Government of **Western Australia**
Department of **Water and Environmental Regulation**

Odour guideline for prescribed premises

Part V Division 3 *Environmental Protection Act 1986*

Department of Water and Environmental Regulation

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168 St Georges Terrace
Perth Western Australia 6000
Telephone +61 8 6364 7000
Facsimile +61 8 6364 7001
National Relay Service 13 36 77
www.dwer.wa.gov.au

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Disclaimer

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1 Odour guideline for prescribed premises

1.1 Introduction

The Department of Water and Environmental Regulation (DWER) administers Part V (Environmental regulation) of the *Environmental Protection Act 1986* (EP Act) in Western Australia. The *Guidance statement: regulatory principles* establishes and sets out how the department will apply principles of good regulatory practice.

The *Guidance statement: decision making* has been developed to guide DWER's decision-making process for applications, amendments and renewals for works approvals and licences, and should be read in conjunction with this guideline. Similarly, the *Guidance statement: risk assessments* sets out DWER's risk assessment framework for works approvals and licences under Part V Division 3 of the EP Act. Both these guidance statements form the framework around which the department considers and applies emission guidelines.

This *Odour guideline for prescribed premises* guides applicants, licensees, consultants, members of the public and DWER staff on the requirements for odour impact analysis.

This guideline only deals with odour impacts as an amenity or nuisance issue. It does not consider air toxics and human health impacts, which will be included in the *Guidance statement: emissions to air* (under development).

This guideline is not intended to apply to land-use planning proposals for odour-sensitive land uses situated near existing or planned odour-generating activities. Planning authorities are responsible for deciding planning applications.

Terms that have specific technical meanings in this guideline are shown in bold italic and are defined in the Glossary.

1.2 Purpose

This guideline sets out DWER's information requirements for the analysis of odour impact for prescribed premises. It must be applied to all applications for works approvals, new licences, amendments to works approvals and amendments to existing licences involving odour emissions, except where the sources involved are ***tall wake-free stacks***. Applicants for proposals involving ***tall wake-free stacks*** should seek advice from DWER regarding appropriate analysis methods.

This guideline does not discuss how DWER uses the applicant's information to assess the risk of odour impact for the proposed activity. DWER's assessment is detailed in its decision document, which will follow the department's regulatory risk assessment framework.

1.3 Review

This guideline is to be reviewed as soon as practicable after the third year of its commencement or at the chief executive officer's discretion.

1.4 Context

An odour is that property of volatilised chemical compounds perceived by our sense of smell. Odours emitted to the atmosphere may result in annoyance or nuisance to members of the public. The following factors, described using the acronym FIDOL, are widely accepted as being important dimensions of ***odour nuisance***:

1. **F**requency of odour impacts
2. **I**ntensity (or strength) of the odour
3. **D**uration of the exposure events
4. **O**ffensiveness of the odour
5. **L**ocation of the impacts (the sensitivity of the receiving environment)

Consideration of these factors is implicit in the analysis approach in this guideline.

2 Odour assessment overview

If the proposed activities have the potential to generate odour emissions, the applicant must undertake an odour analysis following the procedure in this guideline. A report presenting the results and interpretation of the analysis (odour analysis report) must be submitted with the application to help DWER conduct its risk assessment. An overview of the procedure is provided in Figure 1.

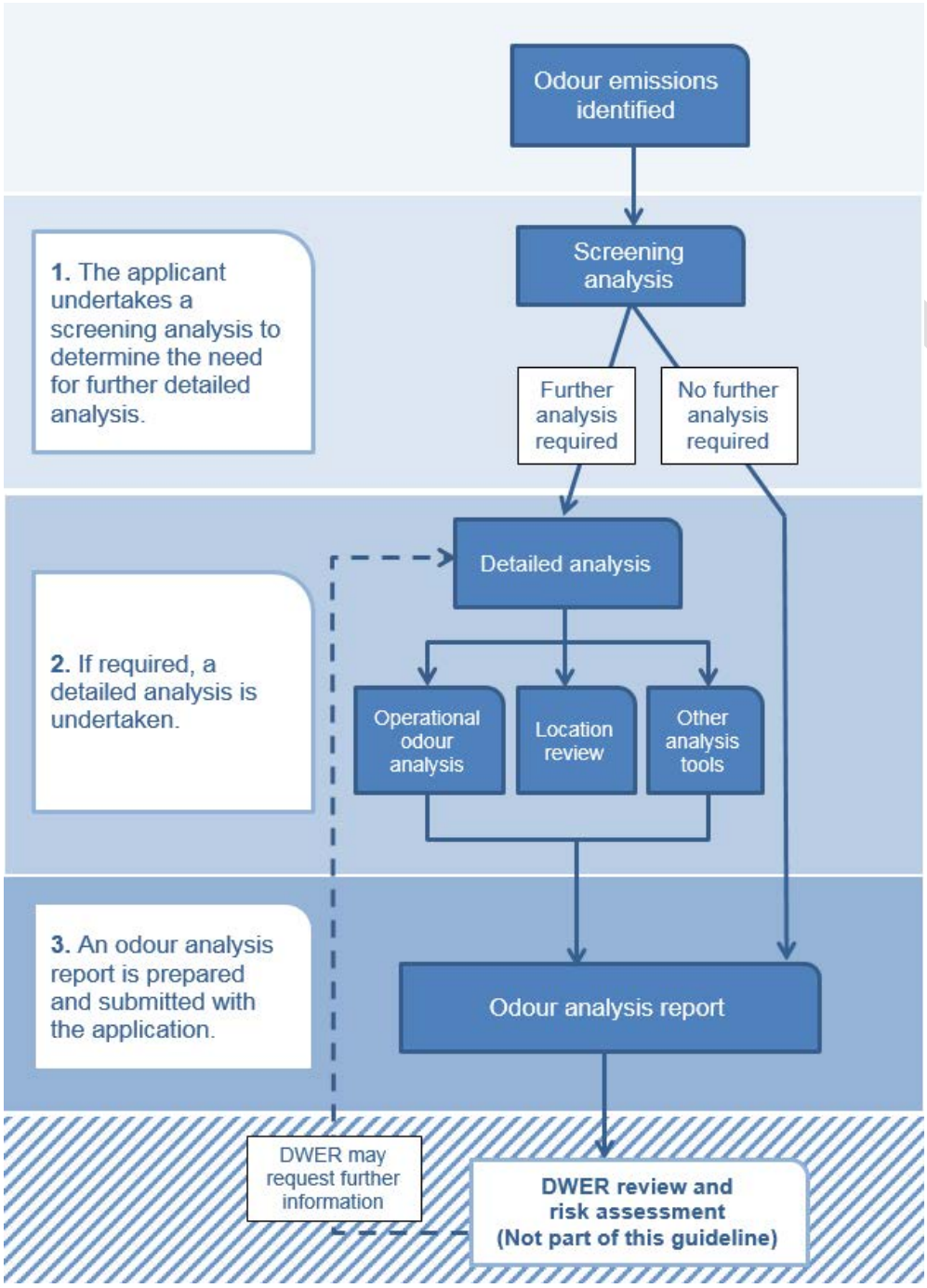


Figure 1: Overview of the odour assessment procedure of this guideline.

Key components of the information required are the screening and detailed analyses and associated reporting. These are discussed in detail in the following sections.

3 Screening analysis

If odour emissions have been identified in an application, a screening analysis must be undertaken to assess whether emissions have a low risk of resulting in unreasonable impact, or whether further detailed analysis of the odour impact potential of these emissions is required.

The screening analysis is composed of separate questionnaire and flowchart worksheets for both new premises and changes to existing premises, as shown in Appendix 1. It primarily involves comparison of the ***sensitive receptor distance*** with the ***screening distance*** (Appendix 2) and provides a conservative desktop indication as to whether odour is likely to be an issue.

Steps in a screening analysis are:

Step 1: Completing the questionnaire relevant to the application (new premises or changes to existing premises)

Step 2: Using the associated flowchart to determine whether a detailed analysis is required

Step 3: Compiling information to support the screening analysis

Where screening analysis indicates that a detailed analysis is not required (see Appendix 1), DWER may still require the applicant to undertake a detailed analysis based on:

1. DWER's knowledge of and experience with regulating similar premises in similar circumstances
2. The compliance history of the applicant
3. Known future changes in the proximity of receptors
4. Insufficient information to substantiate the screening analysis being provided to DWER with the application

4 Detailed analysis

The screening analysis may indicate that a detailed analysis of the odour impact potential associated with an application is required. DWER may also determine that a detailed analysis is required after review of the screening analysis. A detailed analysis will help DWER conduct an odour impact risk assessment for the application. The need for a detailed analysis does not imply that the odour impact potential is other than low.

Tools to aid applicants in undertaking a detailed analysis are summarised in Table 1 and described in Appendix 3. As shown in Table 1, the use of a particular tool depends on whether the application is for new premises or for changes to existing premises. Tool selection will depend on a range of factors including the type of activity, and the availability and reliability of existing site-specific data.

The tools follow the process described in *Guidance statement: risk assessments,* which requires identifying and evaluating the potential emission sources, pathways and receptor impacts. As shown in Table 1, some of the tools are mandatory to ensure this process is followed.

In addition to the mandatory tools, applicants may select other tools in Table 1 that are most appropriate for the application. Tools that use empirical data are generally of higher value than theoretical approaches.

DWER expects that applications with potentially significant odour impacts will include multiple tools in the detailed analysis, including the use of site-specific data where possible. Applicants must demonstrate a clear understanding of the potential odour impacts of their premises. The level of detail provided in the detailed analysis should be commensurate with the impact potential of the proposed works.

Each detailed analysis tool has its own strengths and weaknesses. Consequently, the value of the results of individual tools is enhanced if multiple independent lines of evidence that support each other are provided. For example, the value of odour complaints information from residents is significantly improved if odour field assessments independently confirm the presence of odour in the same area.

Steps in a detailed analysis are:

Step 1: Undertake a mandatory operational odour analysis (OOA) and location review as detailed in Appendix 3.

Step 2: Undertake further analysis using selected tools from Table 1 as required.

Step 3: Compile additional information required to support the detailed analysis

See Appendix 3 for further information on the detailed analysis tools. Table A4-1 in Appendix 4 enables the applicant to indicate which tools they have used.

Table 1: Summary of detailed analysis tools

Detailed analysis tool	For changes to existing premises	For new premises
Emission source tools		
Operational odour analysis (OOA) (mandatory)	Information on operations and odour sources with emissions that have the potential to create offsite odour impacts, together with proposed monitoring and management procedures.	
Odour source assessment (OSA)	Characterisation of odour sources to provide information on emission rates for each source.	N/A
Pathway and receptor tools		
Location review (mandatory)	Examination of the ***sensitive receptor distance*** in relation to the ***screening distance***, the nature of receptors and environmental factors such as local meteorology and topographical features.	
Odour field assessment (OFA)	Survey of odour levels in the field arising from: - the existing premises - other premises or sources in the area.	Survey of odour levels in the field arising from odour emissions from other premises or sources in the area.
Complaints data analysis	Analysis of odour complaint histories to indicate odour impacts from: - the existing premises - other premises or sources in the area.	Analysis of odour complaint histories to indicate odour impacts from other premises or sources in the area.
Community surveys	Survey of community members to identify current or past odour issues related to: - the existing premises - other premises or sources in the area.	Survey of community members to identify current or past odour issues related to other premises or sources in the area.
Relative dispersion modelling	Computer modelling to compare different emissions scenarios (such as variations in emissions or changes in number, configuration or control of sources) through the analysis of the relative variations in predicted ground-level odour concentrations. **This tool does not involve odour modelling against criteria. This type of modelling is not accepted.**	
Comparison with similar operations	Analysis of data from facilities of similar size, throughput, operational conditions, topography, meteorology and emission sources.	

