Ministry for the Environment
Manatū Mō Te Taiao

Good Practice Guide for Assessing Discharges to Air from Industry

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1 Introduction

1.1 Purpose of this good practice guide

This good practice guide outlines good practice recommendations for assessing air quality in New Zealand, mainly for the purpose of resource consent applications.

This guide:

- outlines the regulatory framework for the assessment process, in particular the Resource Management Act (NES for Air Quality) Regulations 2004 (the NES for air quality) and regional plans
- provides technical guidance for addressing the information requirements under section 88 and Schedule 4 of the Resource Management Act 1991 (RMA)
- provides guidance on preparing an assessment of the effect of an activity's discharges of contaminants to air, that is appropriate to the scale and significance of the effects on the environment
- provides guidance on methods for assessing the impacts of air quality on both human health and the wider environment
- identifies the air quality criteria by which impacts should be assessed
- provides guidance on key assessment considerations under the NES for air quality.

This guide updates the Ministry for the Environment's previous *Good Practice Guide for Assessing Discharges to Air from Industry*, which was published in 2008 (Ministry for the Environment, 2008).

The recommendations in this guide provide a practical and reasonable approach to managing discharges to air. The guide is part of a series of good practice guides for air quality developed by the Ministry for the Environment. For a full list of the guides see: www.mfe.govt.nz/air/improving-air-quality/good-practice-guides-councils.

Readers undertaking assessments of discharges of odour and/or dust are also referred to companion guides; the *Good Practice Guide for Assessing and Managing Dust* (Ministry for the Environment, 2016a) and the *Good Practice Guide for Assessing and Managing Odour* (Ministry for the Environment, 2016b). There is a strong relationship between the guides, however, this guide is the first step in any assessment of discharges to air.

The aim is that the good practice guide series, taken together, will help provide comprehensive and consistent management of air quality in New Zealand.

1.2 Target audience

This guide is primarily aimed at practitioners making assessments of the effects of discharges to air from industrial sources. Principally these are council officers and consultants. It will also be of interest, however, to other stakeholders such as industry, planners and resource managers, lawyers and the general public.

As noted above, this guide is designed to provide assistance, advice and sources of information to make the assessment process more streamlined and consistent around the country.

1.3 Legislative context

The recommendations in this guide are not legislative requirements under the RMA or any other legislation. However, they are based on expert advice and consultation with practitioners involved in air quality assessment, and regulators charged with managing air quality. As such they should be taken into account in decision-making processes.

1.3.1 Roles and responsibilities

Under the RMA, the primary responsibility for managing air quality lies with regional authorities. Regional authorities also have responsibilities under the NES for air quality.

Territorial authorities do not have a specific air quality management function under the RMA. Territorial authorities do, however, have primary responsibility for land use that includes activities that may discharge contaminants to air, such as:

- activities involving agrichemical application
- industry
- intensive farming
- transport infrastructure (roads, ports, airports).

District councils also have primary responsibility for managing the location of activities that are sensitive to discharges to air (eg, residential zones). Through managing land use therefore, district plan provisions manage the air quality effects of activities on sensitive land uses.

Territorial authorities and public health authorities have a duty to improve, promote and protect public health under the Health Act 1956 (the Health Act). There is some overlap between the responsibilities of regional councils under the RMA, and the responsibilities of territorial authorities and public health authorities under the Health Act. Primary responsibility for managing air quality lies with regional councils, however, so in general the regional council should be the first point of contact for air quality issues.

A unitary authority is a territorial authority that also has all the responsibility of a regional authority – unifying both roles in one local government body which covers one geographical area.

People with activities that discharge to air (dischargers) must comply with the requirements of:

- the RMA, including section 17 (general duty to avoid, remedy or mitigate adverse effects)
- the NES for air quality
- any relevant regional (and district) plan
- resource consent conditions.

1.3.2 Resource Management Act 1991

The purpose of the RMA as specified in section 5(1) is “to promote the sustainable management of natural and physical resources”. Section 5(2)(c) provides for “avoiding, remedying, or mitigating any adverse effects of activities on the environment”.

‘Effect’ is defined in section 3 of the RMA as including:

(a) any positive or adverse effect; and

(b) any temporary or permanent effects; and

(c) any past, present, or future effect; and

(d) any cumulative effect which arises over time or in combination with other effects –

regardless of the scale, intensity, duration or frequency of the effect, and also includes –

(e) any potential effect of high probability; and

(f) any potential effect of low probability which has a high potential impact.

Section 2 of the Act defines “environment” as including:

(a) Ecosystems and their constituent parts, including people and communities; and

(b) All natural and physical resources; and

(c) Amenity values; and

(d) The social, economic, aesthetic, and cultural conditions which affect the matters stated in paragraphs (a) to (c) of this definition or which are affected by those matters.

The term ‘amenity values’ is also defined in section 2 of the RMA, as:

> those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes.

Section 15

Discharges of contaminants to air are controlled under section 15 of the RMA. Section 15(1) means that discharges from industrial or trade premises[1] are only allowed if they are authorised by a rule in a regional plan, a resource consent, a national environmental standard, or other regulations.

Under sections 15(2) and 15(2A), the opposite presumption applies to discharges from sources other than industrial or trade premises. Unless these sources are controlled by a national environmental standard or a rule in a plan, discharges are allowed as of right and consent is not required. Exceptions to this (prohibited activities under the NES for air quality) are discussed below with reference to the NES for air quality.

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1 *Industrial or trade premises* is defined in the RMA. The RMA definition is reproduced in the Glossary.

In essence, if there is an activity which discharges contaminants into air on an industrial or trade premises, that activity will need to be either:

- a permitted activity in a regulation or plan, or
- have a resource consent.

If the (air discharge) activity is not on an industrial or trade premise then, unless there is a rule or regulation relating to the activity, a consent is not needed.

Section 17

Section 17 of the Act imposes a general duty on every person to avoid, remedy or mitigate any adverse effect on the environment arising from any activities the individual may conduct or have carried out on their behalf. This applies regardless of whether the activity is carried out in accordance with any rule, plan or resource consent.

Section 17(3)(a) and (b) provides for enforcement orders or abatement notices that can be made or served by the Environment Court or and Enforcement Officer.

Section 88 (and Schedule 4)

The RMA specifies information requirements for resource consent applications under section 88 and Schedule 4. These provisions are described in Section 3 of this guide.

Section 104 and 105

Section 104 of the RMA sets out the principal matters, subject to Part 2, that a council must have regard to (and other matters it must disregard) when considering an application for resource consent and any submissions received. Sections 104A to 104D set out the circumstances in which a council may or must grant or refuse consent, with reference to the type of activity for which consent is sought.

Section 105 sets out other matters that councils must have regard to when considering a discharge or coastal permit application that will contravene section 15 or section 15B of the RMA.

Enforcement

Under the RMA, the following enforcement tools may be used:

- infringement notice (issued by council)
- abatement notice (issued by council)
- enforcement order (issued by the Environment Court)
- interim enforcement order (issued by the Environment Court)
- prosecution.

Any person may apply for an enforcement order or take a prosecution. Readers are referred to the *An Everyday Guide to the RMA: Enforcement* (Ministry for the Environment, 2015a) for information on these enforcement mechanisms.

1.3.3 National environmental standards

National environmental standards (NES) under the RMA are regulations that can prescribe technical standards, methods, or requirements. These regulations are implemented by regional councils (for example, air) and district councils (for example, soil).

In 2004, the Government introduced the Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (the NES for air quality) to set a guaranteed minimum level of health protection for all New Zealanders.

Detail of the standards within the NES for air quality can be found on the New Zealand legislation website. It is important to note that Regulation 28 of the NES for air quality enables certain regional rules, resource consents, and bylaws to be more stringent than these regulations. Therefore, you should consult the relevant regional plan(s) for full details of the rules and regulations in an area.

The NES for air quality can restrict the granting of resource consents for certain discharges of certain pollutants, although the restrictions are different for each pollutant. This is discussed in more detail in section 4.1.

Many areas in New Zealand find it difficult to comply with the 24 hour ambient PM_{10} standard, primarily due to domestic fire emissions in winter, and are subject to additional constraints for new industry, or existing industry wishing to increase PM_{10} emissions. This is discussed in more detail in Section 4.1.1.

For information on the monitoring of air quality across regional airsheds, refer to the Ministry for the Environment website, at www.mfe.govt.nz/air/air-quality-airsheds/about-airsheds. Up-to-date, in most cases real-time, monitoring information for PM_{10} is available on regional/unitary council websites, as well as on the Land, Air, Water, Aotearoa (LAWA) website.

Further information on the NES for air quality can be found in:

- the Ministry's 2014 update of the *2011 Users' Guide to the Revised National Environmental Standards for Air Quality: Updated 2014* (Ministry for the Environment, 2014)
- the associated *Clean Healthy Air for All New Zealanders: The National Air Quality Compliance Strategy to Meet the* PM_{10} *Standard* (Ministry for the Environment, 2011).

1.3.4 National policy statements

There is no national policy statement on air quality.

The 2010 New Zealand Coastal Policy Statement (NZCPS) gives effect to the RMA in the coastal marine area. It focuses on discharges to water and coastal areas, but does not explicitly address air quality matters. It should be noted, however, that:

- policy 4 requires coordinated management or control of activities within the coastal environment, and which could cross administrative boundaries (eg, discharges to air in Nelson/Tasman regions)
- policy 11 protects indigenous biological diversity (in the event that any discharge to air may cause adverse effects to indigenous biological diversity)

- the NZCPS has to be taken into account in consideration for an application for a coastal permit for a discharge to air located in the coastal management area.

Typically air quality assessments focus on human health-related matters. The NZCPS may be relevant, however, for emissions of toxic contaminants or dusts in the coastal marine area.

1.3.5 Regional policy statements

Regional policy statements provide an overview of air quality (and other environmental) issues in a region. They specify policies and methods for integrated management of air quality (and other natural and physical resources) in each region.

1.3.6 Regional plans

Regional plans specify the methods for managing natural resources within a region. These plans may be specific to air quality (eg, a regional air quality management plan) or cover all resources in the region. Regional plans must give effect to the provisions of the regional policy statement (as well as the RMA and the NES for air quality).

Regional plans for air quality management generally include objectives and policies for managing ambient air quality, as well as localised effects (eg, dust and odour).

Under section 68 of the RMA, councils can use rules to allow, regulate or prohibit activities.

Regional air plans generally provide for permitting activities with a low potential for adverse effects, provided certain conditions are met. In some cases the activity may be known to be odorous or dusty, but is deemed acceptable (and classified as a permitted activity) based on its location (eg, field ploughing).

Activities with a greater potential for adverse effects may be classified as controlled, restricted discretionary, discretionary or non-complying. These activities require resource consent to discharge contaminants to air.

In addition to rules, non-regulatory mechanisms may be adopted, such as education and development of industry codes of practice.

Regional air quality management plans are developed through a process of public consultation and review, before the plan finally becomes ‘operative’.

The current status of specific plans should be checked with the relevant regional council, as there may be more than one plan that needs to be considered.

1.3.7 District plans

Under section 31 of the RMA, territorial authorities have responsibility to control land use, and to achieve integrated management of the use, development or protection of land and associated natural and physical resources of the district. This includes effects of land use on air quality and on amenity values.

District rules specify the type of activities, including industries that are allowed in different areas or zones.

Importantly, district plans usually provide guidance on amenity expectations within different zones. These take precedence for amenity issues such as odour and dust, over the more general guidance on land-use sensitivity in this guide.

1.3.8 The Health Act 1956

Territorial authorities and public health authorities (district health boards) have a duty to improve, promote and protect public health under the Health Act 1956 (the Health Act). Territorial authorities employ environmental health officers to monitor and take enforcement action against conditions likely to be injurious to health or offensive, as well as to abate nuisances. Public health authorities employ health protection officers, who also have the functions of an environmental health officer under the Health Act.

District health boards often work collaboratively with regional councils to manage air discharges when there is a *health* issue arising from a discharge. In some cases (eg, where industrial emissions are known or suspected to have caused adverse health effects), public health officers, particularly the medical officer of health, can play an important role in speaking for the public.

There is some overlap between the responsibilities of regional councils under the RMA, and the responsibilities of territorial authorities and public health authorities under the Health Act. The first point of contact for air quality issues is the regional councils.

Key points

When assessing the effects for an individual discharge of contaminants to air, consider the specific requirements of relevant legislation, policy, and plans in detail.

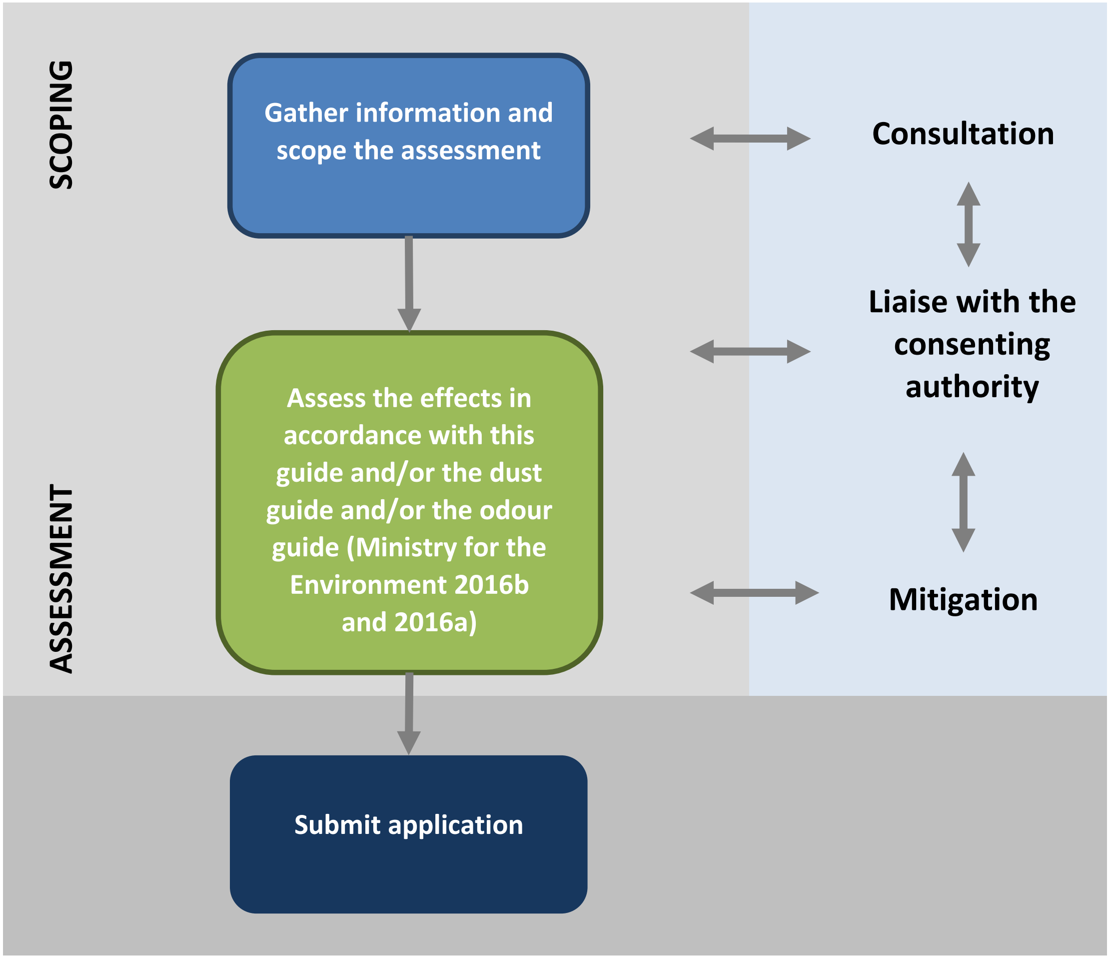
The first point of contact for air quality issues is the regional council.

2 The assessment process

The Quality Planning (QP) website provides guidance and information about each step of the consent process. The QP website is designed for council practitioners and consultants, environmental managers, and others involved in resource management practice under the Resource Management Act 1991 (RMA). This good practice guide is intended to complement the QP guidance by providing specific advice about assessing discharges to air from industry.

An assessment of discharges to air from industry will typically involve the steps shown in figure 1.

Figure 1: Overview of assessment process



The level of detail to which each of these steps is carried out must be appropriate to the scale and significance of the effects that the activity may have on the environment. This section of the guide describes the issues to consider when scoping an assessment and introduces the common methods for assessing air quality effects.

Section 3 describes the information requirements for consent application.

2.1 Liaising with the consent authority

Air discharge consent applications are, by their nature, site- or case-specific. They can also be extremely complex. Establishing what information needs to be lodged with an application before formally lodging it with a consenting authority can significantly reduce the time and cost of an application for all parties.

Liaising with the consent authority can also help ensure the application meets the information requirements of the RMA. The consent authority should not accept an application for resource consent if it does not meet these requirements.

Consent authorities recommend that the first pre-application meeting should be held well before the application is lodged – up to two years before, for potentially complex applications. This timeframe should enable any outcomes of the meetings to be actioned and included within the application, including any necessary ambient air quality monitoring, meteorological monitoring, or stack testing.

The applicant and the consenting authority should continue to talk and negotiate until they confirm an agreed approach for each stage of the assessment process.

Specific issues that should be discussed with the consent authority are outlined throughout this section.

Key points

Liaison with the consent authority should start well before an application is lodged – up to two years for potentially complex applications. The applicant and the consent authority should keep talking throughout the assessment process.

2.2 Consultation

The RMA does not require applicants to undertake consultation, but consulting with neighbours, and any potentially affected parties, is strongly recommended for most air discharge consent applications.

The best time to engage in consultation is before the consent process formally begins. It is important to bear in mind that consultation may not be just a pre-application exercise – it can help throughout the consent process, and form the basis for long-term relationships with your neighbours and the community.

Detailed guidance on consultation is provided in *An Everyday Guide to the Resource Management Act, Series 2.2 Consultation for Resource Consent Applications* (Ministry for the Environment, 2015b).

