BEST PRACTICE GUIDELINE SERIES

COMPOSTING

prepared by

Waste Management Association of Australia
National Technical Committee for Organics Recycling

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1. OBJECTIVE

This Guideline has been prepared to assist composters and prospective composters by providing an overview of the requirements for the planning, establishment and operation of a composting facility.

Commercial composting in Australia is principally concerned with the processing of source-separated organic materials from municipal, commercial and industrial, construction and demolition, and agricultural / forestry sectors that are relatively free of chemical and physical contaminants.

2. DEFINITIONS

The following definitions are consistent with the Australian Standard (AS4454 - 2003) for Composts, soil conditioners and mulches.

Composting – the process whereby organic materials are pasteurised and microbiologically transformed under aerobic and thermophilic conditions.

Compostable Organic Material - a generic term for all organic materials that are appropriate for collection and use as raw materials or feedstocks for composting or in related biological treatment systems (e.g. anaerobic digestion, vermiculture), and is defined by its component materials: residual food organics; garden organics; wood and timber; biosolids; agricultural organics; and other organics. The term and definition is compatible with national materials classification system defined in the Australian Waste Database (see http://www.civeng.unsw.edu.au/awdb/awdb2.htm), and clearly distinguishes between organic materials that can be treated using biological systems, and organic compounds which cannot (such as plastics).

Compost – an organic product which has undergone controlled aerobic and thermophilic biological transformation to achieve pasteurisation and a specified level of maturity.

Fine Mulch – any pasteurised or composted organic product (excluding polymers which do not biodegrade such as plastics, rubbers and coatings) that is suitable for placing on soil surfaces. Fine mulch has more than 20% but less than 70% by mass of its particles with a maximum size above 16mm.

Mulch – any pasteurised organic product (excluding polymers which do not biodegrade such as plastics, rubbers and coatings) that is suitable for placing on soil surfaces. Mulch has at least 70% by mass of its particles with a maximum size of greater than 16mm.

Pasteurisation – a process whereby organic materials are treated to significantly reduce the number of plant and animal pathogens and weed propagules.

Soil Conditioner – any composted or pasteurised organic material including vermicast, manure and mushroom substrate that is suitable for adding to soils. This term also includes “soil amendment”, “soil additive”, “soil improver” and similar terms, but excludes polymers which do not biodegrade such as plastics, rubbers and coatings. Soil conditioners may be either “composted soil conditioners” or “pasteurised soil conditioners”.

Soil conditioner has not more than 20% by mass of particles with a maximum size above 16mm. and results in beneficial effects. This term also includes “soil amendment”, “soil additive”, “soil improver” and similar terms, but excludes polymers which do not biodegrade such as plastics, rubbers and coatings.

3. BENEFITS OF COMPOSTING

Controlled and well-managed composting can provide a sustainable option for the recycling of a wide range of organic materials which include food organics, garden organics, wood and timber residues, agricultural and food/fibre processing by-products, manures, biosolids etc.

Well planned and well managed composting operations can convert organic materials, including troublesome and odorous compounds into valuable soil additives that enhance the chemical, biological and physical properties of soil. The use of recycled organic products improves health and structure of soils and can lead to moisture conservation, improved nutrient utilisation and reduced pesticide and synthetic fertiliser usage.

The diversion of organic materials from landfill into such beneficial uses also has a positive impact on the greenhouse effect. Controlled aerobic composting is a process that is considered to have a zero nett effect on greenhouse gas generation, whereas methane generated from such materials in a landfill without an adequate gas extraction and utilisation system is a potent greenhouse gas.

4. RAW MATERIALS

Raw materials for composting are many and varied and are prepared and mixed with the addition of specific additives to produce a suitable feedstock for composting with respect to factors such as:

- moisture
- porosity
- carbon to nitrogen ratio
- contaminants (as relevant to product quality and regulatory compliance)

(see Reference 7 for detail on this topic)

5. THE PROCESS

The composting process relies on a wide range of micro-organisms to biologically convert degradable organic compounds into more stable materials that are beneficial in soils and growing mixes.

