

Guideline for Composting Facilities and Compost Use in Ontario

November 2009 – Draft for Consultation

Ministry of the Environment

**GUIDELINES FOR COMPOSTING
FACILITIES AND COMPOST USE IN ONTARIO
November 2009**

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SUMMARY

The Ontario Ministry of the Environment (ministry) has prepared a revised *Guideline* for aerobic composting of waste materials along with the proposed regulation changes for discussion purposes. The *Guideline for Composting Facilities and Compost Use in Ontario* replaces the *Interim Guidelines for the Production and Use of Aerobic Compost in Ontario* first released in November 1991 and last updated in 2004. There have been many changes in Ontario's composting industry since the *Interim Guidelines* were released. A revised *Guideline* was needed to describe current legislation, new industry standards and good management practices, as well as reflect advances in technology and science. This *Guideline* sets out three categories of compost quality (AA, A and B).

This *Guideline* has been prepared to assist proponents of composting facilities, ministry staff and others in the siting, design, and approval of aerobic composting facilities, and the production of quality compost based on engineering principles, practical experience, and current legislation.

In general, this *Guideline* applies only to aerobic composting of non-hazardous organic materials for the purpose of producing a humus-like material intended for use as a soil conditioner. Some composting operations (such as backyard composters, on-site composters, and on-farm composting of agricultural wastes) are beyond the scope of the *Guideline*. In addition, the *Guideline* does not address processes that are not aerobic (such as anaerobic digestion and fermentation), does not address biological treatment of hazardous wastes, and does not address processes to produce products that are not intended for use as a soil conditioner (such as the production of animal feed).

The *Guideline* consists of three Parts. **Part I** includes introductory information and an overview of the legislative framework. **Part II** sets out requirements for composting facilities in Ontario. Although this part of the *Guideline* uses mandatory language such as "must" and "shall", the *Guideline* is not a regulation and does not change the provincial legislation and regulations that apply to composting operations. However, the requirements presented in Part II will normally be included in a Certificate of Approval issued by the ministry. Inclusion as a condition of a Certificate of Approval will make the requirement legally binding on the operator of a specific composting site.

Part III of the document provides guidance to facility operators in the following areas:

- site selection and site design;
- composting facility unit operations;
- water management;
- prevention and control of contaminants (including odours); and
- occupational health and safety.

The guidance provided in Part III represents currently accepted best management practices for composting facilities. While proponents may not necessarily be required to operate in conformity with the guidance provided in Part III, they are strongly encouraged to do so.

PART I – INTRODUCTION AND OVERVIEW

1.0 INTRODUCTION

1.1 PURPOSE

Composting provides many benefits. Composting not only diverts organic materials from disposal in landfills, it also helps to return nutrients and organic matter to the soil, providing a valuable material for agriculture, horticulture and landscaping.

The purpose of the *Guideline for Composting Facilities and Compost Use* (referred to as the *Guideline*) is to protect the environment and human health by setting standards and recommending good management practices for the production of compost for beneficial uses.

The *Guideline* also contains details on the ministry's proposed regulatory amendments to Regulation 347 (General – Waste Management) made under the *Environmental Protection Act*, which would exempt compost that meets certain compost quality standards from the need for a Certificate of Approval for use and transport.

1.2 OBJECTIVES

The objectives of the *Guideline* are to:

- help Ontario increase waste diversion from disposal by increasing the composting of organic waste;
- assist in the development of composting as a waste management option in Ontario;
- prevent negative impacts on the environment by ensuring that compost facilities in Ontario and the compost that they produce both meet high standards for quality; and
- serve as a reference document for the design, approval, and operation of safe, efficient composting facilities.

1.3 SCOPE

The *Guideline* applies to aerobic composting of non-hazardous organic materials – including food waste, wood waste, pulp and paper mill biosolids, and digested, stabilized sewage biosolids and septage – for the purpose of producing a humus-like soil conditioner. The *Guideline* should be used together with good judgment and past practical experience in the handling of compostable wastes, their biodegradation, and marketing of the end product.

The *Guideline* does not apply to the following activities (a comprehensive Glossary which includes a description of these activities is located in Appendix 1):

- composting of "Agricultural Wastes", as defined in Regulation 347 made under the *Environmental Protection Act*;
- composting of "regulated dead animals" and "dead farm animals" under the *Food Safety and Quality Act, 2001* and the *Nutrient Management Act, 2002*.
- composting of "specified risk material" (SRM);
- residential backyard composting by householders;
- production of a product that is not intended for application to land or for use as a soil conditioner (e.g. production of a waste-derived animal feed);
- biological treatment of hazardous wastes;
- management of excess soils from construction activities;
- anaerobic digestion;
- vermicomposting or other waste stabilization methods (such as lime stabilization, fermentation, pasteurization); or
- remediation of contaminated soils. Information on remediation procedures is contained in *Guideline for Use at Contaminated Sites in Ontario, June 1996* and *Regulation 153/04-Record of Site Conditions*.

In general, compost to which this *Guideline* applies must meet the pathogen reduction and quality criteria presented in Section 3 of this document. Anaerobic waste treatment and vermicomposting are excluded from this *Guideline* because these processes generally do not meet the pathogen reduction process requirements contained in Section 5.2.2 of this document. Applications for approvals for anaerobic treatment of solid wastes or for vermicomposting will be considered on a case-by-case basis.

This *Guideline* provides some general information on the use of compost on both agricultural lands as a "nutrient" under O. Reg. 267 under the *Nutrient Management Act, 2002*, and on non-agricultural lands as an organic soil conditioner under Regulation 347 under the *Environmental Protection Act*. However, a detailed discussion on the land application of compost is beyond the scope of this *Guideline*. Additional information on the application of compost on agricultural lands is available from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). Additional information on the application of compost on non-agricultural lands is available from the Ministry of the Environment.

This *Guideline* is not intended to restrict process or equipment development. However, proponents of innovative composting techniques or new or updated technology differing significantly from currently accepted practices and processes must ensure that the technology can safely produce good quality compost as described in this *Guideline*. Such proponents are encouraged to contact the appropriate ministry Regional, District or Area Office in this regard.

1.4 ANAEROBIC DIGESTION

Anaerobic Digestion (AD) is the process where plant and animal material is converted into useful products by micro-organisms in the absence of air. Organic matter is put inside sealed tanks and

digested by naturally occurring micro-organisms, releasing methane that can be used to provide heat and power. The popularity of AD is likely to rise as a result of the growing demand for a renewable energy source to replace fossil fuels.

Although this *Guideline* does not apply to the actual AD process itself, the ‘best management practices’ and standards in this *Guideline*, including the quality control criteria for the end-product, should be adopted if the digestate from the AD facility is to be composted. Proponents of an AD facility may also refer to the following sections of this *Guideline* as guiding principles when considering the establishment of an AD facility:

- Laboratory analysis – Section 7
- Site selection considerations and design – Sections 8 and 9
- Health and safety – Section 11
- Wastewater management – Section 12
- Odour prevention and control – Section 13
- Prevention and control of adverse effects – Section 14

Approvals for AD and other bio-energy facilities that generate electricity are required to meet the requirements under the Renewable Energy Approval (REA) Regulation, O. Reg. 359/09 under the EPA. Proponents are encouraged to contact the appropriate MOE Regional, District or Area Office regarding AD facilities.

2.0 LEGISLATION, APPROVALS AND STANDARDS

The mandate of the ministry is to protect clean and safe air, land, and water to ensure healthy communities, ecological protection and sustainable development for present and future generations of Ontarians. Several acts and regulations exist to help the ministry fulfill this mandate. This section provides a brief overview of the key environmental protection acts and regulations that relate to composting:

- The *Environmental Protection Act*, R.S.O. 1990, c. E.19, (EPA) and **Regulation 347** (General – Waste Management) made under the EPA – regulates waste management activities, including the receiving and processing of organic waste materials by compost facilities, as well as the application and use of finished compost in non-agricultural applications.
- The *Ontario Water Resources Act*, R.S.O. 1990, c. O.40 (OWRA) – regulates discharges to surface and groundwater, including stormwater and leachate from composting facilities, to ensure that water resources are protected.
- The *Nutrient Management Act, 2002*, S.O. 2002, c. 4 (NMA) – regulates the application and storage of nutrients, including compost, on agricultural lands.
- The *Clean Water Act, 2006*, S.O. 2006, c. 22 (CWA, 2006)
- The *Environmental Assessment Act*, R.S.O. 1990, c. E.18, (EAA)
- The *Environmental Bill of Rights 1993*, S.O. 1993, c. 28 (EBR).

The reader is advised that this document is intended only as a general guide to some of the environmental protection legislation administered by the ministry. Composting facilities may be subject to other federal, provincial, or municipal laws and may require permits or approvals from agencies other than the MOE.

2.1 ENVIRONMENTAL PROTECTION ACT (EPA)

Part V of the EPA and Regulation 347 set out requirements for handling, storing, managing, and disposing of waste. The input feedstocks to the composting process are waste as defined under this legislation. Unless otherwise exempt, a composting project will require a Certificate of Approval for a Waste Disposal Site (Processing) under Section 27(b) of the EPA.

Section 9 of the EPA regulates the discharge of a contaminant into any part of the natural environment other than water. Composting facilities will also require a Certificate of Approval (Air) under Section 9 of the EPA where there is a direct discharge of contaminants into the

natural environment such as litter, dust, odour or noise.

In addition, a Certificate of Approval for a Waste Management System under Section 27(a) of the EPA is required by the owner of vehicles transporting waste materials. This includes transporting wastes from a source to a composting facility.

Some composting operations are exempt from some aspects of the EPA and Regulation 347. For example, Regulation 101/94 – *Recycling and Composting of Municipal Waste* – made under the EPA, provides an exemption from the requirement to obtain a waste Certificate of Approval when composting only leaf and yard waste, if certain conditions are met. Facilities that are exempt from Regulation 347 are still subject to the general provisions of the EPA. Therefore, even if the site is exempt, operators are strongly encouraged to manage their sites in accordance with good practices as described in this document.

“Agricultural wastes” as defined in Regulation 347 are generally exempt from Part V of the EPA and Regulation 347. On-farm composting of agricultural wastes does not require approval from the ministry. In addition, on-farm composting of dead farm animals – regulated by O. Reg. 106/09 (Disposal of Dead Farm Animals) under the *Nutrient Management Act, 2002* – and off-farm composting of dead animals by a licensed compost facility operating under O. Reg. 105/09 (Disposal of Deadstock Regulation) under the *Food Safety Quality Act, 2001*, are both exempt from approval requirements under the EPA. However where agricultural waste and dead farm animals are received by a compost facility with a Certificate of Approval under the EPA they must be managed according to the requirements of the Certificate of Approval.

Composting operations that process only material that is generated on-site usually are not required to obtain a Certificate of Approval. However, if the finished compost is used off-site, the compost must comply with the pathogen reduction and quality requirements described in Sections 3 and 5.2 of this *Guideline*. If wastes are accepted from off-site, a Certificate of Approval will be required.

The proposed amendments to Regulation 347 would exempt any compost that meets the Category AA quality criteria set out in Sections 3.1 to 3.5 of this *Guideline* from the requirements to obtain a Certificate of Approval for use and transport. There are no restrictions under the EPA on the application of Category AA compost.

The proposed amendments to Regulation 347 would also exempt any compost that meets the Category A quality criteria set out in Sections 3.1 to 3.5 of this *Guideline* and the labelling/notification requirements set out in Section 4 of this *Guideline* from the requirements to obtain a Certificate of Approval for use and transport. Category A compost is to be applied in accordance with the application restrictions provided on the compost label.

Composted material that meets the quality criteria for Category B set out Sections 3.1 to 3.5 of this *Guideline* would continue to be a “waste” that is subject to all of the ministry approval requirements for transportation, use and disposal. However, Category B compost may be put to beneficial use through a variety of applications, such as on agricultural land as a ‘nutrient’

pursuant to O. Reg. 267/03 under the NMA; as an organic soil conditioner on non-agricultural land (e.g., for land reclamation, mining rehabilitation, reforestation, etc.), pursuant to an organic soil conditioning site Certificate of Approval; or as daily, intermediate or final cover at a landfill pursuant to a waste disposal site Certificate of Approval.

Approvals questions, including questions whether a specific exemption applies, can be directed to the appropriate ministry's Regional, District or Area Office, or the Environmental Assessment and Approvals Branch (Appendix 2).

2.2 ONTARIO WATER RESOURCES ACT (OWRA)

Composting facilities, especially those that are not enclosed in a building, often generate sewage (storm water and leachate) which must be properly managed. Approval under Section 53 of the OWRA will be required for any facility that directly discharges sewage to a receiving water body or directly to the ground. A permit to take water (PTTW) may also be required if the site is not serviced. The ministry's district staff should be consulted for further information on the OWRA. 'Sewage', as defined under OWRA Section 1, includes drainage, storm water, commercial wastes and industrial wastes and such other matter or substance as is specified by regulations made under clause 75 (1) (i). For the purpose of this *Guideline*, the word 'wastewater' is often used in place of 'sewage' and also means stormwater and leachate generated at a composting facility.

2.3 NUTRIENT MANAGEMENT ACT, 2002 (NMA)

The NMA came into force in 2002 and enhances the protection of Ontario's water resources by minimizing the effects of livestock manure and other nutrients that are stored on farm properties or land applied. The Act provides clear requirements for environmental protection for Ontario's agricultural industry, municipalities and other generators and receivers of materials that contain nutrients.

The NMA establishes standards with respect to the management of materials containing nutrients and requires farmers and other generators and users of such materials to comply with those standards. The preparation of Nutrient Management Plans (NMPs), Non-agricultural Source Material (NASM) Plans, and Nutrient Management Strategies is a key requirement of the Act. The NMA also provides for the enforcement of the standards by provincial officers.

The proposed amendments to O. Reg. 267/03 under the NMA would exclude Category AA and Category A compost from the definition of a "non-agricultural source material" under the NMA. Accordingly, Category AA and Category A compost could be used on agricultural lands without a NASM Plan; however, where this compost is applied as a nutrient on an agricultural land that is required to have a NMP or NASM Plan, the compost must be applied in accordance with the NMP or NASM Plan and O. Reg. 267/03.

Category B compost may be used on agricultural land as a 'nutrient' subject to the requirements

of O. Reg. 267/03. Under the proposed amendments to O. Reg. 267/03 under the NMA, compost that meets the Category B quality criteria set out in Sections 3.1 to 3.5 of this *Guideline* would be listed as a Category 3 material under O. Reg. 267/03 and would meet the “CM2” metal criteria and “CP1” pathogen criteria as set out in O. Reg. 267/03. Additional information on use as a nutrient is available from OMAFRA.

OMAFRA and the Ministry of the Environment (MOE) are jointly responsible for administering the NMA. OMAFRA works closely with farmers, provides training and education, and is responsible for approvals of nutrient management strategies, nutrient management plans, and NASM plans (as appropriate). The MOE oversees the compliance and enforcement activities related to the NMA.

2.4 CLEAN WATER ACT, 2006 (CWA)

The CWA, 2006 and five of its regulations came into force in July 2006. The purpose of this Act is to protect existing and future drinking water sources through a collaborative and locally driven multi-stakeholder process. Under the CWA, 2006, Source Protection Committees (SPCs) including municipalities, conservation authorities and other key stakeholders will identify and assess risks to the quality and quantity of drinking water sources, and develop plans to manage those risks.

For each source protection area, the SPC will complete an assessment report that identifies vulnerable areas in the watershed, provides an inventory of activities within these areas, and then assesses the risks associated with those activities. Vulnerable areas include wellhead protection areas (areas around groundwater wells), intake protection zones (areas around surface water intakes), areas of significant groundwater recharge, and highly vulnerable aquifers. Whether an activity poses a significant risk will be dependant on where it is located within a vulnerable area, and whether or not the activity uses, stores, or produces chemicals or pathogens that could pose a risk to public health, or if it impacts the quantity of water available within an aquifer or surface water body.

If the scientific assessment shows that an activity, which is located in one of the above vulnerable areas, poses a significant risk to a drinking water source, the SPC and local community must develop policies to manage each of those significant risks. Policies may range from planning policies, to education and outreach policies, to a requirement to develop a risk management plan. Existing measures that manage the risks would be taken into account when setting or implementing these policies.

2.5 ENVIRONMENTAL ASSESSMENT ACT (EAA)

The EAA sets out a planning and decision-making process to evaluate the potential environmental effects of a proposed undertaking. Proponents wishing to proceed with an

undertaking must document their planning and decision-making process and submit the results of their environmental assessment (EA) to the Minister for approval.

The purpose of the EAA is to provide for the protection, conservation and wise management of Ontario's environment. To achieve this purpose, the EAA promotes responsible environmental decision-making and ensures that interested persons have an opportunity to comment on undertakings that may affect them. The EAA defines the 'environment' broadly to include the natural, social, cultural and economic environments.

Ontario Regulation 101/07, Waste Management Projects, prescribes how certain waste management projects will be assessed under the EAA. The regulation and incorporated guideline streamlines the EA process for some undertakings with known environmental impacts and standard mitigation measures. Composting facilities are captured under this regulation as 'waste processing facilities'. Waste processing facilities that process 1,000 tonnes of waste per day or less are not designated by the regulation and therefore have no EA requirements. Waste processing facilities that generate, on an annual average, less than 1,000 tonnes of waste (i.e., residual waste) per day are also exempt from the EA requirements.

For further information on the EA process, staff at the ministry's Environmental Assessment and Approvals Branch should be consulted.

2.6 ENVIRONMENTAL BILL OF RIGHTS, 1993 (EBR)

The EBR requires that the Ministry of the Environment, on behalf of the government of Ontario, maintain a registry of proposals, decisions, and other activities that could affect the environment. The purpose of the "Environmental Registry" is to allow the public to participate in the making of environmentally significant decisions by prescribed ministries. Under the EBR, proposals to issue certain instruments (e.g., Certificates of Approval) must be posted on the registry for public review and comment for a minimum of 30 days before issuance. Instruments that are issued to implement a project that is approved or exempted under the *Environmental Assessment Act* are not subject to the consultation requirements under the EBR.

Where a proposal is posted on the Environmental Registry, the ministry must consider all comments received when making decisions and include a summary of its considerations of those comments when posting a Notice of Decision.

2.7 APPLICATIONS FOR APPROVAL

Applications for ministry approvals can be obtained from the nearest MOE Regional or District Office or from the ministry website at <http://www.ene.gov.on.ca/en/publications/forms/index.php>. The following documents may be of assistance when completing an application:

- *Guide for Applying for Approval of Waste Disposal Sites*, June 2009, PIBS 4183e

- *Guide for applying for Approval (Air & Noise), s.9 EPA*, November 2005

The Environmental Assessment and Approvals Branch of the ministry has also produced examples of complete application submissions:

- *Sample Application Package for a Certificate of Approval for a Waste Disposal site (Composting Facility)*, May 2009, PIBS 6838e – available on the ministry’s website at: <http://www.ene.gov.on.ca/publications/6838e.pdf>
- *Sample Application Package for Air & Noise Certificate of Approval*, June 2007, PIBS 5987e – available on the ministry’s website at: <http://www.ene.gov.on.ca/envision/gp/5987e.pdf>

In order for the ministry to evaluate a proposed composting operation, the proponent must provide the ministry with information that adequately describes the proposed facility. Appendix 3 lists information that is usually required in order to make decisions about a proposed facility. This list may be modified by the ministry, depending on the nature of the proposed facility.

2.8 OTHER JURISDICTIONS

The ministry is not the only agency concerned with the production and use of compost. Several regulatory and voluntary standards for compost production and use have been developed in recent years. In particular, site operators should be aware of the following compost quality initiatives which are summarized in Appendix 4:

- The Canadian Food Inspection Agency regulates the **sale** of compost under the federal *Fertilizers Act*;
- Environment Canada, on behalf of the Canadian Council of Ministers of the Environment (CCME), has developed a national guideline for compost quality;
- The Bureau de Normalization du Quebec (BNQ), on behalf of the Standards Council of Canada (SCC), has published a voluntary industry standard for compost.

PART II – STANDARDS FOR COMPOSTING FACILITIES

3.0 FINISHED COMPOST QUALITY

This section of the *Guideline* contains quality criteria for finished compost including limits for:

- trace elements (or heavy metals) in finished compost;
- trace elements (or heavy metals) in the feedstock;
- pathogens;
- foreign matter content; and
- compost maturity.

These quality criteria are used to identify whether finished compost may be categorized as Category AA, A or B compost. **The finished compost must be tested after the maturation period is complete and prior to release into the marketplace.** If the compost fails to meet *any one* of the criteria set out in Sections 3.1 to 3.5 of the *Guideline* for a specific category, then the compost will fail to meet that category. Analytical methods for determining quality criteria are described in Appendix 7.

The quality parameters in this section are based on the need to protect the environment and human health, and may not include quality parameters of importance to specific end users of compost. Quality requirements for specific market applications may be more stringent than indicated in this document. Many of these specific markets (e.g., nurseries) have established their own quality specifications for materials they purchase or use. Therefore, meeting the quality requirements of this *Guideline* does not ensure that compost will meet the needs of specific end users.

Additional recommended criteria (such as nutrient content, pH and salinity) are presented in the BNQ Industry Standard, CAN/BNQ 0413-200/2005, *Organic Soil Conditioners - Compost*.

The Compost Quality Alliance, a voluntary industry program managed by the Composting Council of Canada that uses standardized testing methodologies and operating protocols to analyze compost, can assist with confirming product quality with respect to specific end uses.

3.1 TRACE ELEMENTS (HEAVY METALS) IN FINISHED COMPOST

Although low concentrations of some trace elements can be beneficial to or even necessary for plant growth and development, higher concentrations of trace elements can be detrimental to human health or the environment. Therefore, this *Guideline* sets out limits on the concentration of trace elements in finished compost.

Finished compost shall be tested for those parameters listed in Table 3.1 and shall be categorized

as either AA, A or B, according to the concentrations listed for each parameter, as calculated on a dry weight basis. Sampling of finished compost shall be conducted in accordance with the guidance provided in Section 6 of this *Guideline*. The chemical analysis of compost samples shall be conducted in accordance with Section 7 of this *Guideline*. Information on laboratory performance criteria is also provided in Section 7 and Appendix 7.

TABLE 3.1 - Maximum Concentration for Trace Elements in Finished Compost

Item	Column 1	Column 2	Column 3	Column 4
	Metal Material	Category AA Compost	Category A Compost	Category B Compost
<i>mg/kg dry weight</i>				
1.	Arsenic	13	13	75
2.	Cadmium	3	3	20
3.	Chromium	210	210	1060
4.	Cobalt	34	34	150
5.	Copper	100	400	760
6.	Lead	150	150	500
7.	Mercury	0.8	0.8	5
8.	Molybdenum	5	5	20
9.	Nickel	62	62	180
10.	Selenium	2	2	14
11.	Zinc	500	700	1850

Some potential feedstocks may be known or suspected to contain organic or chemical compounds other than those metals listed in Table 3.1, which may have an adverse effect on the environment. In such cases, the MOE may require, through a facility’s Certificate of Approval, that the finished compost be monitored for these compounds to establish whether there is likely to be any adverse environmental or human health impact resulting from their presence. The identification of specific compounds and acceptable concentrations in the finished compost will be determined during the facility approval process, based on the source of the organic materials to be composted and the proposed end use of the compost product. Monitoring of compost for such additional compounds may be discontinued when and if acceptable quality is consistently demonstrated, but must be resumed when the organic waste source or processing conditions are changed.

3.2 QUALITY OF FEEDSTOCK

Table 3.2 identifies limits on feedstock that can be used to produce finished compost. For Category AA compost, the feedstock must not contain any of the parameters in a concentration

that exceeds the limits set out in Column 2 of Table 3.2, as calculated on a dry weight basis. In addition, sewage biosolids, pulp and paper biosolids and septage are not permitted to be used as feedstock material for the production of Category AA compost. For Category A and B compost, feedstock must not contain any of the parameters in a concentration that exceeds Column 3, as calculated on a dry weight basis.

TABLE 3.2 - Maximum Concentration for Trace Elements in Feedstock

Item	Column 1	Column 2	Column 3
	Metal Material	Feed for Category AA Compost	Feed for Categories A & B Compost
		<i>Mg/kg dry weight</i>	
1.	Arsenic	75	170
2.	Cadmium	20	34
3.	Chromium	1060	2800
4.	Cobalt	150	340
5.	Copper	760	1700
6.	Lead	500	1100
7.	Mercury	5	11
8.	Molybdenum	20	94
9.	Nickel	180	420
10.	Selenium	14	34
11.	Zinc	1850	4200

3.3 PATHOGENS

In order to reduce the risk of adverse health effects from pathogens, finished compost must meet the criteria specified below, depending on the feedstock source:

1. For leaf and yard waste only:

- a. the composted waste must meet temperature requirements as specified in Section 5.2,
- OR**
- b. *E. coli* < 1000 colony forming units (CFU) or most probable number (MPN)/g total solids, and
Salmonella < 3 MPN/4g total solids (based on an analysis of the entire 4g sample).

2. For all other wastes:

- a. the composted waste must meet temperature requirements as specified in Section 5.2,
- AND**

- b. *E. coli* < 1000 colony forming units (CFU) or most probable number (MPN)/g total solids, and
Salmonella < 3 MPN/4g total solids (based on an analysis of the entire 4g sample).

3.4 FOREIGN MATTER

Finished compost should be virtually free of foreign matter of a size or shape that could reasonably be expected to cause human or animal injury, or damage to equipment. The total foreign matter content and sharp foreign matter content of finished compost shall not exceed the concentrations listed in Table 3.3, as calculated on a dry weight basis.

TABLE 3.3 - Maximum Concentration of Foreign Matter in Finished Compost

Parameter	Category AA	Category A	Category B
Foreign matter	Total foreign matter (including plastics) greater than 3 mm shall not exceed 1.0%, calculated on a dry weight basis; and Compost shall not contain more than 1 piece of foreign matter greater than 25 mm per 500 ml.	Compost shall not contain more than 1 piece of foreign matter greater than 25 mm per 500 ml.	Compost shall not contain more than 2 pieces of foreign matter greater than 25 mm per 500 ml.
Sharp foreign matter	Compost shall not contain any foreign matter greater than 3 mm.	Compost shall not contain any foreign matter greater than 3 mm.	Compost shall have a maximum of 3 pieces of sharp foreign matter per 500 ml; and The maximum dimension of any sharp foreign matter shall be 12.5 mm.

3.5 MATURITY

There is no exact definition of compost maturity. Generally, the term "mature" is used in reference to compost that exhibits limited biological activity and which has degraded to the point where it can be stored without risk of adverse effects, and which can be used without risk to plants from residual phytotoxic compounds.

After a minimum curing period of 21 days, compost must be tested and found to meet one of the following 3 maturity tests (analytical methods for determining maturity are described in Appendix A.7.2.6):

1. the respiration rate is less than, or equal to, 400 mg of oxygen per kilogram of volatile solids per hour; or
2. the carbon dioxide evolution rate is less than, or equal to, 4 milligrams of carbon in the form of carbon dioxide per gram of organic matter per day; or
3. the temperature rise of compost above ambient temperature is less than 8°C.

Alternatively, in the absence of specific tests for maturity, compost must be subjected to a curing period of at least 6 months. The curing process should be taken to commence immediately after the pathogen reduction process ends. During this period, the compost must be turned at least once a month. Maturation is a time-dependent process and a 6-month period gives reasonable assurance that the compost will be sufficiently decomposed and hence, mature. Additional information regarding compost maturity is presented in Appendix 5.

3.6 ADDITIONAL COMPOST QUALITY CRITERIA

These are not specifications, but are ranges of characteristics typical of good compost quality:

Particle Size:	<25 mm
Moisture:	30% - 50%
Total Organic Matter:	> 30% dry weight basis
C/N Ratio:	< 20
pH:	5.5 – 8.5
Soluble Salts:	< 4 ms/cm
Sodium (NA):	<2%

Salts in the form of mineral ions are naturally present in all composts and normally concentrate somewhat during composting. Salt may pose limitations for soil application, since plants have varying sensitivities.

The Compost Quality Alliance (CQA) is a voluntary program established by the Composting Council of Canada and the compost producers using standardized testing methodologies and uniform operating protocols to improve customer confidence in compost selection and utilization. The CQA has established the following criteria/uses based on salt content in compost:

	Soluble Salts (ms/cm)	%Na
Remediation	< 20	< 3%
Soil Amendment	< 6	< 2%
Landscaping	< 5	< 2%
Planting Media	< 4	< 2%
Turf	< 3	< 1%
Potting Soil	< 2	< 1%

4.0 USE OF COMPOST

This section describes the restrictions on the use of each Category of finished compost.