2.3 Tāngata whenua

Sections 5, 6(e), 7(a) and 8 of the RMA relate to the relationship tāngata whenua have with the sustainable management of natural and physical resources, including air. Key areas in which tāngata whenua may be included in the consent application process include pre-application consultation, notification processes, and affected party approvals. Consultation with tāngata whenua is recommended, and may be required, particularly under the following circumstances:

- Where a marae or an area of customary practice is within the potential area of effect of an activity, for consent applications not requiring notification the consenting authority may suggest consultation with, and generally written approval from, the potentially adversely affected marae or iwi.
- In the event of large-scale applications that may affect large portions of the airshed or cause widespread nuisance, the consenting authority is likely to suggest that relevant iwi are consulted, even if there are no local marae or areas of customary practice directly affected.
- Other potential issues of particular significance for Māori are outlined in section 3.5.4 of this guide. Where these issues are relevant, consultation with tāngata whenua will be necessary for a meaningful assessment of these effects.
- It should be noted that some iwi settlements have specific requirements for consultation.
- Statutory acknowledgements recognise the mana of a tāngata whenua group in relation to specified areas. In affected areas there are requirements on consenting authorities that may affect the requirements for consultation and notification.
- Some regional councils have specific requirements for consultation with tāngata whenua, and some require a separate cultural impact assessment.

These consultation requirements should be discussed at the pre-application meeting. Many air discharge consent applications are notified – if an application is either fully or limited notified then all relevant iwi will be directly notified of the application.

Key point

Consultation with immediate neighbours and any other potentially affected parties, including iwi, is strongly recommended for most air discharge consent applications.

2.4 Scoping an assessment

This section describes some of the issues that should be considered in the scoping phase of an assessment.

Site visits

Site visits are essential for:

- assessing an air discharge consent application
- establishing the level of assessment likely to be required.

Sometimes more than one site visit will be required. A site visit can provide context and significant information that cannot be gained from reviewing the application alone, even when this is done in conjunction with maps or photographs. It is particularly important for confirming the surrounding land use, proximity to or presence of sensitive receptors (eg, homes, hospitals, aged-care facilities) and the presence and proximity of complex terrain. Consenting authorities, consent applicants and their advisers should undertake site visits.

Review previous or similar assessments

It is good practice to review similar and previous assessments to inform a new assessment, for example:

- For an existing site, review the previous assessment of environmental effects. This can provide useful background information. A new assessment should always be undertaken, however it may be appropriate to rely on earlier technical work, for example dispersion modelling if there have been no appreciable changes to the activities or receiving environment.
- For new and existing sites, check whether an assessment has been undertaken for a similar site elsewhere – and speak to the relevant council officer and/or review the council files. This can be useful to learn from experience elsewhere, and avoid reinventing the wheel.

Complaints/compliance record

For an existing consent holder applying for consent renewal or expanding in scale, the complaints history should be reviewed.

When it comes to air quality, the most frequent complaints are about dust and odour. The Ministry for the Environment provides separate guidance for assessing dust (Ministry for the Environment, 2016a) and odour (Ministry for the Environment, 2016b) impacts, which should be followed if these have the potential to occur. Where a complaints record indicates that there are actual or potential effects on the existing community, these effects will need to be assessed in detail.

Similarly, where an existing industrial development is seeking consent for expansion or alteration, any compliance records for existing consent conditions should be examined (eg, compliance with stack emission limits). The reasons for non-compliances, if any, should be discussed in the assessment and additional mitigation measures, or alternative consent conditions, proposed.

Overall, the level of assessment expected is likely to be higher for an industry with a poor compliance record and/or history of complaints. Similarly, a lesser level of assessment may be appropriate for a site with a good compliance history and absence of complaints.

Plan requirements

An assessment of the activity against statutory documents is required for any assessment, as described in section 3.3. At the scoping stage, it is particularly important to identify all relevant policies and rules specified in regional and district plans for the activity. These will define the status of the activity (prohibited, non-complying, discretionary, restricted discretionary, controlled or permitted) and may include specific rules, assessment criteria or matters for discretion that need to be considered in scoping the assessment.

Airshed designation under the NES for air quality

Many urban areas in New Zealand are designated as polluted airsheds with respect to PM_{10} under Regulation 17 of the NES for air quality, and are subject to controls on the granting of resource consents for new industrial discharges. It is likely that any industrial development within these airsheds that shows a significant increase in PM_{10} emissions will require a detailed assessment. See section 4.1.1 for further details on airsheds that are likely the breach the Regulations.

For up-to-date information on airsheds, contact the relevant regional council, alternatively visit the Land, Air, Water Aotearoa (LAWA) website.

Physical geography of the receiving environment

The physical geography of an area can significantly affect the dispersion of pollutants, and is a particularly important consideration in dispersion modelling. The scoping assessment should identify whether there are any significant topographical features that may affect dispersion.

Features such as coastlines and mountainous terrain require more complex predictive modelling techniques than, for example, flat inland sites. These considerations are covered in the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004), which is a companion guide to this document.

Background air quality

Background air quality is an important consideration for any assessment of effects on ambient air quality. At the scoping stage, the applicant should determine what information is available (if any) on background air quality, and how this compares to relevant air quality criteria.

Key point

The objective of scoping an assessment is to compile relevant information and identify key issues early in the assessment process.

2.5 Methods for assessing the actual and potential effects of discharges to air

Information requirements for resource consent applications are discussed in section 3 of this guide. **All applications need to address these information requirements in such detail as corresponds with the scale and significance of the effects that the activity may have on the environment**.

One of the key information requirements is an **assessment of the actual and potential effect of the activity on the environment**. This section of the guide introduces the typical methods used for assessment of the actual and potential effects of discharges to air, and provides some discussion on deciding which of these to use.

2.5.1 Qualitative assessment

A qualitative assessment of effects is best suited to activities with minimal discharges to air that are easily controlled by process design and standard operating practices (eg, workshop spray booths). These activities are likely to be permitted or controlled activities under the regional plan.

A qualitative assessment should generally include adequate information:

- to demonstrate that the activity meets any requirements of the relevant regional plan for the type of consent required
- for assessment against any matters for discretion that are specified in the plan.

A qualitative assessment is often the most appropriate method for assessment of odour or dust effects.

2.5.2 Odour assessment

There are a range of tools and methods for assessment of the effects of odour. These include qualitative and quantitative methods. In addition to this guide readers should refer to the *Good Practice Guide for Assessing and Managing Odour* (Ministry for the Environment, 2016b), which is a companion guide to this document.

Specifically, the odour guide provides guidance on:

- what odour is, and how it can affect people
- who is responsible for responding to and resolving odour complaints
- how to undertake odour investigations and to assess the effects of odour, including how to determine when odour has caused 'an offensive or objectionable effect'
- how to monitor and manage the effects of odour through community surveys, odour diaries, and odour management plans
- case law developed under the Resource Management Act 1991 (RMA) relating to odour management in New Zealand
- when to use dispersion modelling and how to interpret the results
- how to measure and manage odour emissions.

2.5.3 Dust assessment

There are a range of tools and methods for assessment of the effects of dust. These include qualitative and quantitative methods. In addition to this guide readers should refer to The *Good Practice Guide for Assessing and Managing Dust* (Ministry for the Environment, 2016a), which is a companion guide to this document.

Specifically, the dust guide provides information on:

- how to assess and manage environmental effects of dust emissions
- sources of dust emissions
- potential health effects and environmental effects associated with dust emissions

- who is responsible for managing dust, based on current legislation and air quality / assessment criteria
- methods available to assess the environmental effects of dust emissions
- how to monitor the effects of dust through surveys, complaints monitoring, and environmental monitoring and how to use these methods for dust assessments
- how to undertake dust investigations in response to complaints
- when to use dispersion modelling
- methods and options for managing and controlling dust emissions
- recent case studies and worked examples illustrating how to manage dust.

2.5.4 Quantitative screening assessment

Air dispersion models are frequently used to predict and assess the potential environmental effects of discharges to air. In brief, the models are used to predict air pollutant concentrations downwind of an emission source. Predicted pollutant concentrations are then compared to ambient air quality criteria and an assessment made of the likely health effects of the discharge.

Section 5 of this guide describes a quantitative screening assessment method to determine whether a proposal is likely to result in exceedances of ambient air quality criteria. The quantitative screening assessment is a dispersion modelling assessment using conservative assumptions so it can be undertaken relatively quickly and easily. This is typically used for applications with well-established discharges to air (eg, small to medium combustion plant).

2.5.5 Quantitative detailed assessment

Section 6 of this guide describes a more detailed quantitative assessment method. The quantitative detailed assessment is a dispersion modelling assessment using essentially the same tools and techniques as a screening assessment. A detailed assessment still uses conservative assumptions. However, these assumptions may be based on better information than a screening assessment and therefore predictions will more closely resemble actual effects.

The delineation between a screening and detailed assessment is somewhat arbitrary. In reality, it is likely that the methodologies described in the screening and detailed procedures would be combined for any significant assessment. For example, a lack of information on existing air quality may result in the need for air quality monitoring, whereas the required dispersion modelling technique may be very straightforward due to simple topography. This is typically used for applications with discharges to air that may have significant effects (eg, large combustion plant) or toxic or carcinogenic discharges to air (eg, chemical manufacturing or crematoria).

2.5.6 Deciding the assessment method and level of detail required

An assessment of effects must include such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

There are no hard and fast rules for determining the tools and methods to use for an assessment, or the level of detail that is required. This is a matter for judgement and should be informed by all of the information considered in scoping the assessment.

For example, a more comprehensive odour or dust assessment is likely to be required if:

- the site has a poor compliance record
- there is a history of complaints
- the site is located in a sensitive receiving environment
- there is a high level of community concern.

Similarly, a quantitative assessment is more likely to be required if:

- the discharges are toxic or carcinogenic
- the activity is classified as discretionary or restricted discretionary in the regional plan
- the site is located in a sensitive receiving environment
- the proposal is for a new discharge of PM_{10} in a polluted airshed
- there is a high level of community concern.

In some cases it will be obvious from scoping the assessment and discussions with the consenting authority that a detailed quantitative assessment will be required. In other cases an iterative approach may be taken. If a quantitative screening assessment indicates there is a potential for non-compliance with air quality criteria, then a quantitative detailed assessment should be undertaken for the contaminants of concern.

For some activities, a combination of all of the methods outlined in this section will be used. For example, a landfill is likely to have potential odour and dust effects, as well as combustion emissions from landfill gas flaring.

It is important to remember that every assessment is different and that the assessment methods and level of detail required should be discussed with the relevant consenting authority.

Key points

All applications need to address the information requirements described in Section 3 in such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

There are a range of methods and tools for assessing the actual and potential effects of discharges to air on the environment. Every assessment is different and that the assessment methods and level of detail required should be discussed with the relevant consenting authority.

2.6 Reporting an assessment

Although specific projects will have specific requirements, any report should address all of the information requirements outlined in section 3 of this guide as these fulfil the requirements of the RMA. An assessment report should therefore include the following features:

1. Executive summary: a statement of the key features and results.
2. Purpose: who has commissioned the project, and why, including the intended outcomes.
3. Introduction: the background to the issues and the relevance of any previous work. Include details of any existing consent requirements and the level of compliance with these requirements.
4. Information requirements: include information to address all of the requirements outlined in section 3.
5. Scope of the assessment: describe the issues to be addressed, and why, as discussed in section 2.4.
6. Methodology: a description of the process used, any models employed, assumptions made, and any statistics or analysis used.
7. Data used: the sources and validity of all input data, including emissions and process data, meteorology, existing concentrations, and all assumptions made.
8. Assessment of effects: the outcomes of the assessment, and all options assessed.
9. Discussion: any implications, uncertainties and reliance on assumptions.
10. Conclusion: a summary of the scope, method, results and implications.
11. References: all material used should be referenced explicitly, and should include web-based links where appropriate.
12. Appendices: any detailed calculations or results that are used. This should include model control files.

All aspects of an assessment should be auditable and repeatable so the approach, assumptions and calculations can be independently reviewed. An assessment report should also include or be supported by supplementary reports or data where applicable, including:

- emissions testing reports
- ambient monitoring reports
- equipment specifications
- model output files
- all input data
- copies of spreadsheets and calculations
- industry-specific and process-specific reports from international literature.

The size and nature of each of these sections should be appropriate for the scale and significance of the effects the activity may have on the environment.

3 Requirements for an assessment of effects

Section 88 and Schedule 4 of the RMA set out the information requirements for resource consent applications. **All applications need to address these information requirements in such detail as corresponds with the scale and significance of the effects that the activity may have on the environment**.

The full text of the RMA, including amendments, can be found on the website of the Parliamentary Counsel's website.[2] General guidance on fulfilling these information requirements can be found on the Ministry for the Environment website.[3]

The following sections provide technical guidance to help address the information requirements of Schedule 4 for activities that discharge contaminants to air.

3.1 Description of the activity

The description of the activity should enable a thorough understanding of the application.

While it should be tailored to the size and type of activity requiring consent, it should be as detailed as possible, covering both current and proposed operations. This is because the consenting authority can only grant consent for what is applied for, and the application is defined by the description.

A number of consent authorities have specific guidance or requirements for information to be included in an application. In the absence of specific guidance, it is recommended that the description of the activity should generally include:

- a summary of the activity or process flow, from raw materials to final product
- details of any relevant historical information, including past changes or any proposed changes to an existing activity
- a site emissions inventory, detailing all stacks and emission points, including:
  - stack heights
  - reasons for stacks
  - whether rain covers are attached
  - efflux velocities and temperature
  - contaminants being discharged (including quantities and concentrations at point of discharge)
- details of all emissions control equipment, including design criteria and general assembly drawings where appropriate

2 http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html.

3 A guide to section 88 and Schedule 4 of the Resource Management Act 1991 on the amended requirements is available on the Ministry for the Environment website http://www.mfe.govt.nz/sites/default/files/media/RMA/section-88-guide-final_0.pdf.

- maximum and normal processing capacities, anticipated hours of operation, seasonal and annual discharge rates (if applicable)
- maximum and normal ratings, capacities and throughput of all major plant equipment, including for boilers, air discharge control equipment, driers, mixing tanks, and processing plant
- a process flow diagram (or, if more appropriate, a process and instrumentation diagram), showing all works, or those proposed to be included on-site, including emissions control equipment and emission points
- a map or diagram showing the location of all operations and discharge points/stacks on-site in relation to the site boundaries as well as the location of sensitive receptors
- details of any materials handling procedures and mitigation measures in place for raw, intermediate, by-product and finished materials
- quantities of raw materials to be stored and handled.

Consent applicants should recognise that data provided in an assessment will usually form the basis for setting the consent conditions. For example:

- fuels in a combustion process may be limited to those identified in the application
- emissions assumed in dispersion-modelling are likely to be adopted as stack emission limits, because the effects of higher emissions have not been assessed.

It is therefore important that any application reasonably reflects all anticipated operational scenarios for a development.

Good practice examples of resource consent conditions are provided in Appendix 1.

Key points

The description of the activity should give a full understanding of the application, and should be in accordance with any specific requirements specified by the consent authority.

Consent applicants should recognise that data provided in an assessment will usually form the basis for setting the consent conditions. It is therefore important that any application reasonably reflects all anticipated operational scenarios for a development.

3.2 Description of the site

The consent authority may have specific requirements for the description of the site at which the activity is to occur. In general, this should include:

- a detailed site location description and map including the street address
- location map (to scale) of all activities and/or processes on site and, if relevant, a discussion of whether alternative locations on site were considered to mitigate adverse effects (refer section 3.4 of this guide)
- details about the zoning of the site and neighbouring areas as given in the relevant operative (and proposed, if relevant) district plans. This should include a description of the amenity expectations of the receiving environment and how this zoning relates to the particular activity giving rise to the air discharges

- a copy of the certificates of title for all parcels of land to be included within the site to which the consent will apply
- an approximate New Zealand Series map reference (eg, NZMS 260 R08 514 508)
- maps showing neighbouring properties, in particular distances to the boundary of the applicant site and any sensitive receptors. A list of all neighbouring property owners and occupiers should also be provided.

3.3 Assessment of the activity against legal and planning instruments

Clause 2 (2) of Schedule 4 requires assessment of the activity against relevant provisions outlined in a number of documents referred to in Section 104(1)(b) of the RMA. These documents include:

(i) a national environmental standard;

(ii) other regulations;

(iii) a national policy statement;

(iv) a New Zealand coastal policy statement;

(v) a regional policy statement or proposed regional policy statement;

(vi) a plan or proposed plan.

The requirements of these documents are discussed in section 1.3 of this guide.

3.4 Alternative locations or methods for undertaking the activity

If it is likely that the activity will result in any significant adverse effect on the environment, then an assessment of effects must include consideration of alternative locations or methods for undertaking the activity.

Consideration of alternative locations should address:

- the sensitivity of the receiving environment, and whether there may be less sensitive locations where the activity could be undertaken
- predominant wind directions, topography and frequency of occurrence of adverse effects
- compliance with any zoning requirements within district, regional or unitary plans
- whether alternative locations on site may be more appropriate.

Consideration of alternative methods of undertaking the activity should consider whether:

- alternative processes are available that produce the same product for a reduced or different level of emissions
- there are alternative management techniques that can be used, which may reduce or change the types of levels of emissions being discharged.

3.5 An assessment of the actual or potential effect on the environment of the activity

This guide is the primary reference tool for assessing actual and potential effects on the environment of discharges to air from industry (see assessment methods in section 2.5). Readers assessing the effects of odour and dust are also referred to the corresponding Ministry good practice guide.[4]

The following section describes the key issues that may need to be considered in any assessment of effects for an activity that discharges contaminants to air.

3.5.1 Health effects

Discharges to air from some activities have the potential to cause adverse health effects. The potential for effects depends on a range of factors including the nature and quantity of the discharge and whether people are likely to be exposed. In some cases the potential for adverse health effects can be assessed qualitatively.

However, for activities with significant potential to cause offsite health effects, a quantitative dispersion modelling assessment is usually necessary to determine whether a proposal is likely to result in exceedance of ambient air quality criteria. These assessment criteria are discussed in section 4 of this guide. Guidance for undertaking quantitative dispersion modelling assessments is provided in in section 5 and section 6 of this guide.

3.5.2 Odour effects

Some activities have the potential to cause objectionable and offensive effects from odour emissions. Odour can cause significant adverse effects on people's lives and well-being. Complaints about odour emissions are one of the most frequent environmental pollution incidents reported to regulatory authorities.

If an assessment requires an assessment of the effects of odour, readers should refer to this guide **and** the *Good Practice Guide for Assessing and Managing Odour* (Ministry for the Environment, 2016b).

3.5.3 Dust effects

Some activities have the potential to cause objectionable and offensive effects from dust (non-combustion particulate matter) emissions. For example, quarrying, aggregate crushing, abrasive blasting, sealed and unsealed surfaces, and material stockpiles.

The effects of dust are primarily determined by particle size and particle composition. Larger dust particles are generally considered to be biologically inert and their effects relate to our sense of aesthetics (soiling, visibility and amenity). However, smaller particles can cause adverse health effects.

