Organic Feedstock Odour Rating Assessment

Department of Environment and Science

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04	21/03/2023	Revised Final Report	LB, GH	GH
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1 Introduction

Arcadis Australia Pty Ltd (Arcadis) have been engaged by the Department of Environment and Science (DES) to provide an Odour Rating approach for emerging feedstocks such as Food Organic and Garden Organic (FOGO) feedstock used during *environmentally relevant activity (ERA) 53(a) Organic material processing by composting* and other relevant ERAs.

1.1 Legislative Framework

The following legislative frameworks, guidelines and historical reports have been considered as part of this assessment:

- Arcadis Phase 1 Critical Evaluation of Composting Operations and Feedstock Suitability – Odour, 20 March 2019 (Phase 1 Recognised Entity Report (Phase 1 RER))[1]
- Arcadis Phase 2 Critical Evaluation of Composting Operations and Feedstock Suitability – Contamination 26 June 2019 (Phase 2 Recognised Entity Report (Phase 2 RER)[2]
- QLD *Environmental Protection Act 1994* (EP Act)
- DES Best Practice Environmental Management Guideline ERA 53(a) Organic material processing by composting (Best Practice Guideline)
- DES Model operating conditions ERA 53(a) – Organic material processing by composting (Model Operating Conditions)
- DES State Code 22: Environmentally Relative Activities (ERA) Assessment Provisions (State Code 22: ERA)
- Environmental Protection Regulation 2019 (EP Regulation)
- Environmental Protection (Air) Policy 2019 (EPP Air)
- Planning Regulation 2017 (Planning Regulation).

1.2 Background

In response to the Queensland Government's commitment to commission an independent review of waste acceptance criteria for composting operations, Arcadis were engaged to undertake a review of composting operations and feedstock suitability which was presented in both the Phase 1 RER and Phase 2 RER.

The Phase 1 RER details odour issues, the composting process, systems and controls, in addition to categorising organic feedstocks and their odour potential. The Phase 2 RER focused on contamination; however, it also included an assessment of odour potential and odour risk ranking of feedstocks likely to be used in composting and provided individual Odour Ratings based on a specific feedstock's odour potential during the composting process (Section 6 in the Phase 2 RER). The Phase 2 RER then provided odour management recommendations that could be used to mitigate operational odour risks, informing updates to the Best Practice Guideline and Model Operating Conditions. Feedback from industry working groups identified that further guidance was required for managing emerging feedstocks such as FOGO, which were not specifically addressed in the original assessment, including how to determine an appropriate Odour Rating and how an approach could align with current regulatory requirements, including the Model Operating Conditions.

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1 https://environment.des.qld.gov.au/__data/assets/pdf_file/0024/226293/phase-1-composting-study-report.pdf
2 https://environment.des.qld.gov.au/__data/assets/pdf_file/0022/226291/phase-2-composting-study-report.pdf

Given the general lack of requirements on most operators to characterise and analyse their feedstocks, there is very little data available on the chemical and physical composition of feedstocks currently being used in Queensland composting operations, a significant data gap acknowledged in the Phase 1 RER. As such, this assessment is considered qualitative in nature and may benefit from further refinement as data becomes available on the odour potential from different feedstock compositions and characterisations.

1.3 Objective and Scope

The objective and scope of this report is to;

- Develop an Odour Rating Report that presents an approach for the assessment of odour potential for:
  - A new feedstock, which has not already been listed in the Phase 2 RER[3], and
  - A new feedstock that has been mixed at the point of generation (comprising of 2 or more previously scored feedstocks such as FOGO)

  The assessment will focus on the typical composition and characteristics of the feedstocks, as well as any pre-acceptance conditions that have been observed that influence odour levels. Supported by completing three “real world” Case Studies demonstrating the range of external factors that can influence Odour Ratings.
- Provide a methodology of how to use the odour rating system, using both the existing green waste and food organics feedstock assessments and the additional feedstock FOGO, as a guide; and
- Evaluation of how this guidance document fits within the planning and approval process.

1.4 Terminology

The terms listed below are used throughout this report and are provided for reference and clarity:

Odour Risk – The potential for odour to cause environmental harm (including nuisance)

Odour Rating – An assigned level of Odour Risk (none to very high) of a feedstock for each Odour Rating Factor based on a scoring scale outlined in Section 2.2

Odour Rating Factors – Used to assess a feedstock’s odour potential using defined risk categories and applying a scoring scale.

Odour Assessment – An assessment of a development’s Odour Risk undertaken by an Appropriately Qualified Person (defined in Section 2.1)

Odour Feedstock Assessment – An assessment of a feedstock’s Odour Rating (section 2) undertaken by an Appropriately Qualified Person (defined in Section 2.1)

[3] Found in Appendix B

PART 1: Odour Rating Process

2 Odour Risk Assessment

Odour risk can be distilled into two parts, feedstock Odour Rating (a function of odour potential) and odour mitigating factors including storage, mixing or onsite handling, processing parameters or technology and seasonality.

The following section provides a discussion of the odour risk assessment methodology, including what impact and effect additional contributing factors may have, available measures that can be taken to mitigate odour risk and how these might assist with attenuation of odour.

2.1 Approach

The approach used to assess the odour potential from a feedstock and assign an odour rating is outlined below in Section 2.2 and assumes acceptable composting practices. The methodology establishes a qualitative assessment process based on five Odour Rating Factors. The odour rating approach focuses on the raw feedstocks, as they would likely be received at a composting facility. Any subsequent site-specific odour assessments will need to consider the practices and the impacts of the composting process on that feedstock and any existing controls, such as environmental authority (EA) conditions relating to feedstock or odour management, in place.

The odour rating is a qualitative assessment, reflecting the lack of detailed compositional and characterisation data for most feedstocks and the expected variability, identified in Phase 2 RER as an odour rating constraint.

The rating of odour is provided in a format that an appropriately qualified person (AQP) with professional experience or guidance in odour management will be able to replicate. It is assumed that an AQP would have experience with odour assessment, how odour relates to different materials and some compositional or characterisation knowledge of the feedstocks under assessment.

An AQP would be required to have similar qualifications and experience to that of a Certified Air Quality Practitioner (CAQP) which includes an Air Quality Science related degree and the following demonstrated work-related experience:

- PhD or master’s qualifications and a minimum of 2 years of related work experience
- Degree qualifications and a minimum of 5 years of related work experience
- Diploma qualifications and a minimum of 10 years of related work experience

Noting that while a CAQP is preferred it is not considered a mandatory requirement providing evidence of the above minimum requirements can be demonstrated.

It is assumed that a Feedstock Management Plan must be developed which includes feedstock Odour Ratings in accordance with Appendix B (taken from Table 55 in the Phase 2 RER). Where the feedstock is not listed, methods are required to assess the odour risk and in turn, determine the Odour Rating of the feedstock as outlined in the following sections.

2.2 Qualitative Odour Rating Methodology

The five factors that contribute to the odour risk of feedstocks can be scored. A summary of these factors is provided below, the definitions of how to score each factor can be found in Appendix A and the process to assess new feedstocks can be found in the following Section 2.3.