NOTE: In addition to satisfying the Ontario quality standards and restrictions on use, all compost products sold in the Canadian marketplace must also meet the safety, efficacy, and labelling requirements as found in the federal *Fertilizers Act* and regulations, administered by the Canadian Food Inspection Agency.

4.1 CATEGORY AA COMPOST

The proposed amendments to Regulation 347 would exempt any compost that meets all of the Category AA quality criteria set out in Sections 3.1 to 3.5 of this *Guideline* from the approval requirements under Part V of the EPA and Regulation 347. Compost that is exempt does not require a Certificate of Approval for the use or transport of that material. There are no restrictions on the application of Category AA compost on non-agricultural lands.

The proposed amendments to O. Reg. 267/03 under the NMA would exclude compost that meets the Category AA quality criteria set out in Sections 3.1 to 3.5 of the *Guidelines* from the definition of a “non-agricultural source material” (NASM) under O. Reg. 267/03. Accordingly, Category AA compost could be used on agricultural lands without a NASM Plan; however, where Category AA compost is applied as a nutrient on agricultural land that is required to have a Nutrient Management Plan (NMP) or NASM Plan, the compost must be applied in accordance with the NMP or NASM Plan and O. Reg. 267/03.

4.2 CATEGORY A COMPOST

The proposed amendments to Regulation 347 would exempt any compost that meets the Category A quality criteria set out in Sections 3.1 to 3.5 of this *Guideline* and the labelling requirements set out below from the approval requirements under Part V of the EPA and Regulation 347.

All Category A compost that is sold or distributed must be labelled with the following information:

- A statement that the maximum rate of application must be less than 8 tonnes dry weight per hectare (80 kg/100 m²) per year, or a total of less than 40 tonnes dry weight per hectare (400 kg/100 m²) over any 5 year period should the application not be on an annual basis. This statement must be expressed in clear language using units of measurement appropriate to the quantity being distributed, such as:

Each 20 kg bag of Category A compost must be spread on a minimum area of 25 m² (5m X 5m). The maximum application rate of Category A compost is 80 kg (4 bags)

per 100 m².

- Identification of any septage, sewage biosolids and/or pulp and paper biosolids used as feedstock for the compost.
- A statement that: “This product should not be used on soils with elevated copper or zinc concentrations.”

Where the compost is sold or distributed in bags, the required label information must be clearly written on the front label of the bag in letters that are a minimum of 5 mm high. Where the compost is sold or distributed in bulk, the required information must appear in large print (font 14 or greater) on a shipping bill or statement accompanying the shipment. Compost that is **sold** must also meet the labelling requirements set out in the federal *Fertilizers Act* and regulations.

Compost that is exempt from the approval requirements under Part V of the EPA and Regulation 347 does not require a Certificate of Approval for the use or transport of that material. However, Category A compost is to be applied by the end-user in accordance with the application rate restrictions provided in this *Guideline* and on the compost label.

In addition, the proposed amendments to O. Reg. 267/03 under the NMA would exclude compost that meets the Category A quality criteria and labelling requirements set out in the *Guideline* from the definition of a “non-agricultural source material” (NASM) under O. Reg. 267/03. Accordingly, Category A compost could be used on agricultural lands without a NASM Plan in accordance with the application restrictions specified on the compost label. However, where Category A compost is applied on agricultural land that is required to have a Nutrient Management Plan (NMP) or NASM Plan, the compost would be considered a nutrient, and therefore must be applied in accordance with the NMP or NASM Plan and O. Reg. 267/03.

4.3 CATEGORY B COMPOST

The transportation and use of Category B compost would continue to require government approval. Category B compost would not be permitted for use in parks or for residential purposes. However, Category B compost may be put to beneficial use through the following applications:

- **Organic soil conditioning** – Category B compost may be used as an organic soil conditioner in a variety of non-agricultural applications (e.g., land reclamation, mining rehabilitation, reforestation, etc.), subject to a Certificate of Approval (organic soil conditioning site) that permits the spreading or application of Category B compost.
- **Agricultural land use** – Category B compost may be used on agricultural land as a ‘nutrient’ subject to the requirements of O. Reg. 267/03 under the NMA. Category B compost that is sold must meet the requirements for application of a commercial fertilizer. Compost that meets the Category B quality criteria set out in this *Guideline* would be listed as a Category 3 material under the proposed amendments to O. Reg.

267/03, and would meet the “CM2” metal criteria and “CP1” pathogen criteria as set out in O. Reg. 267/03. Additional information on nutrient use on agricultural land is available from OMAFRA at <http://www.omafra.gov.on.ca/english/nm>.

- **Blending operations** – Category B compost may be used by a blending facility that has a Certificate of Approval (waste disposal site – processing) permitting the use of Category B compost in its processing operations.
- **Landfill cover** – Category B compost may be used as daily, intermediate or final cover at a landfill that has a Certificate of Approval (waste disposal site) that permits the use of Category B compost as cover.

Category B compost that is **sold** must also meet all requirements set out in the federal *Fertilizers Act* and regulations.

4.4 FAILED COMPOST

Compost that fails to meet the quality criteria for Category AA, A or B set out in Sections 3.1 to 3.5 of the *Guidelines* is a “waste” under the EPA. As a waste, failed compost is subject to all of the ministry approval requirements for transportation, use and disposal.

However, failed compost may be suitable for application to land that has received approval either as an “organic soil conditioning site” under Part V of the EPA, or as a “nutrient” under the NMA. Materials that are applied as a nutrient pursuant to the NMA are exempt from the approval requirements for use under the EPA. Additional information on nutrient use is available from OMAFRA. Additional information on organic soil conditioning sites is available by consulting the local District Office of the Ministry of the Environment.

Failed compost that is not applied to land under an organic soil conditioning site Certificate of Approval or a NASM Plan under the NMA, 2002, must be disposed of at an approved waste disposal site. Proponents should also consult their local District or Area Office to determine whether or not the landfill is permitted under its Certificate of Approval to use failed compost (waste) as daily cover.

5.0 REQUIREMENTS FOR COMPOSTING FACILITIES IN ONTARIO

This section presents operating standards and other requirements for composting sites in Ontario. These requirements will normally be included in a Certificate of Approval for a Waste Disposal Site (Processing) issued by the Ministry of the Environment, making them legally binding on the site operator. There are requirements in the following areas:

- Feedstock quality and testing;
- Process control;
- Sewage (wastewater) management;
- Noise, odour, fire, litter and dust management; and
- Reporting and record keeping.

5.1 FEEDSTOCK QUALITY AND TESTING

The most important quality control steps in the production of compost are the selection, collection, and handling of feedstocks. Clean, source separated wastes are much more likely to produce compost that meets both regulatory and end market quality requirements. Therefore, operators of composting facilities must take reasonable steps to ensure that they accept only those feed materials that can reasonably be expected to produce finished compost that will meet the quality criteria for Category AA, A or B (see Section 3 for information on the quality criteria for each of these categories of compost).

Acceptable feedstocks are:

- Organic
- Biodegradable
- Non-hazardous solid
- Non-hazardous liquid (at facilities that can handle these wastes)
- Those which can be processed into finished compost that meets quality criteria for Category AA, A or B

Examples of acceptable feedstocks include the following:

- Leaf and yard wastes
- Food wastes
- Food processing wastes
- Non-recyclable paper wastes
- Wood wastes (excluding pressure treated wood waste)
- Pulp and paper biosolids *
- Septage *
- Sewage biosolids *

- Agricultural manures
- Crop residues

* Septage, sewage biosolids and pulp and paper biosolids are not acceptable feedstocks for the production of Category AA compost.

Unacceptable feedstocks are:

- Predominantly inorganic
- Hazardous or liquid industrial waste including biomedical, PCB and radioactive waste;
- Specified Risk Material (SRM) or animals infected with bovine spongiform encephalopathy (BSE) or potentially BSE contaminated wastes
- Not readily biodegradable within a reasonable period of time
- Those which contain contaminants or foreign matter in concentrations so high that they cannot reasonably be expected to produce compost that meets the compost quality standards
- Those which contain trace elements in concentrations that exceed the allowed feedstock concentrations set out in Section 3.2

Recent experience with efforts to compost disposable diapers and sanitary products has demonstrated that these materials can be challenging to process. Without appropriate mechanical processes specifically designed to manage these materials, diapers and sanitary products often remain mostly intact in the final compost product, and the uncomposted fibre portion and residual plastic must be removed and disposed as waste. Diapers have also been identified as a contributor to odour problems at compost facilities where accepted. For these reasons, it is not recommended that compost facilities accept diapers and sanitary products as feedstock unless they have implemented special management techniques, odour control systems and processing technologies required to receive these materials.

Note: Operators of compost facilities are responsible for clearly identifying and tracking wastes that will result in the production of different categories of compost (i.e. Category AA, A and B). This is particularly important if more than one category of compost is to be produced. In particular, biosolids and feedstocks with higher trace element (or heavy metals) concentrations need to be carefully tracked prior to receipt, throughout the composting process and during compost sale/distribution.

Procedures for sampling feedstock materials are presented in Section 6. Methods suitable for the analysis of samples are discussed in Section 7.

5.2 PROCESS CONTROL REQUIREMENTS

Highly putrescible wastes, including food wastes, biosolids and manures, should be incorporated into the active composting process on the day of receipt.

Less putrescible wastes, such as leaf and yard wastes (except brush), should not be on-site for more than four days before entering the active composting process.

Food waste and other odour generating feedstocks (e.g., biosolids and manures) should only be processed in a building or enclosed structure, which has technology to collect and treat the odorous air before discharging the air to the atmosphere.

5.2.1 Aerobic Conditions

During composting, the composting mass must be provided with adequate aeration to ensure that aerobic conditions are maintained.

5.2.2 Temperature Control and Pathogen Reduction

Compost feedstocks may contain pathogenic organisms. In order to reduce the risk of adverse health effects from pathogens in finished compost, **all** composted wastes must meet the time and temperature criteria specified below:

- Using the in-vessel composting method, the material shall be maintained at a minimum temperature of 55 degrees Celsius for at least 3 (three) days.
- Using the windrow composting method, the material shall be maintained at a minimum temperature of 55 degrees Celsius for at least 15 (fifteen) days. Also, during the high temperature period, the windrow shall be turned at least five times.
- Using the aerated static pile composting method, the material shall be maintained at a minimum temperature of 55 degrees Celsius for at least 3 (three) days. The preferable practice is to cover the pile with an insulating layer of material, such as cured compost or wood chips, to ensure that all areas of the feed material are exposed to the required temperature.

The temperature of each composting mass must be measured **daily** until the requirements above have been satisfied. The days during which the compost, using the windrow composting method, must meet the prescribed temperature do not have to be consecutive. Once these requirements have been met and the compost mass enters the curing phase, the temperature must be measured at least once **weekly**.

Temperatures should be measured at a sufficient number of points (4 or more) in the composting mass to ensure an accurate temperature profile. Temperatures should be measured at a depth of one metre from the surface of the composting mass.

If temperature monitoring shows that the specified minimum time and temperature relationship

has not been achieved, the material from the composting process must be incorporated back into the composting process at the pre-processing stage or disposed at a waste disposal site.

5.3 SEWAGE (WASTEWATER) MANAGEMENT

Proponents must take appropriate measures to manage wastewater at composting sites. If sewage is directly discharged to a receiving water body or directly to the ground, approval under the OWRA (Section 53) is required. “Sewage”, as defined under OWRA Section 1, includes drainage, storm water, commercial wastes and industrial wastes and such other matter or substance as is specified by regulations made under clause 75(1)(i) of the OWRA.

As part of the approval process, proponents may be required to conduct a hydrologic engineering study of their proposed composting site, especially for larger, outdoor sites. Such a study should identify the quantities of runoff and leachate to be managed and should identify appropriate options for managing it. If the study identifies infiltration as a preferred treatment option, a hydrogeological study may also be required. Proponents who do not wish to conduct a detailed study must meet the following minimum requirements for outdoor composting sites:

- any areas of the site used for receiving, processing, composting, finishing, or storing waste or compost must be located on surfaces which minimize the release of leachate or storm water runoff to groundwater. Surfaces must have a permeability not greater than 10^{-7} centimetres per second;
- the site must be graded such that any leachate or stormwater contaminated with leachate, compost, or waste is directed into a retention pond;
- the retention pond must be sized such that it can safely store 110% of the stormwater runoff from all active areas of the site for a precipitation event based on the intensity of a 24 hour duration event with a 25 year return period; and
- the contents of the retention pond must be treated according to one of the methods outlined in Section 12.3, or by other means acceptable to the ministry.

5.4 ODOUR MANAGEMENT

Uncontrolled odours can cause major problems for a composting facility. Owners and operators are responsible for ensuring that odours are properly managed. Composting facilities are required to obtain a certificate of approval for air emissions under Section 9 of the EPA (unless they are specifically exempt). All composting facilities must develop an odour prevention and control plan. An odour impact assessment may also be required, depending on the size, location and type of the proposed new facility or facility expansion. Detailed information on odour prevention and control is presented in Section 13.

5.5 CONTINGENCY PLANS

Site operators must develop and maintain plans for dealing with noise, dust, litter, fire, emergency and non-routine situations at the composting facility. A copy of these contingency plans must be kept at the site and operations staff must be well acquainted with the contents of the plans. The plan must be implemented as soon as a problem is discovered. Site operators are required to conform to the *Ontario Fire Protection and Prevention Act*, administered by the Office of the Fire Marshal, Ministry of Community Safety and Correctional Services. The specific requirements for contingency plans are outlined in Appendix 3 (11).

5.6 REPORTING AND RECORD KEEPING

The facility operator must establish and maintain records regarding daily operations at the facility, including public complaints. Information must be kept for at least two years and must be made available to a ministry staff upon request. The following information must be included:

- source, type, quality, and quantity of wastes received at the site;
- process operating information (such as temperatures, retention times required under Section 5.2.2);
- quantity of compost and residues produced and the quantity and destination of compost and residue removed from the facility;
- log book of all feedstock and compost sampling events with sufficient detail to clearly identify the source of all samples taken;
- all information, as described in Section 5.6, from laboratory reports/certificates of analysis; and
- log book of all public complaints received and corrective action taken to abate problems.

6.0 FEEDSTOCK AND COMPOST SAMPLING

All sampling and analysis required in a Certificate of Approval is the responsibility of the facility owner/operator.

Composting facilities are generally required to sample and analyse the parameters set out in Section 3 of this *Guideline*. In certain circumstance, however, based on the waste stream, processing method or the suspected presence of toxic substances, the ministry may require additional parameters to be measured or vary the frequency of analysis in the compost facility's Certificate of Approval.

Successful composting requires the accurate measurement of chemical and physical characteristics of the feedstock and the finished compost. Composting involves large quantities of material, so analysis of all material is impractical. Therefore, decisions regarding process, control and compost quality are usually made based on the analysis of representative samples of material.

Collecting a representative sample is the first step in the process of analysing the physical and chemical characteristics of the feedstock or finished compost. Care must be taken throughout the sampling process because poor sample collection or handling practices can render the most careful laboratory analyses useless.

Sampling of materials at a composting facility is generally conducted for one or more of the following purposes:

- to categorize finished compost in accordance with this *Guideline* and compare it to end market quality standards;
- to determine the characteristics of feedstock and amendment materials; or
- to provide information necessary for process control.

The "quality" of the data required for each of these purposes differs. Data can be acceptable for one purpose and unacceptable for another. Therefore, the procedures for collecting and handling samples for each purpose may also differ. Recommended procedures for sampling finished compost are presented in Section 6.1 while recommended procedures for sampling feedstocks and compost in process are presented in Section 6.2.

Regardless of the reason for collecting samples, all sampling should be conducted according to a documented sampling plan. A written sampling plan is needed to help ensure that field samples are representative of the material being sampled, that the results are reproducible, and that samples are collected, handled, and stored in a manner that minimizes any potential sources of bias or error. The sampling plan should clearly specify the field collection and laboratory submission procedures to be used.

The sampling plan should also list procedures to be followed to ensure that the quality of the samples collected is acceptable. Throughout all sample collection and sample handling

procedures, care must be taken to prevent cross contamination of samples. Sampling equipment should be cleaned carefully and clean sample containers should be used.

The sampling plan should provide specific sampling instructions for each feedstock material and the finished compost, including sampling frequency and the number of Laboratory Submission Samples required. The laboratory conducting the analysis can assist in developing the sampling plan for the use of Quality Control samples (such as field replicates).

An outline of a recommended procedure for collecting field samples is included in Appendix 6. This plan can be adapted to suit the specifics of an individual facility. Additional information on sampling can be found in the BNQ Industry Standard, CAN/BNQ 0413-200/2005, Organic Soil Conditioners – Compost.

6.1 SAMPLING FINISHED COMPOST FOR QUALITY DETERMINATION

6.1.1 General Considerations

Finished compost must be analyzed for all mandatory parameters before it leaves the composting site and the results of this analysis should be made readily available to all end users upon request. Samples of finished compost for measurement of mandatory quality parameters should only be taken from compost that is assumed to satisfy the maturity requirements presented in Section 3. Samples submitted for laboratory analysis should be representative of the form in which the compost will be shipped or sold. For example, if finished compost is screened prior to being shipped or sold, then the laboratory sample should also be screened prior to analysis.

Generally, samples submitted for laboratory analysis are composite samples formed by mixing a number of grab samples taken from a lot of finished compost. The composite sample is then reduced in volume for submission to the laboratory.

6.1.2 Sample Frequency

At least two composite samples should be collected from each lot of finished compost. Where the compost feedstock contains any human or animal waste, at least four compost samples should be collected. A lot of compost is defined as 5,000 m³ or less of mature compost and can consist of more than one individual pile of finished compost, provided that the characteristics of each of the piles are similar. If a facility produces less than 5,000 m³ of mature compost annually, the maximum lot size is the quantity of compost produced in a calendar year.

Composite samples should not be formed from batches of compost that have different characteristics or that are derived from significantly different feedstocks. In these cases, separate samples need to be collected, unless previous analysis shows that the concentration of mandatory parameters in each of the finished products is similar.

When a facility can document at least two consecutive years of concentrations of mandatory parameters in finished compost, consisting of a minimum of 4 samples per year, which consistently comply with Section 3, the size of a lot may be increased to 10,000 m³ or less of finished compost, or the amount of mature compost produced at the site in a calendar year, whichever is less. Such documentation must be retained by the facility and made available to the MOE upon request, as noted in Section 6.4.3.

6.1.3 Sample Size

For any lot size, each composite sample should be comprised of a minimum of 10 randomly selected grab samples of the same volume, approximately 1 to 3 litres each. Two composite samples should be formed from independent sets of grab samples taken from different locations within the lot of finished compost. It is important that grab samples be small enough to allow the composite samples to be mixed easily.

6.1.4 Sample Locations

Proper selection of grab sample locations is necessary to ensure that the laboratory submission samples are representative of the lot of compost. Sampling locations that may not be representative of the lot of compost, such as the surface or base of compost piles, should be avoided.

Operator bias must be avoided in the selection of sampling locations. Grab sample locations should be determined by random selection of subdivided areas from a sketch of the lot to be sampled, or by sampling at regular intervals from a randomly selected starting point. Random selection of sampling locations is not equivalent to a haphazard selection process. A systematic method of selecting random, unbiased locations should be used. **See Appendix 6 for additional detail.**

6.2 SAMPLING FOR FEEDSTOCK CHARACTERIZATION

6.2.1 General Considerations

The purpose of sampling feedstocks, amendments, and compost in process is to obtain information necessary to improve or control the composting process, or to confirm compliance with regulatory requirements. The information required depends on the types and sources of feedstock materials. The sampling plan should address the sampling requirements of each feedstock material accepted for composting at the facility. The sampling plan should put into place measures to deal with wastes that could have elevated levels of metals or other contaminants.

When accepting feedstock materials, operators must take reasonable steps to ensure that the resulting compost will satisfy the requirements for Categories AA, A or B compost. This would include only accepting feedstocks where characteristics, particularly heavy metal concentrations, are known.

Many feedstock materials are heterogeneous mixtures of large particle size and cannot be sampled effectively without prior size reduction and mixing.

6.2.2 Sample Frequency

Operators are responsible for characterizing feedstocks with respect to basic physical and chemical parameters of importance to the composting process, such as carbon content, nutrient content, moisture content, physical structure, metal content, etc. Characterization should occur prior to receipt of the waste (feedstock or bulking agent) at the composting facility, and should be repeated whenever changes in the generation, handling, or storage of the waste affect any of its characteristics.

In some cases, operators may choose to rely on published information for wastes that have been well studied (e.g. leaf and yard wastes, food wastes, wood wastes etc.).

Feedstocks which have not been well characterized, which exhibit variability in key process parameters such as C:N ratio, moisture content, or bulk density or may contain high concentrations of heavy metals or other contaminants, should be subjected to a program of laboratory testing. This includes wastes such as biosolids (sewage or paper mill), septage, industrial, commercial and institutional (IC&I) sludges. The MOE may require that the operator establish a program of laboratory testing for these wastes.

In general, feedstocks which have not been well characterized should be:

- analyzed prior to receipt;
- analyzed bi-annually in the first year of receipt;
- if the waste characterization is relatively consistent, the Operator can request a reduction of testing requirements from the MOE; and
- analyzed if characteristics have changed.

Sampling frequency should be increased if:

- the average concentration of any regulated contaminant is greater than 80% of the concentration limit in finished compost of the category of compost being produced; and,
- if the quantity of feedstock is greater than 50% by weight of all materials accepted for composting; or,
- a change in characteristics is expected due to changes at the generator or in the collection, handling, and storage of the material.

Where increased sampling frequency is warranted, sampling should be sufficiently frequent to demonstrate the Operator's diligence in managing the composting process and in ensuring that the resulting compost satisfies the requirements to produce Category AA, A or B compost. It should be noted that sampling and analysis can be undertaken by the Operator, or the Operator can arrange to have the generator undertake the aforementioned sampling and analysis.

6.2.3 Sample Size

Feedstock samples should be composite samples consisting of at least 10 grab samples of the same volume approximately 1 to 3 litres each.

6.2.4 Sample Locations

Where possible, feedstock materials should be sampled from the output of size reduction or mixing operations rather than piles. In particular heterogeneous, large particle size feedstock materials should be size reduced and mixed prior to sampling.

When sampling from the output of processing operations, it is necessary to use a randomization process to avoid bias in the selection of times of grab sample collection. Two approaches can be used: the timing of each grab sample selection can be randomized; or, a starting time can be selected randomly with grab sample collections following at uniform time intervals. Two composite samples should be formed from independent sets of grab samples from conveyor discharges rather than from piles.

In some instances, collecting grab samples from conveyor discharges may not be possible. For piles of feedstock material, follow the directions for random selection of grab sample locations provided in Section 6.1.4.

6.3 SAMPLE PREPARATION AND LABORATORY SUBMISSION

Most facilities will use the equipment available at the composting site to collect composite samples and to reduce the volume of the composite sample to laboratory submission size. Typical sampling equipment will include shovels, brooms, scoops, bins, and plastic bags. A clean area where the compost can be mixed and handled is required. This may be a paved area, an area of a building, or a sheet of plywood.

Composite samples must be thoroughly mixed and reduced in volume prior to submission. Samples must be mixed to a degree that each of the grab samples will lose its identity in the blend. Samples should be reduced in volume in accordance with recognized sample reduction practices, such as coning and quartering or riffing.

Coning and quartering is one of the easiest methods to reduce the volume of samples. Coning and quartering involves mixing grab samples and forming the mixture into a pile or cone. The cone is then flattened and divided into four quarters, the quarters separated, and the opposite quarters combined to form the reduced volume sample. This coning and quartering procedure is repeated until the desired volume of sample is achieved. At each stage of coning and quartering, one of the sets of two opposite quarters is combined and blended to form the new sample to undergo further coning and quartering or to become the sample. The remaining two quarters at any stage are either discarded or retained as a duplicate sample. The duplicate may be retained until analytical results are obtained on the laboratory submission sample, or may be used for quality assurance and quality control.

A laboratory submission sample of one to two kilograms should provide sufficient material to allow for a wide range of physical and chemical analyses and provide a residual amount for retesting, if necessary.

6.4 HANDLING AND SUBMISSION OF SAMPLES

6.4.1 Sample Containers

Plastic "zip-lock" bags or other clean plastic or glass containers with no metal contact should suffice for most compost sampling activities.

Analysis for some parameters may require containers other than clean plastic bags. Operators should confirm container requirements with the intended analytical laboratory prior to sample collection.

6.4.2 Sample Handling and Submission

It will be necessary to complete and submit a completed Chain of Custody form with the Laboratory Submission sample. This includes a description of the sample as well as analytical requirements. Chain of Custody forms are provided by the Laboratory.

Laboratory submission samples should be in a cooler with icepacks, and arrangements made to have them delivered to the laboratory the same or next day. Laboratory submission samples should not be kept on-site.

Samples for analysis of volatile components (e.g. mercury or organic chemicals) may require separate handling to ensure that the analytical sample is representative of the source. The analyzing laboratory should be consulted for specific handling procedures.

6.4.3 Records

Plant owners or operators must keep a log book which records all sampling events. Records of analyses shall be kept for at least two years past the disposition of the compost or for such other period as specified in a regulation or in a condition on a Certificate of Approval. This information must be made available to the Ministry of the Environment on request.

Sampling plans should detail the types of field observations that are to be made during the sampling. Field staff should be diligent in taking field notes of sampling locations, sample depths, any unusual odours observed, or any other observations that could be of potential assistance in interpreting analytical results.

7.0 LABORATORY ANALYSIS

All sampling and analysis required in a Certificate of Approval is the responsibility of the facility owner/operator.

Few composting facilities are large enough to justify an in-house laboratory. As a result, most compost facility operators will submit field samples to an independent laboratory for analysis of metals, maturity, microbiological and other required parameters. The purpose of this section is to assist compost facility operators with the selection of a laboratory and with the interpretation of the results of laboratory testing. Also, as indicated in Section 6.1.1, the results of this analysis should be made readily available to all end users upon request.

Additional information regarding laboratory methods, procedures, and quality control is presented in Appendix 7.

7.1 GUIDANCE ON SELECTING LABORATORIES FOR COMPOST ANALYSIS

Laboratories analyzing compost must be accredited by a body which accredits laboratories to ISO/IEC 17025:2005 standards for analytical laboratories (e.g., the Standards Council of Canada or the Canadian Association for Laboratory Accreditation (CALA)). Accreditation requires regular onsite assessments as well as participation in proficiency testing programs. A directory of accredited laboratories can be obtained from the internet at www.scc.ca and www.cala.ca.

7.2 LABORATORY QUALITY MANAGEMENT

The results of all laboratory analyses of mature compost will be used to determine compliance with this *Guideline*. Therefore, it is essential that all analytical methods be well documented and controlled, consistently applied, and that reasonable quality assurance and quality control procedures be carried out.

Laboratories participating in the analysis of compost must be able to provide evidence that the quality of their data meets the requirements of data quality objectives (DQOs). The ability of a laboratory to meet DQO's depends on a sound Quality Management program, including the development and use of a documented control process. Quality Management (QM) is that aspect of the overall management function that determines and implements the quality policy. The international standard ISO/IEC 17025:2005 outlines management and technical requirements for implementing a laboratory quality management system.

7.3 PERFORMANCE-BASED METHODS SYSTEM

The previous *Interim Guidelines for the Production and Use of Aerobic Compost in Ontario* did not provide guidance regarding the analytical methods to be used when determining compost quality. The *Interim Guidelines* simply specified maximum concentration limits. Since the publication of the *Interim Guidelines*, the composting industry has begun to specify standard methods for compost analysis.

Traditionally, when analytical methods for environmental monitoring and compliance programs are specified, they have been incorporated by reference into regulations. However, listing specific methods in guidelines and regulations has caused some rigidity in the application of these methods.

In order to accommodate potential improvements in laboratory methods and technology, the MOE's Laboratory Services Branch has adopted a "performance-based" method system (PBMS). This system defines what is to be accomplished in the form of performance targets rather than specifying how it should be done through prescriptive methods. Such a system allows laboratories participating in environmental analysis to use any suitable method as long as the method meets specified performance criteria. This approach allows the regulatory community to use new or emerging technologies to meet monitoring requirements. For example, MOE's Laboratory Services Branch has developed a performance-based method for *E. coli* and *Salmonella* spp. for compost.

