
- the proximity of sensitive receiving locations.

Noise prediction, by modelling, should be done at the site selection and planning stage, in order to predict whether adverse noise impacts are likely to occur.

Keep pest and vermin populations low

Pests and vermin should not be present in sufficient numbers to pose an environmental or health hazard or loss of amenity in neighbouring areas. Local amenity will be reduced by the presence of large numbers of pests or vermin on the reprocessing site. Composting and related organics processing facilities with exposed, rapidly biodegradable material may attract a large number of birds, particularly gulls and ibises; this can lead to noise problems and the spread of food scraps away from the site.

Use the following measures:

- Cover rapidly biodegradable organic waste material, keeping the amount exposed to a minimum. Rapidly biodegradable wastes include grass clippings, food and animal wastes and organic sludges.
- Store rapidly biodegradable wastes of food and animal origin in moisture- and vermin-proof bins that are designed and constructed to resist the action of organic acids and to facilitate washing. Locate the bins on a concrete- or bitumen-sealed and bunded washdown apron that is:
  —connected to the leachate collection system
  —protected to stop rain getting into the leachate collection system.
- Take steps to ensure that surfaces are adequately drained to prevent ponds of water forming on the site.
- Episodic outbreaks of pests or vermin at composting and related organics processing facility sites should be controlled by established deterrence measures.

Keep weed population low

It is important to prevent weeds from proliferating, in order to prevent weed propagation via compost, soil conditioner and mulch products.

Noxious weeds should not be present at the site in sufficient numbers to pose an environmental hazard or loss of amenity in neighbouring areas.

It is very important that weeds, weed seeds and propagable shoots are prevented from being transmitted to other locations via the products; weed spread can have serious environmental and negative economic consequences.

Facility occupiers should consider:

- setting up a plan to manage any declared noxious weeds. This could be addressed as part of the EMP if that is required for licensing.
- implementing measures to keep the weed population low throughout the site
- using measures that ensure that every part of a batch of product has been subjected to the stabilisation conditions defined in Table 5 in section 4, since these conditions should ensure the destruction of weed seeds and propagable shoots.

Prevent fires from occurring at the facility

It is important that adequate fire prevention measures are in place, fire-fighting equipment is accessible, and staff are trained and able to manage fire outbreaks at any part of the facility.

Fire prevention. The following points should generally be covered:

- Clear signs should tell the public that flammable liquids are not permitted on the site. This should be reinforced by advice to customers at the gatehouse and inspection of loads at the organic waste reception area.
- Approved amounts of combustible contaminants that have been separated from the organic wastes received for reprocessing and are destined for recycling (such as tyres and plastic bottles) should be stockpiled in small piles or in windrows.
- All fuels or flammable solvents for operational use should be stored in an appropriately ventilated and secure store. This store should be located away from reception, storage and processing areas. All flammable liquids should be stored within a bund that can hold 110% of the volume of the flammable liquids stored there, so that any release of raw or burning fuel cannot cause a fire in the combustible organic materials present on the site or affect the stormwater.

Note that the burning of waste is forbidden in the Sydney metropolitan area and many rural council areas. In many rural areas, occupiers cannot burn any vegetation waste without approval from the EPA or the local council. This approval will set specific conditions regarding the materials that can be burned, the way they are burned and the person responsible for setting and controlling the fire.

Fire-fighting capacity. Occupiers should be able to show that their facilities have sufficient fire-fighting capacity by developing a site-specific fire management strategy to minimise the incidence and impact of fires.

A site-specific fire management strategy should identify:

- the procedure to follow, persons responsible, and equipment to be used in the event of a fire. This will include on-site resources and external resources (such as the Bush Fire Brigade), and details of how it will operate on a 24-hour-a-day basis.
- the maintenance schedules for all fire-fighting equipment and facilities. At a minimum all equipment and facilities should be visually checked for damage on a weekly basis, and test-operated on a quarterly basis.
- details of all the fire-fighting equipment that will be installed at the flammable store and at site buildings.
- how all fire-fighting equipment will be clearly signposted and how access will be ensured at all times.

- details of the firebreaks to be constructed and maintained around all filled areas, stockpiles of combustibles, gas extraction equipment and site buildings.
- training of facility staff in fire-fighting techniques.

Ensure that the premises are secure

The facility should prevent unauthorised entry to the operational parts of the facility. Put into place provisions for denying unauthorised access to the following areas:

- areas used for receiving, storing and processing of wastes and materials
- all areas used to store flammable materials.

The best practice for preventing unauthorised entry to the facility is to:

- install and maintain lockable security gates at the facility
- unless natural barriers prevent entry to the site, install and maintain a 1.8-metre-high wire-mesh fence topped with three strands of barbed wire either around the perimeter of the site or around those parts of the site that are used for reception, storage, processing and flammable storage.

Keep bioaerosol emissions low

It is important from a health protection perspective to minimise emissions of bioaerosols.

Facilities should minimise bioaerosol emissions so that they do not pose health risks. They need to ensure that any increase in bioaerosol levels downwind does not pose a significant risk to the community.

Facilities should be able to document that their dust controls are effective. Both sample collection and estimation of the number of each type of bioaerosol should accord with appropriate protocols and requirements.