Odour Rating Factors A-E

- **Factor A: Putrescible content**
  - The extent to which the material contains readily biodegradable solids or high concentrations of dissolved organics (e.g., sugars) which are likely to decompose rapidly, enhanced by the moisture content of the material.
  - Materials which contain a high proportion of readily biodegradable solids and/or a high concentration of dissolved organic compounds (indicated by a high Biological Oxygen Demand) are at higher risk of going anaerobic or being anaerobic upon delivery and releasing odours during the mixing / blending and initial rapid decomposition phase. These materials are often in liquid or slurry form, or have a high moisture content, which enhances this effect. Such materials are therefore considered to pose a higher risk of odour generation.
- **Factor B: Concentration**
  - The extent to which the relevant odour contributing components are concentrated (or diluted) within the raw material, potentially compounding their impact.
  - Being a liquid feedstock or having high moisture content in itself does not necessarily correlate to high potential odour contribution
- **Factor C: Nitrogen content of the feedstock**
  - Feedstocks which contain high concentrations of nitrogen compounds (such as food, proteins, animal waste, manure, biosolids, grass clippings) are assumed to present a risk of producing ammonia gas during composting and therefore pose a higher odour risk of odour generation.
- **Factor D: Sulphur content of the feedstock**
  - Feedstocks which contain high concentrations of sulphur or sulphurous compounds (such as food waste, paper, gypsum, manure and biosolids) are at risk of producing hydrogen sulphide during composting (under anaerobic conditions) and therefore pose a higher risk of odour generation.
- **Factor E: Content of fats, oils and proteins within the feedstock**
  - Feedstocks which contain proteins, fats and oils are at risk of producing volatile nitrogen and sulphur compounds, as well as volatile organic compounds (VOCs), during composting and are considered higher risk of odour generation.

A total score can be calculated from the combined scoring of the factors described above. As Factors C, D and E could all lead to high odour potential (either individually or combined) these are summed together, and then multiplied by Factors A and B which have a compounding impact, as follows:

Total odour contribution potential score = A x B x (C + D + E)

This total odour contribution potential score is then used to determine a feedstock's Odour Rating as shown in Table 1.

Table 1: Odour rating based on scoring of of feedstock

Odour Rating Score Ranges	Odour Rating
0	None
1 to 7	Low
8 to 14	Medium
15 to 30	High
31+	Very High

A total of 109 definable feedstock types were scored in the Phase 2 RER, an abridged list can be found in Appendix B, for each odour rating factor and provided a total odour rating score. These qualitative assessments were applied in a systematic manner that compared each of the feedstocks based on the Odour Rating Factors A-E. Such a comparative approach means the scores for all feedstocks are moderated and ranked against each other and are not based on absolute scores.

2.3 Assessing the Odour Potential for New Feedstocks

Although detailed, the qualitative odour rating methodology set out in Section 2.2, does not explicitly deal with how a score might be assigned or applied to any new feedstocks. The methodology is a systematic process of evaluation, using the Odour Rating Factors A-E, and comparison against a set of reference points, or benchmarks.

A qualitative assessment approach was adopted as sufficient compositional and characterisation data is not available for most feedstocks and does not allow for quantitative testing.

This section outlines when a new assessment of odour potential may be needed, and how the approach set out in Section 2.2. can be applied to new feedstocks. A new feedstock is a material that has not yet been scored and therefore, requires an odour feedstock assessment.

There are some similar steps required for each of the new feedstock scenarios which can be set out as follows:

1. Identification of relevant reference feedstocks,
2. Comparative scoring of each odour rating factor
3. Calculation of total odour rating

For the scenarios where the new feedstock is very closely related to existing feedstocks it may be appropriate to assess and apply an attenuation to the odour rating (see Section 2.5).

Table 2 provides a structured summary of the assessment steps for each of these three new feedstock scenarios and an explanation of the activities required. Whereas Table 3 includes attenuation and mitigation factors which can lower infrastructure requirements, but not the odour rating.

Table 2: Assessment stages for each new feedstock scenario

Step	Feedstock comprising of 2 or more odour rated feedstocks at generation	Completely new feedstock
	A mix or blend of previously scored feedstocks i.e., Food Organics and Garden Organics	*Previously unscored feedstock that does not fit any of the existing feedstock categories*
1. Identify relevant reference feedstocks	Select 2 or more relevant existing scored feedstocks. As this is a mix it should be evident which feedstocks these are from the description.	Selection of feedstocks that represent either a similar feedstock type or have a similar range of feedstock characteristics (and therefore similar odour rating). A rationale or justification is needed for each of the reference feedstocks chosen and which characteristics are relevant to the choice.
2. Scoring of Odour Rating Factors	Worst case scenario of the Odour Rating Factors A-E	Scoring of each Odour Rating Factors A-E based on the detailed criteria

Table 3: Attenuation and mitigation measures for each of feedstock scenario

Step	Feedstock comprising of 2 or more odour rated feedstocks at generation	Completely new feedstock
1. Attenuation	Assessment of the likely attenuation based on control of Odour Rating Factors Assessment of the likely attenuation measures	No attenuation appropriate as scores are based on a new assessment of Odour Rating Factors A-E
2. Mitigation measures	What odour mitigations are required based on the odour rating? Assessment of the potential impact on odour potential for each mitigation measure.	What odour mitigations are required based on the odour rating?

2.4 Odour Rating Impacts

Feedstocks with a ‘high’ or ‘very high’ Odour Rating trigger additional Model Operating Conditions to ensure appropriate infrastructure and processes are implemented to address the increased odour risk including but not limited to:

- Receiving, storing and initial mixing of feedstock within an enclosed system
- Ensuring that the enclosed system for feedstock receival, storage and initial compost mixing is under negative pressure at all times when in use
- Mixing feedstock with a bulking agent or high carbon material and containing the mix in an in-vessel system or enclosed system as soon as practicable but at least within 6 hours of receipt

- Processing feedstock within an in-vessel system or enclosed system for a minimum of 21 days or until pasteurisation is achieved

2.5 Odour Attenuation

Attenuation of the odour rating for feedstocks (i.e. a legitimate change of the odour rating of feedstock) requires a skilled application of the scoring criteria by an AQP (see Section 2.1) and is only appropriate when there is justifiable cause to assume that:

- Feedstock conditions are consistently and reliably different from those previously scored; or
- Odour Rating Factors A-E are justifiably nearer the conditions for a lower scored feedstock.

To assess the potential attenuation of the Odour Rating Factors A-E (see Section 2.2) it is necessary to identify and collate a summary of the considerations, conditions or constraints that might influence the scoring. This can be structured around the Additional Odour Rating Factors identified in Section 2.6 or for the various stages identified in the Compost Process Plan. Some examples of how these factors are evaluated has been outlined in Appendix C, to illustrate the range of possible justifications for the attenuation of feedstocks across each of the Odour Rating Factors A-E.

2.6 Odour Factors and Mitigation Measures

The odour risk can be mitigated through a number of measures, outlined in the Phase 1 RER, which includes operational and process controls, and odour treatment techniques. These factors have been categorised below and the following sub-sections detail how these factors influence the odour risk of a feedstock:

- Feedstock Type and Storage Requirements
- Mixing and On-Site Handling
- Processing Parameters
- Processing Requirements and Technology
- Seasonality

Furthermore, a number of resources have been published on best practices, including but not limited to the following:

- Best Practice Environmental Management Guideline for ERA 53(a)
- Designing, constructing and operating composting facilities, EPA VIC, 2017
- FOGO Best Practice Collection Manual, Department of Sustainability, Environment, Water, Population and Communities
- Guide to Biological Recovery of Organics, Sustainability Victoria 2018

2.6.1 Feedstock Type and Storage Requirements

A Feedstock Management Plan must be developed prior to the commencement of the activity, as per the Model Operating Conditions for ERA 53(a), which includes the following requirements:

- Characterising the feedstock and determining its odour rating
- Storage requirements based on odour rating and physical composition
- Processing requirements based on odour rating and physical composition
- Sampling and testing the C:N ratio

Table 4 (extracted from Phase 1 RER) sets out the numerous steps that can be taken in the materials receiving area to manage odorous feedstock.