Laboratories analyzing compost may use any method capable of producing data that will meet or exceed the performance targets listed in Tables 3.1 and 3.2, as long as it is a formal written method, or standard operating procedure (SOP). SOP bench procedures must be documented in sufficient detail to ensure uniform application, and must be readily available to technical staff.

A written summary of the method used for such analysis may be required by the Ministry to review data. The summary will assist the Ministry in evaluating if the laboratory method/performance data is in compliance with the data quality requirements.

The method summary should contain the following information as a minimum:

- Unique method identifier used, e.g., EPA 5030, MOE/LSB E3394 or the laboratory Reference Method;
- Method Principle - Brief description of sample preparation and instrumentation, including the detection system;
- Sample preservation if required;
- Sample storage conditions;
- Accreditation - Name of accrediting body and analytes that are accredited;
- Method performance characteristics – including Method Detection Limit (MDL), bias, precision (repeatability/reproducibility), uncertainty, working range, etc. Provide such information in a tabular form. An example is given in Table A7-1.

Additional information regarding method performance requirements is provided in Appendix 7 (including Table A7-1).

7.4 DATA ACCEPTANCE CRITERIA

The acceptability of the laboratory data should be based on the following considerations:

- performance criteria as outlined in Tables 3.1 and 3.2 and Appendix 7 must be met;
- results of all quality control samples that are applicable to the matrix and contaminant group of interest (method blank, duplicate and spiked blank) are within the statistically determined control limits;
- the analyst is expected to respond to any quality control results which exceed the control limits.

7.5 ANALYTICAL DATA REPORTING /CERTIFICATE OF ANALYSIS

Laboratories should summarize analytical results in a stand alone report, based on the following considerations:

- a laboratory's data management system must establish and maintain direct links between sample information such as source, field sample number/code, date/time sampled, test required, etc. and laboratory information such as laboratory sample number/code, date/time analyzed, test performed, analyst identification, etc.;
- the result must include the test/analyst, name/code, the units of measurement, the method used and appropriate qualifying remarks [if the performance based method was used, provide method name/identification, a brief description of method principle (sample processing and instrumental analysis) and a brief statement describing that the method meets all the performance characteristics as outlined in Appendix 7];
- analytical data should be reported on a dry weight basis, and without any correction, unless the correction is clearly identified and described;
- laboratory method detection limits (LMDLs) and all data at and above upper limit of LMDL levels (Tables 3.1 and 3.2) must be reported;
- recoveries of all surrogates (organic analysis) must be reported where applicable; and
- the laboratory should provide the between-run precision and accuracy estimates associated with the reported results.

PART III – GUIDANCE FOR COMPOST FACILITY OPERATORS

The purpose of this part is to suggest approaches and methods to ensure proper siting, design, operation and management of composting facilities. The guidance provided in this part reflects the following objectives for composting facility management:

- prevent or control off-site environmental impacts, especially water contamination, odours, dust, noise and vermin and vectors;
- ensure the safety of on-site personnel;
- prevent emergency situations;
- anticipate seasonal effects that may have an impact on the composting process; and
- produce quality compost meeting the standards.

8.0 SITE SELECTION CONSIDERATIONS

The purpose of this section is to provide general guidance regarding the selection of a site for a composting facility. Proper site selection is one of the most important tasks in implementing a successful composting project. A number of potential problems can be avoided by careful planning at this stage. Several technical, social, and economic factors will help to shape decisions regarding site selection. Among the more important considerations are the following:

- provision for adequate separation between the facility, adjacent land uses, especially sensitive land uses, and sensitive environmental features;
- compliance with local zoning by-laws;
- selection of a site with sufficient space; and
- ensuring convenient access to transportation routes.

General considerations for selecting an appropriate site are discussed in this section. Specific site design criteria are presented in Section 9.0.

Proponents are strongly advised to consult with their local municipality early in the planning process to confirm that they are using the most current siting and land use policies. MOE Guideline D-1 “Land Use Compatibility”, MOE Procedure D-1-1 “Land Use Compatibility: Implementation”, MOE Procedure D-1-2 “Land Use Compatibility: Specific Applications” and MOE Procedure D-1-3 “Land Use Compatibility: Definitions” contain useful information to assist in suitable site selection.

8.1 ECOSYSTEM APPROACH

Through its Statement of Environmental Values, the MOE encourages proponents to adopt an ecosystem approach when planning projects such as composting facilities. It is recommended that projects should be based on an ecosystem management approach that focuses on the prevention of impacts, protection of the existing environment, and opportunities for rehabilitation and enhancement of impacted environments. Additional information on the ecosystem approach can be found in the following Ministry publications: "A Guide to the MOE's Statement of Environmental Values" and "Towards an Ecosystem Approach to Land-use Planning".

8.2 OFFICIAL PLANS, LOCAL ZONING AND BY-LAWS

Official plans are prepared by municipal councils and control the physical development of the municipality, including land use, future development and erection of buildings and structures. Control is exercised through the issuance of bylaws approving development site plans under the official plan, or non-conforming bylaws issued on an interim basis pending revision of the official plan. Proponents are responsible for ensuring that their proposed composting facility meets all zoning by-laws, and should contact the municipality in this regard. It should be noted that most of

Northern Ontario remains unorganized and as a result, issues such as zoning and storm water management become the responsibility of the Ministry of Municipal Affairs and Housing (MMAH) or the Ministry of Natural Resources (MNR). MMAH and MNR should be contacted in this regard.

8.3 SEPARATION DISTANCES AND BUFFER ZONES

Composting facilities should be physically separated from other land uses to help mitigate potential adverse effects such as odours, dust, litter, and noise. This is usually accomplished by setting the composting operation back from the property line and by using visual screens, such as berms, fences, or landscaping.

Adjacent land uses of particular concern include residential developments, schools, places of worship, cemeteries, hospitals, long term care facilities, nursing homes or other public institutions, and environmentally sensitive areas such as wetlands.

In addition to separating or screening a facility from its neighbours visually, compost operators may need much larger "buffer zones" to allow for odours generated at the site to dissipate before they reach a neighbour. Historically, odour emissions have been the most common cause of composting facility closures. Guidance regarding buffer zones is provided in Section 13, Odour Control.

All components of the composting operation (including curing pads) should be located as far as possible from "Sensitive Receptors." In general, smaller composting operations (i.e., those processing less than 50,000 tonnes per year) should be located a minimum of 250 metres from the nearest Sensitive Receptor. Larger composting operations (i.e., those processing 50,000 tonnes or more per year) should be located a minimum of 450 metres from the nearest Sensitive Receptor.

Buffer distances will vary with different situations and different types of composting operations (e.g., indoor or outdoor). Modifications to the buffer distances may be made based on the type of material to be composted, the facility size and design, the operational procedures, the proximity to housing or businesses, and the results of any odour studies conducted.

The compost site operator does not usually have control over future development on neighbouring properties. Therefore, facilities should be sited with a maximum possible separation distance to the property line of the composting site. This will ensure that, regardless of any future development on adjacent lands, minimum separation distances can be maintained. Where possible, facility developers should seek support from municipal councils and planning staff to minimize future off-site odour impacts. This could be achieved by limiting incompatible adjacent development through the official plan or other planning tools.

In addition, any outdoor operations, including curing piles, should be located a minimum of 100 metres from any water well or surface water bodies.

Composting facilities should not be located near airport runways. This is to prevent birds, which may be attracted to the site, from interfering with aircraft. Proponents of facilities to be located near an airport (i.e. within about 8 kilometres) should contact Transport Canada for guidance. Additional information is available in TP-1247-Aviation "Land Use in the Vicinity of Airports, 8th Ed.", Transport Canada, May 2005.

8.4 WATERSHED PLANNING

Local municipalities and conservation authorities should be consulted to determine whether the proposed works conform to an official Watershed, Subwatershed, or Master Drainage Plan for the area.

Conservation Authorities are a commenting agency on proposals submitted to municipalities for review under the *Planning Act* and may thereby indirectly impose requirements such as facilities for erosion and stormwater control, and for sediment control during construction. As a result, a Stormwater Management Plan and sediment control measures may be required as part of a composting site plan submission for approval.

Local conservation authorities may also restrict new development within regulatory floodplains. While these restrictions might not specifically include composting facilities, they may effectively do so by restricting the construction of composting pads, drainage facilities, buildings, and parking lots.

Assessment reports and source protection plans developed under the *Clean Water Act* will need to be considered when selecting a proposed compost site. The source protection plan will identify areas where the facilities may pose a significant risk to drinking water and will set policies to ensure future activities do not pose a significant risk. These policies are mandatory where an activity poses or may pose a significant risk to drinking water.

The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) should also be consulted to determine whether mutual agreement drains are registered against the site, and whether the proposed site works will require modifications to existing drains.

8.5 OFF-SITE TRAFFIC

Proponents should investigate seasonal load restrictions on local roads through their local municipality. Proponents should also investigate the haul routes that will be utilized to transport the feedstock to the compost facility, and consider the most appropriate transport routes to be utilized. Consideration should be given to minimizing dust and noise, especially in residential areas.

9.0 SITE DESIGN CONSIDERATIONS

The purpose of this section is to introduce important considerations for the physical design of composting facilities (considerations for process design are introduced in Section 10). The information presented in this section is an amalgamation of the design lessons learned over time and from facilities of different purpose and configuration. Not all considerations introduced herein are applicable to all facilities. Neither should this section be considered to be a comprehensive treatment of the subject.

Typically a composting site performs a number of different functions including:

- employing the unit operations of composting to convert feedstock into compost product
- providing ancillary systems for wastewater management and prevention of off-site noise, odour and dust impacts
- providing facilities for site administration and staff
- providing separation distance from adjacent land uses
- providing controlled access and site security

The specific design requirements for each function are typically determined by the overall objectives for the composting site, expressed in terms of quantities and types of feedstock and amendment materials, types of product to be marketed, and desired degree of technological sophistication. Often, site design is constrained by limited available area or the requirements of local zoning bylaws. They may specify minimum property line setbacks, limit the portion of the site that can be covered, or impose other requirements depending on the zoning designation.

Design considerations for compost site functions are discussed in the following sections with the exceptions of ancillary wastewater management, odour prevention and control, and the prevention of adverse effects which, because of their importance are addressed in Sections 12, 13, and 14 respectively.

9.1 SITE DESIGN REQUIREMENTS BY PROCESS UNIT OPERATION

The unit operations of the composting process are described in Section 10. This section introduces design considerations for the specific area of the composting site devoted to each unit operation.

9.1.1 Receiving

The objectives of the receiving operation are to:

- receive feedstock material in an orderly manner

- provide a process buffer in the form of temporary storage of feedstock and amendment materials
- document the arrival of materials at the site
- manage contamination
- manage potential odours
- segregate materials
 - by material characteristics (e.g. C:N ratio)
 - by process requirements

Site design considerations for the receiving operation include:

- providing on-site area for truck queuing to keep trucks off public roadways
- providing adequate space for unloading, including overhead clearance, based on the types of delivery vehicles expected
- enclosed receiving areas should minimize potential for fugitive odour emissions by providing fast acting doors, or air-lock systems
- providing a minimum of 3 days feedstock retention to buffer effects of long-weekends and unscheduled process shutdowns
- if liquids wastes are to be received, having adequate and appropriate containment infrastructure (e.g. tank or pit)
- ensuring containment of leachate from high moisture content loads
- providing space and systems for truck rinsing, as required
- providing longer-term storage for amendment materials if required to buffer effects of seasonal variation in supply

9.1.2 Pre-Processing

The objectives of the pre-processing operation are to:

- create a good “recipe”
- promote microbial growth by adjusting
 - moisture content
 - nutrient balance
 - particle size and structure
- prevent on-site and off-site nuisances (e.g. odour, noise, dust, litter, birds/vermin)

Activities of the pre-processing operation include:

- removal of contaminant materials
- size reduction by grinding or shredding
- adjusting the moisture content and nutrient balance by blending feedstock and amendment materials

Site design considerations for the pre-processing operation include:

- allocating space for efficient arrangement of required pre-processing operations
- allocating space for effective handling and temporary storage of contaminant materials
- providing temporary storage between preprocessing and processing area operations to buffer batch vs. continuous or batch vs. batch operations
- noise attenuation and prevention of off-site odours and dust

9.1.3 Processing

The objectives of the processing operation are to control the process of biological decomposition in order to:

- maintain a high rate of decomposition
- achieve pathogen inactivation
- prevent off-site noise, odour and dust impacts

Site design considerations for the processing operation include:

- providing sufficient retention time to satisfy pathogen reduction and volatile solids reduction requirements
- providing adequate space for equipment operation
- ensuring adequate ventilation, forced or passive, to maintain aerobic conditions throughout the composting materials and to remove heat as required
- rehydrating the composting material to maintain adequate moisture content
- combining composting material streams to compensate for volume reduction
- providing adequate separation distance, or containment and control, to prevent off-site odour or dust impacts
- providing adequate space for emergency vehicles

Retention time is the average length of time, typically expressed in days or weeks, which the composting material resides within the unit operation. Typical retention times in the processing operation range from as short as 7 to 10 days to as long as 4 weeks, depending on the nature of the feedstock materials, the degree of process control, and the solids reduction objectives of the processing operation. Normally, the shorter the retention time in the processing operation, the longer the required retention time in subsequent operations.

9.1.4 Curing and Finishing

The objective of the curing or finishing operation is to:

- to ensure the production of a mature product
- to meet regulatory quality criteria

- to meet end market requirements
- prevent on-site and off-site nuisances (e.g. odour, noise, dust, litter, birds/vermin)

Site design considerations for the curing and finishing operation include:

- providing sufficient retention time to satisfy compost maturity requirements
- ensuring adequate ventilation, forced or passive, to maintain aerobic conditions throughout the composting materials and to remove heat as required
- allocating space for the efficient arrangement of product finishing activities such as screening, blending or bagging
- allocating sufficient space for 6 months of compost storage
- allocating sufficient space to store finished compost when market demand is slow
- providing adequate separation distance, or containment and control, to prevent off-site odour or dust impacts

Typical retention times for compost curing range from as short as 3 to 5 weeks to as long as 6 months, depending on the degree of volatile solids reduction achieved in the processing operation, the degree of process control, and the maturity and other quality objectives of the compost product.

9.2 SEPARATION TO MAINTAIN HYGIENIC CONDITIONS

Compost product must be free of viable human pathogens. Pathogen inactivation is achieved at the processing operation during which the composting material is subjected to extended periods of elevated temperatures. The processing operation also ensures that the volatile, i.e. readily decomposable, portion of the composting material is sufficiently reduced such that the continuing decomposition of the composting material is unlikely to create conditions favourable to the regrowth of pathogens.

The composting site design should provide an effective barrier to the reintroduction of pathogenic organisms into composting material that has satisfied the requirements for pathogen inactivation. Direct or indirect contact between processed compost material and feedstock or wastewater should be avoided. Receiving and preprocessing operations and the entrance to the processing operation, as well as all associated mobile equipment, should be confined to a specific area of the site separate from the ‘clean’ area. The ‘clean’ area should incorporate the outlet of the processing operation, the curing and finishing operation, as well as associated mobile equipment.

Transfer of equipment or material between the separate areas of the site should be prohibited, other than for compost material passing through the processing operation. If equipment transfer cannot be avoided, equipment must be properly cleaned prior to use with processed material. Wastewater should not be used for rehydration after the composting material has satisfied the requirements for pathogen inactivation.

9.3 OPERATIONAL FLEXIBILITY AND REDUNDANCY

Operational flexibility enables a facility to accommodate changes in quantity and composition of feedstock materials. Design features in aid of operational flexibility include the ability to bypass unnecessary or failed operations, material buffers, i.e. temporary storage areas, especially between batch and continuous operations, and the ability to temporarily increase the material throughput capacity of specific operations, e.g. by temporarily reducing retention time in processing operation.

Redundancy, or operational contingencies, should be provided for essential operations, e.g. moving material from the tipping floor to preprocessing, compost turning and aeration.

9.4 SITE CAPACITY

Determination of the maximum capacity of a composting facility is important because of the need to balance several different site operations and to ensure that waste received at the site can be processed promptly. Proponents will be asked to specify the maximum annual and daily amounts by type of feedstock to be accepted at the site, as well as the total amount of material (including finished compost) on the site at any one time. For seasonal operations, proponents should specify daily maximum and minimum amounts by type of feedstock. This maximum site capacity will generally be included as a condition in the Certificate of Approval for the site. The purpose of these restrictions is to ensure that the material on site can be physically processed by the proposed facility.

To assist the MOE in determining appropriate limits, proponents need to clearly present calculations of the maximum capacity of the site. These calculations should include a plan for dealing with seasonal variations in feedstock delivered to the site and for the removal of finished compost from the site.

At outdoor sites, the site capacity depends on the size of the composting pad, the size and spacing of piles or windrows, and the time taken to complete the composting process. The size of a windrow usually depends on the type of equipment used for turning. In general, windrows should not exceed about 3 metres in height. At enclosed sites, the site capacity depends on the vessel size and retention time as well as the time and space required for curing.

9.5 COMPOSTING PAD DESIGN

Most composting facilities make some use of outdoor areas for material handling, processing or storage operations. For the purpose of this section, composting pads refers to all engineered surfaces underlying these outdoor areas.

Composting pads are employed in a variety of operations. Regardless of the operation, the

functional requirements of the pad area are similar and include:

- providing a year-round working surface
- preventing infiltration of leachate
- providing adequate drainage to prevent accumulation of leachate or runoff, i.e. ponding

9.5.1 Working Surface

Native surface soils are rarely suitable for direct use as a composting surface.

Composting pads can be constructed from a number of materials, but by far the most common materials are gravel, clay, asphalt, and concrete. All of these materials have been shown to make serviceable composting pads. The major differences between the materials are cost and the effect on water management.

9.5.2 Drainage

The choice of pad material will have a direct impact on the volume of runoff generated at the site and on the volume of water which infiltrates into the groundwater. For example, pads constructed from relatively impermeable materials, such as concrete or asphalt, will have runoff coefficients on the order of 0.75 to 1.0, meaning that 75% to 100% of the precipitation on the site would end up as runoff. In this case, a detention pond would likely be needed to store runoff and leachate.

Drainage of water from a composting pad is typically achieved by sloping the pad towards a collection pond or other water collection/treatment facility, and by aligning windrows parallel to the direction of the slope. Presumably, a porous pad could also be drained by locating drainage tiles under the pad, but this is rare in practice.

Many compost pads are graded to a slope of approximately 2% to 4%. Experience has shown that slopes in this range tend to result in relatively good drainage. Steeper pads tend to encourage water to run off, while flatter pads tend to hold water, encouraging percolation. The slope of the pad can also have an impact on site operations and the quality of runoff from the site. A flat pad (<1%) may encourage the accumulation of leachate or ponded water which can lead to odour and insect problems. Too steep a slope can lead to problems with erosion of the pad or soil adjacent to the pad, further increasing the load of suspended solids in the runoff.

Site topography may be such that precipitation tends to run on to the active composting area. In such cases, drainage works such as berms, swales, and ditches should be used to prevent run-on by redirecting stormwater around and away from the active area.

9.6 BUILDING STRUCTURES AND VENTILATION

Odour generating feedstocks (e.g. biosolids, food wastes) should generally be composted in a building and/or enclosed structure.

Structures built to house composting operations should be designed to withstand the moist, corrosive, and biologically active conditions prevalent at a composting site. Materials used for construction should be chosen with these conditions in mind.

Proper ventilation of buildings is essential for both worker health and safety and for long term maintenance of the building itself. Proper ventilation will minimize worker exposure to the volatile compounds present in organic materials, such as ammonia and hydrogen sulphide, and also exposure to odour and dust. Typically, building ventilation is combined with the odour containment and control system.

9.7 SITE SERVICES AND ACCESS ROADS

Most composting facilities need a source of process water, to adjust the moisture content of the compost mass when needed. The use of wastewater for this purpose is discussed in Section 12. Other alternatives include municipal water supplies, local surface water bodies or wells, collected rainwater, or the use of trucked water supplies. The use of local surface or groundwater supplies may require MOE approval under the OWRA.

Water will also be required for washing equipment and for domestic purposes, such as drinking and hand washing. At larger facilities with daily operations, facilities such as toilets, showers, and change rooms may be appropriate.

If a site is serviced by a sanitary sewer, it may be possible to use the sanitary sewer system as a treatment mechanism for leachate from the site. The use of sanitary sewer connections for this purpose is discussed in Section 12.

The truck access route should avoid roads subject to seasonal load restrictions.

9.8 OTHER SITE DESIGN CONSIDERATIONS

Composting sites must include functions ancillary to the unit operations of the composting process. Key ancillary systems are wastewater management, odour prevention and control, and the prevention of adverse effects which, because of their importance, are addressed in Sections 12, 13, and 14 respectively. Additional ancillary functions can include, but may not be limited to, the following:

- providing public access to drop-off depots or compost pickup areas;

- site administrative functions, e.g. site office and facilities for management and administrative staff, and staff parking;
- process and quality control functions, e.g. SCADA systems, feedstock and compost analysis;
- providing worker amenities, e.g. showers, change room, lunchroom, first aid;
- equipment maintenance and repair, including repair shop and materials and parts storage;
- separation and visual barrier between composting site and adjacent land uses, e.g., berms or tree lines in the property line setback area; and
- space to store water to fight fires.

9.9 SITE SECURITY AND ACCESS

Reasonable care should be taken to ensure that unauthorized persons are kept out of any areas where waste is handled, processed or stored. This can be accomplished by erecting fences and gates, or by conducting activities inside a building. Signs, of a sufficient size to be readable from a public roadway, should be posted at the facility listing:

- address of the site
- name of the owner of the facility and the name and telephone number of a person to contact in an emergency
- hours of operation
- categories of waste that will be accepted at the facility and any rules that relate to the acceptance of such waste

9.10 SITE CONSTRUCTION PRACTICES

The construction of a composting facility can involve several activities which have the potential to lead to erosion of soil or the deposition of sediments in local waters. Activities such as removing topsoil, grading the site, or changing natural drainage patterns should be carefully planned in order to control erosion both during and after the construction period. Additional sources of information regarding erosion and sediment control during construction are listed in Appendix 8.

10.0 COMPOSTING UNIT OPERATIONS

The production of finished compost can be viewed as a series of discrete, but interrelated processing steps or "unit operations". Each unit operation has specific inputs and outputs and subjects the compost substrate to a physical, chemical, or biological process. Each unit operation may comprise several activities.

Raw materials at a composting site generally pass sequentially through four unit operations:

- receiving
- preprocessing
- processing
- curing and finishing

Each of these unit operations can be a continuous process or a batch process. For example, material may be received and processed at the site continuously throughout the year, but some finishing activities, such as screening cured compost, may only be performed on a batch basis.

Unit operations should not be confused with references to the stages of composting. Many documents will refer to the high rate (thermophilic) and curing (mesophilic) stages of composting. These stages refer to the state of biological activity within the compost substrate and not to unit operations.

Viewing the composting process in terms of discrete unit operations has several benefits. For example:

- It assists in the identification of specific potential problem areas. Solutions that focus on the source of the problem can then be developed more logically;
- It allows the operator to identify and control the rate of each of the operations on the site, to ensure that the entire system is balanced, thus avoiding "bottlenecks" in the entire process; and
- It helps to identify opportunities for efficient materials handling, and can help to minimize the overall cost of the total operation.

Each of the unit operations is discussed in detail in the following sections.

10.1 RECEIVING

10.1.1 Objectives

The objectives of the receiving operation are to:

- receive feedstock material in an orderly manner
- provide a process buffer in the form of temporary storage of feedstock and amendment materials
- document the arrival of materials at the site
- manage contamination
- manage potential odours
- segregate materials
 - by material characteristics (e.g. C:N ratio)
 - by process requirements

Specific activities in the receiving operation include:

- waste acceptance
- weighing
- documentation
- tipping

Note: Operators are responsible for clearly identifying and tracking wastes that will result in the production of different categories of compost (i.e. AA, A and B). This is particularly true if more than one category of compost is to be produced. In particular biosolids and feedstocks with metal concentrations higher than Category A need to be carefully tracked prior to receipt and throughout the composting process and compost sale/distribution.

10.1.2 Acceptance and Handling Procedures

Quality control at the receiving stage is a very important step in ensuring the production of compost that meets regulatory and market requirements. Proper quality control depends on clear, documented and enforceable procedures for waste acceptance or rejection. Waste acceptance procedures should begin prior to receipt of wastes. The operator should characterize all new incoming wastes which should at minimum include information on:

- C:N ratio
- moisture content
- physical structure of the waste
- heavy metal content
- non-biodegradable particulate matter (e.g. plastic, metal and glass)
- odour generation potential

In general, it is useful to undertake laboratory analysis of potential new feedstocks. In some cases, operators may choose to rely on published information for wastes that have been well studied (e.g. leaf and yard wastes, wood wastes etc.). It is also prudent to visit the site of waste generation and inspect the waste. Feedstock sampling is discussed in Sections 3.2 and 6.2.

When wastes arrive at the site, waste acceptance procedures should confirm that only wastes

which have been characterized by the operator are accepted. As well, waste acceptance procedures should include a physical inspection of incoming material, which should look for evidence of contamination and offensive odours. Wastes that do not reflect the characterization, due to contamination or other reasons should be rejected from the site, and should be re-directed to an appropriate disposal facility.

Records should be kept of each load of material (waste and bulking agents) received at the site. The records should include a description of the material, the date the material was received, the source of the material and the weight or volume of the load. Records should also be kept of any rejected loads including the source of the material and the reason for rejecting the load.

It is important to direct incoming wastes for prompt pre-processing and incorporation into the composting process.

10.2 PRE-PROCESSING

10.2.1 Objectives

The objectives of the pre-processing operation are to:

- create a good “recipe”
- promote microbial growth by adjusting:
 - moisture content
 - nutrient balance
 - particle size and structure
- prevent on-site and off-site nuisances (e.g. odour, noise, dust, litter, birds/vermin)

Specific activities in the pre-processing operation can include:

- debugging/contaminant removal
- size reduction
- recipe development
 - nutrient balance
 - moisture balance
 - particle size and structure
 - mixing
 - blending

Pre-processing refers to activities intended to prepare the feedstocks for active composting. The objective of the pre-processing operation is to promote ideal conditions for microbial growth within the compost mass. Pre-processing operations will influence the rate of degradation, the nature of process by-products such as leachate and odour, and the quality of the finished compost.

Creation of a good compost "recipe" is achieved by blending feedstocks, by adjusting the

moisture content and nutrient balance (e.g. C:N ratio) of the substrate, and by altering the particle size and structure (by physical means or by adding a bulking agent).

Wastes should be incorporated into the composting process as soon as possible. Wet or odorous material should only be accepted at the site if it can be incorporated into the process promptly and if it can be processed by the system without the release of offensive odours. The immediate addition of bulking or drying agents, or covering wet or odorous material with finished compost, may help to reduce odours if the waste cannot be processed immediately.

Highly putrescible wastes including food wastes, biosolids and manures should be incorporated into the active composting process on the day of receipt.

Less putrescible wastes such as leaf and yard wastes and wood wastes should be on site for no more than four days before entering the active composting process.

Care should be taken when developing the compost “recipe” to not overburden the mixture with highly putrescible wastes, to reduce the potential for odours.

10.2.2 Pre-processing Procedures

10.2.2.1 Debagging and Contaminant Removal

If the wastes arrive in plastic bags they will need to be debagged. The same is true for compostable plastic bags and, to a lesser extent, Kraft paper bags. Debagging helps remove the compostable wastes from the bag and helps to ensure that the wastes can be mixed together. In some cases, a separate piece of equipment is used for debagging. However, often the same piece of equipment is used to facilitate simultaneous debagging and mixing of wastes.

Experience at compost facilities that accept organic materials in plastic bags has demonstrated that plastic bags are difficult to remove. Most existing equipment has proven to be ineffective at breaking the plastic bags. As a result, desirable organic materials can remain trapped in the bags and sent to landfill as rejected feedstock, while significant amounts of plastic residual may end up in the compost, reducing the quality of the final compost product. The use of plastic bags in the collection of feedstock materials has also been identified as a significant source of odours at compost facilities.