Bioaerosols from properly operated composting facilities pose a very small health risk to the community. The risk is largely confined to immunocompromised or sensitive individuals (Millner and others 1994). However, bioaerosols may pose a risk to workers at composting facilities, and occupiers should seek advice from WorkCover NSW on this issue.

Four important methods useful for minimising the emission of airborne pathogens are:

- Do not allow materials that are being processed, or products such as composts, soil conditioners and mulches, to lose too much moisture. Keep the moisture content at 25% (m/m) or more.
- Have adequate dust controls at the facility. (see section 5, Other considerations.)
- Avoid uncontrolled emissions of biogas in aerobic processes by keeping the materials being processed adequately aerated.
- Ensure that every part of a batch of product has been subjected to the stabilisation conditions defined in Table 5, section 4.

Keep stockpiles of raw materials and products low

Keep stockpiles of raw materials and finished products as small as practicable to avoid potential negative environmental impacts. The following targets should be aimed for:

- The quantity of cured material stored at the facility should not be greater than 18 months' worth of production.
- The quantity of Class 1 organic wastes awaiting processing should not exceed 10% of the currently utilised facility processing capacity (tonnes/year).

- The quantity of Class 2 and Class 3 organic wastes awaiting processing should not exceed one day's production, unless it is stored in a manner that prevents the release of odours.

The quantity of organic wastes received for reprocessing each year should be based on either current trends, where available, or on production plans for the forthcoming year.

Marketing of stabilised reprocessed materials. A plan for the marketing and sales or the giving away of the different types of reprocessed materials should be prepared annually and should be based on the anticipated quantities of wastes to be received at the site. The seasonal fluctuations that may affect the availability of different types of feedstock materials will need to be considered.

Measurement and recording of quantities of wastes received and products shipped. The quantities of organic waste received for reprocessing and the finished products transported from the site should be measured or estimated as precisely as possible and reported to the EPA as specified in the environment protection licence conditions.

Composting and related organics processing facilities that accept more than 25 000 tonnes a year of waste should install weighbridges.

If a weighbridge is used it should have a valid Calibration Certificate from the Department of Business and Consumer Affairs and should be operational at all times.

If a weighbridge is not used or if it becomes inoperable, the estimated tonnage of all vehicles should be recorded.

The quantity of each category of organic waste material received for reprocessing should be recorded, together with the waste source, according to the National Waste Classification System (Moore and others 1994).

Data concerning the quantities of reprocessed materials (grouped by type) moved off the site and their destination should be recorded.

Controls should be established to prevent vehicles from being on the site without their presence being recorded in a permanent way.

Ensure adequate staffing and training

The level and nature of staffing and training should be adequate for environmentally responsible and safe management of the composting and related organics processing facility.

Staffing levels should be high enough to ensure that the facility can comply at all times with all provisions of its environment protection licence.

Staff training should be effective enough to ensure that:

- all operators of mobile plant and other equipment are skilled at undertaking all the tasks required of them
- all personnel who operate gas-testing, water-sampling or water-testing apparatus are familiar with the required testing and sample retention protocols
- all personnel who inspect incoming wastes are skilled at identifying wastes that are unacceptable and can record data accurately.

Staffing requirements will vary as a function of the size of the facility, the type of wastes, and the diversity and complexity of site operations.

Ensure the future environmental integrity of the facility

A sound approach to site remediation when the facility closes would include the following points:

- No products, feedstock, amendments, contaminated products, process residues or chemicals remain on the facility.

- All equipment, appliances, bins and process areas have been emptied, cleaned, disinfected and removed.
- The facility has been revegetated or otherwise made stable and suitable for the proposed future land use of the site. The revegetation of any exposed working areas should be started within 30 days of cessation of composting and related organics processing (weather permitting), and the final revegetation layer should be of a depth and type sufficient to support the revegetation scheme proposed.
- The final surface prepared on the site controls surface erosion and protects local amenity.
- Groundwater and surface water monitoring is continued until it indicates the absence of any pollution that would pose a threat to groundwater quality.

APPENDIX: ITEMS TO BE INCLUDED IN AN ENVIRONMENTAL MANAGEMENT PLAN FOR A COMPOSTING OR RELATED FACILITY

Principal component	Subparts
Siting (from Environmental Impact Statement, Statement of Environmental Effects or Statement of Environmental Factors)	• **locality map** showing the siting of the facility and location of environmentally sensitive areas, including residential zones, dwellings, schools and hospitals • **ground plan** of facility, including location of monitoring points/equipment • **natural characteristics of site** (local meteorology (wind and rain patterns), soil morphology, geology, hydrogeology and surface waters) • **facility environmental policy** (including protection of environmentally sensitive areas) • **business plans** (type and quantity of materials to be processed now and in future and type and quality of products) • **staffing** (organisation, headcount, skills, responsibilities, training and proposed working hours)
Water management	• surface water controls • leachate controls and handling • water monitoring and assessment • leachate monitoring and assessment • contaminated water remediation
Gas and odour management	• process controls and monitoring • odour and weather monitoring • management of rapidly biodegradable waste • gas containment and extraction (for fermentation processes) • gas monitoring • remediation of uncontrolled gas emissions • gas oxidation controls and monitoring
Incoming waste management	• screening and recording of wastes received • waste handling and storage
Product quality assurance	• feedstock selection • process controls and monitoring • product testing and monitoring—physical, chemical and biological • management of contaminated wastes and products
Noise management	• scheduling of the operation of noisy equipment and heavy transport vehicles • noise monitoring
Housekeeping practices	• dust and litter control • pest, weed and vermin control • site security • disposal of wastes and contaminated products • maintenance of facility and equipment • stock controls
Fire-fighting and prevention	• fire prevention • fire-fighting provisions

GLOSSARY

Act: the *Protection of the Environment Operations Act 1997.*

Activator (or **Inoculum** or **Starter):** a culture of micro-organisms and/or a mixture of enzymes used for speeding up the start of biodegradation/composting processes. The activator may be in a specially concentrated form or simply be matured organic waste materials recycled in the process.