5 Reporting

An odour analysis report should be submitted with applications containing the screening analysis and, if undertaken, the detailed analysis deliverables.

The screening analysis deliverables are:

1. A statement of the screening analysis outcome
2. A completed screening questionnaire (Appendix 1)
3. A discussion of the screening flowchart (Appendix 1) outcome
4. Supplementary documentation supporting the screening questionnaire responses, including information on special case factors

The detailed analysis deliverables comprise:

1. A detailed analysis summary report table (template provided in Appendix 4)
2. Conclusions from the screening and detailed analyses
3. Attachments including the result of the screening analysis, operational odour analysis, location review, outcomes of other analysis tools selected from Appendix 3 and any supporting documentation

The level of detail provided in the analysis report should be commensurate with the potential for odour impacts related to the proposed works.

When reviewing the odour analysis report, DWER may consider a range of additional factors such as proposed technology, any complaints DWER has recorded, the compliance history and annual audit compliance reports. DWER may also require additional analysis to be undertaken.

Appendices

Appendix 1— Screening analysis

INSTRUCTIONS

Applicants undertake a screening analysis to assess whether further detailed analysis of odour emissions and impacts is required. It primarily involves comparison of the ***sensitive receptor distance*** with the ***screening distance*** (Appendix 2) along with consideration of other information.

Applicants are required to provide DWER with sufficient information to substantiate their screening analysis with their application.

Separate screening procedures are provided for applications for new premises and applications for changes to existing premises.

The screening analysis comprises three steps:

Step 1: Completing the questionnaire relevant to the application (new premises or changes to existing premises)

Step 2: Using the associated flowchart and the questionnaire responses to determine whether a detailed analysis is required

Step 3: Compiling information to support the screening analysis. This can include maps of sources and receptors, topographical maps, specifications for proposed emissions controls or details of ***screening distance*** calculations.

Screening distances **are not provided for some activities and in these instances applicants are required to undertake a detailed analysis.**

An electronic template of the questionnaire for both new and changes to existing premises is provided on the DWER website.

SCREENING ANALYSIS FOR NEW PREMISES

Step 1: Questionnaire

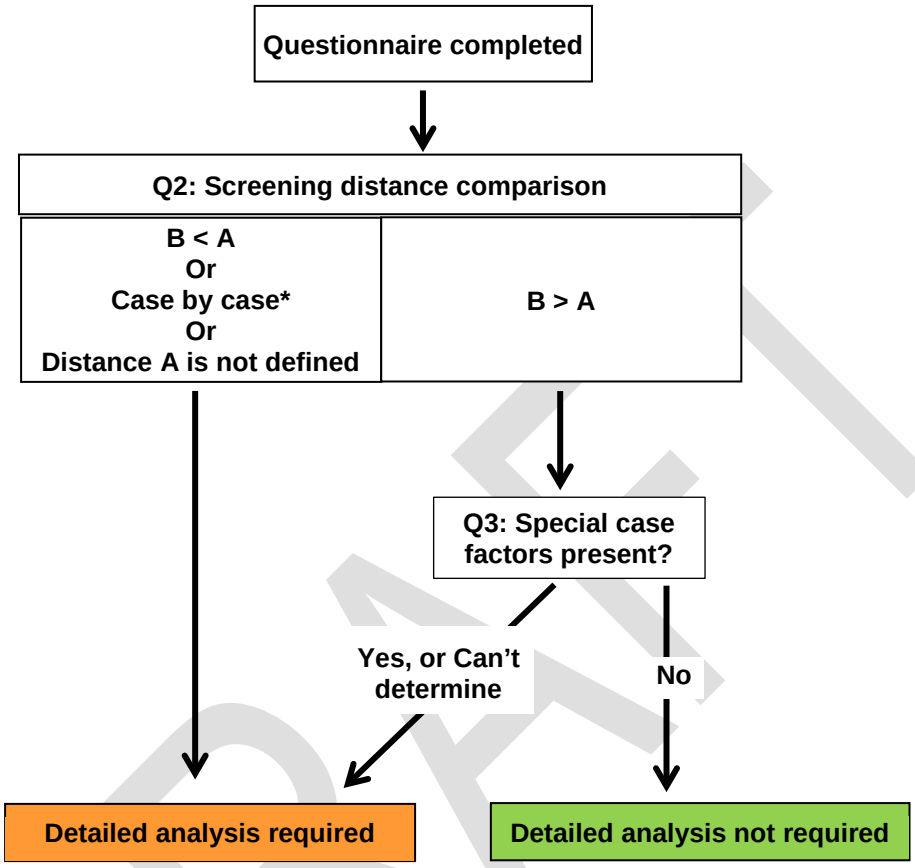
Q1. DESCRIPTION OF ODOUR EMISSIONS Provide succinct information about activities and sources that emit odour using the table below.	
Activity/ odour source	**Description** **Potential for offsite impact (Y/N) and justification**

Q2. SCREENING DISTANCE	
Screening distances for categories of odour-generating activities are identified in Appendix 2. Select the appropriate option from the list below.	
Option 1: The ***screening distance*** is listed in Appendix 2 for this industry category/throughput level. ***Screening distance*** (**A**) = _____ m ***Sensitive receptor distance*** (**B**) = _____ m **OR** **Option 2**: The ***screening distance*** for this industry category and throughput level is specified as case by case in Appendix 2. **OR** **Option 3**: There is no ***screening distance*** for this industry category in Appendix 2.	☐ **B < A**: Detailed analysis required ☐ **B ≥ A**: Go to Question 3 ☐ **Case by case**: Detailed analysis required ☐ **No *screening distance***: Detailed analysis required

Q3. SPECIAL CASE FACTORS	
Are there special case factors that might increase odour impacts beyond the ***screening distance*** shown in Question 2? Please tick the applicable special case factors: ☐ Cumulative impacts from other nearby sources ☐ Presence of an existing elevated odour background ☐ ***Complex terrain*** (see Glossary) ☐ Unusually large and/or complex facility when compared with other Western Australian operations ☐ Unusual configuration of odour sources or technology that does not conform to contemporary leading practice compared with other Western Australian operations	☐ **Yes** or **Can't determine:** Detailed analysis required **OR** ☐ **No:** Detailed analysis NOT required Justification should be provided to support the 'No' response.
Special case factors – justification	
Additional comments	

Step 2: Flowchart

The screening analysis result is determined by using the flowchart below and the responses to the questionnaire.



* As specified in Appendix 2.

SCREENING ANALYSIS FOR MODIFICATION OF EXISTING PREMISES

Step 1: Questionnaire

Q1. DESCRIPTION OF ODOUR EMISSIONS Provide succinct information about activities and sources that emit odour using the table below.	
Activity/ odour source	**Description – new source (Y/N)** **Potential for offsite impact (Y/N) and justification**

Q2. IDENTIFICATION OF CURRENT ODOUR IMPACTS	
Have odour impacts occurred as a result of the current operational configuration? (For example, as indicated by complaints.)	☐ **Yes** or **Can't determine:** Detailed analysis required
	☐ **No:** Go to Question 3

Q3. EMISSIONS FROM PROPOSED MODIFIED PREMISES	
Are the proposed modifications of the existing premises likely to increase the odour emission rate from any source in the facility?	☐ **No:** Detailed analysis NOT required
	☐ **Yes** or **Can't determine:** Go to Question 4

Q4. SCREENING DISTANCES

Screening distances for categories of odour-generating activities are identified in Appendix 2.

Select the appropriate options from the list below:

Option 1: The ***screening distance*** is listed in Appendix 2 for this industry category/throughput level. ***Screening distance*** (**A**) = _____ m ***Sensitive receptor distance*** (**B**) = _____ m	☐ **B < A**: Detailed analysis required ☐ **B ≥ A**: Go to Question 5
OR	
Option 2: The ***screening distance*** for this industry category and throughput level is specified as case by case in Appendix 2.	☐ **Case by case**: Detailed analysis required
OR	
Option 3: There is no ***screening distance*** for this industry category in Appendix 2.	☐ **No *screening distance***: Detailed analysis required

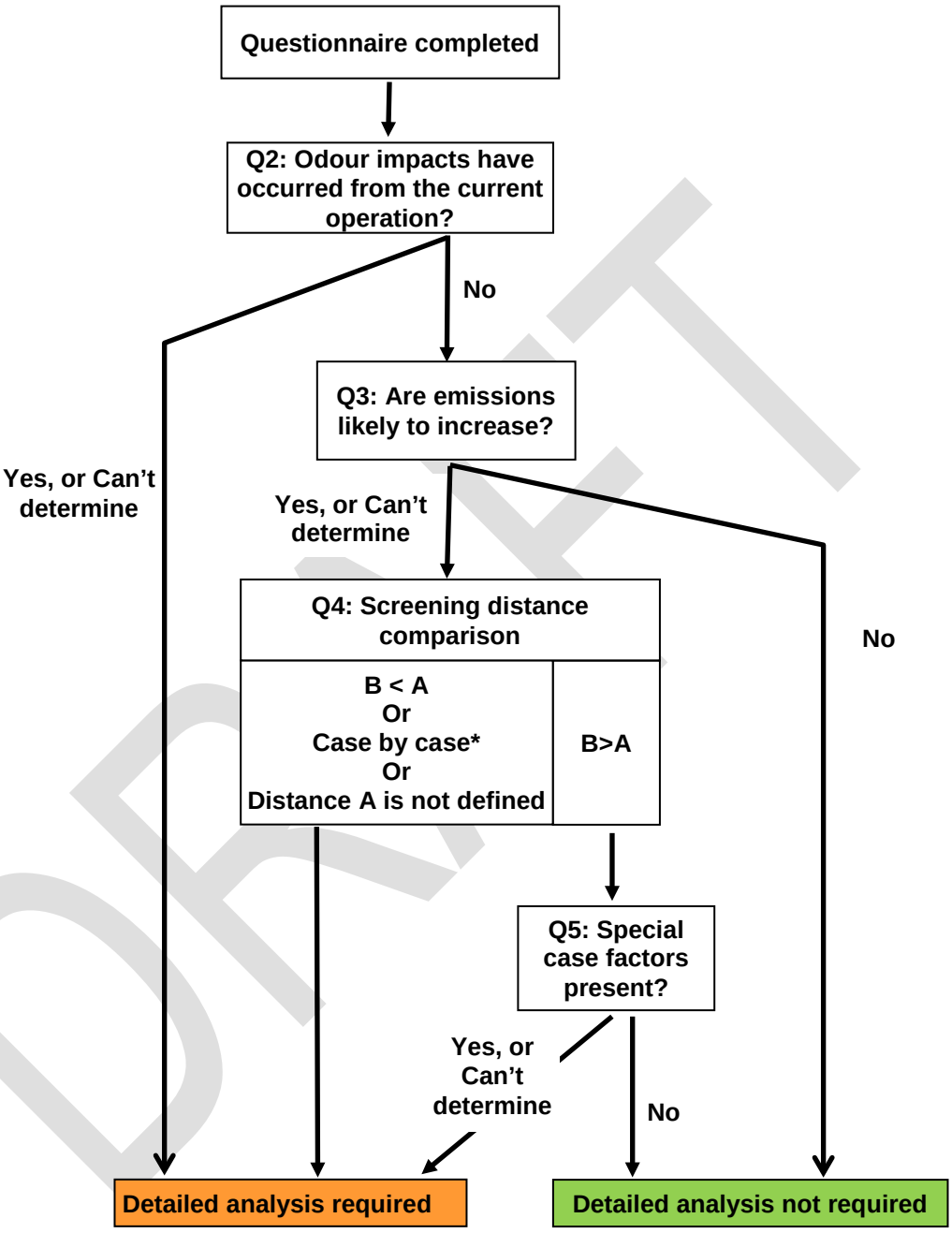
Q5. SPECIAL CASE FACTORS

Are there special case factors that might increase odour impacts beyond the ***screening distance*** shown in Question 2? Please tick the applicable special case factors: ☐ Cumulative impacts from other nearby sources ☐ Presence of an existing elevated odour background ☐ ***Complex terrain*** (see Glossary) ☐ Unusually large and/or complex facility when compared with other Western Australian operations ☐ Unusual configuration of odour sources or technology that does not conform to contemporary leading practice compared with other Western Australian operations	☐ **Yes** or **Can't determine**: Detailed analysis required **OR** ☐ **No**: Detailed analysis NOT required Justification should be provided to support the 'No' response

Special case factors – justification
Additional comments

Step 2: Flowchart

The screening analysis result is determined by using the flowchart below and the responses to the questionnaire.