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4 For specific odour or dust related assessments and supplementary information specific to these topics readers are referred both this guide, and the *Good Practice Guide for Assessing and Managing Odour* (Ministry for the Environment, 2016b) or the *Good Practice Guide for Assessing and Managing Dust* (Ministry for the Environment, 2016a).

In summary, the potential effects of dust are:

- health effects from exposure to contaminants associated with the dust
- health effects from exposure to finer particulate matter (PM_{10} and $PM_{2.5}$)
- nuisance effects such as soiling, effects on amenity and visibility
- effects on ecosystems.

If an assessment requires an assessment of the effects of dust, readers should refer to this guide **and** the *Good Practice Guide for Assessing and Managing Dust* (Ministry for the Environment, 2016a).

Note that the dust guide focusses on dust particles greater than 10 microns due to its localised, nuisance effect when deposited rather than its contribution to a wider ambient issue. Specifically, because of the greater diameter and density of deposited dust, it falls from the air and can impact on land use activities and amenity values such as soiling of buildings as well as visual impacts. The dust guide acknowledges that fugitive dust generated by activities such as construction, roading, and excavation projects can include smaller particles of 10 microns and below which stay suspended in the atmosphere for significant periods and can fall within the respirable range, causing adverse health effects. This smaller fraction of particulate matter includes particles 10 micrometres in diameter (PM_{10} known as 'coarse particles') and 2.5 micrometres in diameter ($PM_{2.5}$ known as 'fine particles').

3.5.4 Social, economic and cultural effects

Clause 7(1)(a) of Schedule 4 of the RMA requires an assessment of:

> any effect on those in the neighbourhood and, where relevant, the wider community, including any social, economic, or cultural effects.

In practice, except for very large proposals, councils mainly assess these matters qualitatively.

Resource consent applications should include an assessment of the positive and negative social and economic and cultural effects of the activity for example:

- jobs
- provision of essential infrastructure
- social costs on health of the activity's air pollution effects
- direct costs associated with the effects of a discharge, for example soiling of buildings or damage of crops
- social, economic or cultural effects of odour or dust discharges, particularly in sensitive locations.

The following air quality issues are of particular significance for Māori, and should be addressed in all air quality assessments:

- deposition of air pollutants onto mahinga kai (places where food and resources are traditionally gathered), marae and wāhi tapu (sacred places)
- reduction of visibility (eg, Putauaki maunga/Mt Edgecombe in the Bay of Plenty is sometimes shrouded in brownish clouds as a result of air discharges that reduce visibility)

- increase in odour (eg, some meat-processing plants have a particular smell associated with their activities and discharges into air)
- impact of contaminants on important or valued sites (eg, discharge material from the flue of a crematorium can be blown by predominant winds over mahinga kai).

For some applications (such as crematoria), tāngata whenua may see themselves as an affected party even when there are no predicted air quality effects, because of the sensitive nature of the discharge in relation to tikanga Māori.

Key point

Resource consent applications should include an assessment of the positive and negative social and economic and cultural effects of the activity

3.5.5 Air pollution effects on ecosystems

Clause 7 (1)(c) of Schedule 4 of the RMA requires an assessment of:

> any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity.

Generally in areas where sensitive ecosystems are likely to be located (ie, rural and forest environments), current background pollutant levels are unlikely to breach critical level guidelines. An assessment of effects on ecosystems would generally only be warranted if valued or particularly sensitive ecosystems are located near large point sources of air pollutants.

Effects on ecosystems can be considered in terms of:

- critical levels – airborne concentrations of contaminants that may cause direct adverse effects
- critical loads – deposition rates of contaminants that may cause adverse effects, typically over longer time periods, for example soil acidification and nitrogen enrichment.

Section 4 of the *Ambient Air Quality Guidelines* (Ministry for the Environment, 2002) provides critical levels for protecting ecosystems from sulphur dioxide, sulphate particulate, nitrogen dioxide, ammonia, ozone and fluoride.

For very large industrial point sources, where consideration of deposition is warranted, the *Effects of Air Contaminants on Ecosystems and Recommended Critical Levels and Critical Loads* (Ministry for the Environment, 2000b) provides some guidance on methods for calculating pollutant deposition rates from predicted or ambient monitoring results, and guidance for assessing whether a discharge is likely to cause adverse effects on ecosystems. Accumulation and deposition are discussed in the next section.

The New Zealand ecosystem air quality guidelines were developed based on knowledge of the effects on exotic (North American and northern European) plant species. There is little information on the effects of air pollutants on native New Zealand species. The robustness of any assessment of air pollution effects on ecosystems in New Zealand is therefore vulnerable to these knowledge gaps and these limitations need to be acknowledged when carrying out an air quality assessment.

Key point

An assessment of effects on ecosystems may be warranted if valued or particularly sensitive ecosystems are located near large point sources of air pollutants.

3.5.6 Deposition and accumulation

Some contaminants such as persistent organic pollutants and heavy metals may persist in the environment, and can have long-term effects. When they are released into the air, persistent contaminants can deposit onto land (or water) and accumulate over the lifetime of a discharge.

A common example is mercury which is a component in coal and is discharged in both particulate and gaseous (vapour) phases. For large point source discharges of contaminants such as mercury, in addition to considering airborne concentrations with respect to ambient air quality standards and guidelines, it may be necessary to consider the potential for people to be exposed by other source-pathway receptor routes. International obligations related to mercury are discussed in section 3.5.10.

Any discharge to air which results in deposition of contaminants into water will be subject to the section 107 restrictions of the RMA. For example, this would be important for deposition of heavy metals, which could have adverse effects on aquatic life. Other circumstances where consideration of deposition and accumulation might be required include:

- a very long lifetime for the discharge (20 years or more)
- particularly sensitive areas for ingestion exposure (eg, near a market garden)
- particularly complex terrain (eg near a hill where localised deposition rates may be elevated, providing there are sensitive receptors at this location).

The rate of accumulation and consequent changes in soil concentrations over time also requires consideration of volatilisation and losses due to run-off. The assessment of effects may also require a health risk assessment approach to consider all exposure routes.

A more detailed discussion of assessing ecosystem effects from accumulation and deposition can be found in the Ministry for the Environment's guide on ecosystem effects (Ministry for the Environment, 2000b).

Key points

Where there is potential for discharges to deposit on land, persist in the environment, and have long-term cumulative impacts, any adverse effects should be assessed and, if necessary, a health risk assessment undertaken to consider all routes of exposure.

Any discharge to air which results in deposition of contaminants into water will be subject to the section 107 restrictions of the RMA.

3.5.7 Risk assessment

Section 3(f) of the RMA defines the meaning of 'effect' to include:

> Any potential effect of low probability which has a high potential impact.

This means that an assessment of effects should consider any industrial incident, process equipment failure, or control equipment failure, that:

- discharges contaminants into air
- has a low probability of occurrence
- has a high potential impact on the surrounding environment.

These low probability, high potential impact effects are assessed using a risk assessment (ie, both likelihood and consequence considered).

For air quality assessments, the term risk assessment can be used to describe two different assessment techniques:

- assessing the risk of unplanned emissions – a method of estimating the frequency or probability with which a hazardous event (unplanned discharge to air) can occur, and the consequence of that event
- human health risk assessment – a method of estimating the nature and probability of adverse health effects in people who may be exposed to chemicals in contaminated environmental media, now or in the future.

In this guide, the term 'risk assessment' is used to describe the first approach, ie, assessing the risks associated with potential industrial incidents that may discharge contaminants into air.

Consider a risk assessment for:

- activities with a track record or known risk of accidental discharges
- activities that emit hazardous air pollutants in significant quantities
- activities that treat hazardous, or potentially hazardous waste
- chemical manufacturing processes where chemical reactions take place
- processes using pressurised vessels.

Risk assessment is a specialised task and should be carried out by suitably qualified experts. This document does not provide guidance on how to undertake risk assessments.

Key points

A risk assessment should be considered for assessment of air quality effects with a low probability of occurrence and high potential impact (ie, consider both likelihood and consequence).

This document does not provide guidance on how to undertake risk assessments.

3.5.8 Legionella and biological contaminants

In addition to chemical contaminants, the discharge of biological contaminants into air has the potential to cause adverse health effects. Where there are sensitive receptors in close proximity (refer table 1 in section 3.7) to a discharge, assessments of biological contaminants should be undertaken for:

- cooling towers
- scrubbers
- wastewater treatment and disposal
- composting.

Cooling towers and scrubbers have been linked to outbreaks of Legionella, or Legionnaire's disease – a potentially fatal, notifiable disease under the Health Act 1956. This is largely preventable through regular testing and disinfection to the requirements of AS/NZ Standard 3666 'Air Handling and Water Systems of Buildings – Microbial'.

The use of compost has been identified as a potential source of Legionnaires' Disease through inhaling soil based species of Legionella bacteria. While there is no New Zealand study showing that composting facilities pose a public health risk, international studies have shown Legionella isolated from samples taken at composting facilities and in composts sold commercially (see for example, Casati S, et al., 2009 and Currie L, et al., 2013).

It is good practice to maintain separation distances (discussed in section 3.9.4) between sensitive receptors and composting facilities to manage the risk of Legionella release as well as amenity effects that may occur despite process controls. The risk of Legionella in compost is also minimised through the use of enclosed composting systems that achieve minimum temperature and residence time criteria.

Key points

Where there are sensitive receptors in close proximity to a discharge, an assessments of the potential effects of biological contaminants should be undertaken for cooling towers, scrubbers, wastewater treatment and disposal and composting.

3.5.9 Atmospheric chemistry and secondary pollutant formation

For certain contaminants, chemical transformation during transport in the atmosphere can be an important consideration. The most common examples with regard to atmospheric chemistry are the:

- oxidation of NO to NO2 when NOx (oxides of nitrogen) are released from industrial emissions
- formation of the secondary pollutant ozone following release of NOx and volatile organic compounds from industrial and other anthropogenic sources
- formation of secondary particulates from sulphur and nitrogen discharges.

A methodology for estimating NO_2 concentrations from modelled NO_x concentrations is provided in Appendix 3 of this guide.

Estimating secondary pollutant effects (ozone and secondary particulates) is technically complex due to the wide range of chemical reactions involved. Typically, only major industrial emission sources (eg, power stations) in or near large urban areas would be expected to assess such effects. The *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004) provides further guidance.

3.5.10 Mercury

At time of writing, New Zealand has signed and is in the process of ratifying the Minamata Convention on Mercury. This instrument is legally binding on States, and aims to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. This convention targets the following activities and sources:

- manufacturing processes in which mercury or mercury compounds are used
- artisanal and small scale gold mining
- coal-fired power plants
- coal-fired industrial boilers
- smelting and roasting processes used in the production of non-ferrous metals[5]
- waste incineration facilities
- cement clinker production
- contaminated sites.

3.6 The nature of the discharge

Characterising the discharge of contaminants to air is a key component of an assessment of effects of discharges to air. Detailed guidance for characterising discharges is provided in section 4 (screening assessment) and section 5 (detailed assessment).

3.7 The sensitivity of the receiving environment

Under the RMA the sensitivity of the environment must be taken into account and should be considered as part of any assessment. The sensitivity of an area will reflect both the provisions of the district plan, which specify land-use and set out amenity expectations for each land-use type, and the actual land uses that exist in the area.

It is recommended that the assessor visit the site in question to determine and/or confirm the land use in person, before undertaking an assessment. Regional council staff should also be able to assist in working out the degree of sensitivity of the surrounding land use.

When assessing air discharges, the sensitivity of a particular location is based on characteristics of the land use, including the time of day and reason that people are at the particular location.

For assessment of amenity effects, reference should be made in the first instance to the relevant district/city and, in some cases, regional plans for specific amenity values for various land-use zones. The district plan is the guiding statutory instrument for amenity.[6]

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5 'Non-ferrous metals' refers to lead, zinc, copper and industrial gold.

Table 1 provides examples and includes general sensitivity classifications that can be assigned to a range of different land uses for assessment of health effects. Table 1 can also provide general guidance for assessment of amenity effects in the absence of any district plan provisions.

Cultural matters such as the presence of marae, mahinga kai (places where food and resources are traditionally gathered), marae and wāhi tapu (sacred places), churches, mosques, theatres, art galleries and sporting/recreational areas and venues may also need consideration.

Table 1: Types of land use and the general sensitivity of the receiving environment

Land use	Rating	Reasons for sensitivity
Hospitals, schools, childcare facilities, rest homes, marae	High	People of high sensitivity (including children, the sick and the elderly) are exposed, and/or People are likely to be exposed continuously (up to 24 hours, seven days a week).
Residential	High	People of high sensitivity (including children and the elderly) are exposed. People expect a high level of amenity in their home and immediate environs (ie, curtilage). People may be present all times of the day and night, both indoors and outdoors. Visitors to the area are unfamiliar with any discharges and are more likely to be adversely affected (which can cause embarrassment to residents and raise awareness of the problem).
Open space recreational	Moderate to high	These areas are used for outdoor activities and exercise, in circumstances where people tend to be more aware of the air quality. People of all ages and sensitivity can be present.
Tourist, cultural, conservation	High	These areas may have high environmental values, so adverse effects are unlikely to be tolerated.
Commercial, retail, business	Moderate to high	These areas have a similar population density to residential areas as people of all ages and sensitivity can use them. Commercial activities may also be sensitive to other uses (eg, food preparation affected by volatile organic compounds emissions from paint manufacture). There can be embarrassment factors for businesses with clients on their premises. Note: Need to consider the time of day, nature of activity, and likelihood of exposure (people are typically present less than 24 hours per day).
Rural residential/ countryside living	Moderate to high	Population density is lower than in residential areas, so the opportunity to be adversely affected is lower. However, people of high sensitivity can still be exposed at all times of the day and night. Often people move into these areas for a healthier lifestyle and can be particularly sensitive to amenity issues or perceived health risks.

[6] See for example *Crown vs Interclean* CRI 2011-092-016845 at paragraph 31.

Land use	Rating	Reasons for sensitivity
Rural	Low for rural activities; moderate or high for other activities	A low population density means there is a decreased risk of people being adversely affected. People living in and visiting rural areas generally have a high tolerance for rural activities and their associated effects. Although these people can be desensitised to rural activities, they may still be sensitive to other types of activities (eg, industrial activities).
Heavy industrial	Low	Adverse amenity effects tend to be tolerated, as long as the effects are not severe. Many sources discharge into air, so there is often a mix of effects. People who occupy these areas tend to be adult and in good physical condition, so are more likely to tolerate adverse effects, particularly if the source is associated with their employment. Note: Need to consider the time of day, nature of activity, and likelihood of exposure (people are typically present less than 24 hours per day).
Light industrial	Moderate	These areas tend to be a mix of small industrial premises and commercial/retail/food activities. Some activities are incompatible with air quality impacts (such as food manufacturers not wanting odours from paint spraying), while others will discharge to air. Note: Need to consider the time of day, nature of activity, and likelihood of exposure (people are typically present less than 24 hours per day).
Public roads	Low	Roads users will typically be exposed to adverse effects from air discharges for only short periods of time.

Key points

The sensitivity of an area will reflect both the provisions of the district plan, which specify land-use and set out amenity expectations for each land-use type, and the actual land uses that exist in the area.

It is recommended that the assessor visit the site in question to determine and/or confirm the land use in person, before undertaking an assessment.

3.7.1 Reverse sensitivity

Reverse sensitivity occurs when sensitive activities, such as residential properties, are allowed to locate where they may be adversely affected by existing industrial or noxious activities. This has the adverse effect of limiting the ability of the industry or noxious activity to operate efficiently and with long-term certainty. Allowing sensitive activities to establish in close proximity to existing industry can potentially result in adverse effects on the health, safety or amenity values of people, as well as potentially adversely affecting the economic and safe operations of industries.

A number of regional and district plans include provisions to manage the effects of reverse sensitivity, for example by restricting the establishment of sensitive activities in certain zones. When assessing discharges to air it is therefore important to assess reverse sensitivity effects that may be generated *by* grant of consent.

For example, separation distances in a district plan may restrict neighbours from undertaking residential subdivision within 300 metre of an established intensive poultry industry. This means that after the intensive poultry industry has been established, it will generate reverse sensitivity restrictions on its neighbours.

However, reverse sensitivity effects may continue to arise depending on land-use planning decisions. For individual sites that are not protected from the effects of reverse sensitivity through plan requirements, and cannot feasibly 'internalise' their effects, maintenance of an appropriate separation distance through property ownership or other legal instruments is the main option to manage reverse sensitivity effects. Separation distances are discussed in section 3.9.4.

3.8 Alternative methods of discharge

An assessment of effects for a discharge of contaminants to air must include a description of any alternative methods of discharge as required by RMA Section 105(1)(c), including discharge into any other receiving environment.

Discussion of alternatives may consider alternative:

- methods of pollution control
- types of pollution control equipment.

3.9 Mitigation measures

An assessment of effects should describe the mitigation measures that will be adopted to manage the actual or potential adverse effects of the proposed activity. This should include measures to avoid accidental emissions (safeguards).

Selection of appropriate mitigation measures is a fundamental part of an air quality assessment and is often an iterative process. For example, if a preliminary assessment predicts significant adverse effects, then additional mitigation measures may be implemented and the effects then reassessed.

The assessment of effects should include adequate detail so parameters that are critical for control of discharge of contaminants to air can be specified in resource consent conditions. The assessment of effects should include proposed consent conditions, which include mitigation measures.

Mitigation measures may include:

- best practicable option and best practice
- emission control equipment
- contingency plans
- offsets (see section 4.1.1)
- separation distances
- on-site management practices, such as proactive maintenance to minimise equipment failure

- alarms, interlocks and monitors for critical aspects of the process as well as emission control equipment
- management plans.

Summary information on abatement equipment is provided in Appendix 2.

3.9.1 Best practicable option and best practice

In accordance with Section 108(2)(e) of the RMA, resource consents may include a condition requiring that the best practicable option is adopted to prevent or minimise any adverse effects caused by a discharge, provided that the inclusion of such a condition is the most efficient and effective means of preventing or minimising any actual or likely adverse effect on the environment. Section 2 of the RMA defines the best practicable option for the discharge of contaminants to air as:

> … the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to—
>
> (a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and
>
> (b) the financial implications, and the effects on the environment, of that option when compared with other options; and
>
> (c) the current state of technical knowledge and the likelihood that the option can be successfully applied.

A range of factors are considered when determining whether an activity is in accordance with the best practicable option. One factor is 'the current state of technical knowledge' which is generally assessed by comparison with best practice. While best practice will generally be consistent for a particular industry, the best practicable option may differ, depending on factors such as the environmental setting and potential for adverse effects.