Although plastic film can be removed (during pre-processing or at the end of the process), and can result in the production of good quality compost, the serious challenges associated with the removal of plastic bags and the significant potential for odour problems caused by organics in plastic bags, suggests that plastic bags may not be suitable for most compost facilities. Where bags are to be used for collection, serious consideration should be given to the use of compostable plastic bags or Kraft paper bags.

The pre-processing stage is an appropriate time to remove other contaminants (e.g. larger non-compostable items and metals). Contaminants are any items that might cause mechanical problems, pose a threat to the safety of workers or the public, or affect the aesthetics or quality of the finished compost. Contaminant removal can be achieved by direct removal from an incoming load of waste, or a dedicated picking line over which incoming wastes are directed for manual removal and mechanical (e.g. magnetic) separation. Any material removed from the incoming feedstock must be properly stored on the site and removed to an appropriate disposal facility.

10.2.2.2 Size Reduction

Some feedstocks, such as leaf and yard waste, brush and wood wastes may require size reduction prior to composting.

Size reduction of incoming feedstock may be required to meet market requirements (e.g. for use as a mulch), or to meet process requirements (e.g. for use as bulking agent). Size reduction will improve the mixing of materials, and will provide greater surface area for microbial action. This may lead to faster composting and higher oxygen demands. It may also impede air flow in the compost due to a lack of porosity, and may lead to the need for more frequent turning of the compost.

10.2.2.3 Recipe Development

Prior to composting, wastes will require recipe development which includes mixing and/or blending.

Few feedstocks have, on their own, the properties necessary to create ideal conditions for composting. In order to approximate ideal conditions, it is usually necessary to blend feedstocks or add a bulking agent, a nutrient amendment, or water.

The moisture content can be changed by adding water directly to the compost, by blending dry or absorbent materials with wet materials, or by turning compost to increase evaporation. The nutrient balance of the substrate can be adjusted by blending feedstocks with different carbon to nitrogen ratios. For example, leaves with a high C:N ratio are often mixed with grass, which has a low C:N ratio. The physical structure of the compost can be altered by shredding or by adding a bulking agent (such as wood chips). In some cases, all three objectives can be met by careful selection of bulking agents. For example, adding dry wood chips to a wet incoming material affects the moisture content, the C:N ratio, and the physical structure of the mixture.

Blending of yard wastes is often based on experience or common practice. However, the blending of other feedstocks should be calculated based on laboratory analysis of the nutrients in the feedstock or on published information.

The aerobic microbes involved in composting require carbon (C) and nitrogen (N) for cell growth and reproduction. Oxidation of organic carbon provides energy, while both carbon and nitrogen are required to construct the molecules comprising the body of the microbe.

On average, the variety of microbes involved in composting require approximately 30 parts carbon to 1 part nitrogen. Therefore, the theoretical optimum nutrient ratio for composting is approximately C:N 30:1. It is important to note that not all organic C in a feedstock is equally available to the microbes. Although high in total carbon, wastes with high lignin content (such as paper fibres or wood chips) have a relatively low percentage of available carbon. This should be considered when determining feedstock blending requirements.

When the C:N is less than 30:1, microbes can readily convert excess N to ammonia which, if the pH is basic, will be volatilized, creating odours. When the C:N is greater than 30:1, less nitrogen will reduce the rate of degradation, and will result in the generation of fewer odours.

In the case of leaf and yard wastes, mixing may be undertaken to ensure that the incoming feedstocks are homogenized prior to composting. In simpler facilities, mixing may be accomplished during the composting process.

In the case of nutrient and/or moisture-rich feedstocks, food wastes, biosolids and manures, mixing and blending with complementary materials is necessary to develop a recipe that helps balance nutrients and moisture, and ensures an appropriate physical structure of the feedstock mix (i.e. porosity). Composting of these wastes typically includes blending them with carbonaceous amendment materials such as wood chips, leaves, sawdust etc., to help balance nutrients and moisture.

10.3 PROCESSING

The objectives of the processing operation are to:

- regulate the microbial process
- maintain aerobic conditions
- maintain high rate of decomposition
- meet time and temperature requirements
- inactivate pathogenic organisms
- prevent on-site and off-site nuisances (e.g. odour, noise, dust, litter, birds/vermin)

Specific activities in the processing operation can include:

- pile formation/vessel loading
- turning
- aeration
- monitoring

Three unit operations - receiving, pre-processing, and curing and finishing - are essentially common to all composting facilities, although there will be variations between facilities. However, the processing operation can vary greatly from one facility to the next. The greatest differences are between processes which occur within a composting reactor or vessel (sometimes called "in-vessel" processes) and non-reactor (or outdoor) processes such as windrows and static piles.

The primary difference between outdoor and enclosed systems is the degree of control that the operator has over the process. Enclosed systems typically involve the use of forced aeration, may involve mechanical turning or mixing, and generally provide greater direct control over the composting process.

Details of the processing operation are generally specific to the technology employed, and a complete description of processing techniques is beyond the scope of these *Guidelines*. However, several published guides which may be of use to operators are included in Appendix 8: Selected References.

Process control information for in-vessel systems is also available from equipment suppliers.

10.3.1 Processing procedures

The objective of the processing operation is to maintain a high rate of decomposition, to prevent odours and other potential adverse effects, to monitor and regulate the microbial process, to maintain aerobic conditions, and to inactivate pathogenic organisms. These objectives are achieved by regulating microbial activity through aeration, mixing, the addition of water and other amendments, and by monitoring process variables such as temperature.

10.3.1.1 Pile Formation/Loading

After recipe development is complete, the mixed and/or blended feedstock is ready for composting. If a non-reactor based system is being used, the material is formed into a windrow or aerated static pile. If a reactor-based system is being used, then wastes will need to be loaded into the vessel, drum or channel etc.

10.3.1.2 Turning

Non-reactor piles (i.e. windrows) require regular turning to provide aeration and further mixing. A loader, excavator or specialized windrow turner can be used.

Reactor based systems, such as channel systems, typically use a specialized turner that mixes and moves composting material.

10.3.1.3 Aeration

Reactor based systems and aerated static piles have an aeration system which mechanically aerates the composting mass. This helps maintain and optimize aerobic conditions during composting.

10.3.1.4 Monitoring

It is important to monitor the composting mass throughout the process to ensure that aerobic conditions are being maintained, and that anaerobic and odour generating conditions do not develop.

The most common way to monitor is through collecting temperature data from the composting mass. This data needs to be collected and documented to ensure that time and temperature requirements are met. Other monitoring can include measuring the oxygen content in the composting mass.

10.4 CURING AND FINISHING

The objectives of the curing and finishing operation are to:

- ensure the production of a mature product
- meet regulatory quality criteria
- meet end market requirements
- prevent on-site and off-site nuisances (e.g. odour, noise, dust, litter, birds/vermin)

Specific activities in the curing and finishing operation can include:

- discharge from reactor-based systems
- turning
- screening
- analyzing

After the time and temperature requirements for pathogen reduction in Section 5.2.2 have been satisfied, the compost must be cured until mature (see section 3.5).

Regulatory requirements for compost quality are discussed in Section 3.0 of this document.

In windrow facilities, curing takes place on the same pad as composting.

10.4.1 Curing Procedures

10.4.1.1 Discharge from Reactor Based Systems

Retention time is the average length of time, typically expressed in days or weeks, which the composting material resides within the unit operation. Typical retention times in the processing operation range from as short as 7 to 10 days to as long as 4 weeks, depending on the nature of the feedstock materials, the degree of process control, and the solids reduction objectives of the processing operation. Compost is then moved, typically with a loader, to an outdoor windrow curing area. The compost is formed into windrows. Curing areas are typically outdoors, although some facilities also have indoor (and typically aerated) curing areas.

Curing and storage areas should be properly graded and drained to avoid the collection of stagnant water or leachate at the bottom of curing piles. Although curing piles are often larger than active windrows, they must be sized such that they can be turned adequately by the equipment available on the site.

10.4.1.2 Turning

During curing, a composting mass must be turned at least once a month, or more frequently if required, to maintain aerobic conditions. This is done using a loader or specialized turner. The temperature of a curing pile should be measured and recorded at least weekly. Optimal moisture levels must be maintained.

10.4.1.3 Finishing

One of the final activities on a composting site is the final preparation of the finished compost for delivery to market. The extent of the activity will depend on the end market requirements, and may include screening, blending, bagging, and loading material for shipment.

10.4.1.4 Analysis

Compost should be sampled and analyzed to ensure it meets regulatory requirements (e.g. heavy metals, pathogens). It is also prudent to analyze for quality parameters to ensure that compost meets desired end market requirements. Regulatory requirements for compost quality are discussed in Section 3 of this document. Compost Sampling and Laboratory Analysis are discussed in Sections 6 and 7 respectively.

11.0 HEALTH AND SAFETY

11.1 THE OCCUPATIONAL HEALTH AND SAFETY ACT

The *Occupational Health and Safety Act*, R.S.O 1990, c. O.1, (OHSA) governs occupational health and safety standards in Ontario. The Act is administered by the Ontario Ministry of Labour. This section attempts to summarize the requirements of the OHSA, and regulations as they apply to composting facilities. In the event of specific questions, reference should be made to the actual legislation, or the Ministry of Labour.

It is the responsibility of the owner/operator to understand the Act and its regulations. Issues listed here may not be exhaustive. This section should be interpreted with an occupational health and safety specialist. It is offered as generally accepted practice, based on experience gained from dealing with facilities of this nature.

In general terms, OHSA requires an employer to take every precaution reasonable in the circumstance to protect workers. OHSA requirements can be addressed through the design and operation of a composting facility and with training and supervision of workers.

Design aspects:

- minimize emissions into the building air from point sources
- provide sufficient hourly air changes
- provide water connections and floor drains to facilitate frequent cleaning
- provide staff washrooms and change facilities

Operational aspects:

- medical screening prior to commencing work
- worker training and supervision on issues such as:
 - no eating, drinking or smoking while working
 - hygiene (e.g. washing hands before eating, drinking and smoking)

11.2 BASIC REQUIREMENTS

Regulation 851/90, (Industrial Establishments), made under the OHSA, prescribes the protective equipment required for various industrial operations and activities. The Regulation requires that workers be protected from exposure to the hazard of injury from:

- noxious gases, liquids, fumes or dust
- sharp or jagged objects which may puncture, cut or abrade the worker's skin
- hot objects, hot liquids or molten metals

- radiant heat

Wherever possible, the design of an operation should reduce worker contact to hazards; however in some circumstances personal protective equipment may be necessary. Appropriate protection includes wearing apparel sufficient to protect the worker from injury or a shield, screen or similar barrier appropriate in the circumstances.

Basic requirements dictate that site operations staff wear protective equipment when appropriate. A worker required to wear or use protective clothing, equipment or devices, must be instructed and trained in their care and use. Protective equipment that may be required includes head protection, eye protection, and foot protection.

Caution should be exercised to ensure that long hair and jewellery do not become entangled in any rotating shaft, spindle, gear, or belt.

The Control of Exposure to Biological or Chemical Agents regulation (O. Reg. 833/90) specifies short and long term exposure limits for some chemical agents germane to composting, such as ammonia (NH₃) and hydrogen sulphide (H₂S). This regulation also includes exposure limits for some types of organic dusts, such as wood and grain dust. While not directly applicable to composting operations, these limits may provide useful guidance to composting facility operators.

11.3 SPECIFIC CONCERNS AT COMPOSTING FACILITIES

At this time there are no composting industry specific regulations under the OHSA. The guidance presented in this section is a compilation of best practices based on experience and information from Ontario, the U.S.A., and Europe.

11.3.1 Pathogens in Feedstock

Some wastes received at a composting facility may contain human pathogens. This includes food wastes, manure, and biosolids. Workers should take precautions (e.g. practice good hygiene) to ensure that they are not exposed to pathogens.

11.3.2 Odours

Odours are generated during the composting process. If compost processing is maintained in an aerobic state these odours can be minimized.

The odours generated from the composting process are not a health risk at the concentrations normally encountered.

11.3.3 Bioaerosols

Bioaerosols are organisms or biological agents which can be dispersed through the air and which can have a negative impact on human health. Bioaerosols associated with composting can include fungi, bacteria, actinomycetes, endotoxins, microbial enzymes, glucans and mycotoxins. These compounds are present in feedstocks and may also be produced at the site. The biological agents in bioaerosols are not associated with pathogenic organisms that may be present in compost feedstock (e.g. bioaerosols are not the result of diapers in the feedstock).

Epidemiological studies of compost site workers in the U.S. and Europe indicate that the risk to healthy individuals is extremely small. However, in cases where the person has a diminished immune system or where the receiver is exposed to very elevated concentrations of bioaerosols, illness may result. Bioaerosols have the potential to produce symptoms such as skin infections, nausea, diarrhea, asthmatic and allergic reactions, hypersensitivity pneumonitis and allergic bronchopulmonary aspergillosis.

Worker exposure to bioaerosols is highest during composting operations that release dust, such as loading or unloading compost reactors, turning windrows and screening.

11.3.3.1 Bioaerosols and Public Health

Bioaerosols can become airborne during some composting operations (such as turning a pile). Therefore, the potential exists for off-site migration of bioaerosols from composting facilities.

A number of studies have investigated background concentrations of bioaerosols in indoor and outdoor environments other than composting facilities. These studies commonly conclude that bioaerosols, particularly the fungus *Aspergillus fumigatus*, are ubiquitous, and that background concentrations of bioaerosols are highly variable. Environments with an abundance of decaying organic material typically have higher background concentrations of bioaerosols, since these environments support the growth of fungi, including *A. fumigatus*. As well, background concentrations tend to vary seasonally, with highest concentrations in the spring and summer.

Several local health agencies have studied the potential public health impacts of off-site migration of bioaerosols from composting facilities. Most of these studies involved monitoring off-site bioaerosol concentrations concurrent with different on-site activities (turning vs. no-turning etc.), and different wind conditions. Off-site bioaerosol concentrations were then compared to the results of epidemiological studies of affected and control populations.

In general, these studies have concluded that concentrations of bioaerosols off-site:

- vary depending on wind conditions and site activity,
- are much lower than those on-site, and
- are below levels believed to cause health effects.

In each case, no clear cause and effect relationship could be established between the bioaerosol monitoring data and epidemiological data. While this result suggests that the impact of composting facilities is not significant, it is cautioned that other factors (e.g. pollen, heat, humidity, smog etc.) may be masking the bioaerosol effect.

11.4 MINIMIZING HEALTH AND SAFETY RISKS

The health risk of exposure to bioaerosols by workers and others in a “Sensitive Receptor” (defined in Appendix A) can be reduced by implementing the measures set out below.

Facility Siting

In general, the siting requirements, including set-back buffers, to address bioaerosols, can be included within the context of requirements to address other potential compost facility nuisances such as dust, noise and odour. The proximity to potentially Sensitive Receptors needs to be considered. Care should be taken when siting a facility in proximity to hospitals or health care centres.

(For further information on the facility setbacks that should be observed to minimize off-site impacts, please refer to Section 8.3 and Section 13).

Facility Design

Enclosed facilities should have adequate ventilation and air exchanges. This type of design consideration is similar to those used to ensure that odorous process air is removed from the facility.

Site Operation

The potential health risk of worker and public exposure to bioaerosols is minimal, and can be managed if good management practices are followed (as per Sections 8.0, 9.0, 10.0, 13.0 and 14.0 of the Guideline.)

A plan should be formulated which addresses steps taken to minimize exposure to pathogens and bioaerosol generation, and how to protect workers at the site. This plan should consist of the following generic recommendations:

A. Medical Screening:

Exposure to opportunistic pathogenic bioaerosols such as *Aspergillus fumigatus* has been shown to be a significant concern only in cases where the individuals exposed have depressed immune systems, or have pre-existing respiratory ailments. It is suggested that persons not be allowed to work at a composting facility if they have one of the following medical conditions:

- asthma

- bronchitis
- tuberculosis
- emphysema
- severe allergies

Workers should produce medical certification of the following medical procedures before working at a site:

- updating of immunizations such as Tetanus; Hepatitis A, B
- chest X-ray and two step Mantoux test

In addition, a single step Mantoux test should be performed two years after the initial Mantoux test.

B. Operational controls

The following relates to compost facility operations:

1. It is important to maintain a proper composting environment. Regular and thorough mixing of compost piles will aid proper composting and minimize the presence of *Aspergillus fumigatus*.
2. Optimal moisture content for windrows is 50-60%. Dust concentrations can be greatly reduced if moisture levels are maintained at optimal concentrations.
3. Maintain a clean site to reduce dust generation. Have a means of wetting down dry and dusty surfaces.
4. All facility operators and compost workers should be trained in methods of dust and bioaerosol control.
5. Schedule worker rotations to ensure that exposure to potentially high bioaerosol generating activities is minimized.

C. Engineering controls

The following relates to equipment:

1. Consider installing a High Efficiency Particulate Abatement (HEPA) filtration unit in loaders and windrow turners. These filters are designed to provide flow-through ventilation, from the ceiling, past the operator's breathing zone, and exiting through the floor of the cab.
2. Ensure that the door seals and structure of loader or windrow turner cabs are sufficiently airtight.
3. Ensure that cab interiors are subjected to a thorough and regular surface cleaning.

D. Protective equipment

The following relates to personal protective equipment (PPE):

1. Mechanical agitation or manual handling: Workers mechanically agitating the active compost or curing compost in an unfiltered wheeled loader or windrow turner should consider using a dust-mist class (NIOSH Class N-95) mask.
2. Normal work clothes and/or coveralls are suitable for site activities.
3. Workers should wear work gloves.

E. Hygiene

The following relates to worker conduct while working:

1. Workers should not eat, drink or smoke while working.
2. Workers should be instructed to wash their hands prior to eating, drinking or smoking.

To protect against pathogens, workers should be immunized as described in section “A” and follow procedures noted in sections “B-E”.

12.0 SEWAGE (WASTEWATER) MANAGEMENT

Composting sites can generate significant amounts of sewage (stormwater and leachate) that is not suitable for release without prior treatment. If sewage is directly discharged to a receiving water body or directly to the ground, **approval under the OWRA is required.** “Sewage” as defined under OWRA Section 1, includes drainage, storm water, commercial wastes and industrial wastes, and such other matter or substance as is specified by regulations made under clause 75 (1) (i) of the Act.

Composting facilities must be designed, constructed, and operated in a manner that prevents contamination of local surface and groundwater, or other adverse effects. The purpose of this section is to:

- outline the concerns related to sewage (wastewater) management at composting facilities
- provide guidance regarding the development of a site water management plan
- discuss water management techniques commonly employed at composting facilities

In Ontario, the potential impacts of discharging wastewater from a composting site to surface or groundwater must be evaluated on a case-by-case basis. In addition, the potential impact of a windrow facility is quite different from the potential impact of an enclosed or in-vessel facility. For these reasons, it is impossible to provide one set of design criteria for determining storage and treatment requirements that can be applied in all cases.

An in-vessel process will tend to generate smaller quantities of leachate, and many in-vessel systems provide for the recirculation of this leachate within the vessel, limiting or eliminating the need for leachate treatment and disposal. Outdoor sites, however, tend to generate significant quantities of both leachate and stormwater, which must usually be collected, treated and released. Since the treatment and disposal requirements for stormwater will generally be less onerous than the requirements for the treatment of leachate, proper site design should ensure that the two are kept separate to the greatest extent possible.

12.1 ENVIRONMENTAL CONCERNS

12.1.1 Stormwater

Stormwater is the overland flow of water resulting from precipitation or the melting of accumulated precipitation, such as snow, that has not been contaminated by contact with waste or compost. Depending on the size, design and location of the composting facility, the facility may affect natural stormwater flows, and may have an impact on the local watershed. Stormwater can also cause erosion problems, both on the composting site and on adjacent properties.

The local municipality and conservation authority should be consulted to ensure that plans to

manage stormwater from the composting facility are consistent with the local watershed management plan.

12.1.2 Leachate

Water that has come into contact with waste or compost, that has percolated through the compost pile, or that has seeped from the compost or waste materials, can possess characteristics and contain compounds that can degrade the quality of surface and groundwater if discharged without treatment. The terms "leachate" or "wastewater" will be used interchangeably throughout this document to refer to any water that has come into contact with waste or compost. Stormwater which comes into contact with waste, compost, or leachate is considered to be leachate, and may require treatment prior to discharge from the site.

Characteristics and compounds in compost leachate that are potentially of particular concern include the following:

Biochemical Oxygen Demand (BOD):

Compost leachate often exhibits high BOD due to the decomposition of organic materials. High BOD reduces the oxygen available for fish and aquatic life in a receiving water.

Phenols:

Some phenols are natural by-products of the decomposition process. Phenols can affect the taste and odour of water, and are an indicator of fish flesh tainting compounds.

Nutrients:

Several nutrients, such as nitrogen and phosphorus, are essential to the composting process. However, nutrients in leachate can contribute to algal growth and eutrophication if released to receiving waters. Some nutrient based compounds, such as de-ionized ammonia, can be acutely toxic to aquatic life.

Trace Metals:

Metals may be toxic to organisms, and may bio-accumulate in aquatic environments.

Also of concern are leachates with a high suspended solids content, a pH that could affect the receiving water, or a high salt content.

Limited testing of compost leachate quality, has indicated that concentrations of conventional pollutants, such as total phosphorus and de-ionized ammonia, can often exceed the Provincial Water Quality Objectives (PWQO). Concentrations of total phosphorus, phenols and trace metals may also exceed PWQO.

12.2 SITE WATER MANAGEMENT PLAN

Good compost site management often requires the development and implementation of a Site Water Management Plan. A Site Water Management Plan is essential for outdoor composting sites and may be required for enclosed facilities. Components of the Site Water Management Plan should include:

- assessment of local conditions
- completion of a site water balance
- determination of appropriate collection, treatment, and disposal methods
- development of contingency plans

12.2.1 Assessment of Local Conditions

The first step in the development of a Site Water Management Plan is the investigation of a variety of site specific local conditions. The scope of such investigations will depend on the scale of the proposed composting operation and on the specific water management options selected for the site.

In general, a proponent should compile the following information on local conditions:

- surface water hydrology (e.g. existing topography, natural versus artificial surfaces, drainage patterns, proximity to surface waters, extent of local floodplains, local precipitation patterns)
- local geology, including soil composition and stratigraphy
- local hydrogeology, such as the depth to the water table, current groundwater quality, and direction of groundwater flow
- local regulatory requirements, primarily municipal zoning and by-laws, and regional conservation authority requirements

This information can be compiled from a number of sources including the following:

- regional mapping (topographic maps, MNR regional soil and bedrock maps)
- regional conservation authorities
- Environment Canada - Atmospheric Environment Service
- regional and municipal governments
- legal site and engineering surveys
- existing well records (MOE and local)
- site visits
- test pits or boreholes

12.2.2 Site Water Balance

Development of a Site Water Management Plan requires an understanding of the balance of water inputs and outputs at a site. The purpose of a site water balance is to determine expected quantities of stormwater and leachate, and the timing of the peak generation for each. The site water balance will also determine the need for active treatment and disposal of collected leachate. Typically, the need for active water management is greatest in the spring and fall.

The specific details of a site water balance will be different for outdoor versus enclosed composting sites. However, even enclosed sites may have large uncovered outdoor areas such as receiving, tipping or mixing areas, and curing and storage areas.

Water inputs at a composting facility include precipitation, moisture in incoming material, process water added directly to the composting material, and wash water for trucks or surfaces. Water is also a natural by-product of the aerobic composting process. Water leaves the site through infiltration into the subsurface, evaporation, as moisture in outgoing materials, or through water treatment, disposal or discharge. Each of these factors is discussed below.

Precipitation:

The greatest challenge of the Site Water Management Plan, particularly at an outdoor site, is to deal effectively with precipitation. Most of Ontario receives an average of between 750 and 1000 mm (about 30 to 40 inches) of precipitation annually, although precipitation volumes can vary greatly from year to year. This means that a typical outdoor composting site must manage about 7,500 to 10,000 m³ of precipitation per hectare of composting pad in an average year.

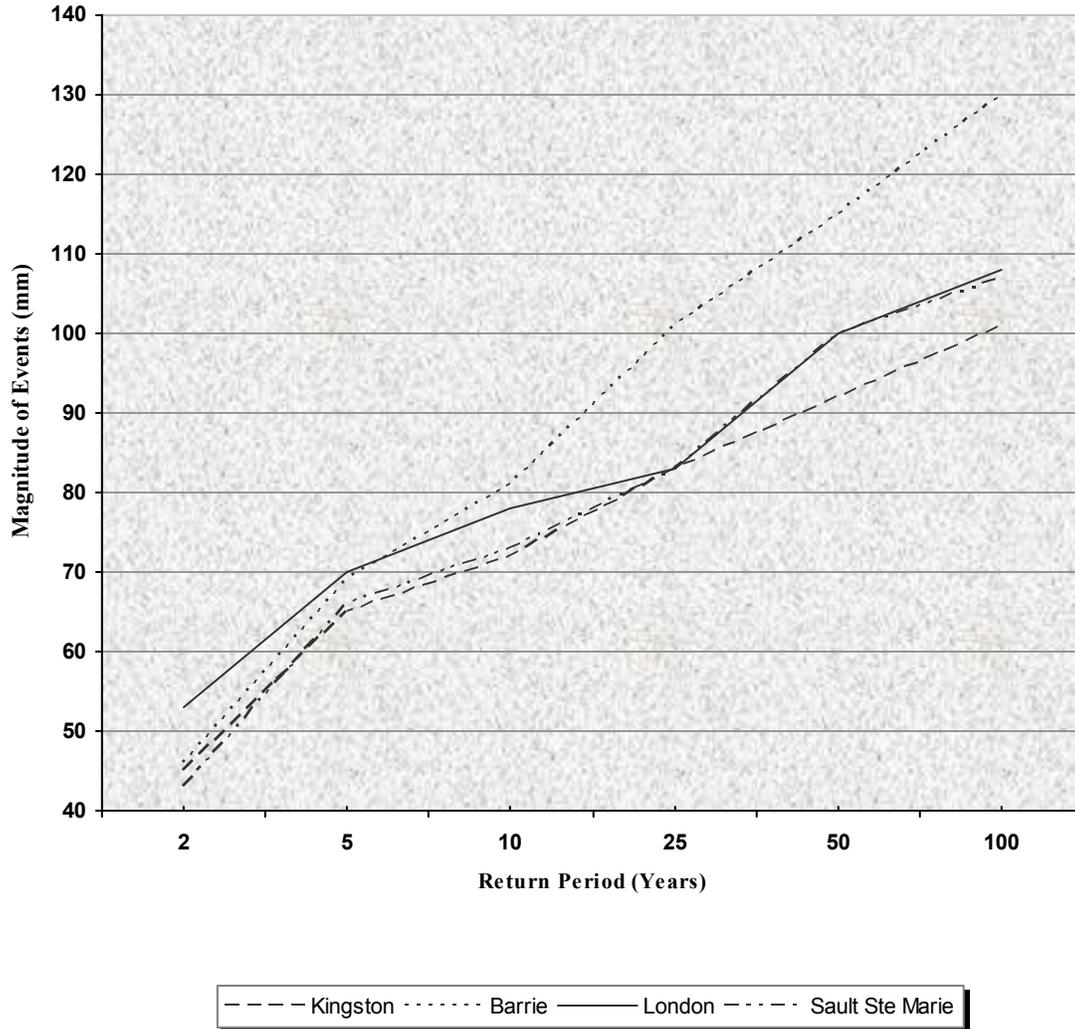
The volume of runoff to be managed at a particular site will depend on precipitation at the site. Precipitation records, summarized in IDF (Intensity-duration-frequency) charts, are available for many Ontario municipalities. This information can be used to determine the quantity of precipitation, and resulting runoff, which could be expected from storms with various probabilities or return periods. For illustrative purposes, Figure 12.1 presents the magnitudes of 24 hour storm events with 2 - 100 year return periods for four Ontario municipalities.

Also of concern is the seasonal nature of precipitation. Figure 12.2 shows the monthly total precipitation at four Ontario municipalities. The figure shows that average monthly precipitation can range from less than 60 mm per month to more than 100 mm per month and that, for many areas of the province, more than half of the precipitation occurs in the six month period from August to January. The figure also shows that average monthly precipitation typically drops in February and March, followed by increased precipitation in April and May. Since precipitation in the winter can accumulate on site in the form of snow and ice, runoff volumes in the spring can be very large. Proponents should generally plan for a prolonged period of wet weather, typically in the fall, a short, intense period of runoff generation, typically during the spring melt, and the possibility of a single, severe storm.