* As specified in Appendix 2

Appendix 2— Odour screening distances

The ***screening distances*** in this Appendix are derived from previous established guidelines in Western Australia, other Australian guidelines, the experience of odour specialists and case studies from prescribed premises licensed by DWER in Western Australia.

The ***screening distances*** assume that the premises is operated in accordance with effective emissions control technology and best practice management.

In some cases, reference is made to S-factor equations. S-factor equations are used to determine ***screening distances*** in this guideline for some intensive livestock industries. The S-factor equations take into account livestock numbers and site factors including design and management, receptor type, topography or terrain, and vegetative cover.

For some categories, a 'case by case' in place of a ***screening distance*** is referred to. This may be related to the facility's size or complexity, the technology or feedstocks used, or other regulatory factors. A detailed analysis is needed in these instances.

Screening distances are not provided for some categories and in these instances applicants are required to undertake a detailed analysis.

Distances are measured according to the procedure in Appendix 5.

Category no. and description	Screening distance (metres)
1. **Cattle feedlot (500 animals or more)** *Premises on which the watering and feeding of cattle occurs, being premises —* *(a) situated less than 100 m from a watercourse; and* *(b) on which the number of cattle per hectare exceeds 50.*	S-factor equations Refer to *National guidelines for beef cattle feedlots in Australia* (Meat & Livestock Australia 2012) for S-factor approach
2. **Intensive piggery (1,000 animals or more)** *Premises on which pigs are fed, watered and housed in pens.*	S-factor equations Refer to **Level 1 only** of the *National Environmental Guidelines for Piggeries* (Australian Pork Limited 2010)
15. **Abattoir (1,000 tonnes or more per year)** *Premises on which animals are slaughtered.*	Without wastewater treatment ponds 500 With wastewater treatment ponds 1,000
16. **Rendering operations (100 tonnes or more per year)** *Premises on which substances from animal material are processed or extracted.*	1,000
17. **Milk processing (100 tonnes or more per year)** *Premises on which —* *(a) milk is separated or evaporated (other than a farm); or* *(b) evaporated or condensed milk, butter, ice cream, cheese or any other dairy product is manufactured,* *and from which liquid waste is or is to be discharged onto land or into waters.*	500

Category no. and description	Screening distance (metres)
18. **Food processing (200 tonnes or more per year)** *Premises (other than premises within category 24) —* *(a) on which vegetables are, or fruit or meat is, preserved, cooked, dried, canned, bottled or processed; and* *(b) from which liquid waste is or is to be discharged onto land or into waters.*	500
22. **Seafood processing (200 tonnes or more per year)** *Premises (other than a fish wholesaler) on which fish or other seafood is processed and from which liquid waste is or is to be discharged onto land or into waters.*	500
23. **Animal feed manufacturing (1,000 tonnes or more per year)** *Premises (other than premises within category 15 or 16) on which animal food is manufactured or processed.*	500
24. **Non-alcoholic beverage manufacturing (200 kL or more per year)** *Premises on which a non-alcoholic beverage is manufactured and from which liquid waste is or is to be discharged onto land or into waters*	500
25. **Alcoholic beverage manufacturing (350 kL or more per year)** *Premises on which an alcoholic beverage is manufactured and from which liquid waste is or is to be discharged onto land or into waters.*	500
31. **Chemical manufacturing (100 tonnes or more per year)** *Premises (other than premises within category 32) on which chemical products are manufactured by a chemical process.*	1,000
32. Pesticides manufacturing *Premises on which herbicides, insecticides or pesticides are manufactured by a chemical process.*	1,000
33. **Chemical blending or mixing (500 tonnes or more per year)** *Premises on which chemicals or chemical products are mixed, blended or packaged in a manner that causes or is likely to cause a discharge of waste into the environment.*	500
34. **Oil or gas refining** *Premises on which crude oil, condensate or gas is refined or processed.*	2,000
35. **Asphalt manufacturing** *Premises on which hot or cold mix asphalt is produced using crushed or ground rock aggregates mixed with bituminous or asphaltic materials for use at places or premises other than those premises.*	Small scale permanent plant (< 2 days/ week operation) 500 Other permanent plants 1,000 Mobile unit: case by case

Category no. and description	Screening distance (metres)
36. **Bitumen manufacturing** *Premises on which bitumen is mixed or prepared for use at places or premises other than those premises.*	1,000
38. **Coke production (100 tonnes or more per year)** *Premises on which coke is produced, quenched, cut, crushed or graded from coal or petroleum.*	2,000
39. **Chemical or oil recycling** *Premises on which waste liquid hydrocarbons or chemicals are refined, purified, reformed, separated or processed.*	1,000
41. **Clay brick or ceramic products manufacturing (1,000 tonnes or more per year)** *Premises on which refractory products, tiles, pipes or pottery are manufactured.*	500
43. **Cement or lime manufacturing** *Premises on which clay, lime sand or limestone material is used in a furnace or kiln in the production of cement clinker or lime.*	2,000
44. **Metal smelting or refining (1,000 tonnes or more per year)** *Premises on which metal ore, metal ore concentrate or metal waste is smelted, fused, roasted, refined or processed.*	Case by case
45. **Metal melting or casting (100 tonnes or more per year)** *Premises on which metal or scrap metal is melted in furnaces or cast.*	300
46. **Bauxite refining** *Premises (other than premises within paragraph (b) of category 5) on which alumina is produced from bauxite refining.*	Case by case
54. **Sewage facility (100 m^3 or more per day)** *Premises —* *(a) on which sewage is treated (excluding septic tanks); or* *(b) from which treated sewage is discharged onto land or into waters.* The following Department of Health reference may be of use to applicants in determining wastewater system loading rates: <http://ww2.health.wa.gov.au/Articles/S_T/Supplement-to-Regulation-29-and-Schedule-9-Wastewater-system-loading-rates>	(a) Plants serving a population > 20,000: case by case (b) Mechanical/biological based plants (e.g. using oxidation ditch technology): case by case (c) Aerated pond-based plants serving a population < 20,000, screening distance is: larger of 150 m and 15.8 $n^{0.4}$ where n is population served. (d) Facultative pond based plants serving a population < 5000, screening distance is: larger of 150 m and 3.3 $n^{0.66}$ where n is population served. (e) Reuse and irrigation schemes only: • spray irrigation 200 • other irrigation methods 50

Category no. and description	Screening distance (metres)
55. **Livestock sale yard or holding pen (10,000 animals or more per year)** *Premises on which live animals are held pending their sale, shipment or slaughter.*	1,000
61. **Liquid waste facility (100 tonnes or more per year)** *Premises on which liquid waste produced on other premises (other than sewerage waste) is stored, reprocessed, treated or irrigated.*	1,000
61A. **Solid waste facility (1,000 tonnes or more per year)** *Premises (other than premises within category 67A) on which solid waste produced on other premises is stored, reprocessed, treated, or discharged onto land.*	Stored, reprocessed or treated 500 Biosolids application areas 1,000
62. **Solid waste depot (500 tonnes or more per year)** *Premises on which waste is stored, or sorted, pending final disposal or re-use.*	200
64. **Class II or III putrescible landfill site (20 tonnes or more per year)** *Premises on which waste (as determined by reference to the waste type set out in the document entitled* Landfill waste classification and waste definitions 1996 *published by the chief executive officer and as amended from time to time) is accepted for burial.*	1,000
65. **Class IV secure landfill site** *Premises on which waste (as determined by reference to the waste type set out in the document entitled* Landfill waste classification and waste definitions 1996 *published by the chief executive officer and as amended from time to time) is accepted for burial.*	1,000
67A. **Compost manufacturing and soil blending (1,000 tonnes or more per year)** *Premises on which organic material (excluding silage) or waste is stored pending processing, mixing, drying or composting to produce commercial quantities of compost or blended soils* **NOTE: Proposed distances apply to compost manufacturing activity. If soil blending only, contact DWER.**	Outdoor uncovered — 2,500 for up to 35,000 tonnes/year 1,800 for up to 20,000 tonnes/year 1,300 for up to 12,000 tonnes/year 800 for up to 5,000 tonnes/year 400 up to 2,000 tonnes/year Above 35,000 tonnes/year, then case by case Outdoor covered, turned windrows — 2,200 for up to 50,000 tonnes/year 1,900 for up to 35,000 tonnes/year 1,500 for up to 20,000 tonnes/year 1,100 for up to 12,000 tonnes/year 650 for up to 5,000 tonnes/year 400 up to 2,000 tonnes/year Above 50,000 tonnes/year, then case by case

Category no. and description	Screening distance (metres)
	Outdoor covered windrows with continuous aeration – 1,600 for up to 50,000 tonnes/year 1,300 for up to 35,000 tonnes/year 1,100 for up to 20,000 tonnes/year 850 for up to 12,000 tonnes/year 600 for up to 5,000 tonnes/year 400 for up to 2,000 tonnes/year Above 50,000 tonnes/year, then case by case In-vessel or enclosed composting with odour control – 600 for up to 50,000 tonnes/year 550 for up to 35,000 tonnes/year 500 for up to 20,000 tonnes/year 430 for up to 12,000 tonnes/year 350 for up to 5,000 tonnes/year 300 for up to 2,000 tonnes/year Above 50,000 tonnes/year, then case by case
68. Cattle feedlot (500 animals or more) *Premises on which the watering and feeding of cattle occurs, being premises –* *(a) situated 100 m or more from a watercourse; and* *(b) on which the number of cattle per hectare exceeds 50*	S-factor equations Refer to *National guidelines for beef cattle feedlots in Australia* (Meat & Livestock Australia 2012) for S-factor approach.
69. Intensive piggery (more than 500 but less than 1,000 animals) *Premises on which pigs are fed, watered and housed in pens.*	S-factor equations Refer to **Level 1 only** of the *National environmental guidelines for piggeries* (Australian Pork Limited 2010)
72. Chemical manufacturing (not more than 100 tonnes per year) *Premises on which chemical products are manufactured by a chemical process.*	500
73. Bulk storage of chemicals etc. (1,000 m^3 in aggregate) *Premises on which acids, alkalis or chemicals that –* *(a) contain at least one carbon to carbon bond; and* *(b) are liquid at STP (standard temperature and pressure),* *are stored.*	300
74. Chemical blending or mixing causing discharge (more than 50 but less than 500 tonnes per year) *Premises on which chemicals or chemical products are mixed, blended or packaged in a manner that causes or is likely to cause a discharge of waste into the environment.*	300

Category no. and description	Screening distance (metres)
75. Chemical blending or mixing not causing discharge (5,000 tonnes or more per year) *Premises on which chemicals or chemical products are mixed, blended or packaged in a manner that does not cause or is not likely to cause discharge of waste into the environment.*	300
83. Fellmongering (1,000 skins or hides or more per year) *Premises on which animal skins or hides are dried, cured or stored.*	• Storing packaged wet-salted and unprocessed hides 250 • Other facilities 500
85. Sewage facility (more than 20 but less than 100 m^3 per day) Premises: *(a) on which sewage is treated (excluding septic tanks); or* *(b) from which treated sewage is discharged onto land or into waters*	(a) For sewage treatment plants 150 (b) Reuse and irrigation schemes only: • spray irrigation 200 • other irrigation methods 50

Appendix 3— Detailed analysis tools

This appendix provides further information on the detailed analysis tools listed in Table 1.