Best practice for a particular industry may incorporate a number of measures, including:

- compliance with appropriate codes of practice
- employing practices that are as good as, or better than, other similar operations
- good on-site management
- appropriate control technology, including monitoring
- operating suitable processes.

There are a number of useful guidance documents that can help define best practice for a particular industry. These include:

- The *Good Practice Guide for Assessing and Managing Odour* (Ministry for the Environment, 2016b) and the *Good Practice Guide for Assessing and Managing Dust* (Ministry for the Environment, 2016a)
- Auckland Council provides guidance on best practice for pollution control equipment. The guidance describes suitable applications, design criteria, operating criteria, monitoring

requirements and standard consent conditions for biofilters, fabric filters (baghouses), incinerators (afterburners), and scrubbers (Auckland Council, 2002[7]).

- Guidance on the best available techniques for a wide range of industrial sectors is available from the website of the European Integrated Pollution Prevention and Control Bureau (EIPPCB).[8] This provides reference documents on the best available techniques under the EU Integrated Pollution Prevention and Control Directive. The UK Department for Environment, Food and Rural Affairs (Defra) also has an extensive range of process guidance notes for specific industries.[9]
- The NSW Department of Environment and Conservation Protection of the Environment Operations (Clean Air) Regulations (2010) provides guidance on what constitutes best practice in terms of emission levels in the State of New South Wales.

It is important to note that international guides are not specific to New Zealand and do not take precedence over guidance in this document.

Key point

An assessment of effects should consider whether the proposal is in accordance with the best practicable option.

This should include consideration of the extent to which the mitigation measures in place (or proposed) are consistent with best practice for the type of industry being considered.

3.9.2 Contingency measures

For activities where there is the potential for discharges to air with a low probability but high potential impact, it is good practice to include a description of contingency measures in an assessment.

A contingency plan may also be appropriate in certain circumstances to provide for additional mitigation measures if adverse effects occur – for example, if effects are uncertain or if the sensitivity of the receiving environment is likely to change over time. In these circumstances, it may also be appropriate to propose a specific review condition in accordance with section 128 of the RMA. A review condition is an effective and efficient way of providing a council the flexibility to review the consent conditions to address specific significant adverse effects that might arise during the exercise of the consent. Example review conditions are included in Appendix 1.

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7 At the time of writing, this document is being updated.

8 http://eippcb.jrc.es/.

9 www.defra.gov.uk/environment/quality/industrial/las-regulations/guidance/.

Key points

Where there is the potential for discharges to air with a low probability but high potential impact, a description of contingency plans should be included in an assessment of effects.

Contingency plans, such as review conditions of consent, may also be appropriate to provide mitigation measures in the event of unforeseen adverse effects.

3.9.3 Offsets

Offsets are when emissions from a new activity are 'offset' by emission reductions elsewhere in an airshed. Offsets are required under certain circumstances under the NES for air quality. Consent conditions to implement offsets may also be proposed by applicants as a mitigation measure.

PM_{10} offsets are required under the NES for air quality where:

- the airshed is 'polluted' (ie, exceeds the ambient PM_{10} standard)
- the proposal will increase ambient PM_{10} by more than 2.5 μg/m^3 as a 24-hour average ad
- it is either a new activity or an existing activity increasing existing PM_{10} emissions.

Detailed guidance for the requirements and implementation of offsets is provided in *2011 Users' Guide to the Revised National Environmental Standards for Air Quality: Updated 2014* (Ministry for the Environment, 2014).

Bay of Plenty Regional Council has adopted specific regional guidance on offsetting (Bay of Plenty Regional Council, 2013). This provides some additional technical guidance that may be useful for other regions if offsets are being considered. Northland Regional Council has also discussed offsets as part of the Marsden Point Air Quality Strategy (Northland Regional Council, 2007).

Key point

Offsets are required under certain circumstances under the NES for air quality. Consent conditions to implement offsets may also be proposed as a mitigation measure by applicants.

3.9.4 Separation distances

Separation distances (buffers) are primarily intended to manage:

- the potential effects of unintended or accidental discharges
- the adverse effects of activities that cannot always be internalised without a separation distance, even with the adoption of best practice (for example, large quarries or landfills)
- reverse sensitivity effects (see section 3.7.1).

Separation distances are not intended as an alternative to source control, but are implemented in addition to pollution controls consistent with the best practicable option.

Maintenance of appropriate separation distances is primarily a land-use planning issue that is managed through district plan provisions, which may include:

- encouraging appropriate location of industry within an area that is zoned for industry in the district plan and is adequately separated from more sensitive zones, with provisions to exclude sensitive activities from the buffer area
- graduated zoning from heavy industry through to light industry and on to highly sensitive land uses such as residential. Councils have to balance this against making sure that the availability of industrially zoned land is not eroded over time
- creating zones and zone provisions (or other planning provisions such as overlays) that alert prospective owners, developers and decision-makers to the potential for reverse sensitivity effects if new sensitive activities are established in particular locations
- buffer distances in district or regional plans for determining activity status (eg, the Auckland Operative Air, Land and Water plan specifies new poultry farms with more than 180,000 birds and a buffer distance of less than 400 metres as discretionary).

Separation distance provisions are included in a number of regional and district plans around New Zealand. These provisions are generally not absolute requirements; rather they determine the status of activities in the plan. This approach allows flexibility and recognises that there may be circumstances where a lesser separation distance is appropriate. However separation distances specified in plans need to be taken more seriously than simply triggering more detailed assessment. The importance of separation distances in plans is supported in case law, most recently in *Craddock Farms v Auckland Council* 2016:[10]

> We note the emphasis Mr Lee Marr, the applicant's planning witness, gave to the separation distances set out in the Auckland ALW Plan as merely setting the status of the activity that determines whether or not it is discretionary or restricted discretionary. The same could be said of the approach in other plans nationally given any setbacks or similar approaches are generally used as a trigger for a resource consent of different stringency. We think that is to unjustifiably downgrade the importance of the consideration that should be given to separation as an approach.

In addition to land-use planning tools, there are steps that industries can take to maintain adequate separation distances to manage the effects of unintended or accidental releases and/or any effects that cannot be internalised. These include:

- appropriate location of industry within an area that is zoned for industry in the district plan and is adequately separated from more sensitive zones
- ownership or control of the separation distance by the industry creating the discharge
- use of notional boundaries established through legal instruments including 'no-complaint' covenants.

This approach is supported in case law, for example in *Hill v Matamata Piako District Council & Waikato Regional Council*, the Court stated:

> We reiterate again in this decision that we are of the view that adverse effects such as objectionable odour emissions should be confined on site… This may well involve extra cost to the industry generally and to particular farmers. As a general principle we are of the view that such cost should be borne by the industry in the event that the siting of operations is such that there is potential to cause adverse effects.

[10] 2016 NZEnvC 051. At paragraph 124.

Most Australian states have published guidelines for appropriate separation distances. However it is important to recognise that the EPA Victoria guidelines (and other similar guidance) are generic. Most of the separation distance guidelines are based on the protection of amenity values at sensitive locations. They do not generally consider risk, or potential health effects. It is also important to note that they do not take into account site specific factors which may influence discharge rates and how they are dispersed (eg, the specific processes and emission controls used on site). They are also applied in all directions and so do not take into account the effects of local topography and meteorology.

Separation distance guidelines are not intended to be used as a pass/fail test, rather as a trigger for more detailed assessment to determine the appropriate separation distance for a particular site. This assessment should consider unintended or accidental releases and/or any effects that cannot be internalised, even with adoption of the best practicable option.

When considering an appropriate separation distance for a site, the assessor should always review the relevant guidance and ensure that the basis of the recommended separation distance is clearly understood.

Key point

Relevant separation distances should be considered when assessing industrial discharges to air, to address unintended or accidental releases and/or any effects that cannot be internalised, even with adoption of the best practicable option.

3.9.5 Management plans

Management plans can be used to show how an activity will comply with the conditions of resource consent and manage adverse effects.

The Quality Planning website provides guidance on the role of management plans, and states:

> Critical actual or potential adverse effects need to be identified, appropriately avoided, remedied or mitigated with conditions before a decision to grant is made and not left to be addressed via a future management plan. Management plans should be limited to non-critical operational processes that lie behind a performance or operational standard.

It is important that management plans are comprehensive ‘living documents’, and are regularly updated. It is good practice that the management plan is made available at the time of applying for a resource consent (albeit in draft form covering key operational matters, pending consent). It is not generally recommended to include the entire management plan as a condition of consent. It is preferable to include specific mandatory aspects of a management plan as consent conditions.

A condition of consent might be the future development of a management plan that gives detailed information on how the consent holder will comply with other conditions of the consent. However, after a consent is granted, a council cannot require that a management plan lodged be subject to council’s approval (as this is unlawful).

Management plans are particularly relevant for control of fugitive dust and odour discharges, and are discussed in detail in the *Good Practice Guide for Assessing and Managing Dust*

(Ministry for the Environment, 2016a) and *Good Practice Guide for Assessing and Managing Odour* (Ministry for the Environment, 2016b).

Key points

Draft management plans should cover all key operational matters and ideally made available at the time of applying for the resource consent.

Conditions relating to management plans cannot reserve the power to approve conditions outside the formal resource consent process. This is because conditions must not unlawfully delegate or defer matters essential to the consent itself. This means that a council cannot reserve the right of approval over management plans submitted after the consent has been granted.

3.10 Affected persons and consultation

Although consultation is not mandatory, it is recommended, as discussed in sections 2.2 and 2.3.

Schedule 4 of the RMA requires that an assessment of environmental effects includes:

- identification of any persons affected by the activity
- any consultation undertaken
- any response to that consultation.

The location of the activity and the sensitivity of the receiving environment will influence the decision as to who is potentially adversely affected.

3.10.1 Notification

Section 95 of the RMA outlines the requirements for notification of applications for consent.

The Quality Planning website provides the following guidance for council assessments for the purposes of notification. Note that this is only for the purposes of notification – not for assessment in accordance with section 104.

> A council must decide if a person is an affected person if the activity's adverse effects on the person are minor or more than minor (but are not less than minor) (s95E).
>
> The council can disregard only such adverse effects as will certainly be less than minor and those effects that are only a remote possibility. The council may also disregard an adverse effect if a rule or national environmental standard permits an activity with that effect and in the case of controlled or restricted discretionary activities, where an effect does not relate to a matter over which control or discretion has been reserved.
>
> Potentially adversely affected persons (depending on the nature and scale of the resource consent application – keeping in mind that the effects on persons who own or occupy the subject site and adjacent sites are disregarded in public notification decisions) may include:
>
> - owners and occupiers of the land (an 'owner' includes any person who is a party to a current written sale and purchase agreement for the land (either conditional or

unconditional), or a similar agreement to take a lease of the land. Where there are joint owners, it is important that each give written approval (or one owner give specific approval on the other's behalf – but not implied consent). Where the property is tenanted, it may be unreasonable to treat a short-term tenant as being affected.

- owners and occupiers of adjacent, nearby and/or downstream land
- tāngata whenua
- downstream resource users
- any Minister of the Crown with statutory responsibilities for an area or a site that could be adversely affected
- the relevant district or regional council
- those persons or organisations whose use or enjoyment of an area could be adversely affected
- adjoining owners/occupiers with sensitive activities (reverse sensitivity effects)
- any other person who the council considers is affected in a manner different from the public generally.

Just because some people and organisations may have an interest in a proposal, does not mean they may be affected. Some potential adverse effect, of at least a minor nature on a person, must be apparent for written approval to be considered necessary. Case law has shown that an affected person is one who is 'affected in a manner different from the public generally'. Being 'interested' in a manner different from the public generally has not been enough.

Adverse effects on persons are broadly conceived and are not limited to direct effects on those who own or occupy land. Persons can also be adversely affected in an environmental sense (ie, indirectly by the proposed activity).

3.10.2 Determining whether effects are more than minor

When assessing whether an activity will have or is likely to have adverse effects that are more than minor, council will have regard to the following:

- the cumulative nature of any effect over time, or in combination with other effects
- the effects of an occurrence (including likelihood and consequence)
- temporary effects, including adverse effects associated with construction work
- the scale and consequences of the effect (eg, high potential impact)
- the duration of the effect
- the permitted baseline
- the frequency or timing of any effect
- whether the effect relates to a s6 or s7 matter
- the area affected (eg, is it an effect on neighbours or the wider environment?)
- the sensitivity of surrounding uses to that effect
- reverse sensitivity issues

- whether the effect is to be mitigated or avoided by a condition contained in the application or offered by the applicant in the application, which the applicant has agreed to.

This will be assessed by council officers on a case-by-case basis.

3.11 Monitoring

Activities that require air discharge consents are often of a scale or significance that warrant monitoring either to gather information for an assessment or to demonstrate compliance with conditions of consent.

An assessment of effects should outline any monitoring that has been undertaken, and any that is proposed. Monitoring requirements will vary depending on the nature and scale of the activity, but may include:

- source emission testing following standard methods, and by companies who are accredited by International Accreditation New Zealand to undertake the method
- process monitoring, for example alarms and controls associated with critical parts of the plant or emission control equipment
- self-monitoring, such as the use of odour scouts and visual monitoring of discharges
- ambient air quality monitoring (guidance on undertaking monitoring is provided in the *Good Practice Guide for Air Quality Monitoring and Data Management* (Ministry for the Environment, 2009).

Further guidance on monitoring the effects of odour and dust emissions is provided in the *Good Practice Guide for Assessing and Managing Dust* (Ministry for the Environment 2016a) and the *Good Practice Guide for Assessing and Managing Odour* (Ministry for the Environment 2016b).

Key point

Activities that require air discharge consents are often of a scale or significance that warrant monitoring either to gather information for an assessment or to demonstrate compliance with conditions of consent.

Readers are referred to other good practice guides for guidance on undertaking monitoring (Ministry for the Environment 2009, 2016a, 2016b).

3.12 Relevant matters in sections 104 and 105

In addition to the information requirements for resource consent applications under section 88 and Schedule 4, it is recommended that applicants address any other matters that the consent authority must have regard to, in accordance with section 104 and section 105 of the RMA.

In particular, for an application affected by section 124 (exercise of resource consent while applying for new consent), information should be provided on the value of the investment of the existing consent holder.

3.13 Out of scope

3.13.1 Global climate change

Sections 70A and 104E of the RMA place the avoidance and reduction of climate change outside the responsibility of consenting authorities in their consideration of discharge consents. The assessment of effects of greenhouse gas emissions from industry on global climate change is therefore outside the scope of this document. Policy measures to control the emission of greenhouse gases are developed and led by the Ministry for the Environment.

3.13.2 Ozone depletion

The Montreal Protocol 1987 is an international agreement for phasing out substances that deplete the ozone layer.

New Zealand has ratified the Montreal Protocol and implemented its objectives through the Ozone Layer Protection Act 1996 and the Ozone Layer Protection Regulations 1996. This legislation controls ozone-depleting substances to prevent their release to the atmosphere through bans on their import and use, etc. Site-specific assessments of the effects of releasing such substances to the atmosphere should therefore not be necessary. The full list of ozone-depleting substances can be found in the Regulations.

4 Ambient air quality criteria

This section of the guide describes ambient air quality criteria[11] which are used to help determine whether the effects of an industrial development on air quality are acceptable.

Ambient air quality criteria provide minimum requirements that outdoor air quality should meet to protect human health and the environment. However, the basis of air quality criteria differs depending on the pollutant in question and the jurisdiction of the agency deriving the criteria.

For example, air quality criteria are derived differently for:

- threshold compounds; substances where a threshold has been established below which there are no known adverse effects from exposure
- non-threshold compounds; substances, such as genotoxic carcinogens, where there is no known safe level of exposure. Air quality criteria for non-threshold compounds are therefore based on an acceptable level of risk.

It is therefore, important that the fundamental purpose of the air quality criteria is understood, as well as its applicability to the nature of the discharge and receiving environment. What may be appropriate criteria for assessment of a constant discharge leading to chronic exposure may not be appropriate for assessment of an infrequent or intermittent discharge.

Irrespective of the pollutant, ambient air quality criteria should not be used as limits to pollute up to. This is especially important for pollutants such as PM_{10}, where there is no clear threshold below which effects do not occur. This is because for non-threshold pollutants, any increase in ambient concentrations may result in adverse effects.

The New Zealand regulatory framework contains the following air quality criteria:

- national environmental standards for air quality[12] (NES for air quality)
- national ambient air quality guidelines
- objectives and policies in some regional plans.

It is important to note that regional plans are statutory instruments under the Resource Management Act (RMA). If the air quality objectives in a regional plan are more stringent than the NES for air quality, then the regional plan takes precedence. For this reason it is very important to check the requirements of the relevant regional plan before undertaking any assessment of the discharges to air from industry.

A thorough air quality assessment should consider the potential effects of both short-term (acute) and long-term (chronic) exposure, where health research has indicated effects over each exposure period may occur.

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[11] Assessment criteria for dust and odour are discussed in the *Good Practice Guide for Assessing and Managing Dust* (Ministry for the Environment, 2016a) and the *Good Practice Guide for Assessing and Managing Odour* (Ministry for the Environment, 2016b) respectively.

[12] Resource Management Act (National Environmental Standards for Air Quality) Regulations 2004.

Air quality criteria published by different agencies may overlap, complement or sometimes contradict each other for some pollutants and for some time averages depending on how and when the criteria were derived. In all cases, the assessment should explain which criteria have been selected and why.

It should also be noted that air quality criteria may become outdated. The Ministry for the Environment website should be checked for any updates to the NES for air quality or guidelines discussed in this section.

For those pollutants not covered by the criteria discussed below, or in cases where the criteria are exceeded, health risk assessment techniques should be applied.

New Zealand and other international ambient air quality criteria are discussed in more detail below.

4.1 National environmental standards for air quality

Schedule 1 of the NES for air quality sets ambient standards in the form of ambient concentration limits for the following pollutants:

- carbon monoxide (CO)
- nitrogen dioxide (NO_2)
- ozone (O_3)
- fine particulate matter that is less than 10 micrometres in diameter (PM_{10})
- sulphur dioxide (SO_2).

The primary purpose of the NES for air quality is to provide a guaranteed level of protection for the health of all New Zealanders.

The ambient standards, therefore, consist of acceptable concentrations for a particular time average, with a specified number of permissible exceedances each year, as summarised in table 2.

Detailed guidance on applying the NES for air quality is provided in the *2011 Users' Guide to the Revised National Environmental Standards for Air Quality: Updated 2014* (Ministry for the Environment, 2014). A number of key issues relevant to the assessment of discharges from industry are summarised and discussed here.

The ambient standards apply in the open air everywhere people are likely to be exposed. This includes roadside verges, residential areas, central business districts, parks and beaches.