Table 4: Approaches to minimise and manage odorous feedstocks in the materials receiving area of composting facilities (Californian Integrated Waste Management Board, 2007)

Possible cause	Management approach
Materials arriving with odours	• Mix materials upon receipt (increase material porosity) • Stockpile bulking agent or high carbon amendments at receiving basin and ready for unexpected deliveries • Make smaller piles • Consider blanketing odorous materials with a thick layer of bulking agent or mature compost • Enclose the receiving floor • Aerate receiving floor • Add lime or wood ash to piles to adjust pH • Reject odorous loads if possible • Eliminate troublesome feedstocks • Incorporate wet or odorous loads directly into actively composting windrows
Material sitting too long prior to being processed or mixed	• Expedite material processing • Increase operating shifts • Reduce incoming throughput • Identify alternative outlets for incoming materials • First in, first out processing • Reduce size of material stockpiles • Increase collection frequency • Increase grinding / processing capacity (contract grinder/screener) • Consider blanketing odorous materials with a thick layer of bulking agent

2.6.2 Mixing and On-Site Handling

Section 6.1.1 in the Phase 2 RER states "*aspects such as appropriate blending with other materials to balance moisture, carbon/nitrogen ratio and porosity were found to be key to minimising odour during composting*". In addition, Section 2.3.2 in the Phase 1 RER, promotes '*getting the right mix*' for example:

- Blending to control the odour factors such as:
  - Low levels of carbon would increase the risk of the feedstock going anaerobic
  - Low concentrations of nitrogen will take longer to mature and increase the risk of odour formation in the composting material
  - Blending with too much liquid would increase the risk of the feedstock going anaerobic

- Mixing feedstock to homogenise the material and prevent or avoid pockets of high sulfur, nitrogen and moisture, and promote a more consistent and manageable composting process

Such factors need to be considered in a Compost Process Plan as do, setting down, turning and aeration, however effective feedstock handling practices will influence the odour potential of the feedstock and the risk of odour throughout the composting process.

2.6.3 Processing Parameters

A Compost Process Plan should include information to support the appropriateness of the composting process parameters, methods and frequencies for monitoring composting material and annual reviews of the effectiveness of the parameters at achieving pasteurisation and minimising odour impacts.

The composting process parameters, set out in Table 5 require monitoring as part of the composting process and can contribute to odour risk in a range of ways.

Table 5: Composting process parameters requiring monitoring that may give rise to odour issues

Compositing Parameter	Description
Maintaining an optimal C:N ratio	High C:N ratio mixes (low on nitrogen) will take longer to mature and increase the risk of odour formation in the composting material. Low C:N ratio mixes (excessive nitrogen) can lead to loss of nitrogen as odorous ammonia gas.
Porosity	The porosity of the mix (the proportion of free air space in the voids) determines how freely fresh air can move through the pile. Low porosity mixes can lead to anaerobic conditions which increases the potential for offensive odours to be generated.
Moisture	Moisture can affect the porosity of the mix. Moisture fills the pore spaces in the composting potentially impeding air flow leading to anaerobic conditions, which increases the potential for offensive odours to be generated.
Acidic conditions (low pH)	Are common in the initial phase of composting due to formation of organic acids. However, prolonged low pH conditions can lead to increased releases of volatile organic compounds.
Oxygen levels	Oxygen levels of 5% within the mix is generally considered to be the minimum threshold for 'aerobic' composting, though above 10% is preferable. Anaerobic conditions increase the potential for offensive odours to be generated.
Temperature	Higher temperatures can increase the volatility of odorous compounds and there is a direct relationship between temperature and odour emissions up to around 65°C

2.6.4 Processing Requirements and Technology

The potential for odour across all stages of the composting process are dealt with in detail in the Phase 1 RER[4]. Approaches to minimise odour issues in turned windrow systems include minimising turning events, covering the windrows with over-sized finished compost to act as a biofilter and reduce exposure to rain. It is

[4] The Phase 1 RER outlined some key advantages to odour management for turned windrows and forced aeration and enclosed systems

important that any additive measures are non-regressive i.e., you cannot add immature product to already matured products (i.e., adding liquid waste on maturation piles or adding unfinished compost to cover the windrows).

Mechanical handling of the feedstock (such as turning[5]) potentially assists the release of odorous gases from within the windrow voids and should be considered in the Compost Process Plan. Odour will occur when odour controls are not effective. Consequently, monitoring and maintaining optimum conditions is essential in odour management.

2.6.5 Seasonality

Seasonality can impact the composting process parameters listed below and the odour risk:

- Volumes of feedstock
  - Feedstock volumes can fluctuate throughout the year based on growing, harvesting or consumption cycles. Acceptance capacity needs to be specified to handle maximum through put.
- Rainy Season
  - During the rainy season, the moisture content increases which can potentially impede air flow leading to anaerobic conditions.
- Hotter weather
  - During summer, the increased temperatures can result in the feedstock putrefying faster and higher temperatures can increase the volatility of odorous compounds.

[5] Compost turning should not be conducted during stable and neutral atmospheric conditions. Turning should not be conducted when winds are blowing towards key sensitive receptors.

PART 2: Odour rating applied to FOGO

3 Odour Rating for FOGO

The following section provides a description of how the odour feedstock assessment methodology, including additional contributing factor, attenuation and mitigation measures, might be applied to a FOGO feedstock.

3.1 Garden Organics (GO) and Food Organics (FO) Odour Rating

The odour rating process, summarised in Section 2.2, is based on the odour risk of feedstock. Due to the lack of detailed compositional data of FOGO and expected variability, the composition of FOGO could range from GO[6], on the lower end with an odour rating of "Medium", to FO, on the high end, with an odour rating of "High" as shown in Table 6 below.

Total odour contribution potential score = A x B x (C + D + E)

Table 6: GO and FO odour rating (can be found in Appendix B)

Feedstock	Garden Organics	Food Organics
Type	Plant matter	Food & Food processing waste
Odour Rating Factors	Moisture content will vary Potentially moderate nitrogen (grass) Depends on age / storage	May contain meat / fat High moisture / nitrogen Likely anaerobic on arrival
A Putrescible	2	3
B Concentrated form	1	1
C Nitrogen content	2	2
D Sulfur content	1	2
E Fat, oil, protein content	1	2
Risk score	8	18
Odour Rating	Medium	High

[6] The Phase 2 RER refers to this as 'Green Waste', however for the purpose of this report, it will be referred to as 'Garden Organics'. This is defined as being green waste from households only and does not include all plant matter.

3.2 FOGO Odour Rating

FOGO has been assessed as having a “High” Odour Rating as there is the potential for a FOGO bin to contain only FO as shown below in Table 7.

Table 7: FOGO Odour Rating

Feedstock	Food Organics Garden Organics (FOGO)
Type	Food & Garden Organics
Odour Rating Factors	• May contain meat / fat • High moisture / nitrogen • Likely anaerobic on arrival
A Putrescible	3
B Concentrated form	1
C Nitrogen content	2
D Sulfur content	2
E Fat, oil, protein content	2
Risk score	18
Odour Rating	High

As the odour rating is only based on the high risk of odour potential, it might be assumed that this presents a ‘worst case scenario’, as the likelihood of the odour occurring is not factored into the odour rating. In reality, FOGO feedstock could reside on an odour rating spectrum that ranges from 8 to 18 (GO to FO rating, respectively).

The attenuation conditions defined in Section 2.5 can easily apply to FOGO in a range of real-world conditions. The influence from the additional odour risk factors (see Section 2.6) on the odour risk of FOGO might attenuate any of the Odour Rating Factors A-E. Examples of the impact on the odour rating from the attenuation of these factors are covered in Section 3.3.