A3-1 Operational odour analysis

An operational odour analysis (OOA) is a document detailing operations at the premises that are likely to emit odour and how odour emissions are to be managed, including monitoring and corrective and contingency actions to minimise offsite odour impacts.

The preparation of an OOA is a mandatory component of a detailed analysis. The OOA demonstrates the applicant's understanding of potential odour sources at their premises and the ongoing management of odour.

An OOA:

- is primarily intended as a management tool for the applicant
- is risk-based and site-specific
- should include normal and foreseeable abnormal conditions
- may include outcome and/or management-based measures.

Some industries may have an existing tool which has similar content and achieves the same outcomes as an OOA. Such documentation may be submitted as part of the application in lieu of an OOA.

The required content of an OOA is provided in Table A3-1. Note that supporting information such as site detail maps and as-built drawings will need to be attached to the OOA.

Table A3-1: Required content of an operational odour analysis (OOA)

Odour emission operations review
Identification of all existing or proposed operations on the premises likely to emit odour. This review should consider normal and all foreseeable abnormal conditions (e.g. batch or continuous production, start-up, shut-down etc.).
Odour sources and emission conditions
Description of all odour sources associated with the existing or proposed operations for all operating conditions, including: • as-built dimensions, geometry and location of sources plotted to scale on a site detail map • estimation of frequency, levels and volumes of odour emissions for each source.
Process controls
Identification of process controls (mitigation, monitoring and management[1]) to be implemented for odour sources. Include details of the type and frequency of controls for each source for all normal operating conditions. Critical operational parameters should be selected for monitoring that: 1. Are indicative of process performance 2. Can be surrogate parameters[2] that are continuously monitored 3. Can be used to identify malfunctions that result in odour emissions (triggers)
Triggers and corrective actions
Specification of monitored parameters (operational and/or environmental)[3] that will be used to initiate corrective actions when pre-determined trigger levels are reached. Specification of corrective actions that are implemented in case of process malfunction that may lead to increased odour emissions. Their purpose is to bring the process back to normal operating conditions. This section should include: 1. A list of parameters adopted for the process 2. Details of the pre-determined trigger level(s) for each parameter 3. Details of the corrective actions to be implemented when a pre-determined trigger level is reached
Corrective action evaluation
Evaluation of each corrective action to assess its effectiveness in response to the issue which triggered it. Evaluation procedures should include: 1. Selection of the parameters to evaluate the effectiveness of corrective actions. These parameters may be the same or different to those specified in the **Process controls** and the **Triggers and corrective action** sections

2. The method to be used to monitor these parameters
3. The decision protocol that will be used to establish the necessary monitoring duration before:
   - resuming normal process operations (corrective action successful); or
   - pursuing contingency actions (corrective action not successful).

Contingency actions

Specification of contingency actions that will be implemented if corrective actions are not successful. These should include:

1. The actions to be taken with sequence of implementation
2. The decision protocol used to verify if normal operations can be resumed

Residual odour impact potential

The residual odour impact potential is a rating of low, medium, high or extreme, based on the likelihood and consequence of odour from operations impacting on sensitive receptors. The proposed controls, corrective and contingency actions, and information from the location review (Section 2 of this Appendix) need to be considered in the rating.

The residual odour impact potential should be rated by the applicant for each process, under both normal and foreseeable abnormal conditions.

The risk matrix in Appendix 2 of DWER's *Guidance statement: risk assessment* should be used for this assessment to provide a systematic framework for rating the impact potential.

[1] Controls may include specific actions/programs established by the applicant such as in-house sniffing patrols or odour assessment panels in the field.

[2] Operational parameters that are readily and continuously measured and better suited to detecting upset conditions than measuring odours directly.

[3] This may include onsite measurements (process parameters, odour surrogates, emissions) or odour monitoring on and offsite.

A sample OOA based on case studies is presented in Table A3-2.

Odour sources and their emission control options available will vary widely depending on the industry category and the types of processes involved. The OOA template allows for these different levels of management through the specification of both corrective and contingency actions for abnormal operating conditions. For some industries, management options may be more limited and the OOA will be less detailed as a result. Notwithstanding the type of operation, applicants should provide a clearly articulated and well-thought-out description of the controls to be implemented to mitigate the identified odour emissions.

An electronic template of the OOA is provided on the DWER website.

Table A3-2: Example of an operational odour analysis (OOA)

Odour emission operations review		Conditions
Batch production within a building		Normal[1]
Odour sources and emission conditions	• Building fugitive emissions – infrequent access to the building from a large door on the north-east facade during the batch (otherwise kept closed), possible large volume of odour emitted with a low intensity level (see site detail map and emissions details attached). • Building air treatment biofilter (see process flow chart and emission details attached). • Stack emissions post-production odour treatment unit during the batch operation (see stack configuration and emission details attached).	
Process controls	• Odorous air is extracted from the building and directed to the biofilter. • Building air temperature (T), relative humidity (RH) and backpressure (P) are continuously monitored at the biofilter air inlets. • The first stage of the production odour treatment unit is in operation (prior to stack emissions). • Compounds X and Y (surrogates) monitored in the stack with a Continuous Emission Monitoring System (CEMS). • Offsite odour monitoring is undertaken using an in-house odour panel following an internal odour Standard Operating Procedure (SOP) between one and two hours after the batch commences.	
Triggers and corrective actions	• If the concentration of compound X is above 5 mg/m^3 (trigger 1) then the second stage of the production odour treatment unit is activated. • If the inlet air temperature (T) is above 40ºC for more than 3 hours (trigger 2) or the relative humidity (RH) is below 85% for more than 3 hours (trigger 3), then the volumetric air flow rate at the biofilter inlet must be reduced by 20%. The expected outcomes of this corrective action are a decrease in the air temperature (T) and/or increase in the relative humidity (RH) under similar humidification conditions while maintaining the negative pressure within the building above 7 kPa.	

Triggers and corrective actions (cont.)	• If the offsite odour intensity level is above Level 2 of the in-house odour intensity scale for more than 30% of the measurement duration indicated in the internal SOP (trigger 4): - the second stage of the production odour treatment unit is activated - the air exchange rate within the building is increased which will increase the negative pressure within the building and limit offsite fugitive emissions - a site inspection is performed to identify any specific operations, actions or abnormal configurations that may be the source of the elevated odour emissions and consequent offsite impacts.
Corrective action evaluation	The corrective actions are effective if: • The monitoring of compound X concentration is consistently below 3 mg/m^3 within 30 minutes. • Compound Y (treated through the second stage of the production odour treatment unit and continuously measured post second stage) is consistently below 1 mg/m^3 within 30 minutes. • The inlet air temperature (T) is below 40ºC and/or the relative humidity is above 85% within the next 3 hours and these limits are maintained even under worst-case conditions (period of the day when ambient air temperature is the highest and ambient relative humidity is the lowest). • Offsite odour intensity levels are below Level 1 of the in-house odour intensity scale for more than 10% of the measurement duration indicated in the internal SOP.
Contingency actions	• If compound X concentration is above 3 mg/m^3 but below 8 mg/m^3 then emissions post second stage of the production odour treatment unit are to be diverted to the carbon filter. • The batch process shall be stopped following an internal SOP if any of the following conditions are encountered: - Compound X concentration is above 8 mg/m^3 - The biofilter inlet air temperature cannot be maintained below 40ºC and/or the relative humidity above 85% within the next 3 hours and under worst-case conditions (period of the day when ambient air temperature is the highest and ambient relative humidity is the lowest). In addition, air must not be directed to the biofilter to protect the bacterial population and the building must be isolated (no door opening). - The offsite odour intensity level is above the Level 2 of the in-house odour intensity scale for more than 30% of the measurement duration indicated in the internal SOP (under the current abnormal conditions) and no operations, actions or abnormal configurations have been identified onsite.

Residual odour impact potential			
Operation/odour source:	**Consequence:**	**Likelihood:**	**Impact potential:**
Batch production, normal operations	Minor	Rare to Unlikely	Low to Moderate

[1] A similar table may be required for some foreseeable abnormal conditions such as batch interruption.

A3-2 Location review

A location review considers the ***sensitive receptor distance***, the nature of receptors, local meteorology and topographical features. This review is a mandatory component of a detailed analysis.

If the screening analysis indicates that a detailed analysis is required, then one of the following situations applies:

- the ***sensitive receptor distance*** is less than the ***screening distance***
- the ***screening distance*** for the activity is to be determined on a case-by-case basis
- there is no ***screening distance*** for the activity in Appendix 2
- the ***screening distance*** has been met but there are special case factors present.

The ***sensitive receptor distance*** in relation to the ***screening distance*** is an important component of the odour impact potential of an activity and must be reported. The sensitivity of receptors may be also considered by DWER in its assessment of odour impact risk. Accordingly, the nature of each receptor in the vicinity of the proposed works must be explicitly identified. The location review should include a map showing the receptors' location in relation to the activity and the ***screening distance*** for the activity. Electronic copies of Google Earth (.kmz files or similar) or inclusion of a map in the report that includes the activity boundary or, at a minimum, markers for the activity and receptor locations are useful for DWER's assessment.

If a ***screening distance*** is defined as 'case by case' or if the activity is not included in Appendix 2, the applicant may include a comparison with separation distances from other published guidance for similar activities.

The location review must also include information on local meteorology and topography, which can have important implications for how odour emissions disperse over adjacent areas. For example, valleys can channel air flows from a source towards a receptor location. At a minimum, the location review should include a topographical map along with wind roses showing long-term wind data from the nearest Bureau of Meteorology (BoM) or DWER monitoring station, with commentary on the potential for complex topographical and meteorological effects. Wind roses showing 9am and 3pm average conditions only are not acceptable.

A3-3 Odour field assessment

An odour field assessment (OFA) is a program of targeted field surveys and analysis designed to characterise ambient odour levels for new premises and modification of existing premises.

For existing premises, ambient odour levels from the premises and from other potential sources are measured at specific locations during specific meteorological and operational conditions prior to the proposed changes at the premises. For new premises, cumulative odour impacts from other potential sources in the vicinity of the future location of the premises are measured.

For both existing and new premises, odour surveys post-commissioning can be carried out for odour management purpose. Outcomes of the surveys carried out pre-commissioning can be used as benchmarks against outcomes of similar surveys post-commissioning to assess if the odour background has changed between the two surveys due to the modified or new premises.

Essential components of OFAs include clearly established objectives, a review of operational conditions and associated odour emissions (for existing premises), review of meteorological conditions, odour field survey implementation and an analysis of the survey results.