Areas that are *not* in the open air and where the ambient standards do not apply include inside:

- buildings
- tunnels
- vehicles.

The ambient standards are also not applicable on sites to which resource consents apply. For example, Acme Fertiliser may operate a large factory, with emission limits specified in their resource consent for discharges of SO_2. The national environmental standard for SO_2 does not apply on Acme's site (workers on the Acme site being protected under health and safety legislation). However, next door (and so off-site) at the Green Fingers Garden Centre, the national environmental standard for SO_2 does apply. This is to protect the health of any members of the public (including Green Fingers staff) that may be exposed to emissions of SO_2.

Table 2: Ambient standards set in the NES for air quality (2004)

Pollutant	Standard	Time average	Allowable exceedances per year
Carbon monoxide (CO)	10 mg/m^3	8-hour	1
Nitrogen dioxide (NO_2)	200 µg/m^3	1-hour	9
Ozone (O_3)	150 µg/m^3	1-hour	0
Fine particles (PM_{10})	50 µg/m^3	24-hour	1
Sulphur dioxide (SO_2)	350 µg/m^3 570 µg/m^3	1-hour 1-hour	9 0

In addition to this, when assessing the potential impacts of discharges to air from industry, careful judgement is needed to determine whether people are likely to be exposed, and over what time period. General guidance is provided in table 3.

Table 3: Location and applicability of the ambient standards for assessment purposes

Averaging period	Locations where assessment against the ambient standards should apply	Locations where assessment against the ambient standards should not apply
1 hour	This includes any outdoor areas where the public might reasonably be expected to spend one hour or longer, including pavements in shopping streets, as well as accessible facades (eg, balconies, terraces).	Any industrial premises that have resource consents (for that pollutant).
8 hours	This includes all outdoor locations where members of the public are likely to be exposed for eight hours as well as the facades of residential properties, schools, hospitals, libraries, etc.	Any industrial premises that have resource consents (for that pollutant). Any location where people are not likely to be exposed for 8 hours – for example roads and footpaths.
24 hours	This includes all outdoor locations where members of the public might reasonably be exposed for 24 hours.	Any industrial premises that have resource consents for that pollutant. Any location where people are not likely to be exposed for 24 hours – for example roads, footpaths and industrial areas where residential use is not allowed.
All		In any enclosed space (ie, not in the open air), including: • indoors • inside tunnels • inside vehicles.

4.1.1 Airsheds that breach the ambient PM_{10} standards

Regulation 17 requires offsets for discharges of PM_{10} from industry under the following circumstances:

- a resource consent application seeks to authorise the discharge of PM_{10}
- the same activity is not already authorised by a resource consent, held by the applicant at the time the new application is lodged with the consent authority
- the discharge would be likely at any time to increase the average 24-hour concentration of PM_{10} by more than 2.5 µg/m^3 in any part of the polluted airshed (other than at the site where the discharge will occur).

The *2011 Users' Guide to the Revised National Environmental Standards for Air Quality: Updated 2014* (Ministry for the Environment, 2014) provides guidance on when these circumstances apply.

Polluted airshed

A polluted airshed is an airshed that has, on average, more than one exceedance of the ambient PM_{10} standard (50 µg/m^3 as a 24-hour average) for each of the past 5 years. An airshed ceases to be polluted when, and only when, the PM_{10} standard has not been breached in the airshed for five years.

Offsets

For the purposes of the NES for air quality, offsets are mitigation measures to counterbalance impacts of new or additional PM_{10} discharges into an already overloaded airshed. This is achieved by requiring that the new or additional emissions of PM_{10} are offset by reductions of PM_{10} emissions elsewhere in the airshed.

A straightforward example of an offset would be a new industry assisting a hospital to convert a coal-fired boiler to natural gas. The reduced PM_{10} emissions from the hospital boiler offset the proposed industrial discharges of PM_{10}.

Regulation 17(3) also requires that offsets must:

- be from another source in the same airshed
- take effect within one year of the grant of the resource consent
- be effective for the duration of the consent.

Further guidance is provided in *2011 Users' Guide to the Revised National Environmental Standards for Air Quality: Updated 2014* (Ministry for the Environment, 2014).

4.1.2 Carbon monoxide, nitrogen dioxide and ozone

For carbon monoxide (CO), oxides of nitrogen (NO_x) and volatile organic compounds (VOCs), resource consents must be declined where the discharge is likely to cause a breach of the CO, nitrogen dioxide (NO_2) or ozone ambient standard, and the discharge is a principal source of CO, NO_x or volatile organic compounds.

Principal source

Whether an activity is a principal source varies depending on the airshed the source is discharging into. The *2011 Users' Guide to the Revised National Environmental Standards for Air Quality: Updated 2014* (Ministry for the Environment, 2014) suggests that, when determining whether a source is a 'principal source', councils should consider the:

- mass emission rate for the source site compared with the total mass emission rate within the airshed
- maximum ground level concentration from the source (any source that results in a maximum ground level concentration of 5–10 per cent of the pollutant ambient standard could reasonably be considered to be a principal source).

For example, in areas with very low background levels of NO_2, consent must be declined for a large discharge of NO_x (a 'principal' source) that would result in a breach of the NO_2 standard (200 $\mu g/m^3$ as a 1-hour average). In an area of elevated levels of NO_2, however, consent may still be granted for a small discharge of nitrogen oxides because it is not a principal source – even if it pushed ambient levels over the NO_2 standard.

4.1.3 Sulphur dioxide

For SO_2, a council must decline an application for a resource consent to discharge SO_2 into the air, if the discharge to be allowed is likely to cause the concentration of SO_2 in the airshed to breach the national ambient air quality standard for SO_2 (either 350$\mu g/m^3$ as a 1-hour average for more than 8 hours per year, or 570 $\mu g/m^3$ for any 1-hour averaging period).

4.2 New Zealand air quality guidelines

New Zealand's *Ambient Air Quality Guidelines* (Ministry for the Environment, 2002) were published as guidance to the RMA, and provide the minimum requirements that outdoor air quality should meet to protect human health and the environment. The guidelines were developed following a comprehensive review of international and national research, and were widely accepted among New Zealand practitioners at the time.

The primary purpose of the *Ambient Air Quality Guidelines* is to promote sustainable management of the air resource in New Zealand.

In addition to the human health-based guidelines presented in table 4**,** guidelines for ecosystem protection are provided for sulphur dioxide, sulphate particulate, nitrogen dioxide, ammonia, ozone and fluoride, as shown in table 5.

The ambient standards in the NES for air quality replace any previous guidelines for that particular pollutant and averaging period.

Table 4: National ambient air quality guidelines (2002)

Indicator	Level	Averaging time
Carbon monoxide	30 mg/m^3	1 hour
Fine particulates (PM_{10})	20 µg/m^3	Annual
Nitrogen dioxide	100 µg/m^3	24 hours
Sulphur dioxide	120 µg/m^3	24 hours
Ozone	100 µg/m^3	8 hours
Hydrogen sulphide	7 µg/m^3	1 hour
Lead	0.2 µg/m^3	3-month moving average*
Benzene	3.6 µg/m^3	Annual
1,3 butadiene	2.4 µg/m^3	Annual
Formaldehyde	100 µg/m^3	30 minutes
Acetaldehyde	30 µg/m^3	Annual
Benzo(a)pyrene	0.0003 µg/m^3	Annual
Mercury (inorganic) Mercury (organic)	0.33 µg/m^3 0.13 µg/m^3	Annual Annual
Chromium (Cr) VI Cr metal and Cr III	0.0011 µg/m^3 0.11 µg/m^3	Annual Annual
Arsenic (inorganic) Arsine	0.0055 µg/m^3 0.055 µg/m^3	Annual Annual

*Calculated monthly

Table 5: Critical levels for protecting ecosystems (2002)

Contaminant and land use	Critical level	Averaging period	Additional requirements
Sulphur dioxide (SO_2): • agricultural crops • forest and natural vegetation • lichen	 30 µg/m^3 20 µg/m^3 10 µg/m^3	 Annual and winter average Annual and winter average Annual	
Sulphate particulate: • forests	 1.0 µg/m^3	 Annual	 Where ground-level cloud present > 10% of time
Nitrogen dioxide (NO_2)	30 µg/m^3	Annual	
Ammonia	8 µg/m^3	Annual	
Ozone (O_3): • forests • semi-natural vegetation • crops (yield) • crops (visible injury)	 21,400 µg/m^3/h 6,420 µg/m^3/h 6,420 µg/m^3/h 428 µg/m^3/h 1,070 µghm^3/h	 6 months 3 months 3 months 5 days 5 days	 Daytime vpd < 1.5 kPa Daytime vpd > 1.5 kPa
Fluoride: • special land use	 1.8 µg/m^3 1.5 µg/m^3	 12 hours 24 hours	

Contaminant and land use	Critical level	Averaging period	Additional requirements
	0.8 µg/m^3	7 days	
	0.4 µg/m^3	30 days	
	0.25 µg/m^3	90 days	
• general land use	3.7 µg/m^3	12 hours	
	2.9 µg/m^3	24 hours	
	1.7 µg/m^3	7 days	
	0.84 µg/m^3	30 days	
	0.5 µg/m^3	90 days	
Conservation areas	0.1 µg/m^3	90 days	

Notes: kPa = kiloPascal is a measure of pressure; vpd = vapour pressure deficit.

Critical levels for NO_2 assume that either O_3 or SO_2 are also present at near guideline levels. Critical levels for O_3 are expressed as a cumulative exposure over a concentration threshold referred to as AOT40 values (accumulative exposure over a threshold of 85.6 µg/m^3, at 0°C), calculated as the sum of the difference between hourly ambient O_3 concentrations and 85.6 µg/m^3, when O_3 concentrations exceed 85.6 µg/m^3. O_3 is only measured during daylight hours, with a clear global radiation of 50 Wm^{-2} or greater.

4.3 Regional plan criteria

Regional plans may specify regional air quality criteria to reflect regional circumstances. It is important to understand the policies and objectives of each regional plan when considering the application of air quality criteria (sometimes referred to as guidelines, targets or goals).

Regional air quality plans give effect to the NES for air quality. Where air quality criteria conflict the more stringent level in a particular instrument applies. Thus a regional air quality objective that is more stringent than an ambient standard in air quality NES supersedes the standard. The regional air quality objectives cannot, however, be more lenient than the standard.

For regional plans that are not operative, the weight given to proposed assessment criteria will need to be carefully reviewed in light of national and international best practice.

4.4 WHO guidelines

In 2006, the World Health Organisation (WHO) published the *Air Quality Guidelines Global Update 2005* (World Health Organisation, 2006).

The primary aim of the WHO global air quality guidelines is to provide a uniform basis for protecting public health from the effects of air pollution. They are intended for worldwide use.

The WHO global air quality guidelines are based on good science and have been developed in a transparent, documented process by international experts in the fields of air pollution and medicine. Although they are not statutory guidelines in New Zealand, it is good practice to consider them when determining whether a discharge is likely to have a significant adverse effect.

Table 6 summarises the WHO global air quality guidelines which were based on the latest scientific evidence at the time of publication and provide useful assessment criteria for chronic impacts for important pollutants such as PM_{10}, $PM_{2.5}$ and nitrogen dioxide for which there are currently no New Zealand guidelines. The WHO 24-hour average $PM_{2.5}$ guideline is consistent with the New Zealand monitoring $PM_{2.5}$ guideline (Ministry for the Environment, 2002). The WHO 24-hour guideline for SO_2 is considerably more stringent than the New Zealand ambient air quality guideline.

In 2013, WHO published a comprehensive review of the science regarding the health effects of air pollution, to incorporate a considerable amount of new scientific information (World Health Organisation, 2013). This new evidence supports the conclusions of the *Air Quality Guidelines Global Update 2005* and indicates that in some cases adverse effects may occur at concentrations lower the guidelines.

The previous WHO ambient air quality guidelines for Europe (World Health Organisation, 2000) may still be relevant for chemicals where there is no New Zealand regulation or guidance (eg, vinyl chloride).

Table 6: WHO global air quality guidelines (2005)[13]

Pollutant	Air quality guideline value	Averaging time
Particulate matter $PM_{2.5}$ PM_{10}	**10 μg/m³** 25 μg/m³ 20 μg/m³ 50 μg/m³	**1 year** 24 hours (99th percentile) 1 year 24 hours (99th percentile)
Ozone (O_3)	100 μg/m³	8 hours, daily maximum
Nitrogen dioxide (NO_2)	**40 μg/m³** 200 μg/m³	**1 year** 1 hour
Sulphur dioxide (SO_2)	20 μg/m³ 500 μg/m³	24 hours 10 minutes

Note: Items in bold are not covered by New Zealand standards or guidelines.

4.5 International air quality criteria

If there are no ambient standards, national, regional or WHO guidelines[14] that are relevant to the contaminant under assessment, a number of other international air quality criteria may be used.

As noted above, air quality criteria published by different agencies may overlap, complement or differ from each other for some pollutants and for some time averages. It is very important when selecting air quality criteria for an air quality assessment, therefore, that the fundamental purpose and derivation of the standard or guideline is understood and explicitly considered in relation to the assessment. What may be appropriate for a constant discharge leading to chronic exposure may not be appropriate for an infrequent or intermittent discharge. An assessment that is made using international air quality criteria should explain which criteria have been selected, and why.

[13] World Health Organisation. 2006. *Air Quality Guidelines Global Update 2005, Particulate matter, ozone, nitrogen dioxide and sulfur dioxide*. Copenhagen: WHO Regional Office for Europe.

[14] NB: See note above about 2000 WHO guidelines (World Health Organisation, 2000) being somewhat dated.

The criteria discussed below are recommended because of their traceable derivation from toxicological data. They should be applied primarily as screening criteria. If the modelling/monitoring results are well within the assessment criteria, then the effects on public health and the environment should not be significant. If the results exceed the criteria, however, then a more detailed health risk assessment may be required (see section 6.6) and/or action will be needed to mitigate the emissions before consent is granted.

4.5.1 Acute exposure

For assessing short-term impacts, the California Office of Environmental Hazard Assessment acute reference exposure limits are recommended. These can be found at www.oehha.ca.gov/air.html. The acute reference exposure limits are concentrations that are not likely to cause adverse effects in a human population, including sensitive subgroups, exposed to that concentration on an intermittent basis for one hour.

Acute reference exposure limits are intended to protect the individuals who live or work in the vicinity of emissions of these substances.

The focus of the acute reference exposure limits is generally a one-hour exposure for non-cancer health impacts. At time of writing they are currently being reviewed to assess their adequacy to protect children.

4.5.2 Chronic exposure

Non-carcinogenic health impacts

For assessing long-term impacts, the US EPA inhalation reference concentrations and air unit risk factors are recommended, and can be found at www.epa.gov/iris/limits.htm.

The inhalation reference concentration is an estimate of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of damaging effects during a lifetime. Note that these concentrations are based on an assumption of lifetime exposure, and may not be appropriately applied to less-than-lifetime exposure situations.

The inhalation reference concentrations are 24-hour averages and focus on non-carcinogenic health impacts.

Alternatively, the California Office of Environmental Hazard Assessment chronic reference exposure levels may be used. A chronic reference exposure level is an airborne level that would pose no significant health risk to individuals indefinitely exposed to that level. Chronic reference exposure levels can be found at www.oehha.ca.gov/air.html.

Chronic reference exposure levels are annual averages and focus on non-carcinogenic health impacts.

Carcinogenic health impacts

A full list of carcinogens, and suspected carcinogens, is maintained by the (World Health Organisation) International Agency for Research on Cancer (IARC), and can be found at www.iarc.fr.

The US EPA air unit risk factors are quantitative estimates of the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/m^3 in air. The interpretation of unit risk would be:

> If unit risk = 2 x 10^{-6} per µg/m^3 then two excess cancer cases (upper-bound estimate) are expected to develop per 1,000,000 people if exposed daily for a lifetime to 1 µg of the chemical in 1 cubic metre of air.[15]

Quantitative estimates of risk factors for carcinogens are provided in the US EPA Integrated Risk Information System database, referred to in the above web address. As with the inhalation concentrations, the unit risk factors are based on an assumption of lifetime exposure, and may not be appropriately applied to less-than-lifetime exposure situations.

Historically air quality assessments in New Zealand have adopted an acceptable environmental risk for exposure by residential receptors to individual environmental pollutants of 1 in 1,000,000. This is still recommended when assessing discharges to air from industry.

4.6 Other air quality criteria

Assessment of contaminants for which there are no readily available guidelines should only be undertaken by experienced air quality practitioners. It requires a thorough understanding of the toxicity of the contaminant(s) in question.

Texas effects screening levels

The 'Texas effects screening levels' are screening levels used in the Texas Commission for Environmental Quality's air permitting process. Some of the Texas effects screening levels have been derived in a transparent manner from toxicological data and are supported by appropriate documentation, and these are appropriate for screening assessments. However, the derivation and basis of some of the screening levels is unclear and where supporting documentation is not available, the use of these criteria is not recommended.

Workplace exposure standards

For some contaminants, and in the absence of any other guidance, the New Zealand Workplace Exposure Standards[16] Time Weighted Average (TWA) can be amended for use as assessment criteria.

The workplace exposure standards (WES) cover many of the chemicals that might be discharged, but they are set for protecting healthy people in a workplace setting (ie, a 40-hour working week). To protect more sensitive members of the community (the very young, the elderly, those whose health is already compromised) these standards should be divided by a safety factor for assessment over an eight-hour exposure period. Recommended safety factors are for:

- low and moderately toxic hazardous air pollutants – WES TWA divided by 50
- highly toxic bioaccumulative or carcinogenic hazardous air pollutants – WES TWA divided by 100.

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15 http://www.epa.gov/risk/glossary.html.

16 www.business.govt.nz keyword: Department of Labour, New ZealandWorkplace Exposure Standards and Biological Exposure Indices.

This is based on division by 42 (rounded to 50). The factor of 42 is used to convert the eight-hour WES TWA into a 24-hour average over a whole week of discharges, and then adding a further safety factor of 10 to account for protecting more sensitive portions of the population than healthy workers. The 100 factor has been derived by the same method, except that a safety factor of 20 has been used to account for more toxic hazardous air pollutants or more long-term chronic effects. Amended WES TWA criteria should be compared with a one-hour average.

Screening criteria from toxicity data

In the absence of any workplace exposure standards, or other suitable criteria, a risk assessment approach may be used to develop screening ambient air quality criteria. However, as stated above this should only be undertaken by experienced air quality practitioners. It requires a thorough understanding of the toxicity of the contaminant(s) in question.