During the process the micro-organisms rapidly multiply as they consume the organic compounds and generate heat which is responsible for the temperature rise in composting material. At the same time the aerobic microbes consume oxygen and if this oxygen is not replenished the system will become anaerobic (low oxygen) with the resultant generation of highly odorous compounds.

The composting process proceeds in a number of stages from the initial lag phase as the microbes are acclimatising and multiplying to the highly active stages when the readily degradable sugars and proteins are decomposed, to the later maturing phases when the “woody” compounds are stabilised.

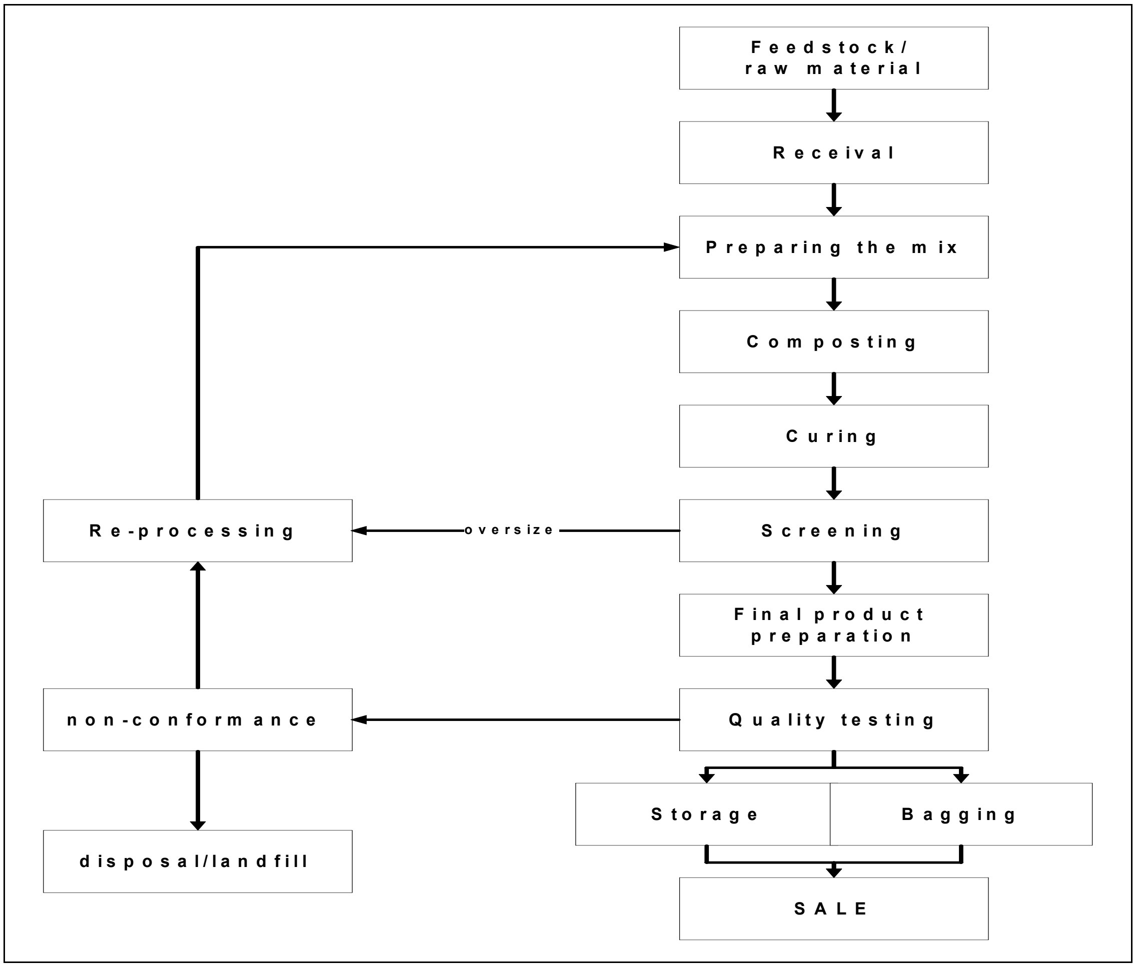
In addition to oxygen, moisture is critical to the function of the microbes by solubilising the nutrients that they need to decompose the organics and to multiply.