3.3 Attenuation of FOGO Odour Rating

In the preparation of this report, a summary of the considerations, conditions or constraints that might influence the scoring of the Odour Rating Factors A-E (see Section 2.2) for each of the composting process parameters (see Section 2.6.2) was prepared. Summarised in Appendix C, this has been provided to illustrate the range of possible justifications for the attenuation of FOGO feedstocks across the five odour rating factors.

Attenuation of the odour rating for feedstocks requires a skilled application of the scoring criteria by an AQP. The example provided in Table 8 below (which does not represent a real worked example) illustrates the impact on the total odour rating that a change of just one of the odour rating factors can have. When these attenuated odour ratings are evaluated against the odour rating ranges (as shown in Table 1), there may be justification for applying a lower odour rating.

Table 8: Example of how attenuation of Odour Rating Factors A-E can impact on Odour Rating

Feedstock Odour Rating Factor		Food Organics	Scope for Attenuation			Garden Organics
A	Putrescible	3	3	3	**2**	2
B	Concentrated Form	1	1	1	1	1
C	Nitrogen Content	2	2	2	2	2
D	Sulfur content	2	2	**1**	2	1
E	Fat, oil, protein content	2	**1**	2	2	1
Risk score		18	15	15	12	8
Odour Rating		High				Medium

3.4 Odour Mitigation Measures for FOGO

The following sections provide an overview of mitigation measures in relation to a FOGO feedstock. The considerations in the below sections could be considered for either an attenuation or mitigation. Any such factors need to be determined on a site-by-site basis by an AQP, with supporting evidence regarding how and/or where attenuation can occur.

Please note, this section does not provide an attenuated or mitigated odour rating for FOGO, but rather steps out how an operator can use mitigation measures to influence the odour potential of site operations.

3.4.1 Feedstock Type and Storage Requirements

As outlined in the Model Operating Conditions for ERA 53(a), a *Feedstock Management Plan* must be developed prior to the commencement of the activity. The following mitigation measures could be considered in the Plan:

- Managing the condition and variability of feedstock through contractual processes and controls, in addition to good design of collection systems can also mitigate odour potential, such as:
  - Avoiding time on the kerbside in bins or at transfer points / avoiding unnecessary delays in collection and transfer of FOGO
    - This has been captured in the Phase 1 RER in Section 2.3.1, which outlines how in most cases, *putrescible feedstock material arrives at a composting facility in an anaerobic condition, as it has begun to decay* - the longer it is in the bin the more it putrefies and generates odour.
    - As recommended for best practice feedstock receival in the Phase 1 RER[7], operators should work with generators and collectors to increase collection frequency and other measures to reduce odour potential.

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[7] Recommendation 7 – Operation Process and Controls

    - If food waste is collected in liners or presented in concentrated form the odour risk may also be increased.
  - Organising collections based on the odour ratings and physical compositions of feedstocks, to minimise high-risk odour loads.
    - The FO:GO ratio directly influences the odour risk, as FO is more putrescible (Factor A), has a higher sulphur (Factor D) and higher proteins, oils and fat content (Factor E).
    - In some instances, collections from multi-unit dwellings (MUDs) FO content may be higher than an average FOGO collection and may pose a higher odour risk, therefore, collection with a high GO content would be preferable to promote porosity, moisture levels, C:N ratio.
- Managing and controlling the receiving and tipping conditions to reduce odour risk of materials arriving with odour (please refer to Table 4 in Section 2.6.1 for management approaches).
- Introducing management approaches for material sitting too long prior to being processed or mixed (please refer to Table 4 in Section 2.6.1 for management approaches).

3.4.2 Mixing and On-Site Handling

As outlined in the Model Operating Conditions for ERA 53(a), an *Odour Management Plan* must be developed prior to the commencement of the activity. The following mitigation measures could be considered in the Plan:

- Appropriate blending to optimise the feedstock mix, with the three main considerations being C:N ratio, moisture content and porosity[8] (see Section 2.6.2 for more mitigation measures)
- As per the Model Operating Conditions for ERA 53(a):
  - Keeping stockpiles of bulking agents or high carbon material so that these materials are available to immediately mix with or cover deliveries of odorous feedstock
  - Mixing putrescible feedstock materials immediately into the compost process, if not pre-treated or dried

3.4.3 Processing Parameters

As outlined in the Model Operating Conditions for ERA 53(a), a *Compost Process Plan* must be developed which outlines the composting process parameters for the feedstock and processing techniques being used on site. Demonstrating an understanding of how the following process parameters directly influence the resulting odour from a FOGO feedstock:

- Maintaining an optimal C:N ratio
- Porosity
- Moisture
- Acidic conditions (low pH)
- Oxygen levels

[8] See Section 2.3.2 in the Phase 1 RER

- Temperature

The Model Operating Conditions for ERA 53(a) also include other information that must be included in the Compost Process Plan including information to support the appropriateness of the composting process parameters, methods and frequencies for monitoring composting material and annual reviews of the effectiveness of the parameters at achieving pasteurisation and minimising odour impacts.

3.4.4 Processing Requirements and Technology

As outlined in the Model Operating Conditions for ERA 53(a), an *Odour Management Plan* must be developed prior to the commencement of the activity. The following mitigation measures could be considered for a FOGO feedstock in the Plan:

- Management approaches to minimise odour issues in turned windrow systems have been outlined in Section 2.2.1 of the Phase 1 RER and the Model Operating Conditions for ERA 53(a):
  - Implement a management strategy for turning open windrows to prevent anaerobic conditions which is determined by an experienced operator through site trials and measurements.
  - Minimising turning events for open windrows, especially during the first 7-10 days of composting, with only the minimum turning required to support pasteurisation and moisture redistribution.
  - Applying a biofilter to mitigate odour from open windrows in the early stages of composting. A simple biofilter may be achieved by applying a thick layer or blanket of finished compost (unscreened or oversize fraction) and/or pure green waste mulch over the windrows once they are initially formed.
  - Ensuring that the biological balance of certain odour generating systems is not disturbed.
  - Promptly cleaning up spilled odorous materials.
  - Installing adequate odour control equipment.
  - Scheduling activities for times when they will have least impact (e.g., avoid undertaking odour-generating activities such as turning windrows of compost at times when it is windy, and the odour might carry to a sensitive or commercial place).
- Implement best practice thermophilic composting phase, maturation phase and screening as per Section 2.3.3 and 2.3.4, in the Phase 1 RER and summarised below:
  - Compost should not be screened until the latter stages of curing, to maintain the compost porosity. Stockpiling of screened compost that is not fully cured can contribute to odour issues[9].
  - Compost piles should not be moved to the next stage of an operation (maturation or curing) until the thermophilic stage of composting has been completed.

[9] There are a number of ways to test the maturity of compost including the SolvitaTM test which can be performed on site and is considered an acceptable method in the Australian Standard AS4454 and several European guidelines

- Refer to Table 6 in Section 5 in the Best Practice Guideline) which includes management practices for managing odours[10].

3.4.5 Seasonality

Even though seasonality is not discussed in the Model Operating Conditions for ERA 53(a), it does impact the composting process parameters and therefore, the monitoring requirements, as the Model Operating Conditions require weather monitoring to inform site operational planning to minimise odour impacts. The impacts weather has on odour emissions is covered in Section 6 in the Phase 1 RER, and it is important to understand seasonality and the correlation between seasons and odour.

Based on discussions with existing composting operators and the FOGO trial Councils (discussed further in Section 4), the FO:GO ratio should be considered in the Compost Process Plan as in can fluctuate based on the following:

- The FO content remains fairly steady throughout the year, with the exception of the Christmas season which results in slightly higher yields and potentially greater protein and fat contents; and
- The GO content increases in the summer months.