Not all precipitation that lands on a site will become runoff. Some precipitation may be

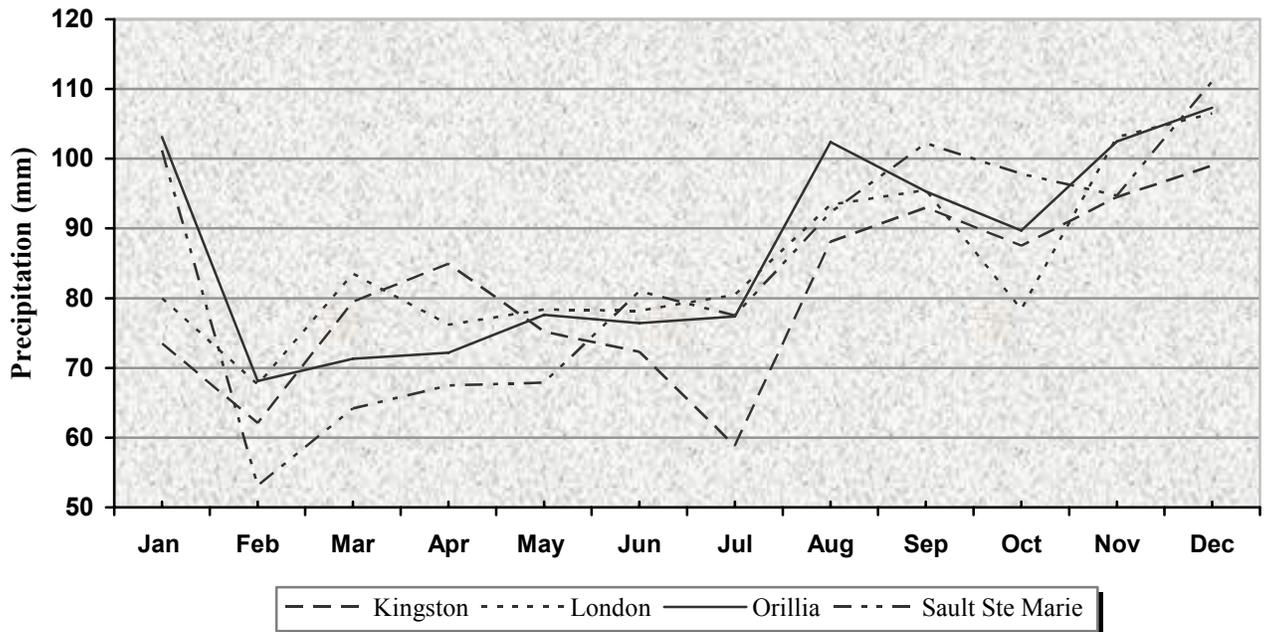
intercepted by compost windrows, may evaporate, or may percolate through the composting pad and into the groundwater table.

Figure 12.1
Magnitudes of 24 Hour Storm Events for Four Ontario
Municipalities



Source: IDF Curves 1990. Atmospheric Environment Service. Environment Canada.

Figure 12.2
Monthly Total Precipitation at Four Ontario Municipalities



Source: Canadian Climate Normals, 1961-1990. 1993 Atmospheric Environment Service. Environment Canada

Incoming Material and Finished Compost

A limited amount of water enters a site in the form of wet feedstock and exits the site in finished compost. Fresh, wet materials, such as grass clippings, food wastes, or sludges can have a moisture content of up to 80% by weight (wet basis). The moisture content of finished compost is typically 30 - 50% by weight (wet basis).

Process Water:

Many compost feedstocks require the addition of water during the processing stage. The quantity of supplemental water required will vary with the quantity and composition of material, amount of natural rehydration, and operational practice. In some instances, the compost may be rehydrated using compost leachate. This practice is discussed in Section 12.4.1 below.

Washwater:

Some composting operations include provisions for the washing of equipment, containers, tipping floors, etc. Once water is used for this purpose, the washwater becomes leachate and must be managed accordingly. The leachate from collection containers and trucks can be very high in BOD, suspended solids and nutrients.

Infiltration:

Infiltration is the percolation of water downwards through a soil matrix. Infiltration can occur through the base of active areas of the site that do not have an impermeable lining, including processing and storage areas, and runoff collection ponds.

Evaporation:

Composting is a dehydrating process as moisture, in the form of water vapour, is driven off. Evaporative water losses from composting facilities depend on the ambient temperature and the temperature of the compost, the relative humidity, and the degree of mechanical or forced aeration. For outdoor sites, wind velocities are also a factor. Significant evaporative losses can be expected from runoff collection ponds and from compost at thermophilic temperatures.

12.3 Leachate Minimization and Collection

12.3.1 Minimizing Leachate and Runoff

MOE's environmental protection strategy places priority on preventing, then minimizing the creation of pollutants. When the creation of pollutants cannot be avoided, the Ministry's priority is to prevent their release to the environment. Application of this approach to water management at composting facilities, means that facilities should be designed and operated with the objective of minimizing the generation of leachate, and preventing its release to the environment.

Leachate generation can be greatly reduced through proper site operations, such as ensuring adequate supplies of dry bulking materials to compensate for very wet feedstocks. Operators should ensure that adequate supplies of dry bulking materials are on hand to absorb excess moisture. Proper addition of bulking materials also helps control odours, and can help to ensure that the nutrient balance of the resulting blend is near optimum for the composting process.

Leachate production can also be controlled by reducing contact between precipitation and waste materials. Even enclosed or in-vessel composting systems may have uncovered active areas such as receiving areas, pre-processing areas, and storage and curing areas. Covering some or all of these areas will reduce the amount of leachate produced at the facility. Covering receiving areas should be feasible for most facilities because of the relatively small space requirement, and because of its contribution toward the objectives of odour and vector control.

12.3.2 Leachate Collection

Unless a site is specifically designed and approved to use infiltration as a water management option, some form of leachate collection system will usually be required. Leachate collection systems may be required to ensure protection of ground and surface waters, to provide year round site accessibility, and to prevent odour and vector problems associated with standing water. A composting site leachate collection system may include drains, berms, ditches and a runoff collection pond.

12.3.3 Uncovered Active Areas

In many cases, subsurface conditions will require that the base of uncovered active areas be designed to limit infiltration. In such cases, all uncovered active areas of the site should be located on a natural or artificial base of low permeability (such as clay, concrete or asphalt), and should be sloped toward the leachate storage and/or treatment and disposal facilities, to eliminate standing water. For sites at existing landfills, slope should direct runoff towards the existing leachate collection system. Windrows of compost should be oriented parallel to the direction of drainage to prevent ponding.

12.3.4 Runoff Collection Pond

Sites with uncovered active areas, and without direct connection to municipal sanitary sewers, will typically require a pond to contain and stabilize, and provide adequate treatment to, leachate prior to disposal. Proponents must ensure that the runoff collection pond can accommodate the runoff and leachate that can reasonably be expected at the site. Where subsurface conditions permit infiltration, the runoff collection pond must be equipped with a natural or artificial liner of low permeability.

As noted in Section 5.3, the site must be graded such that any leachate or stormwater contaminated with leachate, compost, or waste, is directed into a retention pond. The retention pond must be sized such that it can safely store **110%** of the stormwater runoff from all active areas of the site, for a precipitation event based on the intensity of a 24 hour duration event with a 25 year return period.

Stormwater that does not come into contact with waste, compost or leachate should be directed away from the leachate collection pond.

Leachate collection ponds require active management, including monitoring the quantity of leachate, and checking for odours. Ponds may need to be aerated, through natural or mechanical means, to ensure that the high BOD of the combined runoff does not lead to anaerobic conditions. Leachate ponds have to be designed properly and approved under Section 53 OWRA for discharges to surface water receivers.

12.4 LEACHATE TREATMENT AND DISPOSAL

The purpose of this section is to outline several options for the treatment and disposal of leachate from a composting site. If treatment of leachate is required, the Site Water Management Plan must include details of the treatment and disposal methods. Management options discussed in this section include:

- rehydration of compost with leachate
- sewage treatment (direct connection or haul to water pollution control plant)
- discharge to surface water
- spray irrigation
- infiltration

A naturally occurring or engineered marsh could also be considered for leachate treatment and disposal. This option should be fully discussed with MOE Regional staff at the outset.

It should be noted that wetlands are approved as a final polishing system in the treatment of sewage. As such, there is no reliable performance data to suggest that they can be used as a stand alone treatment system

Figure 12.3 presents common management options schematically.

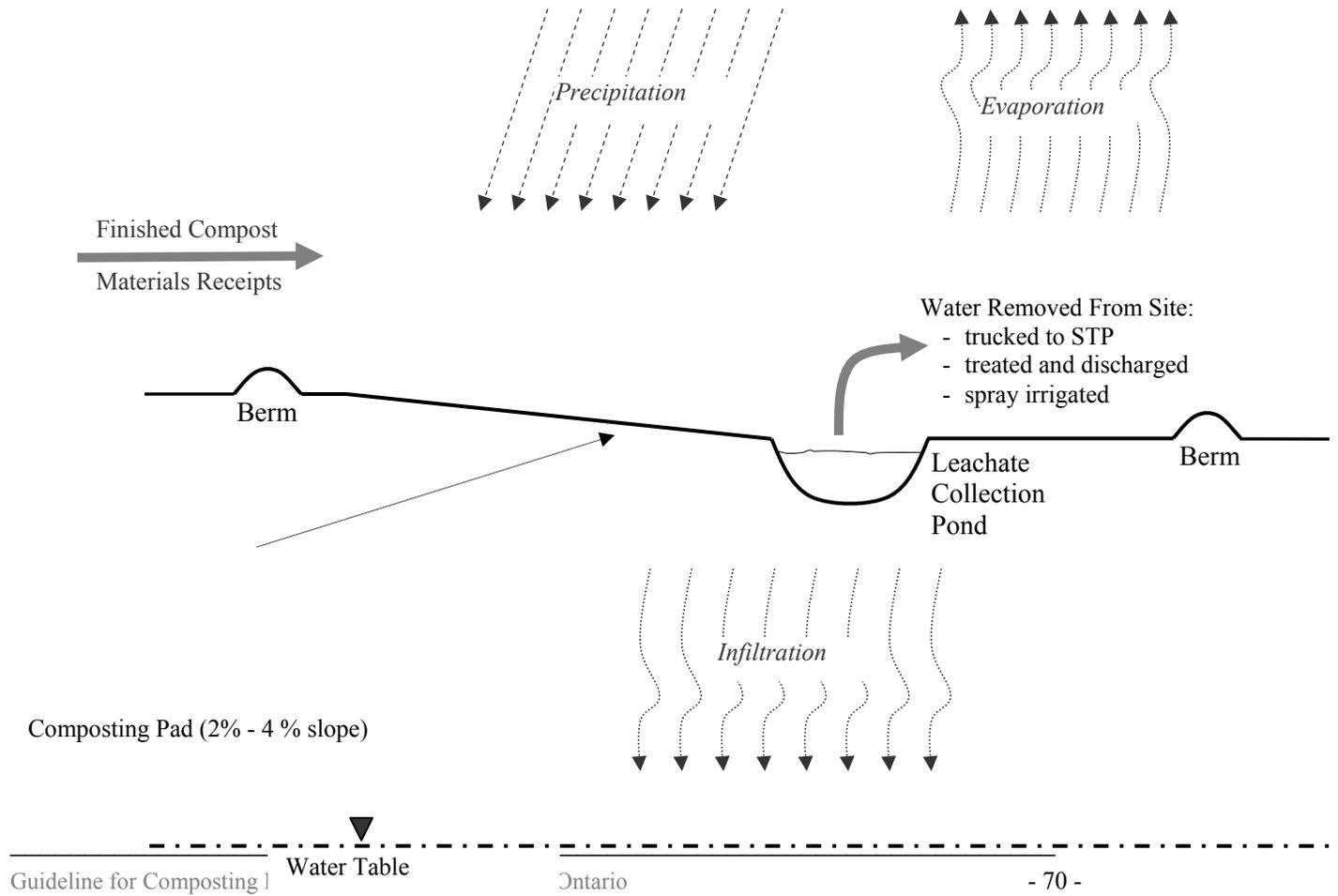
12.4.1 Rehydration of Compost

Water is often added to compost during processing to maintain optimum composting conditions. In some operations, this process water is obtained from a leachate collection pond, allowing the site operator to both reduce water costs and to provide a simple method of leachate treatment.

Leachate should only be used to rehydrate compost that is in the thermophilic temperature range to ensure inactivation of any pathogens present in the leachate. Use of leachate as a water source on compost that has completed the thermophilic stage may re-inoculate the compost with pathogens.

Operators should also be aware that extensive use of this practice may lead to the accumulation of contaminants such as heavy metals, salts, or nutrients in the compost, potentially rendering the compost un-marketable or adversely affecting the composting process. Analytical results from finished compost should be monitored closely, to ensure there is no buildup of levels beyond those specified as acceptable.

Figure 12.3 Composting Site Water Balance



12.4.2 Disposal at a Sewage Treatment Facility

Transporting leachate or combined runoff to a Water Pollution Control Plant may be a viable treatment option. Water requiring disposal can also be transported via a direct connection to a sanitary sewer (through a gravity or force main), or may be hauled to the plant by a licensed waste hauler.

Proponents should be aware that Municipal by-laws and policies may restrict direct connections to sanitary sewer systems. In particular, local sewer use by-laws should be consulted to determine any restrictions on the quantity and quality of any discharges. While combined runoff is likely to meet the quality restrictions on sewer use, municipalities may discourage or forbid connections which drain large outdoor areas.

12.4.3 Direct Discharge to Receiving Waters

All sewage treatment works for direct discharge to receiving surface waters are approved if they meet MOE effluent requirements.

The Provincial goal for surface water quality management is to ensure that the surface waters of the Province are of a satisfactory quality for aquatic life and recreation. The Provincial Water Quality Objectives (PWQO) include numerical and descriptive criteria for chemical and physical indicators, that represent a satisfactory level of surface water quality.

Discharging leachate to a surface receiving water such as a river, stream or dry ditch may be a viable alternative method for disposal of all or a portion of the leachate generated by the composting site. However, provincial surface water quality objectives will typically require that leachate receive biological and/or physical-chemical treatment prior to discharge. Discharge to a receiving water requires a Certificate of Approval under the *Ontario Water Resources Act*. Treatment requirements for discharges to surface waters are outlined in MOE Guideline F-5. Derivation of receiving water based effluent requirements are outlined in Chapter 4 of MOE Procedure B-1-5.

Effluent loading requirements are determined on the basis of the flow and assimilative capacity of the receiving water body. Effluent requirements are established to maintain set dilution ratios of selected contaminants in the receiving water body. The proponent is responsible for completing a receiving water assessment, which will be used to develop specific effluent requirements.

Annual variations in streamflow will determine whether discharge will be permitted on a continuous, non-continuous or flow proportional basis. Discharges to dry ditches (watercourses that go dry seasonally) may be permitted in some instances, provided it can be shown that continuously flowing watercourses downstream will not be negatively affected.

Effluent contaminant loadings and concentrations are based on a parameter by parameter comparison of the quality of the receiving water to the PWQO, and known variations of the receiving water quality and quantity over time, and at different locations in the watercourse.

As a result of this analysis, effluent discharge will be considered under either of two policies for each parameter:

- where water quality is better than PWQO, some degradation of quality, to the limit of the PWQO, is permitted; or
- where water quality does not presently meet objectives, no further degradation will be permitted.

The proponent must arrange a preconsultation meeting with MOE District or Area staff prior to submitting an application under the OWRA. MOE staff will review the proponents receiving water assessment and prescribe effluent requirements.

12.4.4 Land Application/Spray Irrigation of Combined Runoff

Some composting sites treat a portion of the wastewater from the site by spray irrigation or other land application methods. Spray irrigation systems apply waste water intermittently to a field and rely on interactions with the soil and vegetation to treat contaminants in the wastewater. Treatment occurs as a result of soil adsorption, absorption, and volatilization. The vegetation on the site uses many of the nutrients in the waste water. In addition, evaporation and transpiration help to reduce the volume of the wastewater. The treated wastewater eventually infiltrates into the groundwater.

Potential concerns regarding land application or spray irrigation include odours (during or after spraying), drifting of the spray off site, surface runoff and surface water contamination, adverse groundwater impacts. The seasonal nature of the treatment option, is also a concern, since sites need to treat the most wastewater during wet seasons, when fields may already be saturated.

The proposed site for land treatment should not be in agricultural production, but must have a vegetative ground cover (e.g. grasses). The ground cover should be harvested periodically, and can potentially be composted. Reasonable steps must be taken to ensure that the site does not drain directly or indirectly to a surface water body (e.g. through ditches, municipal drains, or tile drains). Applications of wastewater will not normally be approved when soils are frozen.

12.4.5 Infiltration

Allowing wastewater to infiltrate through surface soils into the groundwater is one method of treating and disposing of combined runoff from composting facilities that may be appropriate in some circumstances. Infiltration relies on natural processes in the soil and groundwater to

attenuate and degrade contaminants in the wastewater. Infiltration will only be permitted when it is in accordance with good groundwater management practices.

Significant discharges of combined runoff to groundwater by infiltration are governed by MOE Guideline B-7 "Incorporation of the Reasonable Use Concept into MOE Groundwater Management Activities". This document explains the "reasonable use" approach used in the Ministry's protection of groundwater quality, establishes procedures for determining what constitutes the reasonable use of groundwater on property adjacent to sources of contaminants, and establishes limits on the discharge of contaminants from facilities that are used for the disposal of wastewater or leachate into the shallow subsurface.

The Ministry decision as to what constitutes reasonable uses of groundwater (either existing or potential) is made on a case-by-case basis. This is necessary because the wide variation in the quality, quantity and availability of groundwater makes a fixed approach impractical. In order to determine the reasonable use of a groundwater resource, the Ministry generally considers the following:

- present use of groundwater in the vicinity
- potential use of groundwater in the vicinity
- existing quality and quantity of the groundwater

The Ministry may not support proposals for subsurface disposal of combined leachate by infiltration in the following environments:

- no appreciable attenuation can be provided
- natural attenuation capacity is weak
- subsurface is suited for better use
- consequences of failure are unacceptable

MOE approval for infiltration will generally be required under the Ontario Water Resources Act. In order for the Ministry to evaluate a proposal to treat combined runoff by infiltration, a Hydrogeologic/Soils Report is needed. The scope of the Hydrogeologic/Soils Report may vary depending on the scale of the proposed facility, and the importance of the local groundwater resource. Proponents should discuss the scope of any hydrogeologic investigations with the local MOE District Office/Regional Office prior to proceeding with any investigations.

13.0 ODOUR PREVENTION AND CONTROL

Odour control must be a primary goal of the planning, siting, design and management of all composting facilities. Historically, failure to control odours has been the most common cause of composting facility closures.

Odour control is of critical importance to the success of a composting facility for the following reasons:

- All composting feedstocks contain some amount of volatile odorous compounds when they are received at the facility; some materials, such as residential food waste and diapers are more odorous than others, such as leaf and yard materials. Normal composting operations, such as handling and aeration, will tend to promote the volatilization of odorous compounds.
- Odour is a contaminant regulated under the *Environmental Protection Act*. The Ministry of the Environment has the power to investigate and require facilities to take measures to abate the release of odours. Facilities can be required to implement potentially costly corrective measures. If abatement is unsuccessful, facility closure and/or prosecution may follow.
- In addition, Ontario Regulation 419/05, Air Pollution – Local Air Quality, made under the EPA, establishes contaminant-specific concentration limits for some odorous contaminants.
- Worker exposure to some odorous compounds normally associated with composting, such as ammonia (NH₃) and hydrogen sulphide (H₂S), is regulated under the *Occupational Health and Safety Act*.
- Certain recognizable odorous compounds can indicate a nutrient imbalance, e.g. ammonia may indicate a low C:N ratio, or the presence of anaerobic conditions, possibly indicating that the supply of oxygen needs to be increased.
- Insects and vermin can be attracted by the odour of decomposing organic matter, particularly odours generated by anaerobic decomposition.

A number of factors contribute to the likelihood of a facility experiencing odour problems, with no single factor being determinative of the success or failure of a facility in abating odours. It is recommended that facilities give serious consideration to all of the factors discussed in this section when planning a new compost facility or reviewing existing operations.

Key factors that *minimize* the risk of odours at composting facilities:

- Adequate separation distances from nearest receptors
- Proper facility design (including enclosed structures and odour control technologies)
- Minimizing transportation and storage times of feedstock materials
- Incorporating materials into the composting process on the day of arrival or up to a maximum of 48 hours
- Proper maintenance, operation and repair of air handling and process equipment
- Operator training

Key factors that *increase* the risk of odours at composting facilities:

- Siting a facility too close to residential communities and other “Sensitive Receptors” (defined in Appendix 1)
- Accepting materials with high potentials for odours, such as diapers, sanitary products, animal feces and organics collected in plastic bags
- Allowing excessive transit or storage times for feedstock materials
- Inadequate or poorly maintained equipment, or improper operation of systems
- Inadequate control of the process (e.g., anaerobic conditions, immature compost)
- Receiving and processing materials outdoors

The objective of this section is to provide guidance on odour control measures applicable to siting, design and management of composting facilities.

13.1 REGULATION OF ODOUR

The EPA defines solids, liquids, gases, odour, noise, radiation and vibration as "contaminants" when they are produced by human activities and they have the capability of causing, or actually cause, an adverse effect. Adverse effects, under the EPA, essentially involve negative impacts to people, property, business, or any part of the natural environment.

The Ministry of the Environment has the responsibility to take appropriate measures to address public complaints, and the authority to order the offending facility to take corrective action. A discharge of an odour that causes an adverse effect could result in prosecution. **It is important to remember that the public often has a low tolerance for odours and it is the facility owner/operator’s responsibility to ensure that any odour problems that arise are abated quickly and effectively.**

As noted in Section 2.1, composting facilities, unless otherwise exempt, require a Certificate of Approval issued under Section 9 of the EPA since they may discharge contaminants, including odours, into the natural environment (i.e., the atmosphere). Ontario Regulation 419/05, Air Pollution – Local Air Quality, made under the EPA, establishes contaminant-specific concentration limits (or air standards) that are used in the assessment of environmental impacts, and the issuance of Certificates of Approval under section 9 of the EPA.

Demonstration of compliance with O. Reg. 419/05 begins with the development of an Emission Summary and Dispersion Modeling (ESDM) Report that includes a summary of total air emissions for individual contaminants from a property. Air emissions are then converted to Point Of Impingement (POI) concentrations using mathematical air dispersion models.

Contaminant-specific air standards serve to protect against adverse health and environmental effects. However, odour can be produced even when individual contaminant standards are met, and the prohibition under section 14 of the EPA against discharges which may or do cause an adverse effect can be invoked when odours are discharged. As such, the odour emission rates from all the odour sources in a composting facility should be estimated and used in an air

dispersion model to calculate the odour levels at nearby Sensitive Receptors. This will be used to assess whether an adverse effect is likely to occur. Odour concentrations that are greater than 1 Odour Unit at a Sensitive Receptor, based on a 10 minute average concentration, have the potential to cause an adverse effect and can result in public complaints.

13.2 FACILITY SITING, DESIGN AND MANAGEMENT FOR ODOUR CONTROL

Odour control must be considered in the early stages of facility planning and must influence site selection and facility design. For odour control, good management practice cannot compensate for inappropriate siting and poor design.

This section identifies several opportunities to incorporate odour control into site selection and facility design.

Siting:

- The greater the separation distance between the facility and its nearest neighbours, the greater will be the natural dispersion of odours released. With sufficient dispersion, odours can be diluted to below the concentration at which they can be detected.
- However, natural dispersion alone cannot be relied upon to sufficiently dilute odours from any but small-scale facilities processing only leaf and yard materials or other low odour potential feedstock.
- Smaller composting operations (i.e., those processing 50,000 tonnes or less per year) should be located a minimum of 250 metres from the nearest Sensitive Receptor. Larger composting operations (i.e., those processing more than 50,000 tonnes per year) should be located a minimum of 450 metres from the nearest Sensitive Receptor.
- Separation distances may be modified based on Odour Impact Assessments and Odour Prevention and Control Plans, as well as considerations of facility size and design, equipment and process technologies, types of feedstock materials accepted, and operational procedures.
- Generally, the smaller the separation distance, the more odour controls required to minimize the potential for adverse effect.
- The types of neighbouring land uses (i.e., residential, park, industry, etc.) should be considered. Future uses of land within the separation distances must also be considered.

Design:

- As a general rule, the design of all facilities should include enclosed areas (building or other structure that is completely enclosed) for receiving and preprocessing operations, and possibly for the initial stages of the composting process.
- Open windrow composting is generally not considered viable for most composting applications other than small leaf and yard waste operations or very remote facilities, due to the higher potential for odour emissions. Where open windrow composting is used, facilities are strongly encouraged to use odour control systems, such as compost covers.

- Facilities should be designed to collect and treat the odorous air inside the buildings or structures (e.g., with a biofilter or equivalent technology) before discharging to the atmosphere through a stack.
- Facilities should be designed to enclose important odour sources within the smallest possible enclosure to minimize the quantity of odorous air requiring treatment, and to minimize the release of odours directly into the building air.
- Facility design should consider the use of a double door air-lock system for truck doors at the feedstock receiving area, as well as fast-acting doors.
- Building ventilation should maintain enclosed areas under negative atmospheric pressure (e.g., minimum of 3-6 air exchange rates per hour) to minimize the release of fugitive emissions.
- Facilities should be designed to create partitions to prevent airflow through buildings.
- In the planning and design stage, an Odour Impact Assessment can be used to identify the need for odour containment, collection and treatment. Odour Impact Assessments are discussed in Section 13.3.

Management:

- All wastes should be incorporated into the composting process as soon as possible.
- Wet or odorous material should only be accepted at the site if it can be incorporated into the process promptly and if it can be processed by the system without the release of offensive odours.
- Immediately adding bulking or drying agents, or covering wet or odorous material with finished compost, may help to reduce odours if the waste cannot be processed immediately.
- Highly putrescible wastes including food wastes, biosolids and manures should be incorporated into the active composting process on the day of receipt.
- Less putrescible wastes such as leaf and yard wastes and wood wastes should be on site for no more than four days before entering the active composting process.
- Care should be taken when developing the compost “recipe” to not overburden the mixture with highly putrescible wastes, to reduce the potential for odours.

13.3 ODOUR IMPACT ASSESSMENTS

The purpose of an Odour Impact Assessment is to assess whether the proposed facility siting and design can adequately controls odours such that, under worst-case meteorological conditions, odour complaints are likely to be avoided. Such assessments typically use air dispersion modelling to predict the resulting odour concentrations at Sensitive Receptors under worst-case meteorological conditions, given the local topography and prevailing wind direction. Such assessments may be used to identify the need for additional odour controls, such as odour containment, collection and treatment, when natural dispersion does not dilute odours to below detection threshold concentrations. It is strongly recommended that all compost facilities conduct Odour Impact Assessments before siting the proposed facility or determining the appropriate separation distances from the nearest Sensitive Receptors.

Odour Impact Assessments can also be used to identify effective odour abatement measures at existing facilities. It should be noted that, even where a Certificate of Approval has been issued, if the situation warrants, the Ministry has authority to order completion of an Odour Impact Assessment.

Odour dispersion modeling estimates the atmospheric dispersion of released odours under meteorological and topographical conditions specific to the site. Successful modeling requires familiarity with atmospheric modeling techniques and should be undertaken by a qualified professional. Models accepted for use in Ontario, and instructions for their use, are provided in the guidance document titled “Guideline A-11: Air Dispersion Modeling Guideline for Ontario”.

Dispersion modeling must be carried out using an approved dispersion model with an emission rate and operating scenario as described in Ontario Regulation 419/05. Dispersion modeling can be used in conjunction with measured or estimated odour concentrations for the purpose of assessing the potential off-property odour impact.

Measurement of odour concentration requires specialized sample collection and analysis techniques, that should be undertaken by qualified professionals. In some cases it may be possible to identify a specific odorous compound, or family of compounds, that can be used as an indicator of odour concentration. In these cases it may be possible to use the indicator compound to enable frequent on-site monitoring of odour sources, and the performance of the odour control system.