Criteria can be derived from **inhalation toxicity data** using the same approach used by the US EPA for development of reference concentrations (RfCs) and the WHO in development of Tolerable Daily Intake Values.[17] In accordance with this approach, the reported inhalation no observable adverse effects level (NOAEL) or lowest observable adverse effects level (LOAEL) should be adjusted for 24-hour, seven-day exposure.

To account for the fact that humans may be more or less sensitive than the test animal, a 10-fold uncertainty factor is usually applied. This uncertainty factor is called the 'interspecies uncertainty factor'. An additional 10-fold uncertainty factor, the 'intraspecies uncertainty factor', is usually applied to account for the fact that some humans may be substantially more sensitive to the effects of substances than others.

Criteria can be derived from **oral toxicity data** (eg, acceptable daily intake or reference dose values), for example based on the assumption that the inhalation pathway can account for no more than 10 per cent of the acceptable daily intake. On this basis, a screening criterion can be calculated as follows:

$$C_{\text{screening air}} = 10\% \times \frac{ADI \times BW \times AT}{IR \times EF \times ED}$$

Where:

ADI = acceptable daily intake (mg/kg bw/day)

BW = body weight (kg)

AT = averaging time (days)

EF = exposure frequency (days/year)

ED = exposure duration (years)

IR = inhalation rate (m^3/day)

Appropriate default values for body weight and inhalation rate are provided in table 7.

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17 Assessing human health risks of chemicals: derivation of guidance values for health-based exposure limits. Environmental Health Criteria 170. IPCS, 1994.

Table 7: Body weight and inhalation rate default values

Age	Exposure factors	Value	
Adult	Age	7–30	years
	Body weight	70	kg
	Inhalation rate	20	m3 per day
Child	Age	1–6	years
	Body weight	13	kg
	Inhalation rate	6.8	m3 per day

The exposure frequency and exposure duration parameters should be adjusted to reflect realistic exposure scenarios. For residential exposure, a conservative assumption would be continuous exposure 24 hours per day, 365 days per year.

Example

As a worked example, consider a residential air quality assessment criterion for furan. The US EPA IRIS reference dose for furan is 1 µg/kg body weight.

So for a child:

Acceptable daily intake (mg/kg bw/day)	**1.00E-03**	**US EPA IRIS Reference Dose 1 µg/kg body weight**
Body weight (kg)	13	Child
Averaging time (days)	1	for 24-hour assessment
Exposure frequency (days/year)	1	for 24-hour assessment
Exposure duration (years)	1	for 24-hour assessment
Inhalation rate (m^3/day)	6.8	Child
C_{furan} (child) =	0.0002	mg/m^3
	0.19	$\mu g/m^3$ as a 24-hour average

Criteria not recommended for ambient air quality assessments

The following criteria are not recommended for ambient air quality assessments (but may be appropriate for assessing the consequences of an unintended release):

- the US EPA acute exposure guideline levels (AEGL) for airborne chemicals
- other protective action criteria, such as the American Industrial Hygiene Association Emergency Response Planning Guideline values.

These criteria are designed are intended to provide an indication as to how the general public would react to a chemical exposure at a particular concentration. They do not incorporate a safety factor typical of general ambient air quality guidelines and standards to protect the sensitive member of the community. Therefore, they are generally not appropriate for the assessment of continuous or semi-continuous discharges to air.

Key points

The following criteria for assessing the effects of air quality should be selected, in the following order of priority:

- national environmental standards for air quality
- national ambient air quality guidelines
- regional objectives (unless more stringent than above criteria)
- WHO air quality guidelines
- California reference exposure levels (acute and chronic) and US EPA inhalation reference concentrations and unit risk factors (chronic)
- Texas effects screening levels (if these have been derived from toxicological data in a transparent manner).

Adapted workplace exposure standards and screening values derived from toxicity criteria should only be used as a last resort and only by experienced practitioners with expertise in this field.

In all cases the assessment should explain which criteria have been selected and why.

5 Quantitative screening assessment

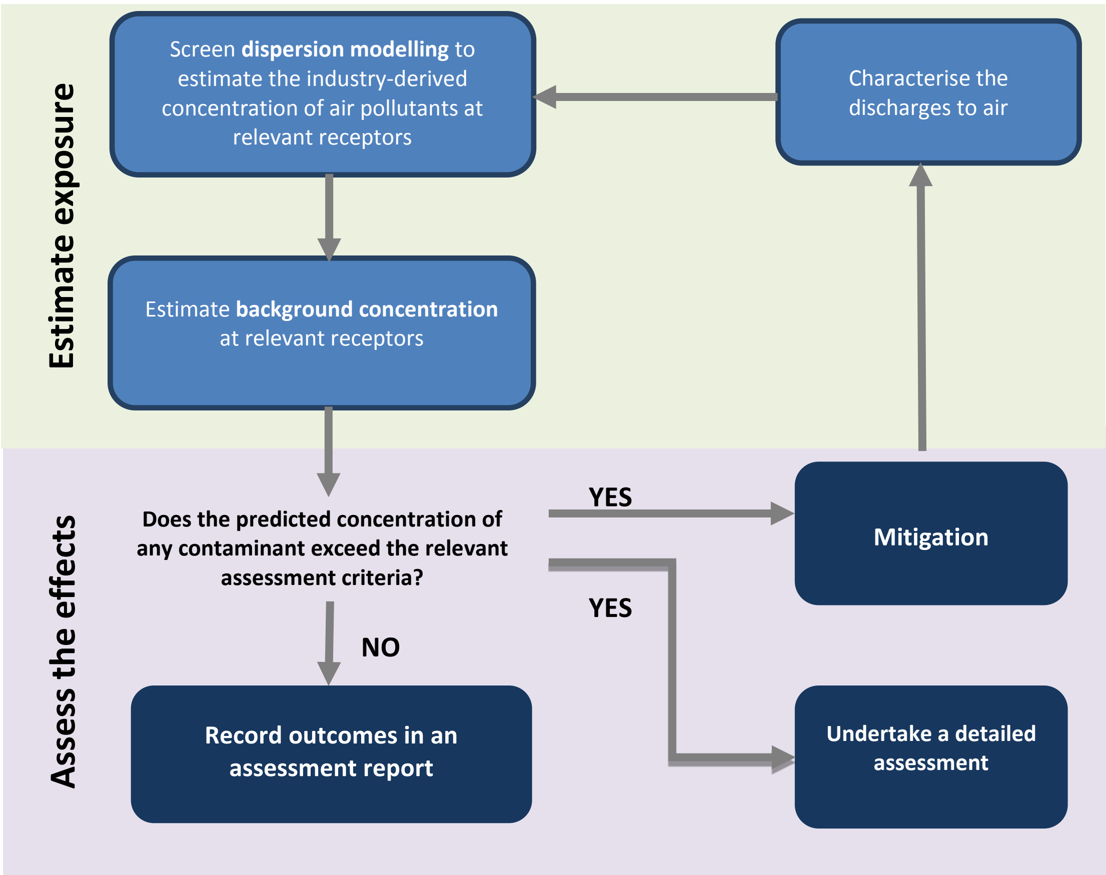
The quantitative screening assessment is a dispersion modelling assessment used to determine whether a proposal is likely to result in exceedance of ambient air quality criteria. A screening assessment is intended to be a relatively simple exercise to provide conservative estimates of air quality effects. These may not be completely accurate but, being conservative, they can provide confidence that a proposal will not result in exceedance of air quality criteria.

If a screening assessment indicates there is a potential for non-compliance with air quality criteria, then a detailed assessment should be undertaken. If the screening assessment indicates that exceedance of air quality criteria will not occur, then no further assessment is required.

The recommended screening assessment process is based on the methods most commonly used in New Zealand. Users who are not familiar with the assessment process should read this section in conjunction with section 6 (detailed assessments).

A quantitative screening assessment will typically involve the steps shown in figure 2. These are described in more detail in the following sections.

Figure 2: Steps in quantitative screening assessment process



Special care is needed for any assessment in an airshed that breaches any ambient standards in the NES for air quality. In particular, within an airshed that breaches the ambient PM_{10} standard, it is likely that any proposal resulting in a significant increase in PM_{10} emissions will require mitigation, or will not be allowed.

Any significant increase in ambient levels of a pollutant in relation to its ambient standard would generally require a detailed assessment. Consultation with the regional council is recommended before undertaking any detailed assessment, and particularly in any airshed that breaches the PM_{10} ambient standard.

5.1 Characterising the discharges to air

Characterising the discharges to air for a screening assessment is essentially the same as for a detailed assessment, with a level of detail appropriate to the nature and scale of the proposal. However, a screening assessment should be based on conservative assumptions, such as continuous maximum emissions for normal operation.[18] The assessment should include enough detail to demonstrate that the emission rates assumed are conservative.

Characterising the discharges to air includes:

- Identifying all air discharges associated with the development. They may be point sources such as stacks and vents, area sources such as ponds or disturbed soils, or volume sources such as fugitive emissions from buildings.
- Describing the sources of the discharge, including all process factors influencing the quantity and nature of the discharges.
- Quantifying the nature of the emissions (pollutant types, concentrations and mass emissions, emission temperatures, velocities, particle sizes, etc).
- Assessing the engineering and operational controls in place to control discharges to air.
- The *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004) provides a description of the information required to define the variety of discharge points for dispersion modelling.
- Quantifying emissions may be based on estimates from process data, emission factors, control equipment performance specifications, fuel properties or the results of emission tests. If emission tests are undertaken, the applicant should liaise with the consent authority to confirm the appropriate test method.[19] Emission testing should be undertaken by professionals who hold IANZ accreditation to carry out the testing.[20] It is also important to record and understand process conditions during emission testing to determine whether emissions are representative of maximum normal emissions.
- It is important to note that although measured emissions data are usually more representative than estimates from process data (eg, emissions factors or engineering calculations) they are also subject to measurement errors and uncertainty. This may have a significant impact on downwind concentration estimates. The *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004) addresses this by recommending the use of a maximum emission rate to cover the worst-case discharge of concern.

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[18] This is the maximum level of emissions that are expected or proposed under normal operating conditions (ie, not accidental emissions due to process equipment failure or control equipment failure).

[19] *Compliance Monitoring and Emissions Testing of Discharges to Air* (Ministry for the Environment, 1998) provides guidance for obtaining pollutant emission rate and concentration data by measuring an existing source.

[20] For some methods there are no accredited companies in New Zealand – in this case it is recommended that applicants liaise with the consent authority to ensure the stack testing is undertaken by suitably qualified professionals.

- An assessment of emissions from industry to air should also address abnormal or uncommon emission scenarios, including start-up, shut-down, upset conditions, and emergency release. These scenarios often result in elevated emissions, or emissions of chemical intermediates that would not normally be released. It is often appropriate to assess these using a risk-based (probabilistic) approach; that is, considering not only the consequences of the release but also the likelihood of it occurring. Consideration of these occurrences is often tailored to a specific situation; for example, considering only short-term average assessment criteria commensurate with the duration of exposure.
- Where a project goes through different stages of development, such as in a mine or an industrial process with anticipated production growth, these project life operating and emission changes should also be addressed in the assessment.

Key points

A quantitative screening assessment should be based on conservative assumptions. The assessment should include enough detail to demonstrate that the assumptions are conservative.

To ensure the integrity of the consenting process, the data provided in an assessment should form the basis for setting consent conditions. For example, stack emission limits should correspond to the maximum emissions that have been modelled and assessed.

5.2 Estimating ground-level concentration of air pollutants

5.2.1 Dispersion modelling

Atmospheric dispersion modelling is most commonly used to estimate the maximum ground-level concentration of pollutants for assessing effects. The (Ministry for the Environment, 2004) includes detailed guidance on all aspects of dispersion modelling.

Steady state Gaussian-plume models are often used for screening assessment because they are (Golder Associates, 2013):

- inexpensive, widely available and easy to apply
- appropriate for small industries, whose impacts are confined to short ranges, and where detailed studies using more complex models are not necessary
- generally well understood, in relation to the assumptions, uncertainties and limitations they have.

Recommendations 3, 4 and 5 of the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004) provide guidance on whether a Gaussian-plume model is the most appropriate tool for a specific air-quality assessment.

Key point

The *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004) provides guidance for dispersion modelling.

5.2.2 Meteorological data

The best available meteorological data should always be used. Local, validated, meteorological data sets are available for many regions, particularly the major cities. The New Zealand Transport Agency (NZTA) website provides a list and metadata for meteorological datasets[21] that are publicly available in New Zealand.

Note that screening meteorological data may be used in screening assessments if there is no local data, however, this has limitations that need to be understood. They will generally only give an indication of the theoretical worst case one-hour concentration.

> **Key point**
>
> Use the best available meteorological data.

5.3 Estimate background concentration

Although it is important to assess the concentration of air pollutants as a result of the proposal, the Resource Management Act (RMA) requires an assessment of the overall end result – the cumulative effect. This means the modelled concentrations must be added to background concentrations. Because the term 'background air quality' can mean various things, for the purposes of this document the following definition applies (Auckland Council, 2014):

> Background air quality means ambient levels of air contaminants not associated with the sources that are explicitly included in the resource consent application. This includes the contribution from any other anthropogenic sources such as industry, domestic heating and transport.

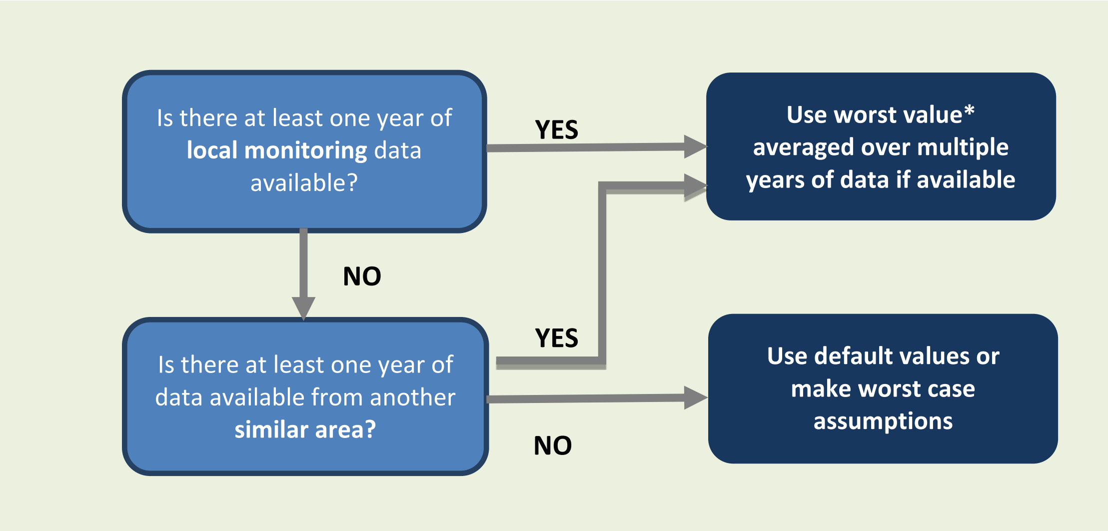
In many urban areas, background concentrations of PM_{10} and nitrogen dioxide (NO_2) are already close to, and in some locations exceeding, air quality assessment criteria. This means that the conclusions of an assessment are highly dependent on the choice of background data, and how this is combined with predicted ground level concentrations to assess cumulative impacts.

The *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004) includes guidance for accounting for background concentrations. For a screening assessment it is generally appropriate to make worst-case assumptions about background air quality.

On this basis, a recommended approach for a screening assessment is outlined below in figure 3. This approach is very conservative, and a detailed assessment may be required if this results in a predicted exceedance of air quality assessment criteria.

21 http://air.nzta.govt.nz/prediction/meteorological-datasets.

Figure 3: Determining background concentration for a screening assessment



* Worst values should ignore any outliers. Averaging values over multiple years of data (if available) will reduce the effect of any non-representative peaks.

5.3.1 Representative monitoring data

The first step in assessing background air quality is to obtain any available monitoring data from the regional council. Most regional councils have monitoring data for PM_{10} and many have data for other pollutants.

The NZTA Transport-Related Air Quality Monitoring System (TRAMS)[22] collates data from the Transport Agency and regional councils. This site allows users to view and export the summary air quality data by region and air pollutant, along with the site metadata.

5.3.2 Options if there are no local monitoring data

If local data are not available, appropriate options for screening assessments are as follows:

1. Compare the location with somewhere similar.

If the area does not have significant large sources, and does not have any complex geographical or meteorological features, then it can be assumed that the air quality will be similar to another area of similar population density, emission sources and meteorology. This method requires that such an area can be identified, and that monitoring data are available.

2. Use default values (as described in the following section 5.3.3).
3. Make a worst-case assumption.

In the absence of default values or air quality data from local or similar areas, it might be necessary to simply guess the existing air quality. The safest guess is to assume a concentration at the upper end of what might be feasible.

It is important to ensure the background concentration selected is appropriate and relevant to the location of the proposed project. For example, to avoid 'double counting', if the assessment includes dispersion modelling to predict the impact of any existing and proposed

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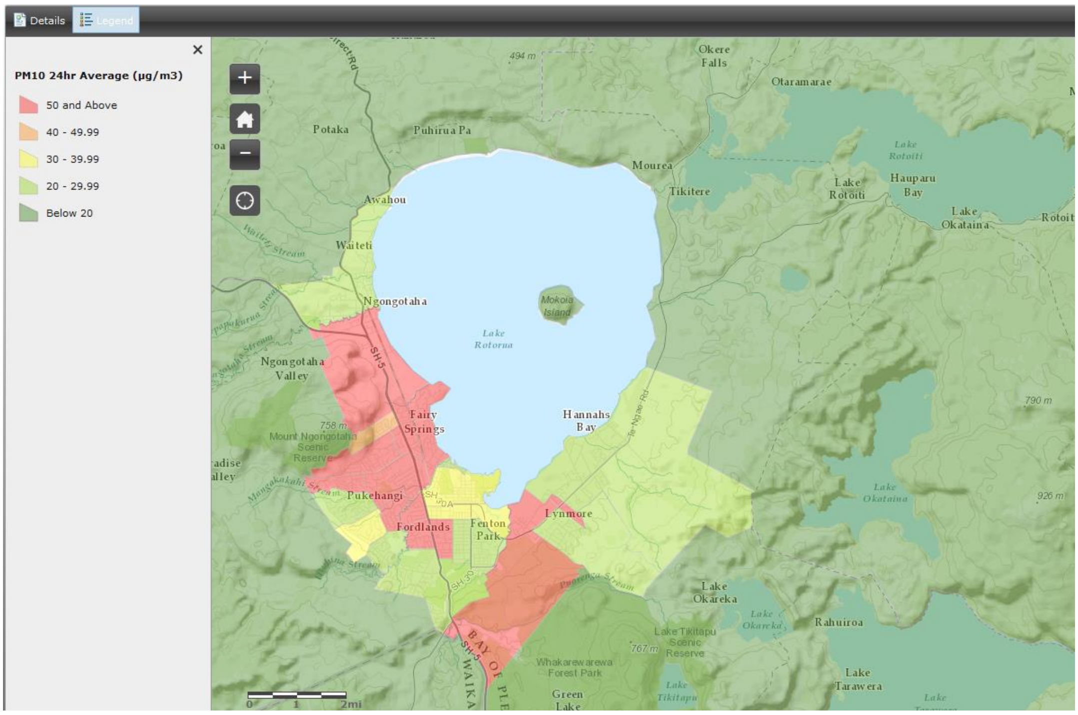
22 www.air.nzta.govt.nz/transport-related-air-quality-monitoring-data.

additional discharges then it is important to select existing air quality data from an area not influenced by the discharge under consideration.