[10] https://environment.des.qld.gov.au/__data/assets/pdf_file/0027/245169/era-gl-bpem-composting.pdf

4 Real World Examples

4.1 Case Studies

A literature review, interviews and the collection of data via a survey of three “real world” case studies was conducted and is provided in Appendix D for the following three sites:

- Phoenix Power Recyclers Pty Ltd, 126 Sandy Creek Rd, Yatala, QLD, 4207
- Remondis Port Macquarie ORRF, 351 Telegraph Point Road, Pembrooke, NSW, 2446
- SoilCo Tweed Heads, 3/132 W Dapto Rd, Kembla Grange, NSW, 2526

The intention of these case studies is to demonstrate the range of external factors that can influence odour risk which require consideration when undertaking site specific odour assessments.

4.2 FOGO Trials

Four Queensland councils are currently undertaking FOGO trials including:

- Ipswich City Council
- Townsville City Council
- Rockhampton Regional Council
- Lockyer Valley Regional Council

Table 9 summarises the internal and external factors identified during these trials which influence odour risk at processing sites.

Table 9: Additional factors observed during FOGO trials that influence odour risk

Internal Factors	External Factors
Managing feedstock (collection system)	Seasonality (moisture content, heat)
Storage methods	Location / Buffer Zones
On-site handling (shredding, blending, turning, screening)	
Infrastructure	

Ipswich FOGO is currently accepted at NuGrow (Swanbank) where it is received on open hardstand (no closed receival hall), blended onsite and processed in an open windrow system. NuGrow installed a real-time odour system that tracks odour in the wind and contaminants in the air, with multiple receptors on the boundary of the facility. However, this doesn’t trigger a mitigation measure, it is solely for data collection at this stage.

Lockyer Valley FOGO is currently accepted at Gatton and Laidley Waste Facilities. It is tipped onto a compacted dirt floor and processed in an aerated floor static pile system. The windrows do not get turned and sit for a minimum of 12 weeks. They have probes in the system to manage temperature and have other control mechanisms to manage moisture, such as the aerated floor. The compost is then screened, stockpiled, and covered by a geosynthetic lining (GSL) membrane (tarp cover) until it is taken offsite for distribution.

Townsville FOGO is processed at McCahills Landscaping Supplies, as a separate batch process in an open windrow system and then screened. The facility is located in a rural setting with no nearby sensitive receptors (>1km away). The feedstock is tipped on the ground in open air and covered in mulch to reduce litter and odour. There are concerns around diversion performance with low FO capture, but this will depend on what FOGO is defined as (kitty litter, pizza boxes etc), the introduction of programs like 'scrap together', support from DES and other states mandating FOGO will all play a part in this.

Rockhampton FOGO is processed at Gracemere NuGrow and is tipped onto the ground outdoors (not hardstand), manual pickers pick out contamination, the FOGO is mixed with liquid waste and other commercial organic waste and then composted in open windrows. The facility is located in open land, next to a sewerage treatment plant (run by council) with the nearest receptors being residents about 100-200m away.

Seasonality can play a major role in the fluctuation of GO and in turn, the proportion of FO and the odour potential of FOGO. Based on audits across the four FOGO trials, it was found that the proportion of FO varied from 1-30%, as summarised below:

- Ipswich: 13- 30% FO
- Townsville: 1-4% FO
- Rockhampton: 3% FO
- Lockyer Valley: 6.4% FO

The ranges reported in Ipswich and Townsville were considered to be from seasonal changes. It is worth noting that the three case study sites (listed in Section 4.1) do not track the proportion of FO as they have no process in place for doing so.

5 ERA 53(a) Approval Pathway

5.1 Model Operating Conditions for composting

To assist potential EA holders Model Operating Conditions have been developed to provide guidance on the administrating authority's expectations for managing risk to the environment and to ensure a consistent approach is applied across the industry. In addition, the Best Practice Guideline has been developed to provide clear and contemporary advice to potential operators to ensure consistent regulation of composting activities under ERA 53(a) in Queensland.

The ERA 53(a) Model Operating Conditions provide advice to potential EA holders on the conditions likely to be applied to their EA. These include additional conditions for operators wishing to accept feedstock with a "high" or "very" high odour rating (such as FOGO). It should be noted that the Model Operating Conditions provide guidance to the administrating authority's expectations in managing risk to the environment. As per Section 2 of the Model Operating Conditions potential EA holders can request modifications to these conditions to suit their particular operations providing adequate evidence (including specialist inputs) is provided demonstrating that the proposed change is unlikely to result in environmental nuisance or cause serious or material environmental harm.

An example of this could be implementing onsite management techniques to lower the odour risk of FOGO once onsite. This approach aligns with the air management hierarchy outlined in the Environmental Protection Policy (Air) 2019 which includes adopting the following measures (where reasonable and practical / in order of preference):

- Using management techniques to avoid creation of odours e.g., using less odorous materials and managing anaerobic ponds to avoid malodours
- Reusing or recycling the air emissions in another industrial process e.g., using vapour recovery technologies in refineries and using biogas as fuel
- Minimising the creation of odours and using best practice technologies to collect and treat odorous emissions e.g., scrubbers, afterburners, bio-filters, adsorption technologies and ozonation
- As a last resort, relying on buffer zones, winds and stacks to disperse emitted odours

5.2 Odour Impact Assessment

In order to support a change to the ERA 53(a) model operating conditions (new site or amendment to existing approval) applicants are required to provide adequate justification to demonstrate the proposed activity is unlikely to result in serious or material environmental harm, and that all reasonable and practical measures have been undertaken to prevent environmental nuisance.