The dispersion model will estimate the facility’s off-property POI odour concentration. An odour detection threshold concentration of 1 odour unit (OU) is defined as the concentration at which 50% of a population can detect the odour. A 10-minute average POI concentration at this level should minimize the potential for an adverse effect. A 10-minute POI concentration greater than this level may be acceptable, depending on the frequency of occurrence and the magnitude of the concentration. Additional information on the determination of frequency is provided in the Ministry’s Technical Bulletin titled “Methodology for Modelling Assessments of Contaminants with 10-Minute Average Standards and Guidelines”.

13.4 ODOUR CONTROL SYSTEM

Most composting facilities will need to provide an odour control system for some or all of their composting operations. Odour dispersion modeling is a tool that can help to determine the specific requirements for odour control at a composting facility. This section describes each element of an odour control system; containment, collection, treatment, dilution and enhanced dispersion.

Also described is the use of masking and neutralizing agents, which should be considered to be a contingency measure, and not an element of an odour control system.

13.4.1 Odour Containment and Collection

Containment involves establishing a barrier to prevent the release of volatile odorous compounds into the atmosphere. Containment can be achieved by enclosing composting operations within a building, by using smaller enclosures for specific composting operations, through the use of partitions, such as plastic curtains, or by creating zones of negative atmospheric pressure (e.g., 3-6 air exchange rates per hour) to draw odorous air into the collection system.

Collection conveys the odorous air from the containment areas to the treatment and/or dilution or enhanced dispersion systems. Collection systems are normally comprised of corrosion resistant ducting connecting each containment area to the intake of a fan. The fan should have sufficient power to maintain containment areas under negative atmospheric pressure (e.g., 3-6 air exchange rates per hour) to prevent fugitive releases of odorous air.

For composting facilities where all or some of the composting operations are enclosed within a building, the building ventilation system usually also serves as the odour collection system.

13.4.2 Odour Treatment

All odour treatment systems involve absorption and/or adsorption with either thermal, chemical or biological oxidation to remove odorous compounds from gas. No treatment system can guarantee continuous removal of all odorous compounds. Removal efficiencies (output/input odour concentrations) vary according to the loading rates, concentration, and types of compounds in the odorous air. The odour removal efficiency can be determined by measuring the odour concentration at both the inlet and outlet of the air pollution control device. Selecting a specific odour treatment system for a facility should be undertaken with the aid of a qualified professional.

Odour treatment systems used at composting facilities include:

Biofiltration

Biofiltration is a proven method of treating odorous emissions from composting facilities. Biofilters are well suited to treatment of high volume-low concentration mixtures of odorous compounds.

Biofiltration involves passing odorous gas through a biologically active medium. Within the medium, two mechanisms, absorption/adsorption and biological oxidation, remove and degrade odorous compounds. Microorganisms live in the aqueous film surrounding the particles of the medium material. Water soluble compounds are absorbed into the water film, where they are degraded by the microorganisms, thus regenerating the absorptive capacity of the medium. Odorous compounds can also be directly adsorbed onto the surface of the medium particles.

Biofilter media can be organic, typically mixtures of ground root-wood, compost and other materials, or inorganic, such as an expanded clay, or a combination of the two. Inorganic media is typically coated with microbial nutrients and pH buffers to encourage microbial growth. Typically, organic medium biofilters have lower capital cost, but require more frequent replacement than inorganic medium biofilters. At the same airflow and odour loading rate, inorganic medium biofilters typically require less area than organic medium biofilters.

Properly designed and maintained biofilters, regardless of the choice of medium, can achieve odour removal efficiencies in excess of 90%. However, unlike other treatment systems, conditions within the biofilter are continuously changing due to ongoing microbial action, climatic conditions and changes in the composition of the odorous air. Maintaining a high removal efficiency requires that the biofilter be routinely monitored for uneven airflow distribution (due to short circuiting), moisture content, temperature, pressure drop due to compaction, and pH (since oxidation of ammonia and reduced sulphur compounds tend to reduce pH).

Biofiltration alone may not be sufficient to treat gasses with high concentrations of ammonia, or reduced sulphur compounds that are relatively insoluble. Literature suggests that ammonia removal efficiencies of biofilters are reduced with higher ammonia concentrations in the treated gas stream. This may be attributed to toxification of the filter media due to a build up of ammonia. As well, a significant acclimatization period may be required to develop a population of nitrifying bacteria. Chemical scrubbing to remove ammonia may be a required pretreatment.

Chemical Scrubbing:

Odorous air is passed through either mist or packed towers, where one or more soluble compounds in a gas mixture are dissolved into a scrubbing liquid. Typically dissolution is followed by chemical reactions which may neutralize odorous compounds. However, it should be noted that chemicals in scrubbers can potentially increase odour emissions on low concentration sources. Two stage chemical scrubbers have been used successfully at larger facilities. Stage 1; scrubbing with sulphuric acid (pH 2-4) to remove ammonia, amines and related nitrogenous alkaline compounds. Stage 2; scrubbing with sodium hydroxide (pH 8-9) to remove hydrogen sulphide and other reduced sulphur compounds.

Bioscrubbing:

Odorous air is bubbled through a biologically active slurry where odorous compounds are biologically oxidized into non-odorous forms. An example of bioscrubbing is the use of compost off gas for aeration at a wastewater treatment plant.

Thermal Destruction:

Incineration, or thermal oxidation, has been shown to eliminate nearly 100% of the odorous compounds present in odorous air. The main drawback with incineration is the energy requirement and cost. Variations of incineration technology include recuperative incinerators and

catalytic incinerators. Recuperative incinerators use heat exchangers to preheat the odorous air or to recover energy for other uses. Catalytic incinerators have a bed of catalyst material immediately following the flame area. The catalyst increases the oxidation reaction rate and enables conversion at lower reaction temperatures than in thermal incinerator units. Typical catalyst materials include platinum and palladium.

Masking/Neutralization:

There are several commercially available formulations marketed as odour treatments. These compounds are one of two basic types:

- counteractants that chemically neutralize odorous compounds
- masking agents, that are perfumes, to cover compost odours with what is considered to be a more pleasant scent

Counteractants can potentially reduce odour concentrations to a minimum of approximately 100 - 150 OU, due to the odour of the residual compounds. However, because of the complex mix of emissions from composting, there is no guarantee that counteractants will be effective. Counteractants should only be used as a temporary abatement measure to address acute odour incidents while longer term solutions are being developed; ongoing reliance on counteractants should not be considered as a replacement for an odour treatment system.

Masking agents attempt to mitigate the impact of an odour by changing its hedonic tone (a measure of pleasantness). However, masking agents add to the overall odour generation rate, and the effect on nearby receptors can be unpredictable. Use of masking agents should not be considered to be part of an odour treatment system.

13.4.3 Dilution and Enhanced Dispersion

Pre-dilution and enhanced dispersion are techniques to alter the dispersive characteristics of emissions from the composting facility, thereby potentially reducing the concentration of odours downwind. However, these techniques do not change the odour emission rate and are not a solution for serious odour problems.

Pre-dilution involves adding non-odorous air to the compost facility air immediately prior to the emission point.

Enhanced dispersion techniques are applicable to point sources of odours, e.g. the outlet of a building ventilation system or odour treatment device. Dispersion can be enhanced by increasing stack height, increasing exit velocity, providing reheat to increase thermal buoyancy and providing forced dilution with ambient air. Things to avoid include, locating the plume within the zone of building or stack downwash, low velocity discharges from the sides or roofs of buildings, using rain caps on roof ventilators, low stack velocity, and nearby topographical influences such as hills and valleys.

13.5 FACILITY MANAGEMENT FOR ODOUR CONTROL

13.5.1 Odour Prevention and Control Plan

All composting facilities should develop and implement an Odour Prevention and Control Plan. An Odour Prevention and Control Plan must include the following elements to reduce or eliminate odour problems:

- assessment of feedstock odour potential
- odour source identification
- nutrient and moisture balance
- site management
- process control
- monitoring of meteorological conditions
- on and off site odour monitoring
- complaint response procedures

The components of an Odour Prevention and Control Plan are described below in Sections 13.5.2 to 13.5.9. Useful information on odour prevention and control can also be found in Sections 8, 9, and 10 of this *Guideline*, as well as in Section 14.

13.5.2 Odour Sources

For the purpose of odour control, it is useful to consider odour sources to be all areas of the facility where odorous compounds are volatilized, i.e. released into the air. This includes both release within an enclosure such as a building or vessel, and release to the atmosphere.

Successful odour control requires a complete inventory of all potential odour sources at the facility, an understanding of the contribution of each source to overall facility odour, operational measures to minimize the odour source where possible and, where necessary, application of an effective control system to the odour source.

Table 13.1 lists important odour sources common to many composting facilities. A particular facility may have additional odour sources.

TABLE 13.1 - Potential Odour Sources

Source Identifier	Location	Description	Type	Release to	Corresponding Emission Control
1	Inbound or Outbound Truck	Truck queue at tipping floor.	Area	Atmosphere	n/a
2	Tipping Floor	Odorous material on tipping floor	Area	Receiving building	Biofilter
			Fugitive	Atmosphere	Truck door
3	Preprocessing Area	Odours released by handling	Area	Receiving building	Biofilter
4	Preprocessing Area	Odours released by debagging and grinding operations	Point	Equipment Enclosure	Biofilter
5	Composting Vessel	Odorous process air from top of compost bed. Odours released during mechanical agitation of compost bed.	Area	Composting vessel enclosure.	Biofilter
			Fugitive	Atmosphere	Man doors
6	Load Out Area	Odours released from mechanical unloading of compost vessel.	Area	Composting building	Biofilter
			Fugitive	Atmosphere	Truck door
7	Composting Pad	Odours released during mechanical agitation of compost bed. Odours from passive ventilation of compost.	Area	Atmosphere	n/a
8	Curing Pad	Odours released during mechanical agitation of compost bed. Odours from passive ventilation of compost.	Area	Atmosphere	n/a
9	Product Finishing and Storage Pad	Odours released during screening. Odours released during product loading Odours released from passive ventilation of compost.	Area	Atmosphere	n/a
10	Access Roads and Pad Areas	Waste on roadways from truck spills and carry over from tipping floor	Area	Atmosphere	n/a
11	Stormwater Pond	Odours from decomposition of dissolved and suspended organic material.	Area	Atmosphere	n/a

13.5.3 Assessing Feedstock Odour Potential

Feedstock materials are often the principle source of odours at a composting site. Odours released during feedstock receiving and preprocessing operations often exceed odours released during the composting process.

Feedstock materials that are received in plastic bags can be a particularly troublesome source of odours at compost facilities. The collection of organic wastes in non-compostable plastic bags appears to interfere with oxygen flow and create uncontrolled anaerobic digestion of the materials, with the potential to create significant odours, often before the materials even arrive at the facility. The potential for odours is especially great where long travel times/distances between the collection point and the compost facility exist.

The inclusion of human (i.e., diapers) and animal waste as feedstock materials also appears to pose additional odour problems in many compost facilities.

Where facilities plan to receive materials with a high potential for odours – such as diapers, animal waste and organic materials collected in plastic bags – special management techniques and/or odour control systems are required.

Odour Precursors

Knowledge of the presence of chemical precursors for the formation of odorous compounds can be used to assess the odour potential of a feedstock. Odour precursors include:

- nitrogen, which is the precursor for the formation of ammonia, amines and indole, and which is in high proportion in materials such as grass clippings, manure, biosolids, fish and meat, many food processing wastes and mixed food waste;
- sulfur, which is the precursor for the formation of organic sulfides, mercaptans and hydrogen sulfide, and which is contained in materials such as manure, in particular poultry manure, biosolids and mixed food waste; and,
- rapidly degrading carbohydrates and fats, which are the precursors for the formation of volatile fatty acids.

Knowledge of the degradability of a feedstock can also be applied to assess its odour potential. The oxygen demand of an abundance of rapidly decomposing material may outpace the rate at which oxygen can be replaced by aeration, leading to anaerobic conditions and the formation of new odorous compounds.

13.5.4 Odour Source Identification

The Odour Prevention and Control Plan should include a complete inventory of potential odour sources. Potential odour sources common to many composting facilities are presented in Table 13.1. The potential odour source inventory can be used as a guide to focus odour reduction efforts.

13.5.5 Nutrient and Moisture Balances

The importance of nutrient balance in odour avoidance was discussed in Section 10.2.2.3

Feedstocks vary in their potential as a source of odours. Knowledge of the physical and chemical characteristics of the feedstock can help identify materials requiring special handling.

Special attention should be paid to wastes with the following characteristics:

Carbon to Nitrogen Ratio:

An abundance of nitrogen relative to degradable carbon will promote the formation of volatile forms of nitrogen, such as ammonia. Total N content, not specific N compounds, is significant, as the nitrogen is readily available. Ammonia (NH₃) is volatile, while ammonium (NH₄⁺) is not. NH₃/NH₄⁺ equilibrium is determined by pH. The equilibrium point is close to neutrality. pH below neutral results in high ammonium while pH above neutral results in high ammonia and ammonia volatilization. To reduce formation of volatile nitrogen compounds, it is necessary to ensure that the C:N ratio of the blended feedstock is not less than 30:1, as described in Section 12.1.

Carbon to Sulfur Ratio:

An abundance of sulfur relative to degradable carbon will promote the formation of volatile reduced sulfur compounds, such as hydrogen sulfide. Sulfur is primarily contained in amino acids and to a lesser extent in other organic molecules. Reduced sulphur compounds, resulting from anaerobic processes, have been linked to odour problems at many composting facilities. To reduce the formation of volatile sulfur compounds, it is necessary to ensure that the C:S ratio of the blended feedstock is not less than 100:1.

High Moisture Content:

Some organic wastes can have moisture contents in excess of 80%. These wastes present special management problems as they:

- tend to compact under their own weight making them less porous and difficult to aerate
- generate leachate
- can be difficult to handle
- require drying or addition of dry amendments

For example, cafeteria food wastes or grocery store wastes often have a very high moisture content.

13.5.6 Site Management

Odour prevention principles must be incorporated into overall site management practices. Management activities must ensure that the facility is maintained in a clean and orderly state.

Suggested management activities include:

- inspection and rejection of loads with strong, offensive odours, at facilities with outdoor receiving/tipping areas
- minimizing on-site storage of feedstocks - some materials such as grass clippings and municipal biosolids should be processed immediately
- washing equipment and surfaces that contact waste with detergent (preferably biodegradable)
- preventing ponding of leachate
- maintaining aerobic conditions in runoff storage pond
- removing residual wastes from the site promptly

13.5.7 Process Control

Managing odour is a function of maintaining the composting mass in an aerobic state. At an outdoor facility, it is critical to understand a site's ability to disperse odour. This will ultimately dictate the intensity of processing activities. For reactor based facilities it is important to ensure that odour abatement equipment, such as biofilters, are in good working order. As well, it is important to minimize "fugitive emissions" (i.e. those emissions not captured by odour abatement equipment). These types of emissions can occur from opening doors for incoming/outgoing vehicles, and other similar activities. Their impact can be minimized by ensuring that a building's aeration system is sufficiently negative to prevent the outflow of odorous air, or by installing an airlocked vehicle receiving area.

13.5.8 Monitoring Meteorological Conditions

Potentially odour releasing activities, such as windrow turning, should be avoided during unfavourable meteorological conditions that minimize natural dispersion. Often, meteorological conditions during the early morning and early evening are most stable and can tend to concentrate odours at ground level. Therefore, it may be advantageous to conduct turning operations at mid-day when the atmosphere tends to be more turbulent and provides better odour dispersion.

Odour dispersion modeling can be used to identify unfavourable, or 'worst case' meteorological conditions. An on-site weather station can be useful for identifying unfavourable and favourable meteorological conditions for day to day operations.

13.5.9 On and Off-Site Odour Monitoring

On-site monitoring should include both routine monitoring by facility staff to identify odorous situations on a daily basis (although it is important to note that employees that are regularly exposed to odours can become desensitized), and a program of periodic sampling and analysis of treatment system emissions. On-site monitoring can provide useful feedback on the effectiveness of site management activities and process control measures. Odorous situations should be noted in the daily site log, and the causes analyzed to prevent repeat occurrences.

If odour problems have been identified (e.g., through public complaints), it may become necessary to increase the monitoring frequency and determine the odour concentration of the input air, to determine whether the removal efficiency of the treatment system is within an acceptable range.

An effective proactive method of monitoring for odours off-site has not yet been developed. Sampling and analysis of odour concentrations near threshold values is impractical. The neighbours of a composting facility can be relied upon to provide ongoing monitoring. Residents should be provided with a contact phone number at the facility, should they experience an odour they might attribute to the facility. Facility management should be prepared to respond quickly to odour complaints.

13.6 RESPONSE PROCEDURES

The importance of initiating and maintaining good relations with the local community cannot be overstated. Public goodwill toward the facility and its management can facilitate quick completion of voluntary odour abatement plans. Public opposition on the other hand, can make an abatement process more onerous and adversarial.

Creating goodwill is the responsibility of the facility management. Experience has shown that communities respond well when they are given the opportunity to become familiar with the operation, and when they are given clear, accurate information. Successful methods for creating public goodwill include: open houses, presentations to schools and local groups, newsletters and other communications tools.

To maintain goodwill it is essential that facility management respond quickly to odour complaints. The response should be designed to achieve the following objectives:

- record the complaint for follow-up and evaluation
- identify the cause of the odour
- confirm that the facility is, or is not, the source of the odour
- implement remedial measures
- reassure residents that the situation can and is being resolved
- follow up regularly with residents and the local MOE representative

Figure 13.1 is a sample Odour Complaint Response form, which can be used to monitor and record odour complaints and remedial actions.

Figure 13.1 Odour Complaint Form

ODOUR COMPLAINT RECEIPT

Complaint Received		Complainant	
Date:		Name:	
Time:		Address:	
Details (character of the odour, time noticed):			
Meteorological Conditions			
Temperature:		Cloud Cover:	
Wind Speed:		Full Partial None	
Direction:		Precipitation:	
Site Activities (windrow turning, waste receipt, screening etc.):			
Response			
Action Taken:		Follow Up Call:	
		Results:	

14.0 PREVENTION AND CONTROL OF POTENTIAL ADVERSE EFFECTS

Composting is an outdoor and indoor product manufacturing process. Adverse effects from a composting facility are a result of poor location/design and/or poor facility operation. Many of the potential off-site impacts from composting facilities can be minimized or eliminated through proper planning at the design stage, and careful attention to site operations.

Site Location and Design are discussed separately in Sections 8 and 9. Considering the prevailing wind direction, and the downwind land use, is critical when planning the location of a composting facility, particularly receiving and processing areas. Buffer zones (together with the use of existing trees, natural features, berms, screens, and fences) should be planned to both visually screen the site from neighbours and to minimize the impact of noise, odour, dust, and litter.

Several potential adverse effects and some suggested methods of control are presented below. The question of odour control at composting facilities is discussed separately, in Section 13, because of its importance and complexity.

14.1 NOISE

Noise can be generated by vehicles entering, leaving, or operating at the composting site, and by equipment used in the compost processing operations.

Proponents should check with their local municipality to ensure that they are complying with any local noise control by-laws.

Measures that can be used to reduce noises from a site include the following:

Site Location and Design

- provide an adequate buffer zone, supplemented with fences, wind breaks or noise barriers if required

Site Operation

- limit hours of operation or coordinate operations with adjacent activities
- limit traffic to and from the facility
- properly maintain all equipment
- specify equipment with noise reduction design features (such as mufflers, sound enclosures, etc.)

14.2 LITTER

Litter, primarily in the form of plastic and paper, can be present in loads of waste. It can also be tracked through and off-site by vehicles leaving the facility.

Measures that can be used to reduce litter from a site include the following:

Site Location and Design

- provide indoor facilities for receiving and pre-processing

Site Operation

- minimize receipt of wastes with a high percentage of foreign matter
- refuse to accept loads from uncovered vehicles
- exercise care during processing and screening of organic waste, particularly during windy days
- install shields around high litter generation points (e.g. conveyors) through the use of litter fences when required
- collect on-site and off-site litter promptly (e.g. by conducting a daily manual pickup)
- ensure that litter and other waste materials at the site are stored in proper containers and disposed of on a regular basis.

14.3 DUST

Dust is generated from dry composts and potentially from roads tracked with mud from vehicles leaving the site.

Measures that can be used to control dust from a site include the following:

Site Location and Design

- use of constructed composting pad surfaces and road surfaces (concrete, asphalt, gravel, etc.)
- use of screening vegetation or other windbreaks
- use of a wheel wash for vehicles leaving the site
- enclosing operations and installing dust collection equipment such as collection hoods, negative air pressure at dust collection points (e.g., 3-6 air exchange rates per hour), wet scrubbers, and bag houses

Site Operation

- maintaining an adequate moisture content in all active composting piles (> 35%)
- wetting dry dusty site roads
- ensure vehicles leaving the site use a wheel wash
- general site housekeeping
- limiting screening and turning activities in high winds

For more information on best management practices for dust control, please refer to Appendix F of the Ministry's "Procedure for Preparing an ESDM Report."

14.4 VERMIN AND VECTORS

Raw organic and composting organic wastes can attract a variety of vermin and vectors including insects, rodents and birds. Once established, vermin and vectors can be very difficult to remove, and they may pose a public health problem.

Rodents and birds may be attracted by the food and shelter available at a composting site. Flies may be attracted to anaerobically decomposing material, and mosquitoes may breed in pools of water on the site.

Possible trouble areas at a composting facility include:

- receiving areas
- processing areas
- stormwater and leachate ponds
- low lying areas on composting pads that collect water
- site perimeters
- roadways

Measures that can be used to control vermin and vectors at a site include the following:

Site Location and Design

- enclosing receiving and composting areas; and
- proper grading and construction of outdoor composting pads or indoor receiving areas to eliminate standing water.

Site Operation

- promptly (i.e. on day of receipt) incorporating wastes (particularly food wastes) into active processing
- covering fresh organic wastes (e.g. food wastes) with a layer of carbonaceous material (e.g. leaves, wood chips) or compost
- maintaining aerobic composting conditions at all times
- controlling ammonia production (which attracts flies) by balancing C:N ratio
- regular turning of windrows to discourage nesting of rodents and birds, and to minimize fly populations
- active management of leachate detention ponds
- regular cleaning of receiving areas
- pest control and traps for vermin as required

14.5 FIRE

Fire can have an impact on an area surrounding a composting facility through the generation of smoke.

Measures that can be used to minimize the likelihood a fire developing include the following:

Site Location and Design

- build facilities that comply with appropriate building and fire codes
- ensure outdoor facilities are built with adequate space for composting, curing and product storage
- ensure that access to water to be used for firefighting is included in the facility

Site Operation

- prohibit smoking at the facility
- exercise appropriate care when using equipment such as welders
- ensure windrows/piles are not built too high (>5m)
- ensure windrows have a moisture content of greater than 45%

14.6 TRAFFIC

Traffic can have an impact on an area surrounding a composting facility. Trucks can generate noise, track mud or litter onto roadways and possibly be a source of odour.

Measures that can be used to reduce traffic impact noises from a site include the following:

Site Location and Design

- ensure the compost facility is built in an area with minimal load restrictions
- ensure the compost facility is built in an area with roads capable of handling truck traffic
- design the facility to accommodate rapid unloading and processing of vehicles
- provide a wheel wash for outbound vehicles

Site Operation

- limit traffic to and from the facility
- maintain clean site roads
- ensure vehicles leaving the site use the wheel wash

APPENDIX 1: GLOSSARY

Adverse Effect - Under EPA Section 1 "adverse effect" means one of more of: (a) impairment of the quality of the natural environment for any use that can be made of it, (b) injury or damage to property or to plant or animal life, (c) harm or material discomfort to any person, (d) an adverse affect on the health of any person, (e) impairment of the safety of any person, (f) rendering any property or plant or animal life unfit for use by man, (g) loss of enjoyment of normal use of property, and (h) interference with the normal conduct of business.

Aerated Static Pile - A static compost pile or windrow is constructed over a grid of perforated piping and a layer of bulking agent (such as wood chips) and/or finished compost. Fans are used to force (inject) or draw (induct) air into the pile and support aerobic decomposition. The pile may be topped with a layer of finished compost and/or wood chips to degrade odorous compounds and to provide insulation thereby maintaining a temperature adequate to destroy pathogens.

Agricultural Waste - In Regulation 347, Section 1, under the EPA, "agricultural waste" means waste, other than sewage, resulting from farm operations, including animal husbandry and where a farm operation is carried on in respect of food packing, food preserving, animal slaughtering or meat packing, and includes the waste from such operations.

Amendment - Amendment means supplemental material added during composting or to compost to provide attributes required by certain customers, such as product bulk, product nutrient value, product pH, and blends of soil materials. Amendment also means, any material, such as compost, lime, gypsum, sawdust, or synthetic conditioners that is worked into the soil to make it more productive.

Biodegradable Material - Organic materials that can be broken down by naturally-occurring bacteria and other microorganisms, usually in the presence of moisture and oxygen, into simple, stable compounds.

Biosolids – includes:

Sewage biosolids – residue from a sewage treatment works following treatment of sewage and removal of effluent.

Pulp and paper biosolids – residue from the treatment of wastewater from the pulp and paper manufacturing process.

Septage – human body waste, toilet and/or other bathroom waste.

Bulking Agent - Bulking agent means material, usually carbonaceous, such as wood chips or shredded yard trimmings, added to a compost system to maintain airflow by reducing settling and compaction.

Compost - For the purposes of this *Guideline*, compost is a solid, mature product produced by an aerobic composting process. Compost is suitable for use as a soil conditioner and can improve

soil structure, water retention, aeration, erosion control and other soil properties.

Composting - In *Regulation 347* of the EPA “composting” means the treatment of waste by aerobic decomposition of organic matter by bacterial action for the production of stabilized humus. For the purpose of this guideline composting also means an aerobic biological process, conducted under controlled, engineered conditions designed to decompose and stabilize the organic fraction of solid waste or other organic matter. Composting includes a thermophilic phase. Simple exposure of solid organic waste under non-engineered conditions resulting in uncontrolled decay is not considered to be composting.

Contaminant - Under EPA Section 1 "contaminant" means any solid, liquid, gas, odour, heat, sound, vibration, radiation or combination of any of them resulting directly or indirectly from human activities that may cause an adverse effect. “Contaminant” is also used in this *Guideline* to refer to foreign materials (such as dirt, heavy metals, plastic scraps, etc.) that make it more difficult to compost a feedstock, or reduce the value of the final compost.

Endotoxin - A toxin that forms an integral part of the cell wall of gram-negative bacteria which is only released upon destruction of the bacterial cell. May cause acute illness such as flu-like symptoms and chronic illness such as chronic bronchitis, depending on the bacterial species and the health of the infected person.

Feedstock - Feedstock means waste that contains primarily biologically decomposable organic materials used for the production of compost. Supplements including additives, amendments and bulking agents are not feedstock.

Fertilizer - Natural or synthetic material used to add nutrients to soil. Most chemical fertilizers contain a mixture of nitrogen (N), phosphorus (P) and potassium (K).

Foreign matter - Any matter resulting from human intervention and made up of organic or inorganic components such as metal, glass, or plastic that may be present in compost. Foreign matter does not include mineral soils, woody material, and rocks.

Sharp foreign Matter: Any foreign matter over 3 mm in dimension that may cause damage or injury to humans and animals during or resulting from its intended use. Sharp foreign matter may consist of, but is not limited to, the following; metallic objects or pieces of metallic objects, for example utensils, fixtures, electrical wiring, pins, needles, staples, nails, bottle caps, glass and porcelain or pieces of glass and porcelain, for example, containers, dishes, glass panes, electric light bulbs and tubes, mirrors.

In-Vessel Composting - A diverse group of composting methods in which composting materials are contained in a reactor or vessel. The purpose of the vessel is to help maintain optimal conditions for composting. In-vessel systems are either fully or partially enclosed. Types of in-vessel systems include: rotating drum systems; horizontal channels either fully or partially enclosed; vertical (silo) configurations; or batch container systems.

Leachate - The liquid which passes through (and, on occasion, out of) a compost pile as the result of rain and other water percolating through and picking up certain soluble waste fractions.

Leaf and Yard Waste - "Leaf and yard waste" is used to refer to grass clippings, tree and shrub trimmings, fruits and vegetables from gardens, flowers, natural Christmas trees (evergreens) and similar organic plant materials generated from gardening and yard maintenance activities at residential and other properties. Tree limbs or other tree parts may be included in leaf and yard waste but only if they are under 7 centimetres in diameter.