Active state: refers to organic waste material that is undergoing or is capable of undergoing rapid biological decomposition. This usually means that it is emitting or is capable of emitting heat in the presence of moisture.

Aerobic: in the presence of air (oxygen)

Alkalinity of water: its acid-neutralising capacity, being the sum of all titratable bases measured as its quantitative capacity to react with a strong acid to a designated pH.

Anaerobic: in the absence of air (oxygen)

Amendments: see **Feedstock amendments**

Amenity: the existence of healthy, pleasant and agreeable (community) surroundings

Aquifer: a saturated permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients

AUSPLUME: an atmospheric dispersion model developed by and available from the Victorian EPA, Herald and Weekly Times Tower, 40 City Road, Southbank 3006.

Batch: samples taken from one site in one day

Bioaerosol: organisms or biological agents that can be dispersed through the air **and** that affect human health

Biodegradable: able to be transformed to a lower state by environmentally significant biological processes

Biogas: gaseous emission from the anaerobic decomposition of organic material

Biogas management strategy: a strategy that is specifically tailored to be appropriate for an individual site and that establishes procedures for the monitoring and control of biogas

The aim of making this strategy is to ensure that:

- biogas does not pose an explosion hazard
- the community amenity is not degraded by odour emissions
- community health is not degraded by emissions of hazardous air pollutants
- the impact of greenhouse gas emissions is minimised.

Bioremediation: the remediation or decontamination of any contaminated matter by the use of processes involving biological organisms

Biosolids: the organic product that results from sewage treatment processes (otherwise referred to as sewage sludge)

Biosolids products: material containing any component of biosolids, including pure biosolids in the form of liquid or cake, or derived materials such as compost, lime sludges or pellets

Buffer distance: the distance between the reception, storage and processing areas of an composting and related organics processing site and a segment of the environment to be protected

Classification of organic waste: see table below.

Waste class and threshold	Types of organic waste material permitted in classification[1] (Classes with larger numbers may contain types from classes with smaller numbers.)	
	Category	**Examples of organic material**
Class 1 (5000 tonnes a year)	**Garden and landscaping material**	Grass[2]; leaves; plants; loppings; branches; tree trunks and stumps.
	Untreated timber	Sawdust; shavings; timber offcuts; crates; pallets; wood packaging.
	Natural organic fibrous material	Peat; seed hulls/husks; straw; bagasse and other natural organic fibrous materials.
	Processed fibrous material	Paper; cardboard; paper processing sludge; non-synthetic textiles.
Class 2 (200 tonnes a year)	**Other natural or processed vegetable material**	Vegetables; fruit and seeds and processing sludges and wastes; winery, brewery and distillery wastes; non-fatty food waste.
	Biosolids[3] and manures	Sewage biosolids, animal manure and mixtures of manure and biodegradable animal bedding materials.
Class 3 (200 tonnes a year)	**Meat, fish and fatty foods**	Carcasses and parts of carcasses; blood; bone; fish waste; fatty processing or food wastes.
	Fatty and oily sludges and wastes of animal and vegetable origin	Dewatered grease trap wastes; fatty and oily sludges of animal and vegetable origin.
	Mixed residual waste containing putrescible organic matter	Wastes containing putrescible organic matter, including household domestic waste that is set aside for kerb side collection or delivered by the householder directly to a waste facility, and waste from commerce and industry.

Notes:

1. These classifications are used only to facilitate reference to these groupings of waste (with different potential environmental impacts) in these guidelines and in environment protection licences: they are **not** used in waste legislation.
2. Particular care should be taken if grass clippings are present at more than 15% mass/mass (m/m) in a mixture.
3. Conditions applying to processing and use can be found in *Environmental Guidelines: Use and Disposal of Biosolids Products* (EPA 1997).

C:N (carbon to nitrogen) ratio: the ratio, by mass, of carbon atoms to nitrogen atoms present in the organic waste material.

Closure plan: a plan required by conditions of an EPA environment protection licence in accordance with Section 76 of the Protection of the Environment Operations Act for a specific facility to establish procedures for the closure of the site. Information to be included in this plan includes:

- timetable for staged remediation
- revegetation or stabilisation program
- proposed post-closure monitoring, maintenance and use.

Compost: stable, pasteurised organic material resulting from the controlled microbiological transformation of organic materials

Compost pad: the prepared area upon which composting takes place

Composting: the process of aerobic conversion (under controlled conditions) of organic wastes by micro-organisms, yielding cured soil conditioners, compost or humus.