The odour field surveys are undertaken using trained odour panellists who record odour levels at specific locations following a strict methodology. Several surveys typically occur over several days and the duration and number of surveys are chosen according to the purpose of the assessment. Odour field surveys can also assist in determining which odour sources most affect a community where the odour characteristics differ sufficiently for odour panellists to confidently distinguish between them in the field.

OFAs carried out for works approval and licensing purposes are typically based on odour plume measurement protocols with assessment of the intensity and character of ambient odours at locations downwind of premises.

OFAs can be an effective odour monitoring and management tool, provided the design and execution adhere to strict protocols, enabling reliable comparisons between analyses to be made over time.

Further information is provided in the published standards referenced in this section.

Odour field survey standards

Australian standards have not yet been developed for odour field surveys. The following European and German standards are widely referred to in this context, are current practice in Western Australia and other Australian jurisdictions and are presented in order of relevance:

- **European standard EN 16841-2:2016** *Ambient Air – Determination of odour in ambient air by using field inspection – Part 2: Plume method*.

  This standard constitutes the primary reference for plume measurement campaigns and replaces the former German standard VDI 3940-2:2006. The stationary plume method in the European standard is preferred due to the experience gained with this method in Western Australia during the past 15

years using the former German standard. A new method (dynamic plume method) is included in the European standard and will also be accepted. However, this new method requires very specific experience and reporting is expected to clearly justify the use of this method as well as the outcomes and limitations associated with the results.

Note that sections of the European standard relating to reverse calculation of source emission rates from field survey results are not supported owing to the large associated uncertainties.

- **German standard VDI 3940-3:2010** *Measurement of odour impact by field inspection – Determination of odour intensity and hedonic tone.*

  This standard is for the measurement of odour intensity and hedonic odour tone in the ambient air (field environment).

  Note that for works approvals and licensing applications, odour intensity measurement must be applied in parallel with plume measurements.

- **European standard EN 16841-1:2016** *Ambient Air – Determination of odour in ambient air by using field inspection – Part 1: Grid method.*

  This standard is for the measurement of the frequency of odour impact in the vicinity of industrial premises. It replaces the former German standard VDI 3940-1:2006.

  Note that limit values from this standard and the German *Guideline on odour in ambient air* (GOAA 2003) (e.g. 10% 'odour hours') have not been demonstrated to be applicable to Western Australian conditions. As such, these values must not be used to measure odour impact extent for works approvals and licensing applications.

Important notes – methods:

1. The odour intensity scale used for field odour assessment includes a descriptor and a number that are common to both the intensity measurements for field assessments (VDI 3940-3:2010) and for intensity measurements under laboratory conditions (VDI 3882-1:1992). DWER requires that **German standard VDI 3940-3:2010** be used to record odour intensity levels under field conditions. According to this standard, an intensity level of 1 or above is selected if the recognition threshold in the field is reached or exceeded. This means that the odour being assessed is 'clearly recognisable', assigned an odour quality and there is no uncertainty or guessing involved.
2. Section 1.1 'Objective' of the **German standard VDI 3940-3:2010** clearly states that '*under field conditions, it is possible to determine the odour intensity in the ambient air at a specific location, but not the associated odorant concentration and the intensity curve as a function of the odorant concentration*'. Weber-Fechner or Stevens laws must not be used to convert odour intensities recorded by an odour panellist in the field to odour concentrations.

Important notes – interpretation and limitations:

1. Where 'distinct' or stronger odour intensity levels (according to German standard VDI 3940-3) are detected at or close to sensitive receptors, DWER will rate the odour impact risk as 'medium' or higher.
2. While field surveys are useful for confirming the presence of odour impacts offsite, they should not be relied on to demonstrate the absence of impacts. It may simply be the case that at the time of the survey, the emission or meteorological conditions conducive to impacts were absent or the measurement location was not within the odour plume.
3. The more limited the field surveys are, in terms of time and resources allocated, the more difficult it is to reliably infer the extent of the odour impact footprint of a premises or other nearby sources.
4. Averaging of the odour intensity levels among the odour panellists for a single measurement is not permitted; odour measurements should be treated as unique at each measurement point.

Odour field assessment using plume measurement

OFAs incorporating plume measurement comprise five steps as discussed below. These OFAs begin with establishing clear objectives and end with the analysis and reporting of results and outcomes, as per the recommendations of the EN 16841-2:2016 standard.

***Step 1:** Defining the odour field assessment objective*

Clear assessment objectives should be defined before undertaking an OFA. Typical issues requiring consideration include the factors that triggered the request for the field assessment and the expected outcomes.

***Step 2**: Process management and environment review*

Before undertaking an OFA for an application to modify an existing premises, the following steps should be considered:

- Have a thorough understanding of the facility processes and gather information regarding odour impact history and the local environment including meteorology and topography.
- Examine details of past process upset occurrences, management practices, number and type of existing odour sources, frequency (time cycle) of emissions and their odour emission rates (OERs) (if available).
- Identify all proposed new or modified odour sources and for each of these estimate the frequency, levels (including peaks) and volumes of odour emissions and potential areas of impact.
- Identify nearby odour sources for the assessment of potential cumulative impacts.

For new premises, the following steps should be considered:

- Collect information on the local environment including meteorology and topography.
- Predict (based on sensitive receptor location and meteorological conditions) the areas where potential emissions will more likely impact once the premises is operational, if it is intended to perform post-commissioning field surveys.
- Identify nearby odour sources for the assessment of potential cumulative impacts.

***Step 3**: Odour field assessment strategy*

Effective OFAs require well-designed strategies that include:

- Identification of factors that are relevant to odour plume impacts at locations of interest. These should include prevailing wind directions, specific terrain features and locations of sensitive receptors and complainants. Wind patterns should be selected with consideration of annual and seasonal influences.
- For existing premises, identification of the process, management and logistical factors that are associated with odour emissions at the premises, and selection of operational conditions to perform field surveys.
- Selection of the areas to be surveyed with reference to the meteorological and operational conditions (including source types) and reconnaissance of these areas for safety and practicability reasons. This step includes pre-location of the measurement points.
- Specification of field survey duration, with reference to the OFA objectives and the meteorological and operational conditions.
- Identification of the minimum number of panellists required for the OFA.
- Development of the procedures to select, train and communicate with panellists.
- Documentation of any deviations from the EN 16841-2 and VDI 3940-3 standards.

***Step 4**: Field survey implementation*

Surveys must be implemented under the supervision of an experienced field operator and follow the assessment strategy previously established. For existing premises, unplanned process conditions that occur at the premises must be recorded. For existing and new premises, unplanned events occurring in the field during the surveys must be recorded. Any impacts of these events on the results must be identified and reported.

***Step 5**: Data analysis and reporting*

OFA results may be reported in various formats depending on the assessment objective. However, as a minimum, the following should be reported:

- the objective of the assessment

- the measurement strategy, measurement conditions and field survey standards followed
- field survey panellist identification and single measurement locations
- odour intensity levels recorded at each measurement point during each single measurement
- odour characters recorded at each measurement point during each single measurement
- the time of each single measurement
- a map depicting the assessment area, odour sources associated with the premises (for existing facility) and other odour sources
- the wind speed and direction for each single measurement
- any deviation from the conditions targeted in the OFA strategy and those occurring during the measurement (conclusions should reflect the influence of such deviations on the results)
- detailed analysis, interpretation and conclusions with regard to the objectives of the assessment.

A useful visual depiction of results is maps of the survey area with each single measurement superimposed as a pie chart at the measurement point, showing for each panellist the various odour intensity levels as a percentage of the single measurement.

Management strategies using plume measurement

Plume measurement campaigns may be used to assess odour impacts before and after modifications to existing premises or the construction of a new premises. This approach may aid odour management strategies by providing:

- an understanding of the odour impacts of an existing premises before and after modifications
- an understanding of the contributions to odour impacts from other nearby odour sources to the cumulative odour footprint and their contribution to the cumulative odour footprint post-commissioning
- a benchmark against which ongoing performance of a new or modified premises may be measured.

A3-4 Complaints data analysis

Complaints data analysis is the assessment of odour complaints made in the vicinity of a proposed or existing premises. The analysis can help identify likely odour sources in the area, the typical odour characters and level of amenity impact. Such analysis can also be used as a benchmark against which ongoing performance of a new or modified premises may be measured.

Complaints data may be held by the applicant or may be available from DWER, local councils or nearby premises. The absence of complaints does not necessarily indicate the absence of an odour problem.

The presence of odour complaints from a community in the vicinity of an odour source may indicate an unreasonable level of ambient odour. However, caution must be applied in interpreting complaints data as several factors may influence complainant behaviour, and odour impact extents inferred from these data may be either over or underestimated.

In the case of applications for changes to existing premises, the number and details of odour complaints received (attributable to the premises) and the actions taken by the occupier in response to those complaints, must be considered for both screening and detailed analyses.

DWER may refer to its internal complaints databases and other sources of information when reviewing applications for both new and existing premises.

Reporting of complaints data analyses should include:

- details of how the data were obtained
- a data summary showing the number of complainants, the total number of complaints and the dates and times complaints were made
- details of odour source verification and actions taken in response to complaints
- discussion of the odour characteristics reported, likely odour sources and the meteorological conditions at the time of complaints
- a map showing the location of odour complaints and potential sources in the area.

A3-5 Community survey and diary study analysis

Community telephone or door-to-door surveys and diary studies can provide valuable information regarding the level and extent of odour impacts from existing sources. Surveys and diary studies may show whether odours at a site have altered over time and can be used to gauge the level of community dissatisfaction with previous odour episodes. Surveys and diary studies can also capture information regarding odour episodes that did not trigger the lodging of complaints.

The design, execution and analysis of surveys require highly specialised knowledge, and must be undertaken by those with demonstrated expertise in this area. Caution must be applied in designing survey questionnaires and interpreting results, as responses requiring memory recall may result in oversights. In general, it is easier for community members to identify changes in odour intensity levels and frequencies over time as opposed to providing accurate details regarding impact frequencies and levels.

Surveys should have a clearly defined purpose and be undertaken over a short timespan to limit opportunities for community members to share their responses which can bias the survey. The guarantee of the anonymity of respondents is an important principle to encourage participation in the survey.

Reporting of community survey and diary study analyses should include:

- qualifications and experience of the person(s) designing, conducting and reporting on the survey or diary study

- details of the survey or diary study plan including purpose, methods, target population and timeframes
- a copy of the survey questionnaire or instructions provided to diarists
- a copy of the raw survey/diary data
- interpretation of the survey/diary results
- conclusions.

A3-6 Odour source assessment

An odour source assessment (OSA) is a program of targeted source sampling and analysis designed to characterise odour sources at an existing premises.

For an existing premises, an OSA can obtain odour emission rates (OERs) for specific sources that will be modified or impacted by the proposed modifications. These OERs may be used in relative modelling to test various scenarios or as a benchmark against which post-commissioning OERs will be compared, or to establish a source hierarchy at the facility to identify odour mitigation priorities.

For a new premises, an OSA can be implemented to obtain OERs for sources at another facility that have been assessed as being representative of sources at the new premises. OERs can also be established post-commissioning for odour source management purposes including ongoing performance verification.

Further information is provided in the published standards referenced in this section.

Odour source assessment steps

Procedures for the identification of major odour sources and for developing effective sampling strategies are described below. Applicants may wish to seek DWER's advice for source assessment at large and complex sites.

***Step 1**: Assessment objectives*

The setting of clear objectives for a source assessment is an essential first step when identifying sources for sampling.