5.3.3 Default values for background air quality

The NZTA has developed default background air quality values for 24-hour PM_{10} and annual NO_2 by census area unit. These default values can be accessed in an interactive map (refer figure 4) or a spreadsheet on the NZTA Transport and Air Quality website.[23]

Figure 4: New Zealand Transport Agency background air quality



Default values for nitrogen dioxide for other averaging periods are also provided by the NZTA in their draft *Background Air Quality Guide* (New Zealand Transport Agency, 2014). These values are shown in table 8. Carbon monoxide, sulphur dioxide, and benzene default values been developed by Auckland Council. These values, also shown in table 8, can generally be used to represent worst case background air quality in other regions, unless there is a local source that needs to be considered.

The methodology for determining these default values is described in the *Use of Background Air Quality in Resource Consent Applications* (Auckland Council, 2014) and the draft *Background Air Quality Guide* (New Zealand Transport Agency, 2014). The overall approach was to use monitoring data, where available, and to select values that are reasonably conservative for assessment purpose.

The default values are intended to provide a quick, easy, and conservative estimate of likely background concentrations.

23 http://air.nzta.govt.nz/background-air-quality.

Table 8: Default values for background concentration of carbon monoxide, sulphur dioxide, benzene and nitrogen dioxide

Contaminant	Area[24]	Averaging time	Default value
Carbon monoxide	Main urban	1 hour 8 hour	5.0 mg/m^3 3.0 mg/m^3
	Secondary or minor urban or rural	1 hour 8 hour	5.0 mg/m^3 2.0 mg/m^3
Sulphur dioxide	Main urban	1 hour 24 hour	20 µg/m^3 8.0 µg/m^3
Benzene	Main urban	Annual	1.0 µg/m^3
Nitrogen dioxide	Auckland central	Annual 24 hour 1 hour	19 µg/m^3 47 µg/m^3 72 µg/m^3
	Other main urban areas	Annual 24 hour 1 hour	16 µg/m^3 43 µg/m^3 65 µg/m^3
	Secondary or minor urban areas	Annual 24 hour 1 hour	13 µg/m^3 38 µg/m^3 58 µg/m^3
	Rural	Annual 24 hour 1 hour	4 µg/m^3 23 µg/m^3 37 µg/m^3

5.4 Assessing the effects

A screening assessment provides a conservative estimate of the likely air quality impacts of a proposal. The maximum ground-level concentration (including background) predicted by the screening methodology should be compared to the relevant assessment criteria (see section 4). This comparison should be made for locations where people may be exposed for the relevant averaging period.

A detailed assessment should be undertaken if either:

- predicted concentration (including background) of any contaminant exceeds the relevant assessment criteria
- screening assessment is inconclusive for any reason.

If these criteria are exceeded, this does not necessarily mean the air quality impacts will be unacceptable. It simply means a more accurate assessment should be undertaken. Mitigation options, or alternative options that do not exceed the criteria, could be considered at this stage, although further assessment may show these are not required.

[24] Note that these areas are based on Statistics New Zealand's definitions.

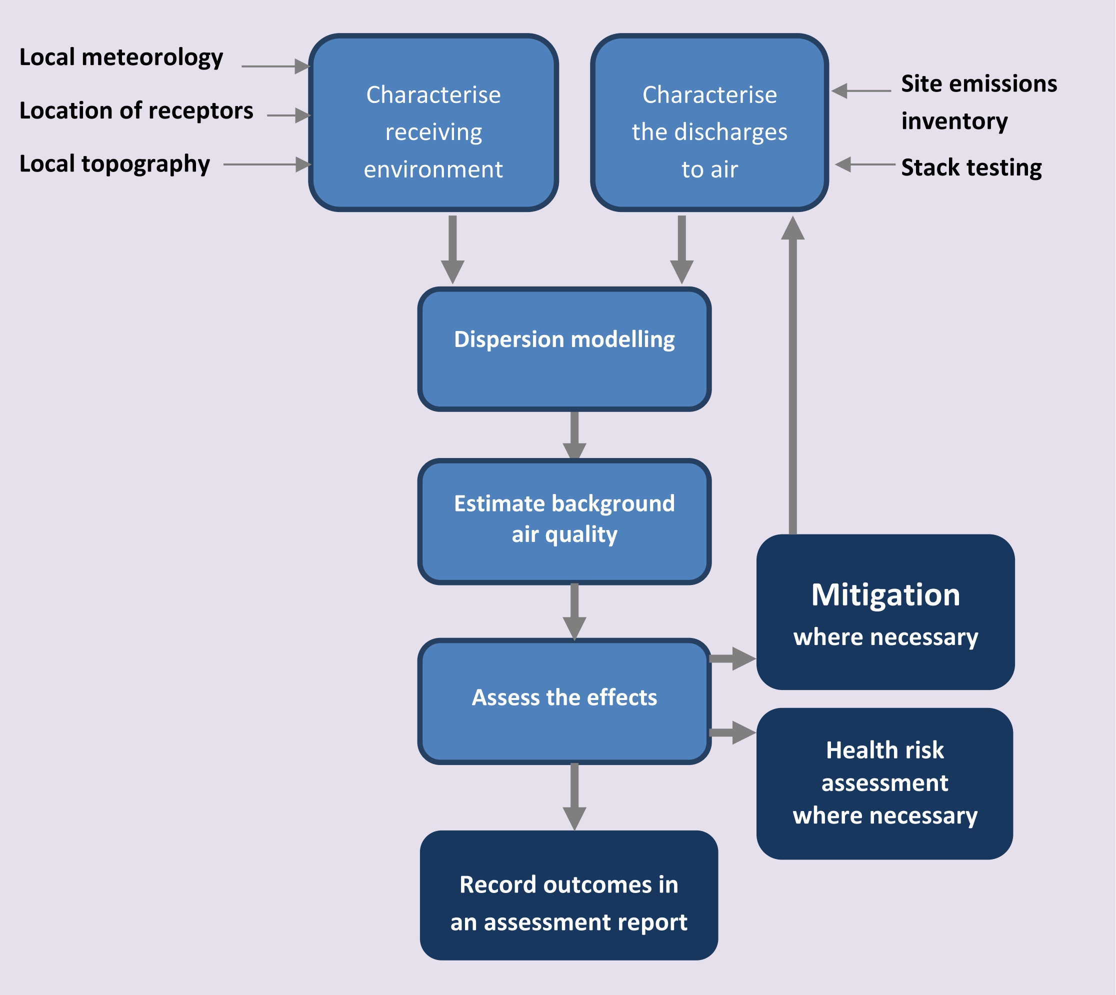
6 Quantitative detailed assessment

A quantitative detailed assessment provides reasonably accurate estimates and a detailed assessment of the likely ambient air quality impacts associated with a proposal, typically using dispersion modelling.

Detailed assessments and screening assessments should be based on conservative assumptions. However, these assumptions for a detailed assessment may be based on better information than a screening assessment and therefore predictions will more closely resemble actual effects.

An overview of the detailed assessment is shown in figure 5.

Figure 5: Detailed assessment process



Compared with a screening assessment, a detailed assessment is usually done through the use of more complex dispersion modelling, site-specific emission information, and local topography, background air quality, and meteorological data.

The delineation between a screening and detailed assessment is somewhat arbitrary. In reality, it is likely that the methodologies described in the screening and detailed procedures would be combined for any significant assessment. For example, a lack of information on existing air quality may result in the need for air quality monitoring, whereas the required dispersion modelling technique may be very straightforward due to the nature of the process and simple topography.

For any aspect of the assessment where detailed information is not available, or is not required, it is appropriate to adopt the conservative assumptions discussed for screening assessments.

As with screening assessments, special care is needed for assessments of PM_{10} discharges in airsheds that breach the PM_{10} ambient standard in the NES for air quality. It is likely that any proposal resulting in a significant increase in PM_{10} emissions (in an airshed that breaches the ambient PM_{10} standard) will require mitigation, or will not be allowed.

6.1 Characterising the discharges to air

Characterising the discharges to air for a detailed assessment is essentially the same as for a screening assessment, the only difference being that more effort is made to quantify realistic emission rates and parameters. For example, a detailed assessment is more likely to involve stack emission testing to obtain:

- pollutant emission rates
- concentration data
- stack parameters.

Section 4.1 of the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004) provides a description of the information required to define the variety of discharge points for dispersion modelling.

Condensable particulate matter

Particulate matter is a complex mixture of small particles and liquid droplets.

Many combustion sources in New Zealand are tested for particulate emissions using US EPA Method 5 (United States Environmental Protection Agency, 1971) which measures *filterable* particulate matter.[25] Filterable particulate matter is defined as:

> Filterable PM means particles that are emitted directly by a source as a solid or liquid at stack or release conditions and captured on the filter of a stack test train.[26]

Because a heated sample train is used to maintain the gases at stack temperature, testing using Method 5 does not measure any *condensable* material that may be present in the stack. Condensable particulate matter is defined as (US EPA, 2010):

> Condensable particulate matter means material that is vapour phase at stack conditions, but condenses and/or reacts upon cooling and dilution in the ambient air to form solid or liquid particulate matter immediately after discharge from the stack. Note that all condensable particulate matter is assumed to be in the $PM_{2.5}$ size fraction.

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[25] Method 5 can be used to measure total filterable particulate, or a size selective sampling head can be used to collect only the PM_{10} (or $PM_{2.5}$) fraction. If an assessment is being carried out of PM_{10} emissions, then it is important to establish whether the sampling has been carried out for total filterable or filterable PM_{10} particulate.

[26] US EPA (2010).

Condensable particulate matter is measured using an alternative test method (US EPA Method 202).

In 2000, research was published showing that emissions of condensable particulate matter can make a significant contribution to total PM_{10} emissions for fossil fuel-fired equipment (Corio and Sherwell, 2000). Similarly, the *Compilation of Air Pollutant Emission Factors. Volume 1: Stationary Point and Area Sources* (United States Environmental Protection Agency, 1995) (known as AP-42) contains an emission factor database for condensable particulate matter. These factors show that condensable PM_{10} emissions can be significant (40–75 per cent) compared with filterable particulate emissions. It is therefore recommended that, where relevant, assessments address emissions of condensable particulate.

Measurement (and assessment) of condensable particulate matter is not straightforward and is generally only recommended for industrial sources that discharge condensable volatile compounds in quantities that are likely to result in significant adverse effects.

Ambient monitoring of $PM_{2.5}$ could be considered as an alternative approach for monitoring the adverse effects of a significant industrial source of condensable particulate.

Key point

Assessments should explicitly assess emissions of condensable particulate matter. However, measurement of condensable particulate emissions is generally only recommended for industrial sources where the effects may be significant.

6.2 Estimating ground-level concentration of air pollutants

Atmospheric dispersion models are most commonly used to estimate contaminant concentrations downwind of a discharge source.

The prediction of pollutant concentrations using atmospheric dispersion models has been covered in detail in the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004). This contains guidance on the application of models for a range of emission types, and meteorological and terrain scenarios.

Dispersion modelling is a highly technical process. By way of illustration, the outcome of a dispersion modelling assessment may rely on:

- monitoring ambient air quality
- monitoring meteorology
- numeric prediction of meteorology by prognostic and diagnostic models
- monitoring stack gas and other source emissions
- estimating emissions (combustion calculations, simulations, etc)
- numeric prediction of plume dispersion in the atmosphere
- terrain and buildings.

Standard quality control techniques, such as the use of calculation checking and aspects as basic as checking that model data are correctly input, are extremely important and should be used.

All assessments that use dispersion models should be based on conservative assumptions, and/or should perform sensitivity analyses for key input parameters.

Sensitivity analysis involves additional model runs, simulating the higher and lower boundaries of expected input parameters (such as emissions estimates or stack temperature), as well as the best estimate. These sensitivity analyses are essential for providing confidence in the robustness of an assessment. This is particularly important where there is vulnerability to adverse effects at the upper boundary of input estimates.

For example, a process might be new, and emission levels are based on simulation. Carry out sensitivity analysis by modelling both the expected and the more unlikely upper estimate emissions. Where such analysis predicts ambient concentrations to be above the assessment criteria for the upper case estimate only, a management response would be expected. The management response might require continuous emissions monitoring under a consent condition to verify the best estimate of emissions, with an associated emission management response agreed in the event that the upper emission estimate is subsequently found to be accurate.

Key points

- Base dispersion modelling on conservative assumptions (which may more closely resemble actual emissions compared with a screening assessment) and explain and justify these in the assessment.
- Alternatively, sensitivity analysis for key input parameters should be undertaken.
- Dispersion modelling should be undertaken in accordance with the recommendations of the dispersion modelling good practice guide (Ministry for the Environment, 2004)[27]
- Any alternative approach should be carefully considered and justified in the assessment.

6.2.1 Meteorological data

Meteorological data are one of the most important inputs into any dispersion model. Detailed guidance on the use and development of meteorological datasets for input into dispersion models is provided in the *Good practice guide for atmospheric dispersion modelling* (Ministry for the Environment, 2004).

As noted in section 3, the New Zealand Transport Agency website provides a list and metadata for meteorological datasets[28] that are available in New Zealand.

Development of meteorological datasets for use with dispersion models is a specialised task.

[27] It is recognised that the dispersion modelling guide may be out of date and not always describe current industry accepted modelling approaches. Where this is the case, and an alternative can be justified, modelling should be undertaken in accordance with appropriate international guidance and in consultation with the consent authority.

[28] http://air.nzta.govt.nz/prediction/meteorological-datasets.

6.3 Estimating background air quality

As discussed in section 4, the RMA requires an assessment of the overall end result – the cumulative effect. This means the modelled concentrations must be added to background concentrations. For the purposes of this document, background is defined as:

> … ambient levels of air contaminants not associated with the sources that are explicitly included in the resource consent application. This includes the contribution from any other anthropogenic sources such as industry, domestic heating and transport.[29]

Background air quality should be considered in all assessments of discharges to air. The level of detail and accuracy required is influenced by the:

- nature of the discharge – large discharges or discharges of pollutants of high toxicity, which may have the potential to adversely impact the environment, require a thorough assessment of the existing air quality
- anticipated air quality – areas that are anticipated to have poor air quality due to a combination of existing emission sources and/or adverse terrain or meteorology would be expected to require a more robust definition of the existing air quality
- sensitivity of the receiving environment – where discharges have the potential to affect highly sensitive receiving environments (see section 2.5.6), existing air quality would be expected to be well-defined.

It is the combination of these that determines the extent to which background air quality should be addressed. A small emission of a low-toxicity pollutant within a commercial/light industrial area, for example, might only require a qualitative statement on background air quality that identifies the reasons air quality is anticipated to be good. On the other hand, a large-scale industrial source with the potential to have an impact on residential suburbs will be expected to provide good-quality, representative and quantitative air quality data.

As noted in above, special care is needed for any assessment in an airshed that breaches an ambient standard in the NES for air quality, in particular, airsheds that breach the PM_{10} standard.

6.3.1 Representative background air quality data

The first step in assessing background air quality is to obtain any available monitoring data from the regional council. Most regional councils have monitoring data for PM_{10} and many have data for other pollutants.

The New Zealand Transport Agency Transport-Related Air Quality Monitoring System (TRAMS)[30] collates data from the Transport Agency and regional councils. This site allows users to view and export the summary air quality data by region and air pollutant, as well as the site metadata.

The consent authority will usually have the best knowledge of the full range of data available within its region, and will also be able to provide an informed opinion as to whether the pre-existing data are appropriate for the assessment proposed.

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[29] http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Documents/gd201401useofbackgroundairqualitydatainresourceconsentapp.pdf.

[30] http://air.nzta.govt.nz/transport-related-air-quality-monitoring-data.

Reviewing background air quality data

For contaminants in the NES for air quality it is important that the monitoring technique and protocols be audited against the requirements of the monitoring methods in Schedule 2 of the NES for air quality. Similarly, measurement of other pollutants should be audited against relevant Ministry for the Environment guidance (Ministry for the Environment, 2002, 2004 and 2009).

The location of a monitoring site and the time of monitoring also affect how representative existing air quality data might be. The site should be representative in terms of location (ideally, within the affected airshed), but also representative in terms of land use and physical setting. The specific location of the monitoring site (eg, its proximity to major sources such as roads and other industry) will also be important.

The time of the monitoring is also relevant – historical data may not be representative if the character of an area has changed markedly since monitoring was last undertaken. For example, historical data from an area that has experienced significant population growth and commercial expansion (and so increased vehicle and potentially industrial emissions) may no longer be representative of current levels.

Trends in air quality should be considered. It is preferable for several years of data to be analysed so any improvement or deterioration of the air quality of an area can be established. As a minimum, one year of data could be used, if there are other longer-term monitoring sites in similar locations that can be used to provide an indication of long-term trends. Ideally, 10 years of data should be used to determine trends.

6.3.2 Options when there is no background data available

If representative background monitoring data is not available, the range of options for generating air quality monitoring data, ranked in order by the increasing effort required to obtain the data, are:

- use default or worst case values, as described in section 4
- use surrogate data from one or more locations with air quality characteristics representative of the area of interest
- use atmospheric dispersion modelling to predict air pollutant concentrations due to existing sources (as well as the concentrations due to the proposed development)
- commission a monitoring programme specifically for the purposes of the consent.

Overall, the pollutants released from the proposed activity, and the assessment criteria that are available for those pollutants, determine the type of existing air quality data required for the assessment.

Use data from surrogate sites

If there is not a representative ambient monitoring site, the assessment could be repeated at one or more ambient monitoring sites that most closely represent the industrial site under consideration.