Composting and related organics processing: for the purpose of these guidelines means the production of composts, soil conditioners, mulches and other products by processes including composting, mulching, digestion and fermentation

Cover material: material used to cover organic waste at reprocessing facilities

Cured: refers to biodegraded organic material that is stable in its current form with respect to normal composting processes

Curing: the process during which an organic material that has already gone through the active/rapid stage of biodegradation becomes cured

Decomposition: the breakdown of organic waste materials by micro-organisms

DUAP: New South Wales Department of Urban Affairs and Planning

Electrical conductivity: sometimes written as **EC**—a measure of the ability of water to conduct an electric current. EC varies with temperature. It is sensitive to variations in dissolved solids, mostly mineral salts.

eH: sometimes written as **Eh,** this is the redox potential that characterises the oxidation–reduction state of natural waters (commonly varying between –500 mV and + 700 mV). It is usually determined potentiometrically in situ in the field.

Environmental issue: consists of three parts:

- *objective*, which sets out the expected environmental results, and guides the formulation of strategies to achieve the objective
- *performance requirements*, which define what must be done to achieve the desired outcome
- *performance measurements*, which set out ways of measuring the performance requirements to determine whether the desired outcome is being achieved.

EPA: the New South Wales Environment Protection Authority

Facility: a premises at which a scheduled activity under schedule 1 to the Act takes place

Feedstock: organic waste(s) suitable for composting, fermentation, mulching and related processes

Feedstock amendments: wastes or materials added to organic waste before reprocessing to improve the final product. Examples include water absorbent biodegradable organic materials (such as sawdust, wood shavings and paper pulp), and/or inorganic chemicals/minerals (such as lime, gypsum, ammonium phosphate or ammonium nitrate) added to modify the pH and/or the nutritional content of the composting mixture.

Fermentation: the anaerobic process of turning organic waste materials into high-energy compounds such as methane, organic acids and alcohols and a solid residue that can be composted and/or cured and pasteurised, yielding compost or soil amendments

Food waste:

(a) the by-products of any one or more of the following activities:
  (i) the preparation or manufacturing of food (including beverages),
  (ii) the processing of meat, poultry or fish, or

(b) food that is unwanted or no longer fit for the purpose for which it was intended (because, for example, it is spoilt or past its use-by date),

but does not include any of the following:

(c) grease trap waste,

(d) packaging,

(e) any food waste that constitutes Group A waste, hazardous waste or industrial waste.

[*Protection of the Environment Operations Act 1997*]

Greenhouse gases: gases, such as methane and carbon dioxide, that are implicated in the greenhouse effect, which in turn is thought to cause global warming

Ground water: any water contained in or occurring below the surface of the ground.

Hazardous waste: any liquid or non-liquid waste that is:

(a) specified in Part 3 of the following Appendix, or

(b) otherwise assessed and classified as hazardous waste in accordance with the procedures set out in the Waste Guidelines.

APPENDIX—Types of Waste

Part 3 Types of hazardous waste

(1) Any waste that meets the criteria for assessment as dangerous goods under the Australian Code for the Transport of Dangerous Goods by Road and Rail, and categorised as one of the following: (a) explosives, (b) gases (compressed, liquefied or dissolved under pressure), (c) flammable solids (excluding garden waste, natural organic fibrous material and wood waste, and all physical forms of carbon such as activated carbon and graphite), (d) flammable liquids, (e) substances liable to spontaneous combustion (excluding garden waste, natural organic fibrous material and wood waste, and all physical forms of carbon such as activated carbon and graphite), (f) substances which in contact with water emit flammable gases, (g) oxidising agents and organic peroxides, (h) toxic substances, (i) corrosive substances.

(2) Pharmaceuticals and poisons (being waste generated by activities carried out for business or other commercial purposes and that consists of pharmaceutical or other chemical substances specified in the Poisons List under the *Poisons and Therapeutic Goods Act 1966*).

(3) Clinical waste.

(4) Cytotoxic waste.

(5) Sharps waste.

(6) Any radioactive waste, being waste that: (a) contains a substance that emits ionising radiation spontaneously, and (b) has a specific activity greater than 100 becquerels per gram, and (c) consists of, or contains more than, the prescribed activity of any radioactive element listed in Schedule 1 to the Radiation Control Regulation 1993.

(7) Any liquid radioactive waste, being waste that: (a) contains a substance that emits ionising radiation spontaneously, and (b) has a specific activity ratio or a total activity ratio (as determined in accordance with the procedures set out in the Waste Guidelines) that is greater than one.

(8) Any declared chemical waste that: (a) is the subject of a chemical control order under the *Environmentally Hazardous Chemicals Act 1985*, and (b) is not permitted to be disposed of to a landfill site because of such an order.

(9) Quarantine waste.

[*Protection of the Environment Operations Act 1997*]

Inactivation: when referring to weed seeds and propagable shoots, means that they are no longer capable of propagating plant forms. When referring to pathogens and other organisms, means a reduction in their numbers and their activity so that they do not pose a threat to the life and health of other organisms.

ISCST3: an atmospheric dispersion model developed by and available from the USEPA

Leachate: liquid released by, or water that has percolated through, waste, and which contains dissolved and/or suspended liquids and/or solids and/or gases.