Whilst elevated temperatures are required to pasteurise the mix and to inactivate weed seeds, plant propagules, and pathogens, excessive temperatures will inhibit the process and limit the diversity of microbial types that are required to efficiently convert the organic substrate into a mature compost.

Hence the monitoring and management of moisture and temperature and the replenishment of oxygen is very important in the operation of an efficient composting process.

The two main food components for the microbes are carbon and nitrogen and the ratio of these elements may need to be adjusted to a suitable level by selection of appropriate raw materials and by the design of the recipe.

A generic flow chart for a composting operation is depicted below:



6. TECHNOLOGIES

Several composting technologies and their variations are successfully used worldwide to convert organic residues into value added products. The choice of technology will depend on many factors including, feedstock type, location, available space, buffer zones, economic constraints, etc.

The following are a selection of the main types of technology in use for the aerobic composting of organic materials:

Turned Windrow – the most common form of composting technology is the turned windrow whereby the pre-mixed composting ingredients are formed into elongated piles with a typical cross section resembling a triangle. The cross sectional dimensions of the windrow depend on the type of machinery used for turning and on the balance between heat retention and oxygen diffusion. During the composting and curing cycles moisture is added to the windrow as required and it is regularly turned with temperature readings being taken on a predetermined basis. The turning process acts to aerate the mix, facilitate passive aeration and also to mechanically break down the material. A sufficiently coarse material is required to facilitate passive aeration, which is driven by the temperature gradient between the hot centre of the windrow and lower ambient temperatures.

Aerated Static Pile – pre-mixed composting ingredients are formed into a pile of varying configuration with an air distribution system underlying the pile. Air is either forced through or drawn through the pile via a fan. The mix is not turned during the cycle, hence the consistency of the premix is critical to the efficient operation of the system. The advantage of drawing air through the pile is that odorous air can be captured and treated, however, fan life will generally be shortened in this mode and power consumption is higher. There are also covered aerated pile systems that allow air to be blown through the piles and still capture the exhaust air for deodorisation. These systems also ensure pasteurisation of the outer layers of the static pile, which otherwise does not reach sufficient temperatures.

Aerated Turned Trough (Agitated Bed) – a technology that can be best suited to the composting of “clumpy” materials that have high odour generation potential. The premix of composting ingredients is generally contained in an elongated walled structure that can be situated above or below ground. A turning machine is mounted above the mix and travels along the walls as it turns the mix, predominantly to cause mechanical break down and homogenisation of the mix. Air is forced through the mix via a fan and an under-floor distribution system. The systems are generally enclosed, hence the exhausted air can be collected for treatment if required.

In-Vessel – there are many and varied configurations of in-vessel systems including horizontal units, vertical units and rotating drums.The premix of ingredients is loaded into a container/vessel of varying configuration and size with the unit then being closed. Air is forced through the mix in the sealed container via a fan and an under-floor air distribution system. The rising air is collected in the headspace of the vessel and recirculated through the mix. As oxygen levels are depleted and/or as temperatures approach the desired level, fresh air is introduced and hot air exhausted. The exhausted air can be treated if required. There are also in-vessel systems in which the material inside the vessel is agitated during the composting process. Where the mix is not turned during the cycle, the consistency of the premix is critical to the efficient operation of the system.

Fully Enclosed Systems - any of the above systems can be set-up in a fully enclosed building operated under negative air pressure with the extracted air being treated through a biofilter or other type of scrubber prior to being discharged to atmosphere.

7. ENVIRONMENTAL CONSIDERATIONS

Proponents should consult their local EPA for specific guidance on State-based environmental regulations on composting facility planning and environmental management. A general overview of environmental considerations for composting facilities is provided below.

Note that facilities should consider the implementation of an environmental management system such as that defined in ISO 14000 to minimise impacts on the surrounding environment.

Odour - In general, the issue most likely to cause problems for a composter is the emission of odour from the operation. Prospective composters must ensure that they have not only addressed measures to minimise odour generation but that they have also selected a site that provides suitable separation from sensitive receptors.