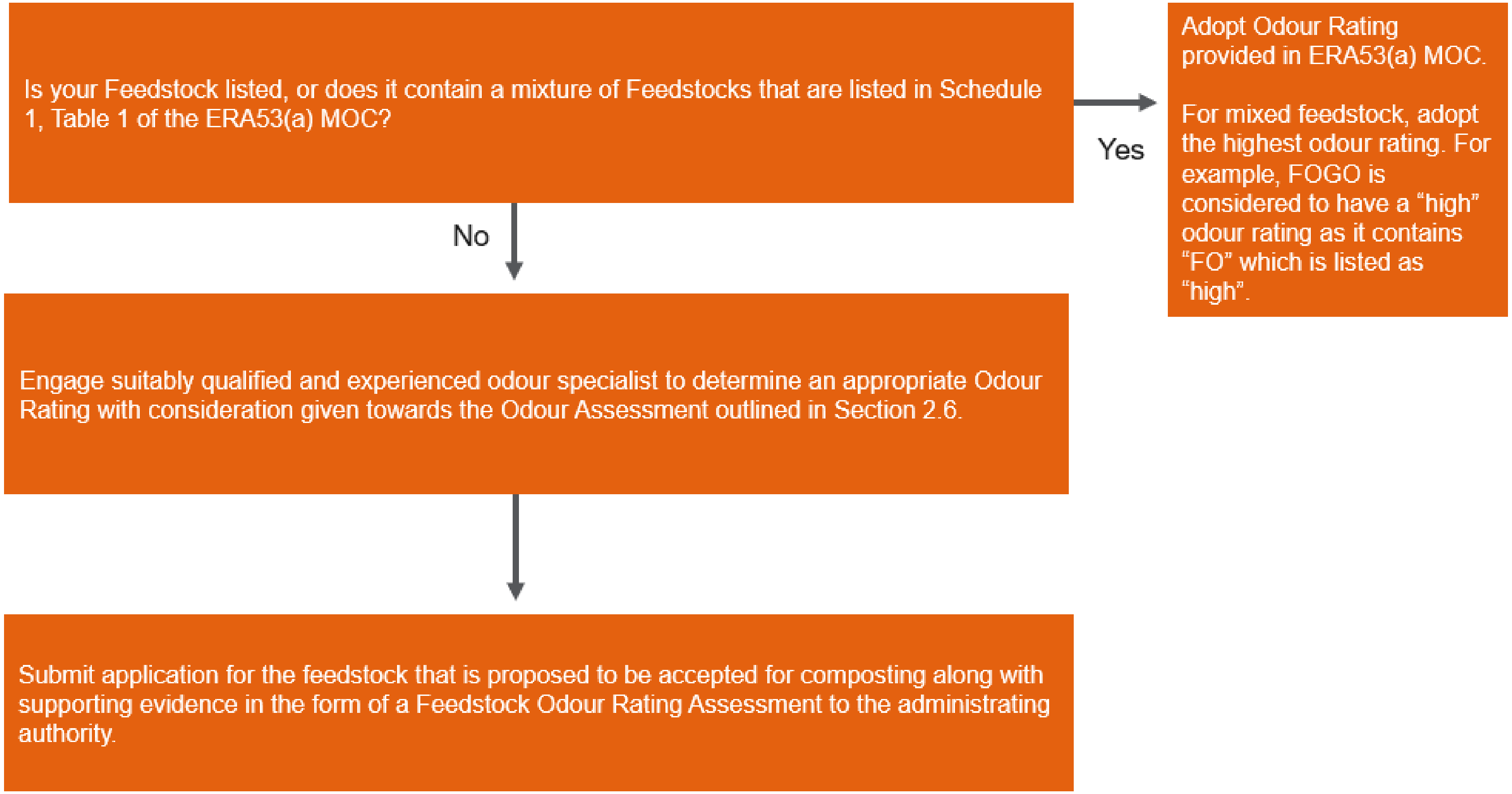
To achieve this objective, it is important to engage an AQP (refer to section 5.5 below) during the preliminary design phase to advise on key design elements relating to odour risk such as location, layout, and operational aspects (as outlined in Section 4 of the ERA 53(a) Best Practice Guideline). It is noted that further assessments may be required to support an amendment to a model operating condition such as onsite trials to demonstrate the effectiveness of the proposed measures.

Following these preliminary assessments, applicants should undertake a preliminary lodgement meeting with the administering authority to discuss any proposed changes to the model operating conditions prior to conducting any trials or preparing and submitting a formal development application or request to amend an existing application.

5.3 Assessing Odour Potential of New Feedstock

As detailed in Section 2.3 an odour assessment for new feedstocks may be required when proposing to accept Feedstocks not already listed in Schedule 1, Table 1 of ERA 53(a) model operating conditions (MOC). An overview of this process is provided in the below flow chart.

Flow Chart: Determining New Feedstock Odour Rating



Appendix A Scoring Tables

Table 10: Putrescible content scores (Factor A)

Score	Definition
0	Very low or zero carbon content overall (i.e., inert materials) and no other significant odour contributing compounds.
1	Low content of readily degradable solids with carbon present as slowly degradable or nonbiodegradable organic matter, and usually with low moisture content and little or no dissolved organics.
2	Moderate content of degradable solids and moisture, and/or dilute dissolved organics if in liquid form.
3	High content of dissolved or readily degradable solids, likely to decompose and turn putrid rapidly, and likely to arrive at a composting facility in anaerobic state. Particularly where no pre-treatment or digestion has occurred.

Table 11: Concentration factor (Factor B)

Score	Definition
1	Odour contributing components are already present in low concentrations or in diluted form in the unblended feedstock, such as weak effluent solutions.
2	Odour contributing components are present in moderate concentrations, mostly naturally occurring levels – not particularly diluted, nor concentrated.
3	Odour contributing components are present in very concentrated and readily available form.

Table 12: Nitrogen content scores (Factor C)

Score	Definition
1	Low or virtually zero content of nitrogen in any form.
2	Moderate content of nitrogen.
3	High content of nitrogen in concentrated solid / sludge form (e.g., dewatered sludges, animal manures) or in concentrated chemical form (e.g., chemical fertiliser residues), particularly if nitrogen is present as ammonia / ammonium.

Table 13: Sulphur content scores (Factor D)

Score	Definition
1	Low or virtually zero content of sulphur in any form.
2	Moderate content of sulphur.
3	High content of sulphur in concentrated solid / sludge form (e.g., dewatered sludges) or in concentrated chemical form (e.g., gypsum), particularly if already present in reduced form (sulphides).

Table 14: Fats, oils, protein content scores (Factor E)

Score	Definition
1	Low or virtually zero content of fats, oils or proteins.
2	Moderate content of fats, particularly if derived from vegetable sources or digested fats and proteins (e.g., biosolids, animal manures).
3	High content of fats and proteins derived from animals and animal products, high content of volatile oils and greases.

Appendix B Defined Feedstock Scoring

Table 15: Defined feedstock scoring (an abridged list taken from Table 55 in the Phase 2 RER[11])

Feedstock	Type	Odour Factors	Putrescible	Concentrated Form	Nitrogen Content	Sulfur Content	Fat, Oil, Protein Content	Risk Score	Risk Rating
Cane residues	Plant matter	- high carbon	1	1	1	1	1	3	Low
Grain Waste	Food & Food processing waste	- assume dry, high carbon - potentially fermented?	1	1	1	1	1	3	Low
Cypress chip	Plant matter	- high carbon	1	1	1	1	1	3	Low
Forest mulch	Plant matter	- high carbon	1	1	1	1	1	3	Low
Pine bark	Plant matter	- high carbon	1	1	1	1	1	3	Low
Wood chip	Plant matter	- high carbon	1	1	1	1	1	3	Low
Worm castings suitable for unrestricted use	Plant matter	- assume mostly matured	1	1	2	1	1	4	Low
Soft Drink Waste	Food & Food processing waste	- assume high sugar content	2	1	1	1	1	6	Low
Sugar and sugar solutions	Food & Food processing waste	- assume high sugar content	2	1	1	1	1	6	Low
Starch Water Waste	Food & Food processing waste	- high starch / sugar content	2	1	1	1	1	6	Low
Green waste	Plant matter	- potentially moderate nitrogen (grass) - depends on age / storage	2	1	2	1	1	8	Medium
Beer	Food & Food processing waste	- wet, potentially anaerobic?	2	1	2	1	1	8	Medium
Brewery effluent	Food & Food processing waste	- wet, potentially anaerobic?	2	1	2	1	1	8	Medium
Mushroom compost (substrate)	Plant matter	- assume composted but not mature - composting odours	2	1	2	1	1	8	Medium
Vegetable waste	Food & Food processing waste	- high nitrogen / moisture	2	1	2	1	1	8	Medium
Molasses Waste	Food & Food processing waste	- highly biodegradable	3	1	1	1	1	9	Medium

[11] The original report rated a wide range of feedstocks some that are not organic and no longer considered suitable for composting or other organic methods of waste management, or are not clearly defined within the original report and therefore, have not been included below)