Litter: solid waste that has been carelessly discarded and is not part of the collection system

Lysimeter: an instrument to collect water flowing through the vadose zone or unsaturated zone in the soil

Material recovery: a form of resource recovery in which the emphasis is on separating and processing waste materials

Methane (CH_4): an explosive, odourless and colourless gas produced by organic waste material undergoing anaerobic biological decomposition

Mulching: the size reduction of organic wastes using one or more of the processes such as the following: cutting, milling, shredding and grinding. Usually the mulch is then pasteurised.

Non-liquid waste: any waste that:

(a) has an angle of repose of more than 5 degrees, and
(b) does not contain, or is not comprised of, any free liquids (as determined in accordance with the Waste Guidelines), and
(c) does not contain, or is not comprised of, any liquids that are capable of being released when the waste is transported, and
(d) does not become free flowing at or below 60 degrees Celsius or when it is transported, and
(e) is generally capable of being picked up by a spade or shovel.

[*Protection of the Environment Operations Act 1997*]

Offensive odour means an odour:

(a) that, by reason of its strength, nature, duration, character or quality, or the time at which it is emitted, or any other circumstances:
    (i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or
    (ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or
(b) that is of a strength, nature, duration, character or quality prescribed by the regulations or that is emitted at a time, or in other circumstances, prescribed by the regulations

Organics: natural organic materials of waste and non-waste origin, including organic waste

Organic waste: includes wood, garden, food, animal, vegetative and natural fibrous material wastes and biosolids

Pasteurisation: the process involving heat and resulting in reduction in the levels of human, animal and plant pathogens and in the inactivation of weed seeds and propagable shoots

Pathogen: a living organism that can be harmful to humans, animals, plants or other living organisms

Performance measurement: specifies the process to be followed in measuring environmental characteristics to determine whether a particular performance requirement or desired outcome is being met or achieved, or the extent of the difference between the measured characteristic of the environment and a particular performance requirement or a particular desired outcome

Performance requirement: defines the quantifiable or qualifiable characteristics of the environment against which environmental quality can be assessed

pH: the negative logarithm of the hydrogen ion concentration of an aqueous solution. This provides a measure of whether a solution is acid or alkaline.

Premises: includes:

- a building or structure, or
- land or a place (whether enclosed or not), or
- a mobile plant, vehicle, vessel or aircraft

Propagule: a part of a plant that can lead to the growth (propagation) of a full plant in the environment, such as a seed, rootstock, stem or leaf

Putrescible waste:

(a) food waste, or

(b) waste consisting of animal matter (including dead animals or animal parts), or

(c) biosolids categorised as Stabilisation Grade C in accordance with the criteria set out in the Biosolids Guidelines.

[*Protection of the Environment Operations Act 1997*]

Rapidly biodegradable waste: biodegradable organic waste, including putrescible waste, that is able to be decomposed under favourable conditions by microbial action, in both the presence and the absence of oxygen, to a noticeable extent within 14 days

Recycling of waste: the processing of waste into a similar non-waste product

Related processes [composting and ..]: processes for the conversion of organic wastes into soil conditioners, compost, humus or other products (for example, mulching, fermentation and digestion). They should be processes that are carried out under controlled conditions.

Relative per cent difference: the difference between duplicate samples divided by the average and expressed as a percentage

Reprocessing of waste: the processing of waste into a different non-waste product

Resource recovery: the extraction and use of materials from mixed waste. Materials recovered can be used in the manufacture of new products. Recovery of value includes the production of energy by using components of waste as a fuel, production of compost using organic waste as a medium, and reclamation of land.

Run-off: the portion of precipitation that drains as a surface flow

Run-on: where surface water runs off one site and flows on to the site in question (that is, the composting and related organics processing site)

Sample environmental technique: a technique that suggests possible means for achieving the environmental outcomes in Part 5 of these guidelines

Sludge: material that has settled to the bottom of a waste-treatment device

Solid: see **Non-liquid waste**

Solid waste landfill: a site for the disposal of solid waste by landfilling, as defined in *Environmental Guidelines: Solid Waste Landfills* (EPA 1996).

Spadeable: a physical state of material in which the material behaves sufficiently like a solid to be able to be moved by a spade at normal outdoor temperatures

Stabilised or stable: not prone to further biodegradation (see **Cured**)

Surface water: includes all natural and constructed waterways or channels whether flow is intermittent or not; all lakes and impoundments (except lined dams associated with landfilling activities; and other marshes, lagoons and swamps)

The Act: the *Protection of the Environment Operations Act 1997*

Toxins: substances that are harmful to humans, animals or plants

Transfer station: a waste facility used to transfer waste from collection vehicles to a bulk haul vehicle in order to achieve long-distance transportation efficiency

Treatment of waste: the processing of waste into a different type of waste

Uppermost aquifer: the nearest geological medium to the base of the reprocessing surface that does or could potentially act as an aquifer.

Vadose zone: the zone beneath the topsoil and overlying the watertable, in which water in pore spaces coexists with air or in which the geological materials are unsaturated

Vector: a carrier that is capable of transmitting a pathogen from one organism to another

Vermiculture (or vermicomposting): a composting process that uses worms and micro-organisms to convert organic waste into nutrient-rich humus

Waste: as defined in the *Waste Minimisation and Management Act 1995* and the *Protection of the Environment Operations Act 1997*:

waste includes:

(a) any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment, or

(b) any discarded, rejected, unwanted, surplus or abandoned substance, or

(c) any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, reprocessing, recovery or purification by a separate operation from that which produced the substance, or

(d) any substance prescribed by the regulation to be waste for the purposes of this Act.