Maturity - Compost that has undergone extensive decomposition and as a result exhibits limited biological activity, can be stored and handled without adverse effect, and can be used without risk to plants from residual phytotoxic compounds.

Municipal Waste - Commonly referred to as "municipal solid waste" (MSW). For the purpose of this *Guideline*, municipal solid waste (MSW) also means materials discarded by individuals in the course of their daily activities at home and by commercial businesses, industries and institutions as a result of normal operating activities. MSW is usually subdivided into Residential Waste and IC&I Solid Waste. MSW does not include liquid industrial or hazardous wastes.

Organic Soil Conditioning - In Section 1 of Regulation 347 under the EPA "organic soil conditioning" means the incorporation of processed organic waste in the soil to improve its characteristics for crop or ground cover growth.

Organic Soil Conditioning Site - A site which has received MOE approval to receive "processed organic waste".

Organic Waste - Waste containing carbon based compounds. In the composting industry, the term is often used in a more restrictive sense to refer specifically to biodegradable, compostable wastes of plant or animal origin, such as food scraps, grass clippings, yard wastes, etc., but excluding lumber, plastic, rubber, oils and other hydrocarbons, and other organic chemicals.

Pathogens - Organisms, including some bacteria, viruses, fungi, and parasites, that are capable of producing an infection or disease in a susceptible human, animal, or plant host.

Quality Assurance - A system of activities and procedures which allows for the producer of a product (i.e. data) to demonstrate that it is constantly producing a product of definable quality. QA consists of those activities that assure that all necessary QC activities were defined and carried out according to protocol. QA is primarily a supervisory responsibility.

Quality Control - (QC) describes specific activities conducted for the purpose of maintaining quality in sample collection, analysis, and recording. Primarily a scientific or technical function performed by research or technical staff.

Quality Management - (QM) is the process of ensuring that a full and complete QA and QC program is established, that proper evaluation of the total program occurs, and that appropriate actions are taken when satisfactory quality is not being achieved. QM involves the specification of what constitutes acceptable quality, the detailing of the means by which it is determined that the specified quality has been achieved, and the defining of what actions will be taken when the desired quality is not met. QM is normally the responsibility of project management.

Sensitive Receptor - means any location where routine or normal activities occurring at

reasonably expected times would experience adverse effect(s) from odour discharges from the facility, including one or a combination of:

- (a) private residences or public facilities where people sleep (e.g., single and multi-unit dwellings, nursing homes, hospitals, trailer parks, camping grounds, etc.);
- (b) institutional facilities (e.g., schools, churches, community centres, day care centres, recreational centres, etc.);
- (c) outdoor public recreational areas (e.g., trailer parks, play grounds, picnic areas, etc.); and
- (d) other outdoor public areas where there are continuous human activities (e.g., commercial plazas and office buildings).

Sewage - Under the OWRA, “sewage” includes drainage, storm water, commercial wastes and industrial wastes, and such other matter or substance as is specified by regulations made under clause 75 (1) (i).

Sludge - A semi-solid substance consisting of settled sewage solids combined with varying amounts of water and dissolved materials generated from municipal or industrial wastewater treatment plants.

Soil Conditioner - Any material added to the soil in order to beneficially enhance the soil's physical or chemical properties or biological activity. It is recommended that an agronomist and/or the MOE be consulted when unconventional materials are being considered for use.

Source Separation - The segregation of used materials from municipal waste into specific material categories at the point of generation, in order to facilitate recycling or composting.

Stability - The term ‘stability’ is sometimes used interchangeably with ‘maturity’. However in its generally accepted meaning, ‘stability’ refers only to reduced biological activity. It is a sub-set of maturity. Compost could appear stable as a result of a nutrient imbalance or lack of moisture, and not extensive decomposition, and could become ‘unstable’ if any of the limiting conditions are removed. All mature compost is stable, but not all stable compost is mature.

Substrate - A blend of feedstocks in the active composting stage and not yet finished compost.

Thermophilic Phase - A period in the composting process characterized by the predominance of active micro-organisms which thrive at a temperature range of 45°C to 75°C.

Water - Under EPA Section 1 “water” means surface water and ground water, or either of them. For the purpose of this *Guideline*, wastewater refers to storm water and leachate generated at a composting facility.

Waste - Under EPA Part V Section 25 "waste" includes ashes, garbage, refuse, domestic waste, industrial waste, or municipal refuse and other such wastes as are designated in the regulations. Regulation 347 under the EPA designates a variety of things as “waste” and also exempts certain wastes from the requirements of EPA Part V and Regulation 347.

Windrows - Windrows are rows of organic material stacked into elongated piles with a triangular cross-section. Both turned and static windrow systems are used for composting. In the former, the windrows are periodically torn down and reconstructed or turned mechanically (the outside layer

of the original windrow becoming the interior of the rebuilt windrow, in order to aerate and mix the organic wastes, speed the decomposition process, and reduce odours).

Wood - Wood suitable for composting generally includes lumber, tree trunks, tree branches or other wood wastes, except for particle board, that are not contaminated by glue, paint, preservatives or other materials or attached to non-wood material.

APPENDIX 2: LIST OF MOE OFFICES

Central Region	West-Central Region	South-Western Region	Eastern Region	Northern Region
<p>Central Region Office 5775 Yonge St., 8th floor North York ON M2M 4J1 Toll free: 1-800-810-8048 Tel: (416) 326-6700 Fax: (416) 325-6345</p> <p>Toronto District Office 5775 Yonge St., 8th floor North York ON M2M 4J1 Toll free: 1-800-810-8048 Tel: (416) 326-6700 Fax: (416) 325-6346</p> <p>Halton-Peel District Office 4145 North Service Road, Suite 300 Burlington ON L7L 6A3 Toll free: 1-800-335-5906 Tel: (905) 319-3847 Fax: (905) 319-9902</p> <p>York-Durham District Office 230 Westney Rd. S., 5th floor Ajax ON L1S 7J5 Toll free: 1-800-376-4547 Tel: (905) 427-5600 Fax: (905) 427-5602</p>	<p>Hamilton Regional Office 12th floor, 119 King St. W. Hamilton ON L8P 4Y7 Toll free: 1-800-668-4557 Tel: (905) 521-7640 Fax: (905) 521-7820</p> <p>Hamilton District Office 9th floor, 119 King St. W. Hamilton ON L8P 4Y7 Toll free: 1-800-668-4557 Tel: (905) 521-7650 Fax: (905) 521-7806</p> <p>Guelph District Office 1 Stone Road W. Guelph ON N1G 4Y2 Toll free: 1-800-265-8658 Tel: (519) 826-4255 Fax: (519) 826-428</p> <p>Niagara District Office 9th floor, 301 St. Paul St. St. Catharines ON L2R 3M8 Toll free: 1-800-263-1035 Tel: (905) 704-3900 Fax: (905) 704-4015</p>	<p>London Regional Office 2nd Floor, 733 Exeter Road London ON N6E 1L3 Toll free from area code 519: 1-800-265-7672 Tel: (519) 873-5000 Fax: (519) 873-5020</p> <p>Barrie District Office 54 Cedar Pointe Dr., Unit 1203 Barrie ON L4N 5R7 Toll free: 1-800-890-8511 Tel: (705) 739-6441 Fax: (705) 739-6440</p> <p>Sarnia District Office 1094 London Rd. Sarnia ON N7S 1P1 Toll free number: 1-800-387-7784 Tel: (519) 336-4030 Fax: (519) 336-4280</p> <p>Owen Sound Area Office 1580-20th St. E. P.O. 967 Owen Sound ON N4K 6H6 Toll free from area code 519: 1-800-265-3783 Tel: (519) 371-2901 Fax: (519) 371-2905</p> <p>Windsor Area Office 4510 Rhodes Drive, Unit 620 Windsor ON N8W 5K5 Toll free number: 1-800-387-8826 Tel: (519) 948-1464 Fax: (519) 948-2396</p>	<p>Kingston Regional Office Box 22032, 1259 Gardiners Road Kingston ON K7M 8S5 Toll free for area codes 613/705/905: 1-800-267-0974 Tel: (613) 549-4000 Fax: (613) 548-6908</p> <p>Kingston District Office Box 22032, 1259 Gardiners Road Kingston ON K7M 8S5 Toll free for area codes 613/705/905: 1-800-267-0974 Tel: (613) 549-4000 extension 2692 Fax: (613) 548-6920</p> <p>Belleville Area Office 345 College Street East Belleville ON K8N 5S7 Toll free from area code 613: 1-800-860-2763 Tel: (613) 962-9208 Fax: (613) 962-6809</p> <p>Ottawa District Office 2430 Don Reid Drive Ottawa ON K1H 1E1 Toll free: 1-800-860-2195 Tel: (613) 521-3450 Fax: (613) 521-5437</p> <p>Cornwall Area Office 113 Amelia St. Cornwall ON K6H 3P1 Toll free number for area code 613: 1-800-860-2760 Tel: (613) 933-7402 Fax: (613) 933-6402</p> <p>Peterborough District Office 300 Water Street, Robinson Place Peterborough ON K9J 8M5 Toll free from area codes 613/705/905: 1-800-558-0595 Tel: (705) 755-4300 Fax: (705) 755-4321</p>	<p>Thunder Bay Regional Office Suite 331, 435 James St. S. 3rd Floor Thunder Bay ON P7B 6M1 Toll free from area codes 705/807: 1-800-875-7772 Tel: (807) 475-1205 Fax: (807) 475-1754</p> <p>Thunder Bay District Office Suite 331, 435 James St. S. Thunder Bay ON P7B 6M1 Toll free from area code 705/807: 1-800-875-7772 Tel: (807) 475-1315 Fax: (807) 473-3160</p> <p>Sudbury District Office Suite 1201, 199 Larch St. Sudbury ON P3E 5P9 Toll free from area codes 705/807: 1-800-890-8516 Tel: (705) 564-3237 Fax: (705) 564-4180</p> <p>Timmins District Office Ontario Govt. Complex Hwy 101 East, P.O. Bag 3080 South Porcupine ON P0N 1H0 Toll free in area codes 705/807: 1-800-380-6615 Tel: (705) 235-1500 Fax: (705) 235-1520</p> <p>Kenora Area Office 808 Robertson St. P. O. Box 5150 Kenora ON P9N 3X9 Toll free from area code 807: 1-888-367-7622 Tel: (807) 468-2718 Fax: (807) 468-2735</p> <p>North Bay Area Office 191 Booth Road, Unit 16 & 17 North Bay P1A 4K3 Toll free: 1-800-609-5553 Tel: (705) 497-6865 Fax: (705) 497-6866</p> <p>Sault Ste Marie Area Office 289 Bay Street, 3rd Floor Sault Ste. Marie ON P6A 1W7 Tel: (705) 942-6354 Fax: (705) 942-6327</p>

Waste Management Policy Branch	Standards Development Branch	Environmental Assessment and Approvals Branch
<p>135 St. Clair Ave. W., 7th Floor Toronto ON, M4V 1P5 Tel: (416) 325-4111 FAX: (416) 325-4437</p>	<p>40 St. Clair Ave. W., 7th Floor Toronto ON, M4V 1M2 Tel: (416) 327-5519 FAX: (416) 327-2936</p>	<p>2 St. Clair Ave. W., 12A Floor Toronto ON, M4V 1L5 Tel: (416) 314-8001 Toll free: 1-800- 461-6290 FAX: (416) 314-8452</p>

APPENDIX 3: OPERATING PLAN

Appendix 3 provides a summary of siting and operating information requirements that will likely be required when applying for approval of a composting site.

1. Site Description (*existing or proposed site*):

- Names of the owners, operators and/or lessees of the proposed facility;
- Vicinity map (with an approximate scale of 1:20,000) clearly labelled to show the boundaries of the proposed facility and also showing each of the following for a distance of 200 metres from the boundaries of the proposed facility:
 - population centres and commercial/institutional/industrial operations;
 - surface waters and regional floodplain limits; and
 - the direction of prevailing winds.
- Site plan (with an approximate scale of 1:2,000 and with one meter contour intervals) clearly labelled to show:
 - the boundaries of the proposed facility;
 - existing and proposed buildings and appurtenances on the site;
 - all roads, parking areas, fences, and gates on the site;
 - receiving, processing, storage and loading facilities or areas on the site;
 - existing and proposed elevation contours and topography;
 - leachate and storm water management facilities on the site;
 - property lines and residences;
 - surface drainage, surface water bodies, culverts and drains, and potable wells; and
 - for composting operations taking place within a building/structure, a scaled floor plan showing equipment layout, receiving, storage and loading areas, ancillary operations, mechanical rooms, office areas, etc.

2. Feedstocks:

- Description of the expected source, quality and quantity of the solid waste to be composted;
- Maximum annual tonnage to be processed at the site, the maximum daily tonnage to be received at the site, and a general description of expected seasonal variations in the solid waste type and/or quantity;
- Detailed calculation showing that the site can accommodate the proposed maximum tonnage while conforming to the building code, fire code and good housekeeping practices; and
- Description of bulking agents, additives, inoculants, or amendments used in the process (if applicable) including the approximate quantity.

3. Site Operations:

- Schedule showing the days and hours that the facility will operate;
- Description of preparations for daily opening, daily procedures, and procedures followed after closing for the day;
- Description of how feedstocks, substrate, finished compost, and different compost classes will be separated, tracked and handled;
- Estimates of the daily traffic to and from the facility, including number of trips by private or public vehicles, and quantities of material contained in each vehicle;
- Description of procedures for unloading trucks, and for inspecting incoming loads for contamination and odorous material;
- Description of procedures for handling and storing materials and removal of surplus or non-processable residue;
- Description of the methods for separation, processing, storage, and ultimate disposal of non-compostable materials (if applicable);
- Description of methods of measuring, mixing, and proportioning input materials, including bulking agents, amendments, accelerators or additives;
- Description of any size reduction or grinding of materials; and
- Expected length of the composting stabilization period and a description of the method(s) to be used to measure maturity.

4. Process Design and Equipment Specifications:

- Process flow diagram(s) for the entire process, showing all major equipment and flow streams, and indicating quantities of material by wet weight, dry weight, and volume;
- Description of the type of composting process(es) to be used (e.g. windrow, static pile, in-vessel, etc.);
- Description of the method of supplying and controlling air to the process (air injection methods and/or methods of turning or mixing), including the aeration capacity of the system;
- Planned retention time of material in the process;
- Manufacturer's performance data for major equipment; and
- Description of the material handling processes in the curing phase (e.g. materials screening, bagging).

5. Process Monitoring and Control:

- Description of monitoring procedures for temperatures, oxygen content, and moisture content; and
- Description of the location of all temperature, oxygen and any other monitoring points, and the frequency of monitoring.

6. Site Water Management Plan:

- Water balance for the site including calculations of the volume of surface water run-off that must be handled at the site (based on local municipal, conservation authority, or other standard criteria);
- Estimates of the quantity and quality of stormwater and leachate to be treated; and
- Description of methods to collect and control surface water run-off and leachate, including the method for treatment or disposal of leachate generated.

7. Hydrogeologic/Soils Report:

If infiltration is to be used to treat leachate and runoff from the site, a Hydrogeologic/Soils report may be necessary. Such a report should include a description of the subsurface soil and water conditions at the site, including the following information:

- Average depth to the water table;
- Background information on groundwater quality;
- General direction of groundwater flow;
- Soil composition and stratigraphy;
- Estimates of the permeability of the soil;
- An assessment of the attenuation capacity of the soil; and
- Determination of compliance with Guideline B-7, including any calculations required by Procedure B-7-1 (if necessary).

The scope of the Hydrogeologic/Soils Report may vary depending on the scale of the proposed facility, and the importance of the local groundwater resource.

8. Finished Compost Markets and Quality:

- Description of the primary markets for the compost; and
- Plan for ensuring compost quality, including a plan to analyze the compost in accordance with Section 5 of this *Guideline*.

9. Odour Prevention and Control Plan:

Odour prevention and control plan including:

- Facility design;
- Facility siting;
- Facility management;
- Compost unit operations;
- On & off site odour monitoring;

- Formal odour complaint response procedure.

Results of the odour impact assessment (if undertaken) including:

- Point of impact odour concentration limits used;
- Buffer area;
- Meteorological conditions used;
- Dispersion model used; and
- Baseline odour emission determination (if undertaken).

10. Financial Assurance:

For privately owned facilities subject to EPA Part V Approvals, posting of financial assurance to cover the cost of removing all raw and processed material from the composting site, and for site decommissioning, is required. The level of financial assurance can be identified by reference to Ministry of the Environment Policy F-15, "Financial Assurance".

11. Contingency Plans:

Contingency plans should be developed detailing actions to be taken in event of the following:

- Feedstock or finished material from the composting process that is off specification;
- equipment failure or breakdown;
- Delivery of unacceptable waste to the facility;
- Use of compost that cannot meet primary markets due to poor quality or other factors;
- Inclement weather;
- Groundwater contamination;
- Fire; and
- Spills.

Contingency plans should include the following information:

- Descriptions of the procedures to be used;
- Information about the personnel who will be responsible;
- Descriptions of the emergency equipment and emergency communications systems; and
- Plans for notifying the municipal clerk's office, local Fire Department, appropriate government agencies, and other persons.

12. Contaminant Minimization and Control:

- Description of practices, procedures, and equipment to be used to minimize, control, and monitor potential adverse effects at the site;
- Potential adverse effects to be addressed include noise, dust, litter, birds, vermin, and vectors; and
- Description should include procedures to register, report, and investigate these complaints.

APPENDIX 4: OTHER RELEVANT REGULATIONS AND STANDARDS

Federal Fertilizers Act

The *Fertilizers Act* is the legislative authority under which Agriculture and Agri-Food Canada monitors and controls fertilizers and supplements sold or imported into Canada. This protects the farmer and the general public against potential health hazardous and fraud in marketing as well as ensuring a fair marketplace. It therefore regulates compost when sold either as an amendment to soil, or as a fertilizer with plant nutrient claims.

Some fertilizers and supplements are exempt from the Act and its Regulations, such as animal and vegetable manures sold in their natural condition, fertilizers and supplements intended and labelled for export, potting soils (unless they claim a nutrient/supplement value) and supplements intended for experimental purposes.

BNQ Industry Compost Quality Standards

The *Bureau de Normalisation du Québec (BNQ)*, acting on behalf of the Standards Council of Canada (SCC), establishes industry standards for adoption by the SCC and allows products that meet their standards to bear seals reflecting high quality. Within the SCC, the BNQ is recognized as having primary responsibility for organic fertilizers and soil supplements. As such the BNQ is the only standards writing organization of the SCC accredited to write industry standards for compost.

This voluntary standard will be supported by a BNQ certification program to verify the conformance to requirements with the help of independent laboratories accredited by the BNQ. The conformance does not necessarily mean that a product will meet additional requirements of some regulating authorities. It will be up to compost producers to verify their product conforms to existing requirements by regulating authorities.

CCME Guidelines for Compost Quality

The objectives of the national CCME guidelines are to help protect public health, the environment, the composting industry, and to encourage source separation. The CCME's top priority over the next few years is to harmonize environmental programs across Canada.

The specific goals of the *CCME Guideline* are:

- protect public health and the environment across Canada;
- encourage source separation of MSW to produce a high quality product;
- produce harmonized compost standards across Canada, while accommodating

- different groups and interests; and
- ensure consumer confidence through consistent nation-wide product quality standards; and
- ensure that composting is allowed to develop as an important waste/resource management solution, and an environmentally sound industry, that diverts valuable organic materials from landfills and incineration.

The *CCME Guideline* applies to compost produced from municipal waste (MSW) or other feedstock as determined by regulatory agencies. It applies to compost that is sold or given away, excluding residential backyard composting or on-farm compost of materials generated on property, under their control, and for use on property under their control. Compost based products are not directly targeted by the *CCME Guideline*.

The *CCME Guideline* is based on four criteria of product safety and quality: foreign matter; maturity; pathogens; and trace elements. These standards integrate the concept that exposure is an integral part of risk, by establishing different categories of material, on the basis of their safety and quality. The *CCME Guideline* is designed to allow the flexibility necessary for different regulatory agencies to respond to specific local needs and environments.

APPENDIX 5: COMPOST MATURITY

The purpose of this appendix is to provide additional information on methods for assessing compost maturity. Generally, ‘maturity’ is used in reference to compost that has undergone extensive decomposition, and as a result exhibits limited biological activity, can be stored and handled without adverse effect, and can be used without risk to plants from residual phytotoxic compounds.

The term ‘stability’ is sometimes used interchangeably with ‘maturity’. However in its generally accepted meaning, ‘stability’ refers only to reduced biological activity. It is a sub-set of maturity. Compost could appear stable as a result of a nutrient imbalance or lack of moisture, and not extensive decomposition, and could become ‘unstable’ if any of the limiting conditions are removed. All mature compost is stable, but not all stable compost is mature.

This appendix describes methods for assessing maturity based on the chemical characteristics, biological activity, and potential phytotoxicity of the compost. It covers the compost maturity requirements described in Section 3.4.6, as well as other measures that can be used in the field and in the laboratory.

A5.1 CHEMICAL CHARACTERISTICS

A5.1.1 General

The maturity of compost can be assessed by comparing certain chemical characteristics of the compost to those of the feedstock material. Changes in chemical composition are relative, are indirect indicators of maturity, and will differ from facility to facility, and from feedstock to feedstock. Chemical indicators of compost maturity discussed in this section include:

- reduction in volatile solids during composting
- changes in the carbon/nitrogen ratio.

Except at larger facilities with on-site laboratories, these analyses would be undertaken at an off-site laboratory.

A5.1.2 Reduction in Organic Matter (Volatile Solids Reduction)

Compost feedstock materials can be considered to be composed of three parts: water; volatile solids; and inert solids. Volatile solids are typically carbon based compounds, a portion, but not all, of which can be decomposed into carbon dioxide and water by biological activity. As decomposition progresses, greater amounts of the carbon compounds are converted into carbon dioxide and water, reducing the remaining amount of volatile material. Inert solids are typically mineral compounds that are generally immune to biological decomposition, and remain in solid

phase throughout the composting process. The difference in the proportion of volatile solids to inert solids between the feedstock and the compost is referred to as volatile solids reduction. The amount of volatile solids reduction gives an indication of the extent of decomposition of the compost. Mature compost will typically have undergone a volatile solids reduction of 40% to 60%, depending on feedstock characteristics and processing conditions.

Volatile solids reduction at maturity should remain relatively constant, as long as feedstock characteristics and process conditions remain stable, and therefore can be used as an indicator of maturity. However, volatile solids reduction at maturity is specific to the feedstock and process conditions and therefore each facility will require a different value for each feedstock. Measures of volatile solids reduction at maturity in use at one facility generally cannot be applied at another, unless feedstock and process conditions can be closely copied.

The volatile solids content is normally measured by ignition of dried samples to constant weight, typically in a muffle furnace at a temperature of 600°C. Adding materials to or removing materials from the compost prior to volatile solids analysis, such as by screening the compost to remove plastics and other contaminants, or to remove bulking materials, will make the measurement of volatile solids inaccurate. None of the constituents in the feed material sampled should be removed before sampling the finished compost, or an error will be introduced.

The volatile solids reduction is calculated by the expression:

$$100 \left(1 - \frac{(\% \text{ ash in Raw } X \% \text{ VS in Treated})}{(\% \text{ VS in Raw } X \% \text{ ash in Treated})} \right)$$

where: VS = Volatile Solids
Raw = Feedstock to composter
Treated = Compost from composter

A5.1.3 Organic Carbon and Carbon/Nitrogen Ratio

The composting process decomposes some organic carbon compounds to carbon dioxide and water, thereby reducing the amount of carbon remaining. The difference in organic carbon content between the feedstock and the compost can be used to indicate maturity. The organic carbon content of a compost is normally measured by combusting a sample of the compost in a laboratory, and analyzing the carbon dioxide in the combustion gases. The presence in the material of organic carbon from non-biodegradable sources, such as plastics and rubber, will introduce errors.

The measurement of organic carbon can be paired with a measurement of total nitrogen to determine the carbon/nitrogen ratio (C:N) of a feedstock or compost. For feedstock with high C:N, it is generally assumed that nitrogen is conserved, i.e. that no nitrogen is lost during composting. As the organic carbon content of a material is reduced during composting process, the C:N will decrease.

Feedstock with a low C:N ratio, i.e. excess quantities of nitrogen, will not conserve nitrogen through the composting process. Nitrogen can be lost as volatile ammonia or oxides (NO, NO₂), or by leaching of dissolved or soluble forms. Therefore, a low C:N feedstock may not be significantly reduced by composting, as nitrogen loss keeps pace with organic carbon loss. A high pH will promote nitrogen loss through ammonia volatilization. However, at maturity the C:N for most compost is typically 22 or lower. Nitrogen losses from nitrogen rich feed materials will introduce an error in such assumptions, but will not change the typical value of the carbon/nitrogen ratio for the finished compost.

Regardless of feedstock C:N, the final C:N at maturity for most compost is typically 22 or lower.

A5.2 BIOLOGICAL ACTIVITY

A5.2.1 General

The maturity of a compost can be assessed by measuring the amount of biological activity. Methods used to measure biological activity discussed in this section are:

- oxygen uptake/CO₂ evolution rate
- spontaneous heating.

A5.2.2 Oxygen Uptake/Carbon Dioxide Evolution

The amount of biological activity in compost can be assessed by measuring the rate of oxygen consumption or carbon dioxide evolution per unit time of the biological mass. The oxygen uptake rate measures the rate at which a sample of compost consumes oxygen. The rate of oxygen consumption will be at its highest when the food source for the micro-organisms is most plentiful (i.e. at the start of the process) and will be at its lowest when the available food source has been depleted (i.e. in the curing stage). Results are normally reported in milligrams of oxygen consumed per gram of volatile solids per unit time (typically an hour). The use of volatile solids is a proxy for the biological mass. This introduces a factor to be considered for any comparisons among facilities.

Carbon dioxide evolution uses a similar approach, but relies on a by-product of the composting process (i.e. consumes oxygen and releases carbon dioxide). Results are normally expressed as milligrams of carbon, in the form of carbon dioxide, per gram of organic matter per day.

Facilities that use oxygen meters for process control or monitoring purposes could use such equipment as the basis for conducting oxygen uptake rates. The temperature at which such tests are conducted should be representative of the process being monitored. A temperature of 55°C is recommended for oxygen uptake rates on the active stage of composting, and a temperature of 37°C is recommended for the curing stage. All samples used in such tests should be adjusted to

50% moisture content to ensure that oxygen transfer is not limiting.

A5.2.3 Spontaneous Heating

This test can be undertaken in a laboratory and the temperature rise, relative to ambient, should be less than 8°C. This is further described in Section 3.5.

This test can also be undertaken in the field. This procedure involves measuring the rate at which a large sample of compost reheats through biological activity, as well as measuring the final temperature achieved. As the age of the composting mass increases, the available food supply diminishes to the point where the level of biological activity is insufficient to maintain or raise the temperature of a sample pile. The equilibrium temperature of the sample pile provides a measure of compost maturity. The lower the equilibrium temperature of the sample pile, the more stable the compost. The size of the sample must be sufficiently large to provide a reasonable simulation of conditions in a properly operated compost pile. A minimum size of 2 metres in diameter and 1.5 metres high is large enough to provide for air diffusion into the pile, and to provide sufficient self-insulation to allow for retention of heat generated in the pile.

The measure with this method is the maximum temperature attained in a sample pile that has been withdrawn from a compost pile, a curing pile, or a storage pile. The sample material is mixed to ensure aerobic conditions, and the material is re-formed in a small pile. The material should be corrected to a moisture content of 45 to 55%. The final temperature, measured approximately 0.5 metres into the pile, achieved after three days is a measure of the maturity. Failure to properly aerate the material before forming the test pile, conducting the test during extremely cold weather, or conducting the test with material that is excessively wet or dry, will inhibit the biological process and give a false reading of maturity.

The method is typically conducted outside because of the quantity of material involved. It is recommended that this procedure not be used outside when the mean daily temperature is less than about 5°C. This test may be conducted within a heated building, if desired. Both the temperature achieved and the temperature rise above ambient should be recorded.

A5.3 PHYTOTOXICITY

A5.3.1 General Characteristics

Tests of plant seed germination or plant growth in compost or compost amended soil, provides the ultimate test of the suitability of compost for its intended use as a soil amendment. Immature compost typically contains residual amounts of intermediate decomposition products, some of which are phytotoxic.