		- potentially anaerobic on arrival?							
Vegetable oil wastes and starches	Food & Food processing waste	- high carbon, wet - could be anaerobic on arrival	2	1	1	1	3	10	Medium
Yeast Waste	Food & Food processing waste	- fermented, yeast odour - potentially anaerobic	2	2	2	1	1	16	High
Animal manures, including livestock manure	Animal Matter	- wet and high nitrogen content - potentially anaerobic on arrival	3	1	3	1	2	18	High
Food Organics	Food & Food processing waste	- may contain meat / fat - high moisture / nitrogen - likely anaerobic on arrival	3	1	2	2	2	18	High
Food processing effluent and solids	Food & Food processing waste	- wet / high nitrogen - likely anaerobic on arrival	3	1	3	1	2	18	High
Paunch material	Animal Matter	- partially digested / fermented grass - likely anaerobic on arrival	3	2	3	1	1	30	High
Abattoir waste	Animal Matter	- decomposing meat and fat content - high protein, wet and potentially anaerobic on arrival	3	2	3	1	3	42	Very high
Animal processing waste	Animal Matter	- wet and high nitrogen content - decomposing meat / fat content - high protein - potentially anaerobic on arrival	3	2	3	1	3	42	Very high
Tallow Waste	Animal Matter	- high fat and protein content - likely anaerobic on arrival	3	2	3	1	3	42	Very high
Grease trap – treated grease trap waters and dewatered grease trap sludge	Food & Food processing waste	- wet, food and grease content - likely anaerobic on arrival	3	2	3	1	3	42	Very High
Grease trap waste	Food & Food processing waste	- wet, food and grease content - likely anaerobic on arrival	3	2	3	1	3	42	Very High
Animal Waste, including egg waste and milk waste	Animal Matter	- high fat and protein content - wet and likely anaerobic on arrival	3	2	3	2	3	48	Very high

Appendix C FOGO Attenuation Factors

Table 16: Range of possible justifications for the attenuation of FOGO feedstocks across the Odour Rating Factors A-E

	Factor A – Putrescible Content	Factor B - Concentration	Factor C – Nitrogen Content	Factor D – Sulphur Content	Factor E - Content of fats, oils and proteins
Maintaining an optimal C:N Ratio	Influenced by the ratio of FO to GO. FO can increase and contain higher levels of protein during holiday periods. FO contains a high proportion of readily biodegradable solids and are at higher risk of going anaerobic and releasing odours. The putrescible content can be blended, and additional materials can be added to achieve an optimal C:N ratio. A high N content can lead to the production of ammonia gas. Low nitrogen mixes will take longer to mature and increase the risk of odour formation in the composting material.	The feedstock can be influenced by the types of residences collected from i.e., high FO content from MUDS, which increases the odour contributing components. High N content results in these contributing components being concentrated within the raw material, potentially compounding their impact.	Influenced by the proportion of FO to GO volumes. Nitrogen levels are higher in FO compared to GO and are therefore assumed to present a risk of producing ammonia gas. Excessive nitrogen can lead to loss of nitrogen as odorous ammonia gas. Blending, shredding and screening can cause trapped odour gases to be released – high risk activity where controls should be considered.	Influenced by the proportion of FO to GO volumes. Sulphur levels are higher in FO compared to GO and are therefore assumed to present a risk of producing hydrogen sulphide. Excessive sulphur can lead to loss of sulphur as odorous hydrogen sulfide. Blending, shredding and screening can cause trapped odourous gases to be released - high risk activity where controls should be considered.	Influenced by the proportion of FO to GO volumes. Fats, oils and protein levels are higher in FO compared to GO and are therefore at a higher risk of producing volatile nitrogen and sulfur compounds, as well as VOCs and volatile fatty acids (VFAs). Blending, shredding and screening can cause trapped odourous gases to be released – high risk activity where controls should be considered.
Porosity	Influenced by the proportion of FO to GO volumes. Food and grass clippings reduce porosity while woody garden waste increase porosity, which helps prevent anaerobic conditions. Pockets of wet limit the porosity.	FO has a higher concentration of odour contributing components, potentially compounding their impact. Increasing porosity helps to avoid issues such as saturation of piles and puddling of liquids, which can contribute to odour release.	Porosity encourages aerobic conditions, reducing the risk of the production of ammonia gas. Pockets of wet compost limit the porosity and contribute to anaerobic conditions.	Porosity encourages aerobic conditions, reducing the risk of the production of hydrogen sulfide. Pockets of wet compost limit the porosity and contribute to anaerobic conditions.	Porosity encourages aerobic conditions, reducing the risk of then producing volatile nitrogen and sulfur compounds, as well as VOCs. Pockets of wet compost limit the porosity and contribute to anaerobic conditions.
Moisture	Influenced by the proportion of FO to GO volumes. Moisture levels are higher in FO compared to GO and increase in wet and humid conditions. Moisture fills the pore spaces in the composting potentially impeding air flow leading to anaerobic conditions. Moisture content is balanced by adding water if too dry or by adding dry material if too wet.	Influenced by the proportion of FO to GO volumes. Moisture levels increase in wet and humid conditions and are higher in FO compared to GO. High moisture content can lead to wet pockets, filling the pore spaces which can impede air flow and lead to anaerobic conditions. Feedstock with higher moisture contents are at a higher risk of odour contributing components being more concentrated, potentially compounding their impact.	Feedstocks with a high moisture content are at higher risk of going anaerobic and increasing the risk of the production of ammonia gas.	Feedstocks with a high moisture content are at higher risk of going anaerobic and increasing the risk of the production of hydrogen sulfide.	Feedstocks with a high moisture content are at higher risk of going anaerobic and increasing the risk of the production of volatile nitrogen and sulfur compounds, as well as VOCs.
Acidic conditions	Low pH is common in the initial phase of composting due to	Low pH is common in the initial phase of composting due to	Neutral pH supports the required microbial activity. At a	Neutral pH supports the required microbial activity. At a	Neutral pH supports the required microbial activity. At a

	formation of organic acids. However, prolonged low pH conditions can lead to increased releases of volatile organic compounds.	formation of organic acids. However, prolonged low pH conditions can lead to increased releases of volatile organic compounds.	higher pH, gaseous losses of ammonia are likely to occur.	lower pH, odorous sulfides are produced.	lower pH, odorous volatile fatty acids are produced.
Oxygen levels	Highly putrescible content feedstocks have a biological oxygen demand and are at higher risk of being anaerobic and producing odour. Exclusion of oxygen can occur through pockets of wetter vs drier waste.	Materials which contain a high proportion of readily biodegradable solids and/or a high concentration of dissolved organic compounds (indicated by a high Biological Oxygen Demand) are at higher risk of going anaerobic and releasing odours. Exclusion of oxygen can occur through pockets of wetter vs drier waste.	Anaerobic conditions increase the risk of the production of ammonia gas.	Anaerobic conditions increase the risk of the production of hydrogen sulphide.	Anaerobic conditions increase the risk of the production of volatile nitrogen and sulfur compounds, as well as VOCs.
Temperature	Higher ambient temperature levels throughout the composting process will increase the volatility of odorous compounds.	Higher ambient temperature levels throughout the composting process will increase the volatility of odorous compounds.	Seasonally, nitrogen levels are higher in summer and lower in winter. Higher ambient temperature levels throughout the composting process will increase the volatility of odorous compounds.	Higher ambient temperature levels throughout the composting process will increase the volatility of odorous compounds.	Higher ambient temperature levels throughout the composting process will increase the volatility of odorous compounds.

Appendix D Case Studies

Organics Resource Recovery Facility

Port Macquarie, NSW

Overview

The Port Macquarie In-Vessel Composting (IVC) facility known as Organics Resource Recovery Facility (ORRF) is located at Pembrooke near Port Macquarie and has been in operation since 2001. It was further designed to provide a treatment solution for biosolids and residual waste, as a response to the legacy carbon pricing scheme in 2012, by reducing the carbon emissions potential of landfilled waste. The residual waste processing capability did not remain after carbon legislation was repealed; however, the site still uses the process for managing biosolids, FOGO and commercial food wastes.

The ORRF receives source separated organics, FOGO (weekly collection) and biosolids from Port Macquarie Hastings Shire Council and some commercial food wastes.