When defining these objectives consideration should be given to:

- The factors that triggered the requirement for the odour source assessment, for example to support an operational odour analysis (OOA), and how the source assessment will assist addressing these factors.
- Whether characteristics of any offsite impacts (e.g. frequency, timing and/or odour character) may aid in identification of particular odour sources at a facility that will require detailed investigation during the OSA.

***Step 2**: Process and management review*

The identification of significant odour sources on a premises requires a thorough understanding of all operations and processes. To achieve this, discussions with operations staff and a review of each of the processes are essential.

Important elements of this step include identifying:

- the main odour- generating processes at the facility
- the inputs and outputs of these processes
- the levels and frequency of emissions from sources within these processes
- changes in emissions due to upset conditions or process failure
- contingency plans and management responses for upset conditions or process failure.

***Step 3**: Odour sampling strategy*

The design of the OSA sampling strategy should be based on the objectives of the assessment and should include:

- the expected outcomes of the assessment
- the steps required to achieve those outcomes
- any limitations of the strategy and their impact on the assessment outcomes.

The strategy should also detail:

- which sources are to be sampled
- how those sources will be sampled (sampling devices, monitoring locations)
- the sampling duration and chronology
- number of samples and duplicates to be taken
- key process conditions that influence emission rates
- meteorological conditions under which the sample should be collected (if any)
- a brief justification for each of these strategy details.

At a minimum, sampling strategies for batch processes should ensure that peak emission conditions are captured and/or emission conditions that have been identified as being responsible for adverse impacts on amenity. Where multiple similar odour sources are present, odour concentration and flowrate measurements for one suitably representative source may be sufficient to characterise all sources.

Sampling strategies may be unavoidably constrained by various factors. Any constraints encountered that have influenced the adopted sampling strategy or outcomes must be documented.

***Step 4**: Odour sampling – standards and minimum requirements*

a. Standards

Unless specified otherwise, odour sampling and concentration analysis should be undertaken in accordance with:

- AS/NZS 4323.1:1995 *Stationary source emissions – Selection of sampling positions*; and
- AS/NZS 4323.3:2001 *Stationary source emissions – Determination of odour concentration by dynamic olfactometry*.

The use of the AS/NZS 4323.4:2009 *Stationary source emissions – Method 4: Area source sampling – Flux chamber technique* for determining emission rates of area sources is not supported. The German standard VDI 3880:2011 *Olfactometry static sampling* is the recommended standard for area source sampling.

Deviation from standard sampling and analysis protocols is occasionally unavoidable. Any deviations should be recorded and their impacts on results discussed in the assessment report.

b. Sampling duration and process conditions

The choice of sampling time generally depends on source geometry and/or accessibility, process characteristics (for example, intermittent, batch or continuous emissions) and meteorological conditions. Selected sampling times should be documented and justified in the sampling strategy with actual sampling times (and reasons for any variations) detailed in the assessment report.

Depending on the assessment objectives, OSAs may require sampling of several emission scenarios, including normal operating conditions, plant start-ups and shut-downs, maintenance events and upset conditions.

c. Sampling of pipes and ducts

The sampling of underpressure or overpressure pipes and ducts should be performed as described below. In either case, the sampling procedure must ensure that:

- there is no condensation or captured particles in the sample bag
- sample gas streams do not pass directly through the pump to avoid contamination.

When sampling an overpressure pipe or duct, the sample bag is to be filled using the pressure of the source gas stream. A restriction on the flow rate (for example, at a critical orifice) may be necessary to achieve a sufficiently long sampling period.

When sampling an underpressure pipe or duct, the empty sample bag is to be located inside a sealed container. The pressure in the container is subsequently reduced by a pump such that the odorous air sample is drawn into the bag (lung principle).

d. Pre-dilution

Pre-dilution of samples must be performed with a dry neutral gas that is odourless and safe for breathing such as air (from a pressured cylinder) or nitrogen. Pre-dilution may be necessary to:

- avoid condensation in the sample bag, which can affect sample integrity and contaminate the olfactometer
- cool the air stream before entering the sampling bag or container
- dilute and adjust sample concentrations to be within the operating range of a particular dynamic olfactometer.

Static and dynamic pre-dilution must be performed in accordance with AS/NZS 4323.3:2001; these techniques are also discussed in VDI 3880:2011.

e. Filtration

Filtering of sampled air may reduce odour levels as any odorous compounds adsorbed on the filtered particles will be removed at the same time. For this reason, filtering should be avoided if possible. On the other hand, particles can contaminate the olfactometer. As a result, filtration remains an option when sampling a gas stream with a significant particle concentration as indicated in AS/NZS 4323.3:2001. Any filtration used during sampling should be reported together with a discussion of the degree to which the filtration may have affected the reported odour concentrations.

f. Number of samples

It is recommended that a minimum of two consecutive samples is taken from each odour source or source category and unique sampling location.

For area or volume sources, a single composite sample containing air collected from multiple locations over the source is allowed.

g. Sample transport and storage

Samples must be kept in containers that guarantee the mechanical integrity of the sample bag and be stored under conditions that prevent sample deterioration by exposure to low or high temperature and light (especially sunlight). Variation of ambient pressure should be avoided and it is recommended to use air-tight containers to transport samples by air. AS/NZS 4323.3:2001 requires that the analysis is performed as soon as possible and within 30 hours of collection. DWER strongly recommends samples be analysed within 6 hours of collection. This shorter time is in line with recent trends in Europe (e.g. VDI 3880:2011) and recognises that odorous compounds in samples degrade significantly with time.

Where remote or isolated area sampling precludes analysis within 6 hours, DWER expects the impacts of delayed olfactometry on concentration measurements to be discussed. Ideally, the extent of odour concentration decay with time should be established empirically. DWER recommends that this is done following the methodology in VDI 3880:2011 *Olfactometry static sampling*.

***Step 5**: Emission rate measurements and calculation*

Procedures for measurement of emissions and calculation of emission rates from various types of odour source are outlined below.

a. Point source emission measurement

Emissions that emanate from a small opening such as a stack or a vent are conventionally referred to as point source emissions. Methods used for sampling point sources and measuring fluxes may also be applied where no emissions to the atmosphere are present, such as in ducts connecting two pieces of equipment to assess control efficiency.

Odour emission rates (OERs) for point sources are calculated by multiplying the exhaust gas odour concentration (OC) in odour units (ou) by the volumetric flow rate Q (in m^3/s); OER is expressed in $ou.m^3/s$. The flow rate is obtained from velocity measurements made in accordance with a standard method, such as USEPA Method 2. The calculation of the OER is detailed in Appendix G of the AS 4323.3.2001.

$$OER = Q.OC$$

Important note*:*

The odour emission rate calculations must be reported with uncertainties related to the sample concentration (from sampling through to the measurement of the odour concentration) and flow rates.

b. Volume source emission measurement

The term volume source refers to a fully or partially enclosed structure such as a building from which odorous air escapes through openings which may not have well-defined geometry.

Sampling and flow-rate measurements

The sampling strategy for an enclosed structure depends on the geometry of the structure, the number and types of openings and the air flow patterns within and through the structure. The number of samples required and the sampling locations depend on various factors including air inlet and outlet locations and wind directions. When well-defined outlets can be identified and safely accessed, it is recommended that sampling and flow-rate measurements be undertaken at these outlets. Sampling at identified inlets should also be carried out if it is likely that the inlet air is already odorous.

When well-defined outlets are not present or are not able to be safely accessed, an alternative procedure involves calculation of the odour concentration of the air escaping the structure using an average concentration of simultaneous measurements at various interior locations. Where interior locations are generally inaccessible, a conservative estimate of the odour concentration may be arrived at by assuming that the average concentration measurement of the most odorous locations applies to the entire volume. All details of this estimation process must be provided in the report.

The exit flow rate Q (m^3/s) from an enclosed structure (required to complete the OER calculation) may be difficult to determine. A simple method involves a grid of velocity measurements across main exit points or vents. The Q value for each outlet can be estimated from the average velocity v (m/s) across the outlet area A (m^2). Large uncertainty is attached to this value owing to the potential variations of the velocity across the outlet area during the time required for the grid velocity measurements. The average exit flow rate Q may then be calculated according to:

$$Q = vA$$

Alternatively, Q can be estimated from the air exchange rate (*AER*) within the structure. The AER is the number of times the air in the volume source is renewed per unit time. Q is calculated from the product of the *AER* and the building volume V (m^3). For example (assuming no significant dead-zones or accumulation):

- for a building of volume 5,000 m^3; and
- an *AER* of 6/h (i.e. 6 complete air changes per hour)
- the air flow rate Q (m^3/h) through the building can be calculated from:

  $Q = AER$. V = 6/h x 5,000 m^3 = 30,000 m^3/h

The AER may be determined by various methods including monitoring changes in concentration of a tracer gas. This method is recommended for naturally ventilated structures without clearly defined outlets for odorous air as referenced in VDI 3880:2011.

When designing the sampling methodology, consideration should be given to the fact that building ventilation rates may depend on the speed and direction of prevailing winds.

The methodology selected to assess the exit flow rate from an enclosed structure must be detailed in the assessment report, including an estimate of individual and total uncertainties.

OER calculation

From estimates of the exit flow rate *Q* and odour concentration *OC* the OER ($ou.m^3/s$) can be calculated from:

$$OER = Q.OC$$

c. Area source emission measurement

Important note*:*

Although standards exist for surface sampling of area sources, there are numerous measurement issues which have not been resolved despite substantial international research efforts. These issues are related to both the type of equipment used and the source itself, and result in high levels of uncertainty.

Consequently, characterisation of area source emission rates via surface sampling is not recommended unless there is clearly identified value in so doing. If implemented, detailed information should be provided on the configuration of the sampling device, the reason for its choice and operational conditions under which the sample was collected.

The use of the AS/NZS 4323.4:2009 *Stationary source emissions – Method 4: Area source sampling – Flux chamber technique* for determining emission rates of area sources is not supported.

Area sources are liquid or solid surfaces which emit odours and can be classified as active or passive, depending on the gas flow velocity across the surface. VDI 3880:2011 defines these as:

- passive surfaces if the gas flow velocities are less than 30 metres/hour such as ponds, landfill cells, tailings storage facilities and open livestock pads
- active surfaces if the gas flow velocities are greater than 30 metres/hour such as aerated ponds, forced ventilated compost windrows and biofilters.

Emissions from area sources depend on a number of environmental factors including the atmospheric temperature, pressure, relative humidity, wind speed and direction, as well as the temperature, composition, viscosity, and volatility of the surface.

Sampling, flow-rate measurements and OER calculation

Area source sampling devices commonly used include:

- wind tunnels

- isolation flux-hoods (also called isolation flux chambers)
- sampling hoods for active sources (also called 'witch's hats')
- equilibrium chambers.

Isolation flux-hoods generally underestimate passive area-source emission rates compared with wind tunnel devices. Wind tunnel devices are preferred for sampling passive surfaces. 'Witch's hats' or wind tunnel devices are preferred for sampling aerated (active) surfaces. The choice of sampling methodology adopted must be justified in the assessment report. As indicated in Step 4, the use of the AS/NZS 4323.4:2009 *Stationary source emissions – Method 4: Area source sampling – Flux chamber technique* for area source emissions measurement is not supported.