A substance is not precluded from being waste for the purposes of the Act merely because it can be reprocessed, re-used or recycled.

Waste Guidelines: the document called *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes,* issued by the EPA and in force as at 1 July 1999 (EPA 1999a)

Water management strategy: a strategy that describes the measures to be taken to protect ground water and surface water, including:

- measures to prevent uncontrolled discharges from the facility
- measures to avoid discharges of water of lower environmental quality than those of the receiving waters
- measures to monitor the quality of waters that are present at or near the facility and the environmental quality of which may be affected by activities on the facility
- measures to be taken to remediate waters in the event of confirmed pollution by discharges.

Watertable: the level of the upper surface of an aquifer

REFERENCES AND BIBLIOGRAPHY

Legislation

- *Waste Avoidance and Resource Recovery Act 2001*
- *Protection of the Environment Operations Act 1997*
- Protection of the Environment Operations (Waste) Regulation 1996
- Protection of the Environment Operations (General) Regulation 1999
- Clean Air (Plant and Equipment) Regulation 1997

References

ARMCANZ 1997, *Minimum Construction Requirements for Water Bores in Australia*. Agriculture and Resource Management Council of Australia and New Zealand, Canberra

Barth J. and Stöppler-Zimmer H 1998, Compost Quality in Europe, *Biocycle*, August, pp 75–6.

CEN – European Standard for Standardisation 1997, *European Standard—Air Quality—Determination of Odour Concentration by Dynamic Olfactometry, CEN/TC264/WG2/N222/e*, European Committee for Standardisation, Brussels.

de Bertoldi M 1998, Composting in the European Union, *Biocycle*, June, pp 74–5.

Denlay J 1993, *Guidelines for Composting in Australia—Return it to the Earth*, Friends of the Earth, Sydney.

Department of Urban Affairs and Planning 1996, *EIS Practice Guideline: Composting and Related Facilities*, DUAP, Sydney.

EPA 1996, *Environmental Guidelines: Solid Waste Landfills*, New South Wales Environment Protection Authority, Sydney.

EPA 1997, *Environmental Guidelines: Use and Disposal of Biosolids Products*, New South Wales Environment Protection Authority, Sydney.

EPA 1998, *Approved Methods for Sampling and Analysis of Water Pollutants in NSW*, New South Wales Environment Protection Authority, Sydney.

EPA 1999a, *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes*, New South Wales Environment Protection Authority, Sydney.

EPA 1999b, *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW*, New South Wales Environment Protection Authority, Sydney.

EPA 2000a, *NSW Industrial Noise Policy*, New South Wales Environment Protection Authority, Sydney.

EPA 2000b, *Addendum to Environmental Guidelines: Use and Disposal of Biosolids*, New South Wales Environment Protection Authority, Sydney.

Glenn, J 1998, Solid Waste Composting Trending Upward, *Biocycle*, November, pp 65–72.

Hirschberg K-J 1993, *Guidelines for Groundwater Monitoring at Municipal Landfill Sites*, Geological Survey of Western Australia, Perth.

Millner P D, Olenchock S A, Epstein E, Rylander R, Haines J, Walker J, Ooi B L, Horne E and Maritato M. 1994, Bioaerosols associated with composting facilities, *Compost Science & Utilization*, Autumn 1994, pp 8–57.

Moore S J, Kung B, Tu S-Y, Toong P and van den Broek B 1994, Progress towards establishment of a National Waste Database for Australia, in *Proceedings of the Second National Solid and Hazardous Waste Convention*, Melbourne, May 1994, Waste Management Association of Australia, Sydney.

Standards Association of Australia 1987, *Australian Standard AS2922–1987 Ambient Air—Guide for Siting of Sampling Units*, Standards Association of Australia, North Sydney.

Standards Australia 1999, *Australian Standard AS 4454–1999: Composts, Soil Conditioners and Mulches.* Standards Australia, Homebush.

USEPA 1989, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities (PB89–151047)*, United States Environmental Protection Agency Office of Solid Waste, Washington DC.

USEPA 1991, *Handbook: Groundwater, Volume II: Methodology (EPA/625/6–90/016b)*, United States Environmental Protection Agency Centre for Environmental Research Information, Cincinnati.

USEPA 1992, *SW–846 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, United States Environmental Protection Agency Office of Solid Waste and Emergency Response, Washington DC.

Washington State Department of Ecology 1997, *Draft Compost Facility Resource Handbook*, Washington State Department of Ecology, June 1997 (available at http://www.wa.gov/ecology/swfa/compost/draftcompost.html)

Bibliography

American Public Health Association, American Water Works Association and Water Environment Federation 1995, *Standard Methods for the Examination of Water and Wastewater* (19th Edition), APHA, Washington.

ANZECC 1992, *Australian Water Quality Guidelines for Fresh and Marine Waters*, Australia and New Zealand Environment and Conservation Council, Canberra.

ANZECC 1992, *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, Australia and New Zealand Environment and Conservation Council, Canberra.

Bidlingmaier W 1993, Odour emissions from composting plants, *Compost Science & Utilization*, Vol 1, No 4, pp 64–8.

British Columbia Ministry of Environment, Lands and Parks 1992, *British Columbia Municipal Composting Resource Guide*, pp 6–24.