A5.3.2 Seed Germination

The use of a seed germination test provides a realistic measure of the impact of compost for its intended use as a soil amendment. Immature compost can have a phytotoxic effect on plant growth which will be manifested during the germination of seeds.

One of the more popular seed germination tests is the cress test. A known weight (typically 10 grams) of cress (*Lepidium sativum*) seeds are germinated in a growing medium amended with compost and the weight of the plant material after six days is measured and compared to a control sample. Reductions in the weight of plants grown in the compost amended medium are deemed to be due to compost phytotoxicity or compost immaturity. Compost is considered mature if the harvested weight of cress grown in the compost amended medium is at least 90% of the harvested weight of the control sample. The test is fairly simple to perform, and most facilities should experience no difficulty in performing the test at least a week in advance of product shipment.

A5.3.3 Plant Growth

The use of compost as a soil amendment to enhance plant growth may also be used as a test of maturity. Such a test is most likely to be used on a market specific basis, possibly as a quality control test as a condition of a compost supply contract, rather than as a general indicator of maturity. The benefits for a particular plant may not apply to another plant species. Use of such a test would normally be in comparison to growth in a typical greenhouse or nursery growing medium. The use of this approach would not be limited to phytotoxic effects but could also detect any other growth impacts (negative or positive) from the compost. Such a test is time-consuming, and the results are available only after a lengthy period. Large volume users of compost may use such a test months in advance of the intended use of compost.

APPENDIX 6: SAMPLING METHODOLOGY

Appendix 6 describes methods for producing representative lab submission samples of finished compost and of feedstock and other materials.

Sampling has the following three steps:

1. Collecting grab samples (A6.2)
2. Combining grab samples to create a composite sample (A6.3)
3. Reducing the volume of the composite sample to lab submission sample size (A6.4)

Sampling should be based on a predetermined sampling plan developed prior to taking samples. Decisions in the field can bias results and should be avoided.

A6.1 EQUIPMENT REQUIRED

The following equipment is recommended for compost and feedstock sampling:

- small hand shovel
- clean plastic bag, bucket or pail large enough to contain 10 grab samples of 1-2 litres
- clean tarp at least 2m x 3m
- implement handle that can be cleaned and disinfected between samples to split sample on tarp
- clean sample containers (new plastic bags)
- marker to uniquely identify sample (e.g. date, location, lot#, etc.)
- shovel to remove rejected materials from tarp

A6.2 COLLECTING GRAB SAMPLES

A6.2.1 How to Take Random Grab Samples From a Lot of Compost

A lot of compost is 5,000 m³ or less of mature compost and can consist of more than one individual pile of finished compost, provided that the characteristics of each of the piles are similar. If a facility produces less than 5,000 m³ of mature compost annually, the maximum lot size is the quantity of compost produced in a calendar year. This methodology can be applied to other materials managed in lots.

Operator bias must be avoided in the selection of sampling locations. Grab sample locations should be determined by random selection of subdivided areas from a sketch of the lot to be sampled. Random selection of sampling locations is not equivalent to a haphazard selection process.

To randomly select grab sample locations from a lot of compost, follow these steps:

1. Select a starting point (such as the head of a windrow).
2. Measure the perimeter of the lot of compost (this can be done by pacing).
3. Divide the total perimeter into 10 parts, i.e. the number of grab samples to be collected, to give the length of 1 distance interval.
4. Generate a two digit random number¹ between 0 and 1, and multiply that number by the distance interval, rounding up or down as required.
5. Pace off this distance from the starting point to find the first sampling location.
6. At the midpoint between the top and bottom of the lot, dig approximately 1 metre into the compost using a small shovel or similar tool.
7. Collect a 1-2 litre grab sample and place the grab sample in a plastic bucket or pail.
8. Walk a distance equal to the distance interval and collect a second grab sample of equal volume to the first, and combine with the first grab sample in the plastic bucket or pail.
9. Repeat until all 10 grab samples have been collected.

Random selection of grab sample locations is illustrated in Figure A6.1.

A.6.2.2 How to take Grab Samples from Incoming Feedstock Materials

Many feedstock materials are heterogeneous mixtures of large particle size and cannot be sampled effectively without prior size reduction and mixing.

Unbiased sampling of feedstock materials that are received throughout the year requires random selection of the time of sampling. To randomly select times to sample from a continuous stream of material, e.g. the output of a size reduction or screening operation, follow these steps:

1. Define the period for which a laboratory submission sample is required and express in appropriate units, e.g. number of truckloads expected within a defined period of time, or required to deliver a predetermined quantity of material.
2. Divide the period into 10 equal intervals, i.e. the number of grab samples to be collected, to give the length of one grab sampling interval.
3. Generate a two-digit random number and multiply by the grab sampling interval, rounding up or down as required, to identify the starting interval.
4. At the starting interval, collect a 1-2 litre grab sample, and place in a plastic bucket or pail.
5. Wait one sampling interval and collect the second grab sample, combining the second grab sample of equal volume with the first grab sample in the plastic bucket or pail.
6. Repeat until all 10 grab samples have been collected.

¹ Spreadsheet software programs and many calculators have functions to generate random numbers. In Excel, two digit random numbers between 0 and 1 can be generated from the following formula:
=round(rand(),2)

A6.3 CREATING A COMPOSITE SAMPLE

Individual grab samples need to be well mixed together to form a composite sample. Proper mixing ensures that all material collected in the grab samples has an equal likelihood of being selected for the laboratory submission sample.

Proper mixing is a difficult task. Several tools and techniques can be used, including:

- placing the composite sample on a small tarp and then “rolling” the tarp in different directions
- tumbling the composite sample in a plastic barrel or drum with a closable lid
- placing the composite sample on a clean surface and repeatedly shovelling material from the outside to the inside of the pile and then flattening the pile

A6.4 PREPARING A LABORATORY SUBMISSION SAMPLE

Preparation of a laboratory submission sample is the methodical reduction of the volume of the composite sample (10-20 litres) until only the amount required for the laboratory submission sample remains (approximately 1-2 litres). A proper size reduction methodology is required to ensure that all of the material in the composite sample has an equal likelihood of being selected for the laboratory submission sample.

The ‘cone and quarter’ technique can be used to prepare a laboratory submission sample. Coning and quartering employs the following steps:

1. Form a "cone" in the centre of the tarp, and split into four "quarters" by slipping a stick or tool handle under the tarp and lifting it up to split the cone in half, then split the cone the other way into quarters.
2. Flip a coin to decide which two diagonal quarters to accept and which to reject.
3. Use a shovel to remove the two rejected quarters from the tarp, and combine the remaining two quarters.
4. Repeat the process until you are down to 5 to 10 kg, or twice what the lab wants, and split in half once more.
5. Reject one half (or store as a duplicate sample), and place the other half into a clean new plastic bag to send to the lab for analysis.
6. The other half of the composite sample can be stored and used to confirm analytical results, or sent to a different laboratory for analysis.

APPENDIX 7: ANALYTICAL METHODS FOR COMPOST

A7.0 LABORATORY ANALYSIS

See section 7 for general laboratory Quality Management and accreditation, and expectations regarding documentation of methods.

A7.1 LABORATORY METHOD

As described in section 7, a written summary of the method used for such analysis may be required by the Ministry to review data. The summary will assist the Ministry in evaluating if the laboratory method/performance data is in compliance with the data quality requirements. An example of method performance characteristics, as mentioned in section 7.3, is presented in the following table:

Table A7-1 Method Performance Characteristics

Parameter	MDL (Units)	Bias (%)	Precision		Working Range (Method Linearity) (Units)	Uncertainty K = 2
			Repeatability (Within – Run)	Reproducibility (Between – Run)		

Notes:

- Bias (%) = (Mean Value - Certified Value)/Certified Value X 100
- Specify material(s) used for bias/precision and number of determinations (n) used for each study.

A7.1.1 Method Detection Limit (MDL)

The method detection limit is a statistically defined method attribute. Measured results falling at or above this point, are interpreted to indicate the presence of an analyte in the sample with a specified probability - greater than 99% - and assume that sources of error in identification or biases in measurement are known and controlled.

Procedure for MDL Determination

Either of the following two methods is acceptable for determining the MDL.

Take a minimum of eight aliquots of the sample to be used to calculate the method detection limit, and process each through the entire analytical method. If a blank measurement is required to calculate the measured level of analyte, obtain a separate blank measurement for each sample aliquot analyzed.

Calculate a result (x) for each sample/blank pair.

Calculate the standard deviation (S) of the replicate measurements as follows:

$$S = \sqrt{\frac{\sum (x_i - \bar{x})^2}{(n-1)}}$$

where: x_i = the analytical results in the final method reporting units for the eight replicate aliquots (i = 1 to 8)
 \bar{x} = the average of the eight replicate measurements

An alternative is to use historic within run replicate analysis data, and calculate the standard deviation (S) of the replicate measurements as follows (this is suggested for Soil samples):

$$S = \sqrt{\frac{\sum (x_1 - x_2)_i^2}{(2n)}}$$

where: x_1, x_2 = the two replicate results for each of the n replicate pairs (minimum n = 40)

From the estimate of S, compute the MDL as follows:

$$MDL = t(n-1, \alpha = 0.01) S$$

where: $t(n-1, \alpha = 0.01)$ is the Student's value appropriate for a 99% confidence level given the degrees of freedom n-1.
 S = the standard deviation as determined above.

Table of Student's <i>t</i> Values at the 99 Percent Confidence Level		
Number of Replicates	Degree of Freedom (n-1)	<i>t</i> (n-1)
7	6	3.143

8	7	2.998
9	8	2.897
10	9	2.821
11	10	2.764
16	15	2.603
21	20	2.528
26	25	2.485
31	30	2.457
∞	∞	2.369

A7.1.2 Reporting Detection Limit (RDL)

Reporting Detection Limit (RDL) is the minimum concentration a laboratory is expected to be able to measure. In other words, laboratories are required to achieve a Laboratory Method Detection Limit (MDL) less than or equal to the RDL value. RDL is typically set at 1/10 of the maximum permissible contaminant concentration criteria. However, there may be situations where (for practical reasons) the RDL may be set at a value closer to the maximum permissible contaminant concentration criteria. Laboratories that achieve a MDL less than the RDL must report results below the RDL values.

The RDL requirement for each test is given in Section 6.

A7.1.3 Bias

Bias is the difference between the expectation of the test results and an accepted reference value (ISO 3534-1, 3.13). Certified reference materials (CRMs), if and when available, should be used to assess laboratory bias. If a CRM of exactly the same type of material as the sample is unavailable, a similar CRM may be used. For example, a CRM of plant tissue or sludge may be used for compost analysis.

The bias requirement for each test is given in Section 6.

Participation in one or more proficiency testing (PT) programs also provides a means of determining bias.

A7.1.4 Precision

Precision is defined as the closeness of agreement between independent test results obtained under prescribed stipulated conditions (ISO 3534-1, 3.14 amplified by ISO 5724-1 to 6). The measure of precision is usually expressed in terms of imprecision, and computed as a standard deviation of the test results. Less precision is reflected by a larger standard deviation.

A laboratory must establish both repeatability and reproducibility as given in the above referenced ISO document.

Repeatability is precision determined under conditions where independent test results are obtained with the same method, on identical test material, in the same laboratory, by the same operator, using the equipment within short intervals of time (ISO 3534-1, 3.16).

Reproducibility is precision determined under conditions where test results are obtained using the same method, on identical test items, on different days and/or different operators.

It is desirable to determine precision at 10 x MDL.

The precision requirement for each test is given in Section 6.

A7.1.5 Method Working Range

The working range of the method for each analyte must be established and documented in the method. The working range, is the range over which the analytical system exhibits a well-established relationship between the amounts of material introduced into the analytical system, and the instrument's response. The equation defining this relationship must be documented (i.e., linear, quadratic etc.).

No sample result should be reported that is outside the working range of the method. If a result is too high, the sample should be diluted. If too low, a larger aliquot (portion) of sample must be analyzed to meet the requirements of the method detection limit.

A7.1.6 Uncertainty of Measurement 3

Uncertainty of measurement must be estimated (as given in the above reference) for all analytes. Such estimation(s) shall be expressed at 95 % confidence levels (k=2).

A7.1.7 Analytical Control Status

The laboratory must establish protocols for monitoring and controlling critical factors that affect the measurement process. Acceptance limits must be established and the course of action to be taken when an exceedance occurs must be specified.

Control charting and trend analysis are the requirements of the current ISO 17025. The laboratories are required to meet this standard. The number of analytes being monitored and charted for control, will depend on the individual behaviour of each analyte in a given laboratory setting. However, it is usual practice to demonstrate control of all analytes for a period of at least one year, after which time a few selected, representative analytes, can be monitored and charted for control of an entire group. The pertinent data for the remaining parameters should be recorded and stored for future use, if necessary.

A7.1.8 Qualitative Identification Criteria

Qualitative identification criteria are crucial to the accurate assessment of contaminants, and will vary depending on the analytical technique employed. Laboratories should record all relevant criteria used for identification, such as, retention time, spectral wavelength, co-elution of peaks for specific m/z's, ion abundance ratio requirements, etc. These criteria must be documented in the method, and data must be available on file for review.

A7.1.9 Interferences

Interferences are difficult to predict in many cases, but may be indicated by unacceptable spike recoveries in environmental matrices, especially when such recovery problems were not noticed in testing clean matrices. Any known interference must be reported.

It is understood that there may be cases where interferences render resolution impossible. However, it is expected that the laboratory will make every reasonable effort to resolve and quantitate every required parameter. In the cases where compost is known to contain unidentified interferences, a different detection method or additional clean-up must be used where possible.

The laboratory analyst must document the effect of the interference on data interpretation. If the effect is severe, the laboratory may elect not to report a result.

A7.1.10 Recommended Laboratory QC Procedures

Laboratory QC procedures must meet ISO/IEC 17025:2005 as a minimum. Examples of such QC procedures are given below.

Pre-service QC:

- labware and reagent blanks
- instrument setup standard
- reference standard to validate in-house standards

- certified reference material to validate method bias
- instrument detection limits (IDLs) and detector linearity/curves (minimum of 3 point calibration)

In-service QC:

- baseline drift blanks
- standards
- instrument checks

Run quality QC:

- method spiked blanks
- method blanks
- in-house matrix check material
- replicate sample (minimum of one set per run of 30 samples)
- spiked samples, if applicable

Laboratories must maintain records of data to show that the analytical systems were in control at the time of analysis. The results of these quality control and performance-monitoring checks should be tabulated and summarized for ready retrieval, evaluation, and auditing.

A7.1.11 Data Acceptance Criteria

The basis for determining the acceptability of laboratory data should include the following:

- Method consistent with the principle as given under specific test (Section 6) has been applied.
- The performance characteristics (RDL, bias and precision) of a method used for compost analysis should be within specifications as given under each test (Section 6).
- The results of all applicable quality control samples should be within the acceptable range. See specific tests (Section 6).
- The analytical system should be in control at the time of analysis.

A7.1.12 Data Reporting

A laboratory's data-management system should establish and maintain direct links between sample information (such as source, field sample number or code, date and time sampled, tests required), and laboratory information (such as laboratory sample number or code, date and time analyzed, tests performed and identification of the analyst who did the work).

A properly recorded result shall include the test or analyte name or code, the units of measure, the method used for analysis, and any qualifying remarks.

The number of digits following a decimal point should not exceed the number of digits after a

decimal point appearing in the method detection limit.

Analytical results may be corrected to take into account any positive results of associated method blank for some specific analysis. A method blank result above the method detection limit is normally considered a positive result. The criteria or control limits for blank corrections should be determined by laboratories on the basis of historical data, and these should be documented. Otherwise, data should be reported without correction. If a correction is made, it should be clearly identified and described.

All data should be reported. Data below RDL should have remark as < RDL. Data below MDL should have remark as < MDL.

All data should be reported on a dry weight basis.

A7.2 DATA QUALITY REQUIREMENTS

Data quality requirements for the analysis of compost are given in this section. Laboratories may use the methods that are referenced under specific tests, or other validated methods that meet data quality requirements as given under each test.

A7.2.1 Metals - Cd, Cr, Co, Cu, Pb, Mo, Ni, and Zn

Matrix Compost

Method Principle

A portion of prepared (dried and ground) sample is extracted with a heated, strong mixed acid solution, brought to volume with pure deionized water, and analyzed using a spectrometric technique.

Sample Preparation

Digest a portion of previously air dried ground and sieved (≤ 2.00 mm) sample with concentrated nitric acid/hydrochloric acid mixture (1:3) by heating to 110°C for 90 minutes. Adjust volume with pure deionized water, decant/filter and then analyze.

Instrumentation

Inductively Coupled Plasma/Optical Emission Spectrometer (ICP/OES).

Laboratory QC Samples per Run

Method Blank, Matrix Matched In-House Control or CRM, Calibration Check and Sample Replicate.

Method Performance Criteria

Analyte	Compost Cat. AA Limit (µg/g)	RDL (µg/g)	Bias (%)	Reproducibility (RDS)
Cadmium	3	1.0	± 15	30
Chromium	210	21	± 15	30
Cobalt	34	3.4	± 15	30
Copper	100	10	± 15	30
Lead	150	15	± 15	30
Molybdenum	5	2.5	± 15	30
Nickel	62	6.2	± 15	30
Zinc	500	50	± 15	30

Notes:

Bias - Use appropriate Certified Reference Material for bias determination.

Precision - Additional allowance may be permitted if the concentration of the test material is close to MDL.

The above data is based upon the MOE/LSB method and consensus values.

Reference Method

MOE/Laboratory Services Branch - E3470

A7.2.2 Mercury

Matrix Compost

Method Principle

Mercury in the sample is converted to the inorganic form by acid digestion process. The inorganic mercury in aqueous solution is then reduced with stannous chloride, and analyzed by CV-FAAS.

Sample Preparation

Digest a portion of previously air dried ground and sieved (≤ 2.00 mm) sample with 50% v/v Aqua Regia (hydrochloric acid/nitric acid - v/v 3:1) in the presence of potassium permanganate by heating within a temperature range of 90°C to 110°C for 1 hour and 15 minutes. Treat excess permanganate with hydroxylamine sulphate. Reduce inorganic mercury with stannous chloride prior to analysis. Adjust volume with pure deionized water, decant/filter and then analyze. Report results on dry weight basis.

Instrumentation

Cold Vapour Flameless Atomic Absorption (CV-FAAS)

Laboratory QC Samples per Run

Method Blank, Matrix Matched In-House Control or CRM, Calibration Check and Sample Replicate.

Method Performance Criteria

Analyte	Compost Cat. AA Limit ($\mu\text{g/g}$)	RDL ($\mu\text{g/g}$)	Bias (%)	Reproducibility (RDS)
Mercury	0.8	0.1	± 15	30

Notes:

Bias - Use appropriate Certified Reference Material for bias determination.

Precision - Additional allowance may be permitted if the concentration of the test material is close to MDL.

The above data is based upon the MOE/LSB method and consensus values.

Reference Method

MOE/Laboratory Services Branch - E3058.

A7.2.3 Arsenic and Selenium

Matrix Mature Compost

Method Principle

A portion of sample is digested in oxidizing acid mixture to convert all forms of arsenic and selenium to arsenate (AsO₄)³⁻ and selenate (SeO₄)²⁻ respectively. The arsenate and selenate are then reduced with sodium borohydride to arsine and hydrogen selenide, which are then analyzed by flameless atomic absorption spectrophotometry.

Sample Preparation

Digest a portion of previously air dried, ground and sieved (≤ 2.00 mm) sample with concentrated Nitric acid/Hydrochloric acid mixture (1:3), by heating at an appropriate temperature (such as the temperature given in MOE/LaSB Method E3470). Adjust the volume with pure deionized water, decant/filter and then analyze.

Instrumentation

Hydride - Flameless Atomic Absorption Spectrophotometry (HYD-FAAS).

Laboratory QC Samples per Run

Method Blank, Matrix Matched In-House Control or CRM, Calibration Check and Sample Replicate.

Method Performance Criteria

Analyte	Compost Cat. AA Limit ($\mu\text{g/g}$)	RDL ($\mu\text{g/g}$)	Bias (%)	Reproducibility (RDS)
Arsenic	13	1.3	± 15	30
Selenium	2	1.0	± 15	30

Notes:

Bias - Use appropriate Certified Reference Material for bias determination.

Precision - Additional allowance may be permitted if the concentration of the test material is close to MDL.

The above data is based upon the MOE/LSB method and consensus values.

Reference Method

Bibliography

1. Guidelines for the Accreditation of Environmental Testing Laboratories, CAN-P-1585 (November 2006), Standard Council of Canada.
2. Estimation of Analytical Method Detection Limits (MDL), Environment Ontario, revised June 1991, PINS 299.
3. Quantifying Uncertainty in Analytical Measurement, second edition; EURACHEM/CITAC Guide.

A7.2.4 E. coli

Matrix Mature Compost

Analysis

Finished compost must meet the criterion of less than 1000 *E. coli* colony forming units (CFU) or most probable number (MPN) per gram of total solids. At least one gram of solid must be analysed to report that *E. coli* was not detected.

Method Principle

A volume of buffered dilution water is added to a weighed amount of sample material, and processed with a Stomacher™ or equivalent. Serial dilutions are then prepared using the supernatant. Serial dilutions are then plated out on mFC-BCIG agar (or other selective agar) and incubated.

Sample Preparation

Add an amount of buffered dilution water to a weighed mass of sample material. Process in the Stomacher™ or equivalent for 2 minutes. Decant off supernatant.

Instrumentation

Classical microbiological techniques – selective agar, incubator, biochemicals for confirmation.

Laboratory QC Samples per Run

Positive and negative controls run with each set of samples, plus spiked samples for recovery every 20 samples, or each week the samples are analysed if fewer than 20 samples.

Method Performance Criteria

Under development

Reference Method

MOE/Laboratory Services Branch - E3433

Notes

1. Sample storage and shipping on ice at temperatures from 0°C to 10°C, but not frozen.
2. Analysis must be performed within 48 hours of sample collection.

A7.2.5 Culturable *Salmonella* spp.

Matrix Compost

Analysis

Finished compost is considered acceptable with respect to *Salmonella* if it contains less than 3 *Salmonella* most probable number (MPN) per 4-g sample (dry wt). The entire 4-g dry weight sample must be analyzed to report that *Salmonella* was not detected.

Method Principle

The sample is diluted, homogenated and decimal dilutions are prepared and inoculated into selective enrichment growth media, in a three or five-tube most probable number method (MPN) assay. *Salmonella* spp. are enumerated statistically using the appropriate MPN table, after confirmation of positive tubes in MPN test. The specific protocol must meet the performance criteria described below.

Sample Preparation

A volume of buffered dilution water is added to a weighed amount of compost and homogenated in a Stomacher™ bag or equivalent. *Salmonella* are enumerated from the sample using a 3- or 5-tube MPN method with a minimum of 3-replicate serial dilutions. The full 4-g sample must be analysed.

Instrumentation

Filter apparatus, incubators, sterile tubes, Stomacher™ bags or equivalent.

Sample Shipping and Storage

- 1) Samples must be shipped via overnight service on the day they are collected, and shipped

- and stored and at 0° to 10 °C without freezing.
- 2) Sample processing must be initiated within 30 hours of sample collection.

Laboratory QC Samples per Run

One method blank, one negative, and one positive control for every 20 samples, or each week during which samples are analyzed if 20 or fewer samples are analyzed.

Performance Criteria (under development)

Detection limits of *Salmonella* sp. in compost are expected to be from 0.3 to 3 MPN *Salmonella* per one gram of material.

Reference Methods

Standard methods are required for culturing *Salmonella* by MPN including, but not limited to, American Public Health Association (APHA) and US Department of Agriculture (USDA) or equivalent methods.

1. APHA 1992. Standard methods for the examination of water and wastewater. Method 9260 D. American Public Health Association.
2. USDA 1998. Microbiology Laboratory Guidebook. 3rd Ed. Chapter 4. “Isolation and identification of *Salmonella* from meat, poultry and egg products. United States Department of Agriculture Food Safety Inspection Service.
3. CEAEQ (Centre d’expertise en analyse environnementale du Québec) (2006). Recherche des salmonelles: méthode présence/absence. MA.700-Sal-PA 1.0 (Detection of *Salmonella*: presence/absence method. MA.700-Sal- PA1.0).
<http://www.ceaeq.gouv.qc.ca/methodes/pdf/MA700SalPA10.pdf>

Sample preparation suitable for solid compost samples are described in the following:

1. US EPA Report No: EPA/625/R-092/013. (Revised July 2003) Environmental Regulations and Technology: Control of pathogens and vector attraction in Sewage Sludge. Appendix F: Sample preparation for fecal coliform tests and *Salmonella* sp. analysis. Cincinnati, OH: Office of Research and Development.

A7.2.6 Maturity

Respiration rate

The respiration rate of finished compost shall be measured in milligrams of oxygen per kilogram of volatile solids per hour, using the procedure described in Standard CAN/BNQ 0413-220.

Carbon Dioxide Revolution rate

The carbon dioxide revolution rate of finished compost shall be measured in milligrams of carbon, in the form of carbon dioxide per gram of organic matter per day, to be determined in accordance with TMECC Method 05.08-B.

Temperature rise

The temperature rise in finished compost shall be measured in degrees Celsius, to be determined in accordance with the procedure described in TMECC Method 05.08-D.

APPENDIX 8: SELECTED REFERENCES

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Haug, R.T., 1993, The Practical Handbook of Compost Engineering, Lewis Publishers, Florida.

Northeast Regional Agricultural Engineering Service, 1992, Field Guide to On-Farm Composting NRAES-114, Ithaca, NY.

Northeast Regional Agricultural Engineering Service, 1994, Composting for Municipalities- Planning and Design Considerations, NRAES-94, Ithaca, NY.

Northeast Regional Agricultural Engineering Service, 1999, On-Farm Composting Handbook, NRAES-54, Ithaca, NY.

United States Environmental Protection Agency, 1994, Composting Yard Trimmings and Municipal Solid Waste, EPA530-R-94-003. (economic information is outdated)

The Composting Council, 1994, Compost Facility Operating Guide, Alexandria, Virginia.

Northeast Regional Agricultural Engineering Service, 1992, On-Farm Composting Handbook, NRAES-54, Ithaca, NY.

APPROVALS FOR COMPOSTING FACILITIES

Relevant Legislation – Copies of relevant provincial legislation may be obtained from the Ministry of Government Services for a nominal fee. Contact the Ontario Government Bookstore, 880 Bay Street, Toronto, Ontario, M5S 1Z8. Telephone Inquiries: (416) 326-5300. **Electronic copies of Ontario legislation and guideline documents (including those listed in the following**

pages) can be obtained from the ministry's website at www.ene.gov.on.ca.

MOE, 1994, Guide for Applying for Approval of Waste Disposal Sites, Ontario Ministry of the Environment, Approvals Branch, November 1994.

MOE, 1992, General Information - Certificates of Approval (Air), Section 9 Environmental Protection Act, Ontario Ministry of the Environment, Approvals Branch, August 1992.

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MOE, 1994, A Guide to Approvals for Recycling Sites, Leaf and Yard Waste Composting Sites and Compost Use as Required under Ontario Regulation 101/94, Ontario Ministry of the Environment, PIBS 2477.

RELATED GUIDELINES AND STANDARDS

BNQ, 2005, Organic Soil Conditioners - Compost, Bureau de Normalisation du Quebec, CAN/BNQ 0413-200/2005.

CCME, 2005, Guidelines for Compost Quality, Canadian Council of Ministers of the Environment, ISBN 1-896997-60-0.

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The Great Lakes Center for Occupational & Environmental Safety and Health, 1996, Environmental Characterization of Bio-Aerosol Emissions from the DK Recycling Systems Inc., Composting Facility in Lake Forest Illinois, June 14, 1996, University of Chicago School of Public Health, Health Hazard Evaluation Report 96-001.

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MOE, 1994, Stormwater Management Practices Planning and Design Manual, Ontario Ministry of the Environment, June 1994, PIBS 3150

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Tyler, R.W., 1996, Winning The Organics Game: The Compost Marketer’s Handbook, ASHS Press, Alexandria, Virginia.

COMPOSTING RESOURCES ON THE INTERNET:

The Composting Council of Canada: <http://www.compost.org>

Cornell University – Composting (managed by the Cornell Waste Management Institute):

- http://www.css.cornell.edu/compost/composting_homepage.html; and
- <http://www.cals.cornell.edu/dept/compost/>