The specific odour emission rate (SOER) is defined as the quantity of odour emitted per unit surface area per unit time (units: ou.m^3/s/m^2). It can be calculated from the sampling device footprint area and the sweep air flow rate. The total OER (ou.m^3/s) for an area source is calculated by multiplying the SOER by the surface area A (m^2) of the source:

$$OER = SOER \,.\, A$$

Care must be taken to ensure that SOERs are representative of the whole surface. Odour emissions are affected by factors such as effluent flow rates, turbulence, temperature and composition that generally vary across the surface. Heterogeneities over both the micro-scale (footprint of the hood) and the macro-scale (the entire surface) can be significant. An effluent pond SOER close to the inlet (where fast-moving, highly turbulent and untreated effluent is exposed) may be much higher than near the outlet (slow-moving, treated effluent). Windrows may also emit unevenly across their surfaces with emission rates at the crest being higher than those of the mound sides.

Temporal and spatial variations may occur at some sources which are difficult to characterise. Such variability can be dealt with either by adopting conservative emission rates based on worst-case measurements or undertaking composite measurements.

These additional considerations apply to the following types of area sources:

Liquid surfaces: a sampling program should consider the following source characteristics:

- flow patterns (i.e. fast- and slow-motion zones)
- inlet and outlet locations
- gradients of temperature across the surface
- aerated or non-aerated zones
- presence of foam, sludge or other material that may be carried along with the sweeping air into the sampling tube and bag causing contamination.

Management and production cycles should be reviewed to capture key information regarding flow rates and chemical loads.

Active surfaces: DWER recommends the methodology in Section 5.2.2 of VDI 3880:2011 be used for estimation of emission rates of active surfaces. This section

provides strategies and methods for sampling such sources, including the number of individual areas to be sampled and calculation of an OER for the whole surface.

Windrow emissions are generally highest when the windrows are first formed, turned or collapsed at the fermentation phase of the composting process. Sampling programs should aim to characterise these peak emissions periods.

Passive surfaces: For large sources such as extensive ponds or landfill cells, variations in emissions are more difficult to identify and therefore more difficult to characterise using traditional methods. Alternative methods may be used but must be sufficiently documented for DWER to assess the method's reliability.

d. Emissions measurement of other source types

Sources with fugitive emissions

Sources with fugitive odour emissions generally have no specific geometry or configuration from which sampling and flow-rate measurements may easily be undertaken and their emissions points may be difficult to identify. Fugitive emissions may arise from leaks in plant equipment (valves, flanges, pump seals) or activities such as shredding, grinding, turning or disturbing odorous material and the loading of trucks. It should be noted that emissions from area and volume sources are sometimes referred to as fugitive emissions. However, in this document these source types are considered separately as described above.

No published standards or guidelines for sampling fugitive emissions are available at present. However, techniques for characterising fugitive source emissions include:

- direct sampling of odour (using appropriate equipment such as temporary enclosures)
- plume sampling close to source
- estimation of likely OER based on process calculations.

Large uncertainties are associated with such fugitive OER estimates.

Spray drift odour emissions

Methods do not currently exist for reliably quantifying OERs from activities involving spray drift. Odour impact assessments dependent on OER estimates from spray drift will not be accepted.

Landfill odour emissions

Landfill emission rates may be highly variable both temporally and spatially across the active faces and capped cell surfaces, depending on factors such as management practices, type of waste delivered, weather patterns and capping material. These factors contribute to landfill odour emission rates and are very difficult to reliably quantify. Odour impact assessments dependent on OERs estimates from landfill active faces will not be accepted.

***Step 6**: Odour source assessment reporting*

Odour source assessment reports should document the following:

a. Assessment objective and outputs

- The objective of an odour source assessment must be clearly defined.

b. Odour source assessment strategy

- Documentation of all significant odour sources, their OERs and the reasons for excluding any odour sources from the assessment.
- Diagrams clearly illustrating the location of the sources within the premises boundary.
- An odour source information summary with details on the sources and the sampling strategy (see Table A3-3); this should detail why specific plant operating conditions were selected to characterise source OERs in support of the assessment objectives.

An electronic template of the source information summary table is available on the DWER website.

Table A3-3: Source information summary

Description of the source/reference/location (map attached)	
Type of source	
Dimensions	
Elevation	
Expected sampling conditions (source or process attached to the source)	
Actual sampling conditions (source or process attached to the source)	
Sampling strategy/ sample location and equipment used	
Number of samples	
Identification of the odour samples	
Sampling times	
Pre-dilution factor at the sampling stage	
Any deviation from AS/NZS 4323.3:2001 or other standards adopted	

c. Sample analysis

A summary of the odour concentration measurements (see Table A3-4) should be provided with supporting documentation including all laboratory analysis reports.

Table A3-4: Sample analysis

Location and time of the measurement	
Static pre-dilution factor prior to any measurement	
Number of panellists	
Average panel odour detection threshold	
Odour concentration of the air emitted at the source (after considering any pre-dilution factors)	
Odour laboratory repeatability and accuracy	
Uncertainty (upper and lower limits)	
Any comment on limitations on the results or deviation from AS/NZS 4323.3:2001	

d. Interpretation of results and conclusions

The outcomes of the odour source assessment must be detailed and interpretations and conclusions must be discussed with reference to the objectives of the assessment.

Any deviations between the operational conditions targeted in the sampling strategy and the conditions at the time of the measurements must be provided. Conclusions must reflect the influence of such deviations on the results.

A3-7 Relative dispersion modelling

Relative dispersion modelling refers to the comparison of two or more modelling scenarios (e.g. using different pollution control equipment) without specific reference to air emission criteria. Relative modelling may be used in the context of odour impact assessments where changes in emission rates resulting from proposed changes to an existing facility can be reliably characterised. Relative modelling may also assist applicants to identify which odour sources on a site with multiple sources are best controlled, configured or managed to most cost-effectively limit impacts. The odour emission rate calculations must be reported with uncertainties related to the sample concentration (from sampling through to the measurement of the odour concentration) and flow rates.

Important note:

So-called 'criterion modelling' that compares the predicted concentrations at sensitive receptor locations against regulatory criteria is not accepted for odour impact assessment purposes owing to the large associated uncertainties.

Applicants should be aware of the usual requirements for dispersion modelling as specified in DWER's *Air quality modelling guidance notes*. This modelling guidance should be followed to the extent that it applies to odour modelling. Note that the modelling guidance is subject to change from time to time and applicants are advised to refer to the most current version available on the DWER website.

Modelling percentile

DWER recommends that 99.5th percentile concentrations be reported for relative dispersion modelling assessments. Concentrations of this percentile are less prone to issues relating to intermittent emissions than lower percentiles and are less sensitive to the statistical robustness issues of higher percentiles.

Meteorological data

Odour dispersion modelling should be performed using a minimum of one complete and continuous year of high quality (validated) meteorological data. It is the applicant's responsibility to ensure the data used are representative of the site and of sufficient quality. A wind speed resolution of 1 knot (0.51 m/s) is coarser than desirable for odour modelling purposes; use of such datasets should be avoided where possible. Any procedures used in pre-processing meteorological data or prognostic programs to synthesise data must be documented.

Hours of receptor sensitivity

Relative modelling assessments should include all hours of source emission as input. Modelled hours of emission should not be limited to those hours during which receptors are deemed to be odour sensitive.

Model selection

Model selection is at the applicant's discretion, however the model must be appropriate for use. Note that simpler models such as steady-state Gaussian models may provide acceptable results for some relative odour modelling scenarios.

Relative dispersion modelling reporting

Reporting for relative modelling should include:

- the objective of the modelling exercise
- electronic copies of the model configuration and input files
- a description of meteorological data used and procedures used to prepare these data
- a description of the sources included in the modelling and their emissions characteristics
- conclusions.

A3-8 Comparison with similar operations

This tool allows for the performance of similar facilities to be used in support of applications. It comprises the gathering of information on impact extents, source characteristics and appropriate separation distances.

The outputs of this tool may be incorporated into other detailed analysis tools such as the siting review tool. Points for consideration when comparing odour studies or experience of similar operations include:

- size
- throughput
- operational conditions, technology levels and management
- topography
- meteorology
- emissions sources
- seasonal or other temporal factors which effect odour emissions
- the aim of referenced studies
- the completeness of these data.

Appendix 4— Summary table for detailed analysis

The following summary table templates must be provided in the detailed analysis.

An electronic template of the detailed analysis summary table is available on the DWER website.

Table A4-1: Summary of detailed analysis tools used by the applicant

Detailed analysis tools	**Tick if used**	**Applicant's comments**
Source		
Operational odour analysis (OOA) **(mandatory)**	☐	
Odour source assessment (OSA)	☐	
Pathway and receptor		
Location review **(mandatory)**	☐	
Odour field assessment (OFA)	☐	
Complaints data analysis	☐	
Community surveys	☐	
Relative dispersion modelling	☐	
Comparison with similar operations	☐	

Appendix 5— Measuring sensitive receptor distances

A5-1 How to measure sensitive receptor distances

Sensitive receptor distances should be measured from the 'activity boundary' of the industrial activity to the nearest sensitive land use. The activity boundary of the industrial activity is the area (within a convex polygon) that includes all current or proposed industrial activities (including the plants, buildings or other sources) from which emissions may arise (including stockpiles, windrows, leachate ponds and odour-control equipment).

Measuring from the activity area allows for any separation that is provided within the property boundary of the industry site to be considered. If an industry changes its use or moves a relevant activity within the property boundary, these changes will be reassessed by DWER to consider adequacy of sensitive receptor distances.

Two methods to measure sensitive receptor distances are provided below. These methods differ in the way the measurement point for the nearest sensitive land use is determined.

A5-2 Method 1 - Activity boundary to property boundary (the 'urban' method)

Method 1 measures the distance from the activity boundary of the industry to the property boundary of the nearest sensitive land use, as illustrated in Figure A5-1.

Method 1 should be applied where the nearest sensitive land use is either:

- in an urban area or township; or
- on a site less than 0.4 hectares, or in a zone allowing subdivision to be less than 0.4 hectares.

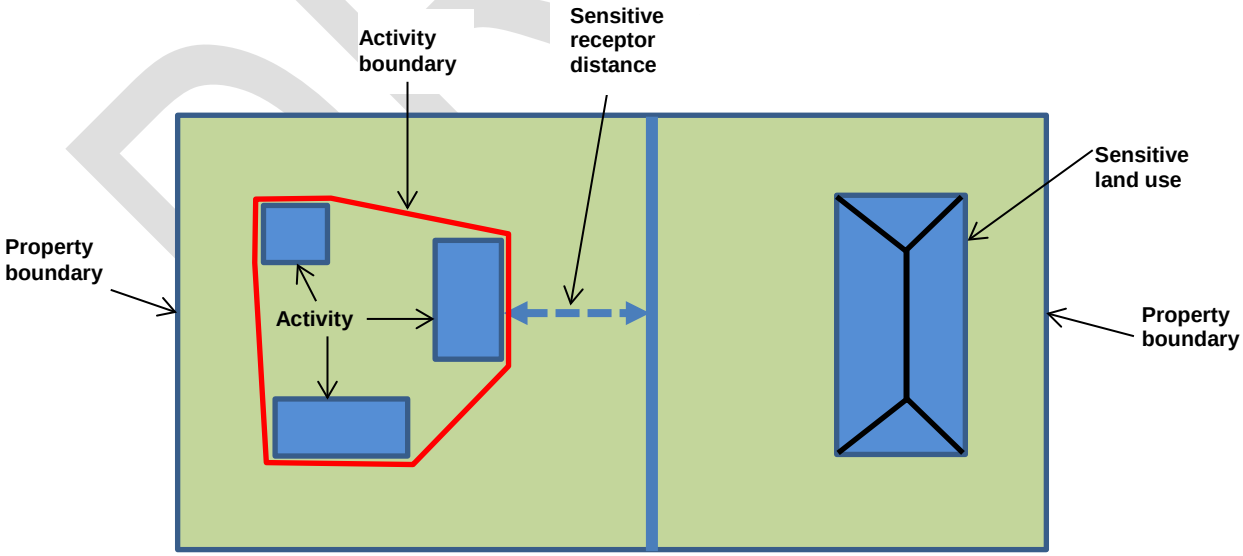


Figure A5-1: Method 1 – the 'urban' method

A5-3 Method 2 – Activity boundary to activity boundary (the 'rural' method)

Method 2 measures the separation distance from the activity boundary of the industry to the activity boundary of the sensitive land use, as illustrated in Figure A5-2. The activity boundary of the sensitive land use is the area (within a convex polygon) that includes all current or proposed sensitive uses (including residences, garages and carports, barbecue areas, clotheslines and swimming pools).