California Code of Regulations, Title 14–Natural Resources, Division 7—California Integrated Waste Management Board California Solid Waste Management Regulations, Environment Reporter; Bureau of National Affairs Inc; Washington DC; 1121:0501

Codes, Rules and Regulations of the State of New York, Title 6, Chapter IV—Quality Services, SubChapter B—Solid Wastes, Part 360—Solid Waste Management Facilities; Environment Reporter; Bureau of National Affairs Inc; Washington DC; 1261:0501

Conrad P 1995, Biosolids management: improving results at in-vessel composting system, *Biocycle,* May, pp 42–5.

de Bertoldi M 1993, Compost quality and standard specifications: European perspective, in Hoitink, HAJ and Keener, HM (eds), *Science and Engineering of Composting: Design, Environmental, Microbiological and Utilization Aspects*, Renaissance Publications, Ohio 43085, pp 523–35 (also contains other relevant articles).

de Bertoldi M 1995, Composting food processing waste in the European Economic Community, *Compost Science & Utilization,* Spring, pp 87–92.

Department of Environment and Planning 1992, *Tasmanian Solid Waste Management Policy— Position Paper*, Division of Environmental Management, Hobart.

Department of Environment (UK) 1991, *Landfill Gas, Waste Management Paper No 27*, Department of Environment, London.

Department of Housing 1998, *Managing Urban Stormwater: Soils and Construction*, NSW Department of Housing, Sydney.

DLWC 1997, *Biosolids Management for Country NSW*, NSW Department of Land and Water Conservation, Sydney.

Department of Water Resources 1992, *A Practical Guide for Groundwater Sampling*, Department of Water Resources, Technical Services Division, Parramatta.

Dixon F M et al 1995, Metal levels in garden vegetables raised on biosolids amended soil, *Compost Science & Utilization*, Spring, pp 55–63.

Dravnieks A, Masurat T and Lamm R A 1984, Hedonics of odors and odor descriptors, *Journal of the Air Pollution Control Association,* Vol 34, No 7, pp 752–5.

Dunson J B 1993, Control of odors by physical-chemical approaches, in Hoitink H A J and Keener H M (eds) *Science and Engineering of Composting: Design, Environmental, Microbiological and Utilization Aspects*, Renaissance Publications, Ohio 43085, pp 242–61 (also contains other relevant articles).

EPA 1996, *Managing Urban Stormwater: Treatment Techniques*, New South Wales Environment Protection Authority, Sydney.

EPA 1997, *Green Waste Action Plan*, New South Wales Environment Protection Authority, Sydney.

EPA 1997, *Manual of Air Quality Testing*, New South Wales Environment Protection Authority, Sydney.

EPA and Sydney Water 1994, *Procedures for Dynamic Olfactometry* (draft), NSW Environment Protection Authority and Sydney Water, Sydney.

Epstein E 1994, Public Health Issues: Composting and Bioaerosols, *BioCycle,* January, pp 51–7.

Epstein E 1993, Neighborhood and worker protection for composting facilities: issues and actions, in Hoitink H A J and Keener H M (eds), *Science and Engineering of Composting: Design, Environmental, Microbiological and Utilization Aspects*, Renaissance Publications, Ohio 43085, pp 319–38 (also contains other relevant articles).

Federal Ministry for the Environment 1993, *Environmental Policy in Germany, Technical Instructions on Waste from Human Settlements (TA Siedlungsabfall) and Supplementary Recommendations and Information* (translated by Language Services of the Federal Environment Ministry), Bonn.

Giggey M D , Pinnette J R and Dwinal CA 1995, Beyond buffers: odor control factors in compost site selection, *BioCycle*, February, pp 74–9.

Giles G 1995, Commercial and institutional organics: composting residential and commercial streams, *BioCycle,* May, pp 78–9.

Goldstein N 1994, Positive results: odor control progress at composting sites, *BioCycle*, February, pp 64–7.

Hentz L H, Murray C M, Thompson L L, Glasner J B and Dunson J B 1992, Odor control research at the Montgomery County Regional Composting Facility, *Water Environment Research*, Vol 64, No 1, pp 14–27.

Jackson M and Campbell A, *RO Dictionary and Thesaurus*, Recycled Organics Unit, Sydney.

Jensen, J 1994, *The Worms Crawl In, The Worms Crawl Out*, *Resource Recyclin*g, May, pp 22–29.

Kelly S 1993, Large scale yard waste composting, *BioCycle,* September, pp 30–2.

Lee G F and Jones-Lee A 1993, Revisions of State MSW landfill regulations: issues for consideration for the protection of groundwater quality, *Environmental Management Review,* No 29, Third Quarter, pp 31–54.

Maryland Solid Waste Management Regulations (Code of Maryland Regulations, Title 26, Department of the Environment, Subtitle 04, Regulation of Water Supply, Sewage Disposal and Solid Waste, Chapter 07—Solid Waste Management); Environment Reporter; Bureau of National Affairs Inc; Washington DC; 1201:0501.

Maynard A A 1995, Cumulative effect of annual additions of MSW compost on the yield of field-grown tomatoes, *Compost Science & Utilization*, Spring, pp 47–54.