Waste is received, tipped, stored and shredded in an undercover area that has open sides. The content of food in the 'FOGO' feedstock is supplemented (or increased) by commercial sourced food waste that is blended with kerbside FOGO prior to mixing.

FOGO and transfer station mulch (garden only waste[1]) is shredded using a slow speed shredder. An equal third blend of biosolids and post-shredded transfer station mulch and FOGO is loaded into a mixer in 7.5tonne batches then transferred into one of eight tunnels.

Composting

The composting process uses 4 tunnels each 25m deep, 6m wide, 4m high, with forced airflow and air extraction. Each tunnel processes approximately 225 tonnes, spending 9 days in one tunnel, then turned into another tunnel for a further 9 days.

Extracted air goes through a large ($450m^2$) biofilter, made up of various densities of organic medium such as wood chip or bark.

Odour Factors

The site has not received any odour complaints during the 20 years of operation; however the site is surround by state forest and is about 1.5km from the nearest receptor.

The process was designed to manage very odorous feedstocks but has fewer odour control measures than other similar sites. The mixing process has been designed to achieve a consistent feedstock and a controlled composting process - both measures that can curtail odour potential.

The most odourous part of the process is at the reception and blending. Some odour risks and controls at this stage include:

- not in a controlled atmosphere
- active management of feedstock reception
- good knowledge of feedstocks

Site representatives noted that odours are more significant in and around Christmas time with a lot of high protein FOGO loads (with meats, prawn shells etc.). The FO content is not known but understood to be minimal.

[1] The terminology of the case study has not been altered, in order to remain true to what the individual operator have referred to the waste as. However, please note that the Phase 2 RER refers to this as 'Green Waste' and this report refers to it as 'Garden Organics'. This is defined as being green waste from households only and does not include all plant matter.

Phoenix Power Recyclers - IVC

Yatala, Qld

Overview

Phoenix Power currently operates a 50,000 tpa organics processing facility in Yatala, Queensland, which has been operational for 3 years and is designed to accept food waste, organic liquid wastes, garden organics or green wastes[1] and timber.

Waste is tipped in the fully enclosed receival area which maintains a negative pressure, along with interlocked fast acting doors (8 seconds to close) sequenced so only one is open at a time to avoid through air flows. FOGO and green waste or mulch is shredded using a slow speed shredder inside the receival area.

The Facility currently operates 4 concrete vessels able to process ~500 tonnes per tunnel. Each tunnel has multiple aeration lines that supply forced air into the composting matrix. Air is distributed by a series of nozzles located within small channels that run the length of the bay. The pasteurisation phase of the composting process typically runs for 11 days in each vessel.

The circulating air delivers oxygen for the process and upon discharge through an exhaust point at the top of the vessel, it is directed through a wet scrubber and then via a bio filter before venting to atmosphere. The biofilter uses a wood chip and ironbark matrix to maximise microbial activity to remove odour compounds such as VOC's. The composting feedstock is blended within a mixing pit where liquid and slurry wastes are mixed with FOGO, GO or woodchip to a specific density and moisture content suitable for composting. If the feedstock is too dense for sufficient air flow, the composting material can be transferred between tunnels. Maturation occurs outside on a hardstand area in windrows post pasteurisation.

The EA requires the operator to accept wastes with the potential to generate odour nuisance to be delivered and stored inside. The current approval allows for the in-vessel process to be doubled in size to manage a capacity of 100,000 tonnes per annum. Other activities approved for future development include a 150kt per annum biomass fueled power station for thermal treatment of green waste and the potential generation of ~15MWe.

Feedstocks

Typical feedstocks include:

- FOGO from Brisbane (~30t/week)
- Food waste from Gold Coast Council (~14t/week)
- Industrial organic waste e.g., DAF sludge
- Grease trap waste
- Liquefied food via *Pulp Master* (JJsWaste)

Operational preference is to receive FOGO feedstock as fresh as possible for better C:N ratios. In most cases, the food component in FOGO is unrecognizable as it has already started to putrefy and is in a liquid state. Green waste is seasonal and can vary from year to year based on the weather conditions. For example, in 2019 there was a 40% variation in winter and summer in comparison to only 15% in 2022.

Odour Factors

The site previously experienced issues with odour and underwent process changes to address these issues. A range of industrial receptors surround the site.

Operations have adapted during site commissioning and have addressed any release of odour either caused or released at the following points:

- Air surge through receival area
- Slow activation doors that were also affected by corrosion
- Air release through a conveyor feed inlet to the mixing pit
- Build-up of liquids in uncovered bunding area
- Incorrect density when filling vessels can lead to anaerobic activity – a process dependent on shred dimensions, waste blend, machine operator and onboard weighing.

[1] The terminology of the case study has not been altered, in order to remain true to what the individual operator have referred to the waste as. However, please note that the Phase 2 RER refers to this as 'Green Waste' and this report refers to it as 'Garden Organics'. This is defined as being green waste from households only and does not include all plant matter.

SoilCo – Stotts Creek ORF

Tweed Heads, NSW

Overview

SoilCo operates several in vessel and windrow composting facilities in NSW that accept FOGO. The Organics Recycling Facility (ORF) in Stotts Creek, NSW, is an in-vessel composting facility designed to accept and process FOGO. It is co-located on a Council owned waste site and operated by SoilCo under contract. There are 4 tunnels, 40m long, 6m wide and 6m high accepting approximately 300t per tunnel. The system uses an aerated floor, with extracted air passing through a condenser and biofilter.

The Development Approval (DA) is for 25,000 tpa, the facility is designed to operate at 21,000 tpa and is currently accepting 19,000 tpa. The Environmental Protection License (EPL) is for up to 50,000 tpa. The DA included an Odour Assessment and an Odour Management Plan and requires an odour logbook be maintained and any instances investigated. The Environmental Protection License requires:

- Processing building doors must be closed at all times except for vehicle entry and exit.
- processing building must have complete enclosure and operated under negative pressure at all times.
- All loading/unloading and other operations (i.e., material handlings, sorting, screening and composting tunnels operations) inside the processing building must be undertaken when doors are closed.
- The air drawn from the composting tunnels and the processing building must be connected to and treated by the biofilter.
- No waste, except for the composted product and virgin excavated natural material, is to be stored outside the processing building
- Oversized compost and contaminated material extracted from the waste must be stored within the processing building under negative pressure and must be disposed of at a facility that can lawfully receive the waste.

The site was developed following a tender process for Tweed Heads Council which had a technology and operational specification.

Feedstocks

The facility in Tweed Heads accepts FOGO from Tweed Shire and Ballina Shire Councils who both operate a weekly FOGO collection. FOGO is collected in 240 litre bins by side lift vehicles and delivered directly to site. FO makes up approximately 5-15% of the total waste input.

SoilCo noted that there experience seasonal fluctuations in tonnage based on the garden organic[1] and growing seasons – although data has been affected by the rain events throughout 2022. There are no other feedstocks used in the process

Odour Factors

As part of the EPL the site must report on the odour emission performance. This was not available to report on here, however, some comparable data was provided from other sites. Unprocessed raw FOGO may have a peak odour level at around 2600 units, whereas green waste or FOGO with low food content could be anywhere from 520 to 1,800 units. For comparison the odour release from the turning of windrow composting could reach 2,000 units. Finished compost at the maturation stage is around 40 units.

[1] The terminology of the case study has not been altered, in order to remain true to what the individual operator have referred to the waste as. However, please note that the Phase 2 RER refers to this as 'Green Waste' and this report refers to it as 'Garden Organics'. This is defined as being green waste from households only and does not include all plant matter.