Method 2 should be applied where the nearest sensitive land use is both:

- not in an urban area or township; and
- on a site at least 0.4 hectares, or in a zone requiring subdivisions to be at least 0.4 hectares.

Irrespective, where offsite effects may be experienced, the industry producing emissions should be separated as far as possible from the nearest sensitive land use.

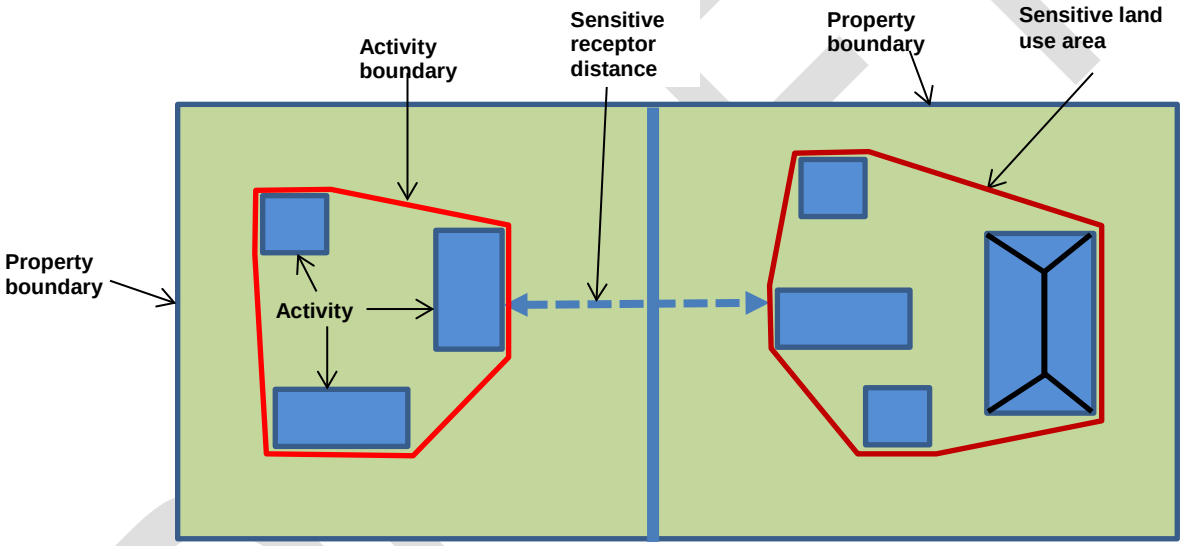


Figure A5-2: Method 2 – the 'rural' method

Table A5-1 below illustrates which method should be used for measuring sensitive receptor distances in different circumstances.

Table A5-1: Selection of measurement method of sensitive receptor distance

		Site are or subdivision requirements	
		Less than 0.4 ha	**At least 0.4 ha**
Urban area or township	**Yes**	Method 1	Method 1
	No	Method 1	Method 2

Source: EPA Victoria; Guideline: recommended separation distances for industrial residual air emissions (2013)

Glossary

Area source	A solid or liquid odour-emitting surface such as a pond, biofilter or stockpile. Examples include wastewater treatment ponds, windrow mounds and uncovered cattle feedlot pads.
Annoyance	The complex of human reactions that occurs as a result of an immediate exposure to an ambient stressor (odour) that, once perceived, causes negative cognitive appraisal that requires a degree of coping. Annoyance may or may not lead to nuisance and a complaint action (van Harreveld et al. 2002).
CEN	The Comité Européen de Normalisation (European Committee for Standardisation).
Complex terrain	Topographic features that may influence the odour plume pathway, such as hills and valleys.
Dilution factor, dilution ratio	The ratio of total gas flow volume (after dilution) divided by sample flow volume in a gas stream; that is: $\frac{\text{Total volume (diluent + odorous sample)}}{\text{Volume of odorous sample}}$
Dynamic olfactometer	A dilution apparatus that delivers accurately controlled flows of pure neutral odourless gas and mixtures of neutral and odorous gases with known dilution factors to sniffing ports (olfactometry). Dynamic olfactometers are primarily used to determine the concentration or concentration-intensity relationship of an odorous gas sample.
Fugitive emissions	Pollutants emitted to the air which are not caught by a capture system and do not originate from a stack, chimney, vent or other functionally equivalent opening designed specifically for the release of emissions. These also include small releases from leaks in plant equipment such as valves, flanges, pump seals and buildings. Emissions from surfaces such as ponds are also considered to be fugitive emissions.
Measurement cycle	The time required for a single measurement at a measurement point during a field survey; this is typically 10 minutes in duration.
Measurement point	The panellist's position at which one or more single measurements are carried out during a field survey.
Odorant	A substance which stimulates a human olfactory system so that an odour is perceived (AS NZS 4323.3:2001).
Odour concentration	The dilution factor required to dilute the sample to the odour detection threshold (1 odour unit) using dynamic olfactometry.

Odour detection threshold (ODT)	The lowest concentration (highest dilution factor) at which 50% of a human panel can identify the presence of an odour without being able to recognise the odour under olfactometric laboratory conditions.
Odour emission rate (OER)	The amount of odour emitted per unit of time from an odour source expressed in $ou.m^3/s$ (AS 4323.3:2001).
Odour intensity	The relative perceived strength of an odour. Intensity descriptor scales must be applied differently according to the German standards for the determination of odour intensity under laboratory conditions (VDI 3882-1:1992) and under field conditions (VDI 3940-3:2010).
Odour nuisance	The cumulative effect on humans, caused by repeated events of annoyance over an extended period of time that leads to modified behaviour (van Harreveld et al. 2002).
Odour panellist (panellist) or odour panel (panel)	A person or group of people who have been tested and are qualified to undertake odour measurements in an odour laboratory or in the field in compliance with AS NSZ 4323.1:2001 and EN 16841-2 and VDI 3940-3 standards respectively.
Odour sample (sample)	An odorous gas collected and contained in a sample bag for subsequent analysis.
Odour unit (ou)	The unit of the odour concentration in Australia and New Zealand. One odour unit is that concentration of odorant(s) at standard conditions that elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one reference odour mass (ROM) of n-butanol evaporated in 1 cubic metre of neutral gas at standard conditions for olfactometry (AS 4323.3:2001). Note: a number of jurisdictions including many European countries consider odour concentration to be similar to a chemical concentration with units of ou/m^3. These units are sometimes used in Australian and New Zealand publications.
Operator	A person who directly coordinates and instructs an odour panel in the field or in an odour laboratory.
Point source	A source from which emissions emanate from a specific opening such as a stack or vent.
Reference odour mass (ROM)	The accepted reference value for the odour unit equal to a defined mass of a certified reference material. One ROM is equivalent to 132 μg n-butanol (CAS No. 71-36-3) which, evaporated in 1 cubic metre of neutral gas at standard

	conditions for olfactometry produces a concentration of 40 ppb (0.04 μmol/mol). Reference: AS 4323.3:2001.
Screening distance	The industry-specific recommended distance between the activity boundary and nearest sensitive receptor or land use that is used to screen low odour risk (see Appendix 2).
Screening distance equation	An equation or formula used in this guideline to determine screening distances from facilities using site-specific data. In some cases, these are referred to as S-factor equations.
Sensitive receptors/ Sensitive land use	Places where people live or regularly spend time and which are therefore sensitive to emissions from industry, with implications for human health or amenity. They include, but are not limited to, residences, health care establishments, places of accommodation, places of study, child care facilities, shopping centres, places of recreation, and some public buildings. Commercial, industry and institutional land uses which require high levels of amenity or are sensitive to particular emissions may also be considered sensitive land uses.
Sensitive receptor distance	The actual distance measured between the activity boundary of a facility and a sensitive receptor (see Appendix 5).
Single measurement	The measurement of odour impact at a measurement point over a defined measurement cycle.
Specific odour emission rate (SOER)	The odour emission rate per unit of surface area for area sources expressed in $ou.m^3/s/m^2$.
Standard conditions for olfactometry	In Australia (ASNZS 4323.3.2001), this is a temperature of 0°C (273.15 K) and a pressure of 1 Atmosphere (101.3 kPa) on a wet basis.
Tall wake-free stack	A stack that has the stack tip sufficiently elevated to avoid wake effects of nearby structures. For the purposes of this guideline, a stack is considered to be wake-affected if it is less than 2.5 times the height of nearby structures or terrain features (measured from ground-level elevation at the base of the stack), and wake-free if greater than this height (reference: USEPA *Good engineering practice*, 1985).
Volume source	A fully or partially enclosed structure such as a building from which odorous air is escaping through one or more openings.

References

The following documents have been referenced in the course of preparing this guideline.

Australian and New Zealand Standard (AS/NZS) 3580 series, *Methods of sampling and analysis of ambient air*, Standards Australia, Sydney.

AS/NZS 4323.1:1995, *Stationary source emissions – Selection of sampling positions*, Standards Australia, Sydney.

AS/NZS 4323.3:2001, *Stationary source emissions Part 3: Determination of odour concentration by dynamic olfactometry*, Standards Australia, Sydney.

AS/NZS 4323.4:2009: *Stationary source emissions area source sampling – Flux chamber technique*, Standards Australia, Sydney.

Department of Environment and Conservation 2005, *Approved methods for the modelling and assessment of air pollutants in New South Wales*, Department of Environment and Conservation, Sydney.

Department of Environmental Protection 2002, *Odour methodology guideline*, Department of Environmental Protection, Perth.

Department of Environment 2006, *Air quality modelling guidance notes*, Department of Environment, Perth.

Department of Environment Regulation (DER) 2015, *Guidance statement: regulatory principles,* Department of Environment Regulation, Perth.

DER 2016, *Guidance statement: decision making,* Department of Environment Regulation, Perth.

DER 2016, *Guidance statement: risk assessments,* Department of Environment Regulation, Perth.

European Standard (EN) 16841-1, 2016. *Ambient air – Determination of odour in ambient air by using field inspection – Part 1: Grid method, CEN (European Committee for Standardisation).*

EN 16841-2, 2016. *Ambient air – Determination of odour in ambient air by using field inspection – Part 2: Plume method, CEN (European Committee for Standardisation).*

United States Environmental Protection Agency, USEPA Method 2: Determination of stack gas velocity and volumetric flow rate (Type S Pitot Tube).

van Harreveld et al. 2002. *Assessment of community – response to odour,* R&D Technical Report P4-095/TR*,* UK Environment Agency, Bristol*.*

Verein Deutscher Ingenieure (VDI) 3880, 2011, *Olfactometry static sampling; Verein Deutscher Ingenieure* (Association of German Engineers), Düsseldorf, Germany.

VDI 3940 Part 3, 2010, *Measurement of odour impact by field inspection – Determination of odour intensity and hedonic odour tone; Verein Deutscher Ingenieure* (Association of German Engineers), Düsseldorf, Germany.