Miller F C 1993, Minimizing odor generation, in Hoitink H A J and Keener H M (eds) *Science and Engineering of Composting: Design, Environmental, Microbiological and Utilization Aspects*, Renaissance Publications, Ohio 43085, pp 219–41 (also contains other relevant articles).

NSW Department of Housing 1998, *Managing Urban Stormwater: Soils and Construction*, New South Wales Department of Housing, Sydney.

Nolan – ITU Pty Ltd 1998, *Evaluation of the Proposed Garden Waste Ban—Data Identification and Collation—Report No. 2*, report for the Environment Protection Authority NSW, May 1998.

Ontario Ministry of Environment and Energy 1994, *A Guide to Approvals for Recycling Sites, Leaf and Yard Waste Composting Sites and Compost Use*, Ontario Ministry of Environment and Energy Toronto, Canada.

Reinhart D R and Trainor S D 1995, Windrow cocomposting of municipal biosolids and yard waste, *Compost Science & Utilization*, Spring, pp 38–46.

Rhineland-Palatinate Ministry of the Environment and Commission of the European Communities 1992, *Guidelines for the Composting of Organic Waste*, W-6500 Mainz, Germany.

Rhode Island Department of Environmental Management, Division of Air and Hazardous Materials, Regulation DEM-DAHM-SW03-92—*Rules and Regulations for Solid Waste Management Facilities*; Environment Reporter; Bureau of National Affairs Inc; Washington DC, 1301:0501

Richard T L and Woodbury P B 1994, Impact of separation: what materials should be composted?, *BioCycle*, September, pp 63–8.

Sharma N 1994, Recycling of organic wastes through earthworms: an alternative source of organic fertilizer for crop growth in India, *Energy Conversion Management*, Vol 35, No 1, Pergamon Press Ltd, pp 25–50.

Simson S E and Connelly C M 1994, Composting and costs: the bigger the better, *Waste Age,* September, pp 95–8.

Standards Association of Australia 1984, *Australian Standard AS 2724.1–1984 Ambient Air-Particulate Matter Part 1—Determination of Deposited Matter as Insoluble Solids, Ash, Combustible Matter, Soluble Solids and Total Solids*, Standards Association of Australia, North Sydney.

Standards Association of Australia 1987, *Australian Standard AS 2990–1987, Quality Systems for Engineering and Construction Projects*, Standards Association of Australia, North Sydney.

Standards Association of Australia 1991, *Australian Standard AS3580.10.1–1991 Deposited Matter—Gravimetric Method*, Standards Association of Australia, North Sydney.

Standards Australia 1996, *Australian Standard AS3743 – 1996: Potting Mixes.* Standards Australia, Homebush.

Standards Australia 1997, *SAA HB97–1997: Integrating Quality and Environmental Management Systems ISO9001 and ISO14000*, Standards Australia, Homebush.

Standards Australia/Standards New Zealand 1996, *Australian/New Zealand Standard AS/NZS ISO14000:1996—Environmental management systems—Specification with guidance for use*, Standards Association of Australia, North Sydney.

The Composting Council 1994, *Organic Waste Composting—Model State Regulations*, The Composting Council, Alexandria, USA.

The Staff of *Biocycle* (eds) 1991, *The Biocycle Guide to the Art & Science of Composting*, The JG Press Inc, Emmaus, Pennsylvania.

The Staff of *BioCycle* (eds) 1994, *Composting Source Separated Organics*, The JG Press Inc, Emmaus, Pennsylvania.

Thompson J L, Murray C M and Grimes D K 1995, Improving odor scrubbing performance, *BioCycle,* February, pp 82–6.

USEPA 1994, *Composting Yard and Municipal Solid Waste (EPA530R94003)*, Unites States Environmental Protection Agency Office of Solid Waste and Emergency Response, Washington DC.

Victorian EPA 1996, *Environmental Guidelines for Composting and Other Organic Recycling Facilities*, Best Practice Environmental Management Series Publication 508, Victorian Environment Protection Authority, Melbourne.

Walker J, Goldstein N and Chen B 1986, Guide for decision makers: evaluating the in-vessel composting option, *BioCycle*, Part I: April, pp 22–7, Part II: May–June, pp 34–9.

Walker J M 1993, Control of composting odors, in Hoitink H A J and Keener H M (eds) *Science and Engineering of Composting: Design, Environmental, Microbiological and Utilization Aspects*, Renaissance Publications, Ohio 43085, pp 185–218 (also contains other relevant articles).

West Virginia Code of State Regulations, Title 47, Legislative Rules, Department of Natural Resources, Series 38—*Solid Waste Management*, Environment Reporter; Bureau of National Affairs Inc; Washington DC, 1346:0501

Wilkinson K, Tymms S, Hood V and Tee E 1998, *Guide to Best Practice—Composting Green Organics*, EcoRecycle Victoria, Melbourne.

Williams T O 1995, System evaluation: odors and VOC emissions control methods, *BioCycle*, May, pp 49–56.

Williams T O and Miller F C 1993, Composting facility odor control using biofilters, in Hoitink H A J and Keener H M (eds) *Science and Engineering of Composting: Design, Environmental, Microbiological and Utilization Aspects, Renaissance Publications*, Ohio 43085, pp 262–81 (also contains other relevant articles).

WorkCover NSW and Victorian WorkCover Authority 2000, *Health and Safety at Work—The Waste Management and Recycling Industry*, WorkCover NSW, Sydney