The strategy for minimisation of odour generation must take into account the following:

- selection of appropriate technology
- type of raw materials and their odour content on receipt
- method of receival and storage of raw materials
- method of mixing of raw materials
- mix ratios of raw materials
- management and monitoring of the composting process.
- management and monitoring of the curing process
- management of leachate
- screening of fresh composts
- collection and extraction of odorous air from various sources (receival, mixing, composting)
- appropriate means of deodorising exhaust air

The appropriate State environment agency will be able to provide detail of specific requirements for the establishment of a composting facility.

Dust - Dust emissions from a composting facility have the potential to cause unacceptable off-site effects. Such emissions are related to:

- handling of raw materials such as sawdust and dry manures and mulches
- turning of piles/windrows
- screening of composts
- wind sweeping of trafficked clay pad areas
- truck movements on access roads

Development of a strategy for the minimisation of dust generation must take into account the need for enclosure of certain operations, the maintenance of suitable moisture levels within materials and the matching of specific operations to the prevailing weather conditions.

Leachate/ Stormwater - Leachate can be generated from:

- excess moisture in the raw materials
- release of water in the composting process
- infiltration of rainwater/stormwater
- excessive irrigation.

A management strategy must be developed to ensure that there is not the potential for leachate to contaminate groundwater or surface waters or to cause odour problems.

This strategy must take into account the lining and contouring and bunding of the working pad, the mixing ratios of raw materials, the collection and management of rainwater, and the diversion of run-on water. This water may be used for watering purposes on-site to off-set overall water usage

The correct sizing of the collection pond is critical to the successful management of site waters, particularly during times of high rainfall and low evaporation. . Composting facilities typically aim for zero discharge of water from the site.

Vectors - Vectors such as flies, birds, mice and rats can be attracted to a composting facility in search of food. A strategy must be developed to minimise the attraction of the operation for such unwanted guests. This strategy will take into account issues such as the rejection of materials with high vector attraction capacity, the rendering of food items non-recognisable to minimise bird attraction, the minimisation of odour generation and the prevention of leachate “pooling”.

Noise - A composting facility may use a variety of heavy machinery and equipment that has the potential to cause off-site noise impact. These include loaders, shredders, trucks, mixers, turners, screens and fans. A strategy must be developed to ensure that the off-site impacts of such items will not exceed local regulations.

Factors that must be considered include the selection of suitable equipment, the need for acoustic enclosures, suitable hours of operation, and proximity to sensitive receptors.

Litter - Contamination of composting feedstocks with plastic film and paper can lead to litter problems both within and outside a facility. A strategy must be developed to minimise the potential for litter problems, with issues to be addressed to include:

- minimisation of the entry of litter items into feedstocks by segregation at the point of generation

- receival and mixing of materials indoors
- potential to screen products in a protected area
- establishment of windbreaks and litter fences
- cessation of specific operations on days of high wind

Fire - History shows that the outbreak of fire at composting facilities is a very real threat and one that usually results in dramatic damage to the facility and the business.

The development of a fire prevention and fire management plan is a prerequisite to the commencement of operation of a facility. Issues that need to be addressed include:

- sizing and management of piles of dry woody materials such as timber and bark, green organics and sawdust.
- monitoring and maintenance of suitable moisture levels in composting piles.
- monitoring of pile temperatures.
- prohibition of smoking on site
- assessment and minimisation of the risk of spark generation from operating equipment.
- reticulation of fire fighting water at suitable flows and pressure, from a supply of suitable capacity.
- prevention of unlawful entry to the site.

8. PROCESS CONTROL

The level of process control will depend to some extent on the technology selected, however, as a minimum the following aspects need to be addressed:

- selection of raw materials and recipes to give a mix of suitable carbon to nitrogen ratio, moisture content and porosity.
- monitoring of chemical and physical contaminants in feedstocks.
- in-situ monitoring of process parameters such as temperature, and moisture content at a frequency, and by a method, that provides confidence in the composting and pasteurisation conditions that have been attained.
- validation of the mixing/oxygenation procedures of the material to ensure exposure of all parts of the mix to the appropriate conditions.
- detailed external analysis of products at a frequency that gives confidence in the quality and consistency of the materials being produced.

9. FACILITY PLANNING

Close examination of the environmental, social and economic viability of a proposed facility is critical to its long term future. Many operations have floundered financially due to the failure of the proprietor to recognise all the costs of the operation, the true value of the end product and the importance of charging gate fees for incoming materials. Financial problems then lead to environmental problems as the operator takes "short cuts" in an attempt to reduce costs and improve cash flow. Issues that need to be addressed at the initial feasibility and planning stage include:

Planning Requirements - Planning authorities will defer to environmental regulators for assessment of many of the issues relating to a proposed composting facility, however, primary considerations for the planners will include:

- land zoning
- buffer distances/surrounding land use
- flood issues
- traffic flows
- landscaping
- hours of operation

Financial Assessment - In addition to the normal considerations of a financial evaluation, the following factors need to be critically assessed for a prospective composting operation:

- feedstock availability, consistency and seasonality.
- competition for feedstock.
- potential revenue from feedstock.
- availability and cost of blending ingredients.
- volume and weight loss factor - from initial mix to final product.
- product type and achievable price.
- transport costs.
- cash flow impacts by market seasonality.
- cost of residue disposal.

Environmental Issues (see Section 6) -

- types of materials to be accepted
- technology to be employed
- odour management
- noise control
- vector control
- stormwater/leachate collection and reuse
- dust and litter management
- fire prevention
- consultation with neighbouring property owners and occupiers
- climatic conditions

General Considerations -

- size of operation and area of land required for proposed operation with allowances for expansion and for peak storage periods
- availability of services to the site
- suitability of access roads in all weather
- site security

10. PRODUCT

A composters aim should be to produce a product that is compliant with the appropriate Australian Standard and which is “fit for purpose”.
Recycled Organics product has been adopted as a generic term for a range of products manufactured from compostable organic materials (garden organics, food organics, residual wood and timber, Biosolids and other organic materials). Specific recycled organics (RO) products, and products with RO content are defined in the following Australian Standards:

- AS 4454 (2003) Composts, Mulches and Soil Conditioners;
- AS 3743 (2003) Potting Mixes;
- AS 4419 (2003) Soils for Landscaping and Garden Use;
- AS 4422 (1998) Playground Surfacing.

There are also many unprocessed organic materials and RO products for which standards do not exist, such as raw leaf mulches and manures. No product standards or regulations govern the use of such undefined materials.

Manufacturing of a quality product that suits the requirements of markets is essential for commercial success. Proponents should consider the introduction of a quality management and occupational health and safety management system to ensure product of consistent quality is manufactured within a safe working environment.

11. PRODUCT MARKETS

The importance of developing sustainable markets for the product/s cannot be overstated. Not only will lack of sales create financial hardship it will also lead to the accumulation of excessive stockpiles of material on site, often resulting in environmental and operational problems.
Consideration should be given to the seasonality of markets and the development of outlets for the product that can help to balance out such fluctuations in sales.

12. REFERENCE DOCUMENTS

All of the following reference documents can be accessed via an on-line internet catalogue at www.rolibrary.com

Standards Australia AS 3743 (1996). Potting Mixes. Standards Association of Australia; Homebush, NSW, Australia.

Standards Australia AS 4419 (1998). Soils for landscaping and garden use. Standards Association of Australia; Homebush, NSW, Australia.

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Recycled Organics Unit (2001). Producing Quality Compost: Operation and management guide to support the consistent production of quality compost and products containing recycled organics. Recycled Organics Unit, The University of New South Wales, Sydney, Australia.

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Recycled Organics Unit (2002). Guide to Selecting, Developing and Marketing Value-Added Recycled Organics Products. Recycled Organics Unit, The University of New South Wales, Sydney, Australia.

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NSW Department of Urban Affairs and Planning (1996). Composting and Related Facilities EIS Guideline. NSW Government Printing Service, Sydney, Australia

NSW EPA (2002). {Draft} Environmental Guidelines: Composting and Related Organics Processing Facilities. NSW EPA, Sydney, Australia, February 2002

13. REFERRAL ORGANISATIONS

Compost Australia is the peak national association for the organics processing and recycling industry. The various State contacts for Compost Australia can be accessed at www.compostaustralia.com

The primary referral bodies for prospective composters will be the environmental regulatory agency within their home State, as well as the local planning authority.

A national contact listing for various government agencies and research organisations can be accessed at www.recycledorganics.com via the “contacts and links” page