The results should be presented for each site along with a qualitative, comparative assessment of the applicant's location, and how this compares to the ambient monitoring sites. This should explicitly consider the following for each monitoring site and the industrial location:

- local topography and meteorology
- traffic volumes and distance to roads
- likely emissions from domestic heating (related to population density and housing characteristics)
- location of the industry being assessed in relation to the monitoring site location
- other industrial emission sources.

If the predicted concentration is close to the assessment criteria, or if the conclusion of the assessment depends on which ambient monitoring site is selected, pre-project monitoring should be considered.

Use atmospheric dispersion modelling

Atmospheric dispersion modelling to estimate background concentrations is not generally appropriate in urban areas. Dispersion modelling may be a viable option, however, in locations where:

- there are a small number of existing emission sources in the area, for which reliable emission data are available
- any contribution to ambient levels from other hard-to-characterise sources, such as vehicle emissions, domestic fires or dust from wind erosion, is negligible.

The onus would be on the applicant to obtain emission data for other sources and to undertake detailed dispersion modelling for these sources. This approach is relatively complex and should not be undertaken without consulting the relevant council. The *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004) provides advice on the appropriate application of dispersion models.

Pre-project monitoring

Pre-project monitoring may be necessary for significant projects where there is no representative background monitoring, and robust assumptions cannot be made.

For detailed assessment of background air quality, it is important that the background air quality data and meteorological data are measured at the same time. Therefore, a meteorological dataset for the pre-project monitoring period would also need to be developed. This is a complex and highly specialised task and should not be undertaken without consulting the consent authority.

The Ministry for the Environment's *Good Practice Guide on Air Quality Monitoring and Data Management* (Ministry for the Environment, 2009) provides recommendations on ambient air quality monitoring. Ideally, the monitoring should run continuously for at least 12 months, and preferably for 24 months, to account for variability in meteorological conditions.

For pollutants where there are no default values and no monitoring data available, the overall approach for assessment of background concentrations is likely to be similar, and should consider the following:

- Is the modelled concentration significant compared to the assessment criteria?
- Are there any other nearby sources of the pollutant in question?

The extent of assessment required will depend on the predicted maximum ground level concentration from the source, and how likely it is that the air quality assessment criteria could be exceeded. This will need to be assessed on a case-by-case basis.

If assessment criteria are likely to be exceeded, and there is no available monitoring data, then modelling or monitoring to estimate background concentrations of non-criteria pollutants may be necessary.

Key points

If the project has significant discharges to air, with no representative background air quality data, then pre-project monitoring may be necessary.

If pre-project monitoring is undertaken, the monitoring should be undertaken over a sufficient period to obtain representative data. This is typically at least 12 months.

6.4 Assessing the effects

6.4.1 Incorporating background concentrations

Background air quality data and predicted pollutant concentrations must be considered together against the selected assessment criteria. Adding the background data and predicted results to provide an estimate of the cumulative impact, to be compared with the selected assessment criteria, is reasonable for annual average concentrations.

For short-term concentrations, addition of peak background concentrations to modelled concentrations is appropriate where the criteria are not breached. However, this approach can lead to an overly conservative assessment due to issues relating to the spatial and temporal coincidence of background and predicted concentrations. These are outlined below:

- Spatial coincidence problems – it is often difficult to know whether the background data are representative of the point at which the modelled peak occurs. In general, they will not be located in the same place, so adding the two will overestimate actual future concentrations.
- Time coincidence problems – both modelled and background concentrations may vary with the time of day, due to factors such as meteorological patterns, operational variations, and changes in background emission sources (eg, winter emissions from home heating and/or peak traffic emissions). In some cases, the peak caused by a point-source emission may not occur at the same time as the background peak, so adding the two together may overestimate the predicted concentration.

The best predictive assessment technique is to use hourly, sequential ambient air quality monitoring data that are recorded in the airshed of interest, and then add the hour-by-hour predicted concentrations. These predicted concentrations should be made using meteorological data, recorded at the same time as the recorded air quality data. Where data are available, this approach is recommended.

Background values for remote areas in New Zealand are provided in Appendix 4.

Incorporating background concentrations of NO_x and NO_2

Nitric oxide reacts with ozone (O_3) in the atmosphere to form nitrogen dioxide and oxygen.

$$NO + O_3 \rightarrow NO_2 + O_2$$

A recommended method for estimating the downwind conversion of nitric oxide to nitrogen dioxide is provided in Appendix 3.

6.4.2 Comparing model results with air quality criteria

The final step in the assessment is to compare the predicted cumulative concentration with the relevant assessment criteria. This should address both the short-term and long-term impacts of discharges to air, and relevant matters such as carcinogenicity and bioaccumulation.

In all cases, as noted in section 4, the selection of air quality criteria should be justified. In doing so the purpose of the standard or guideline should be clearly stated. *None* of the criteria provided in section 4 are levels that may be 'polluted up to'.

The predicted cumulative concentration should generally be compared with the relevant assessment criteria as follows:

- For 8-hour, 24-hour and annual averages, the maximum ground level concentration should be compared with assessment criteria.
- For 1-hour averages, the 99.9th percentile value of the predicted ground-level concentration should be reported as the maximum ground-level concentration likely to occur and compared with assessment criteria.[31] Other percentile values (eg, maximum, 99.5th and 99th percentile values) should also be evaluated to provide an indication of the representativeness of the 99.9th percentile value ground-level concentration.

Specific guidance for assessing likely compliance with NES for air quality is provided in the *2011 Users' Guide to the Revised National Environmental Standards for Air Quality, Updated 2014* (Ministry for the Environment, 2014).

6.4.3 Assessing the likelihood of an exceedance

Most assessments of effects are based on maximum expected emission rates. This is appropriate and necessary to ensure compliance with air quality criteria. However, in some

[31] Reporting of the 99.9th percentile value for 1-hour averages is in accordance with the recommendations of the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004) and is consistent with the Victorian Environmental Protection Authority State Environment Protection Policy (Ambient Air Quality), which states "The 99.9th percentile is selected because this avoids the possibility of setting expensive emission controls based on a single extreme set of meteorological conditions".

cases the maximum emission rate is much higher than the average emission rate, and it may be unlikely to occur on the same day that maximum ground level concentrations are predicted.

Where an assessment is based on maximum emission rates, it is recommended that the assessment should include a qualitative discussion of the conservatism in the predicted maximum. The probability of an exceedance occurring should also be calculated if this can be supported by quantitative data (including, for example, emission test results and production records).

6.4.4 What if the assessment predicts an exceedance?

It is likely that some assessments will predict exceedance of air quality assessment criteria in urban areas, especially for PM_{10} and $PM_{2.5}$, because background levels are already close to, or exceed, assessment criteria. If this is the case, it is appropriate to provide additional information to adequately assess the actual or potential effects.

Some issues that should be discussed to support an assessment of the actual or potential effect where there is a predicted exceedance include:

- relevant assessment criteria specified by the NES for air quality, for example whether the industry is a principal source of CO, NO_x or VOC
- the number of exceedances predicted
- the distribution of cumulative concentration results, and if the exceedance is an outlier
- the relative contribution to each exceedance of background versus the industry
- the likelihood of people being exposed for the relevant averaging period, and if the predicted exceedance is in an industrial area, or a residential area
- the number of properties, or the area affected by the predicted exceedance
- whether the industry is minimising emissions and achieving the best practicable option
- the likelihood of the exceedance occurring (this is discussed further in section 6.4.3)
- the options for mitigation (mitigation options are discussed in section 3.9).

For any assessment where exceedances of air quality assessment criteria are predicted, applicants are encouraged to talk to the consent authority.

6.5 Case studies

CASE STUDY: CONSENT GRANTED ALTHOUGH EXCEEDANCE OF AMBIENT STANDARD PREDICTED

Environment Southland granted consent for a new process, for which modelling predicted exceedances of both the WHO guideline (annual average) and PM10 ambient standard (24-hour average).

Why/how could they grant consent to such an activity?

- The process included best practice mitigation (baghouses).
- The concentrations of PM_{10} were predicted to decrease rapidly with distance from the site boundary (see figure 6).
- There were no sensitive receptors in the area impacted by the discharges.
- The location was remote, and public access difficult.

Accordingly, it was considered unlikely that people could reasonably be exposed over the relevant time periods (either 24-hour or annual averages). As such, no breach of the relevant assessment criteria would occur in practice.

Figure 6: Maximum predicted 24-hour total suspended particulates (TSP) (as PM_{10})

CASE STUDY: EXCEEDANCE OF PROPOSED REGIONAL STANDARDS

An industrial site in Auckland predicted off-site exceedance of the proposed 24-hour Regional Air Quality Standard for SO_2. Why/how could Auckland Council grant consent in this case?

- The default background concentrations of SO_2 were considered likely to be conservative, based on more detailed review of the monitoring data.
- The affected receptors were in an industrial area where 24-hour exposure was considered to be unlikely. This means that whilst an exceedance was predicted, the assessment showed that no persons were likely to be exposed (to this exceedance).

6.6 When a health risk assessment is required

In some situations it may be necessary to complete a health risk assessment as part of a detailed study. This would include determining exposure and dose via all relevant pathways (eg. inhalation, dermal, ingestion, etc), assessment of dose-response data, and characterisation of the health risks from the exposure and dose assessments.

Comprehensive air pollution health risk assessments are recommended when:

- there is a significant discharge of contaminants with no clear threshold for adverse effects
- plan provisions require it
- there is a significant discharge and/or background concentration and/or uncertainty about historical emissions of contaminants that are toxic, carcinogenic, teratogenic, mutagenic or bioaccumulative.
- there are multiple exposure pathways that may collectively result in adverse effects.

Health risk assessments are specialised tasks and are typically only undertaken for large, or particularly toxic, discharges. Seek expert assistance for any health risk assessment.

Key point

Seek expert assistance for any health risk assessment, as this is a specialised task and typically only carried out for very large, or particularly toxic, discharges.

Appendix 1: Example consent conditions

Conditions in resource consents must be clear, reasonable and enforceable. Air discharge consents often include design specifications to ensure that control equipment meets, and continues to meet, the emissions assessed at the time of consent. Conditions must balance flexibility for the consent holder to use any technology to achieve emission limits, and certainty for the regional council and neighbours that the consent holder will use appropriate technology. Consent conditions must also be practical, and able to be monitored to demonstrate compliance.

This section provides some examples of consent conditions that have been implemented by consent authorities. In some cases, specific numbering or details have been removed, however these conditions are all based on actual examples.

Guidance on consent duration is not provided. However, *Good Practice Guide for Assessing and Managing Odour* (Ministry for the Environment, 2016b) outlines key parameters from case law that may be relevant when considering term of consent.

For further information on drafting consent conditions, refer to the Quality Planning website.

General conditions

1. The discharge of contaminants into air shall be carried out in accordance with the information submitted with the application as detailed below:
    - Application form for air discharge consent and assessment of air discharge effects prepared by XXXX, dated XXXX.
    - Application form for land-use consent and assessment of environmental effects prepared by XXXXX, dated XXXX.
    - Drawings XXXXX, dated XXXX.
2. No alterations shall be made to the plant or processes that do not, or are not likely to, comply with the provisions of this consent, a regional rule or regulations under the Resource Management Act 1991.
3. The consent holder shall be responsible for all discharges of contaminants into air from the site and shall make any person undertaking activities on site, on its behalf, aware of any relevant conditions of this consent.
    - Production at the site shall not exceed the thresholds specified in the application as detailed below: XXXX Plant XX tonnes per hour, and XXXX tonnes per year
    - YYYY Plant YY tonnes per hour, and YYYY tonnes per year
    - ZZZZ Plant ZZ tonnes per hour, and ZZZZ tonnes per year

    (Note: Production limit conditions may be necessary for batch or seasonally influenced production.)
4. All processes on site shall be operated, maintained, supervised, monitored and controlled to ensure that emissions authorised by this consent are maintained at the minimum practicable level.

5. All processing equipment, buildings, ducting and emissions control equipment shall be maintained in good condition and as far as practicable be free from leaks in order to prevent the discharge of fugitive emissions. This includes regular tuning of the natural gas boilers so that fuel efficiency is maximised.
6. There shall be no noxious, dangerous, objectionable or offensive odour to the extent that it causes an adverse effect at or beyond the boundary of the site.
7. There shall be no noxious, dangerous, objectionable or offensive dust to the extent that it causes an adverse effect at or beyond the boundary of the site.
8. There shall be no noxious, dangerous, objectionable or offensive visible emission to air, other than water vapour, to the extent that it causes an adverse effect at or beyond the boundary of the site.
9. Except as authorised by conditions of this consent, there shall be no discharges to air of any hazardous air pollutant to the extent that it causes, or is likely to cause, adverse effects to human health, the environment or property at or beyond the boundary of the site.
10. All processes on site shall be operated in accordance with the Air Quality Management Plan detailed in Condition x of this consent.

    (Note that management plans should be limited to non-critical operational processes that lie behind a performance or operational standard.)
11. An enforcement officer shall be notified as soon as practicable in the event of any significant change in the discharge of contaminants to air either that may result in adverse effect on the environment, human health or property or that may result in a breach of these consent conditions.

Emission limits

12. Emission tests shall be conducted on xxx emission points, to determine compliance with Condition x. These tests shall:
    a. Be conducted within six months of the commencement of this consent and then once every two years thereafter for the term of the consent.

       (Note that frequency depends on significance of adverse effects, stability of process, sensitivity of receiving environment etc.)
    b. Be conducted during process conditions that will give rise to maximum normal emissions.
    c. Record and describe in lay terms the process conditions that give rise to the emissions.
    d. Comprise not less than three separate samples with the xxx concentration results corrected to 0 (zero) degrees Celsius, 1 (one) atmosphere pressure and a dry gas basis.

       (Note: Combustion emissions further require correction to a fixed carbon dioxide or oxygen content.)
    e. Be carried out in using an International Accreditation New Zealand-accredited method by an IANZ-accredited stack tester.

(Note that for some less common air contaminants there may not be an IANZ accredited stack tester available. In these situations it is recommended the method should be approved by the consent authority)

13. The results of all tests, including a record of all relevant operating parameters, raw data, calculations, assumptions, and an interpretation of the results, shall be submitted to the consent manager (or relevant person/department at the consent authority) within XX days of the samples being taken.
14. Without limiting the generality of Conditions x, x, x, the consent holder shall ensure that the discharge of [total suspended particulate/PM_{10}/sulphur dioxide/toluene/mercury, etc] shall not exceed the corresponding emission concentrations below:

Emission point	Pollutant	Concentration (mg/m^3)	Emission rate (g/s)	Emission rate (kg/annum)

All emission concentrations shall be corrected to 0 (zero) degrees Celsius, 1 (one) atmosphere pressure and dry gas basis. Where the discharge is the result of a combustion process, the concentration should also be adjusted to 12% carbon dioxide or 8% oxygen by volume.

(Note: Dioxin emissions concentrations require correction to 11% O_2. Guidance on how to calculate these corrections is provided in Compliance Monitoring and Emission Testing of Discharges to Air (Ministry for the Environment, 1998).)

Reporting

15. All records, monitoring and test results that are required by the conditions of this consent shall be made available on request by an enforcement officer during working hours, and shall be kept for a minimum of two years from the date of each entry.
16. All air quality complaints received shall be recorded. The complaint details shall include:
    a. The date, time, location and nature of the complaint.
    b. The name, phone number and address of the complainant, unless the complainant elects not to supply these details.
    c. Weather conditions, including approximate wind speed and direction, at time of the complaint.
    d. Details of key operating conditions at time of complaint.
    e. Any remedial actions taken.

    (Note: Odour (and where relevant dust) complaints should further record the complainant's perception of FIDOL factors. Readers are referred to the relevant good practice guide).

17. Details of any complaints received shall be provided to the consent manager (or relevant person/department at the consent authority) within 24 hours of receipt of the complaint(s).

Process

The following are examples of general process conditions:

18. No part of the process shall be operated without the associated emissions control equipment being fully operational and functioning correctly. This includes ensuring that all ducting to air emission control equipment shall draw sufficient negative pressure during operation to ensure that fugitive emissions are kept to a practicable minimum.

19. Appropriate interlocking controls shall be implemented to ensure that XXXX plant shall only operate with the [afterburner/bag filter/insert abatement equipment] being fully operational and functioning correctly.

20. All processing equipment, buildings, ducting and emissions control equipment shall be maintained in good condition and as far as practicable be free from leaks in order to prevent the escape of fugitive emissions.

21. The doors to the XXXX building shall remain closed except for the purpose of direct access. Immediately following ingress or egress from the processing building, the doors shall be closed in order to prevent the escape of fugitive emissions.

Consent conditions should include critical process parameters and operating criteria for emissions control equipment. Some examples follow:

22. Discharges to the air from the dryers shall be via bag-filters, capable of achieving the particulate emission concentration limit specified in Condition XX and particulate mass emission limit specified in Condition XX.

23. Discharges from the dryers shall be:

    a. To air via stacks terminating not less than 39 metres above the local ground level;

    b. Via stacks at least 9.0 metres above the roof level of the dryer buildings; and

    c. From the stacks vertically into the air and not impeded by any obstruction above the stack which decreases the vertical efflux velocity from that which would occur in the absence of such an obstruction.

24. The minimum efflux velocity of exhaust air from the dryer exhaust stacks shall be 20 metres per second at the maximum continuous rating of each dryer.

25. For each milk powder dryer:

    a. The outlet(s) of the dryer bag-filters shall (each) be fitted with a broken bag detector and alarmed to the Milk Powder Plant control room;

    b. The broken bag detector shall be set to ensure, as far as practicable, that any damage or deterioration that could cause exceedance of the 10 milligrams per cubic metre (corrected to zero degrees Celsius and 101.3 kilopascals on a dry gas basis) total particulate emission concentration standard is detected; and

    c. The operators shall be advised immediately if any such exceedance is detected.

Meteorological monitoring consent conditions

Meteorological monitoring (ie, wind direction and wind speed) is often required for any activity with potentially significant effects of dust or odour. Siting should be in accordance, as far as practicable, with AS/NZS 3580.1.1:2007 Methods for sampling and analysis of ambient air – Guide to siting air monitoring equipment.

26. Within three months of the date of commencement of this consent, the Consent Holder shall install and operate a meteorological monitoring station to measure wind speed, wind direction and temperature at the site. The monitor shall continuously log these meteorological conditions in real-time and be in a location that minimises the potential for obstacles to affect the accuracy of the readings.

Odour monitoring consent conditions

27. The consent holder shall conduct field inspections of odour from the site. These field inspections shall:
    a. Occur at a frequency set out in the AQMP required by condition XX but at a frequency of no less than once every calendar month;
    b. Occur while XXXXX are being processed;
    c. Be conducted by someone not in frequent contact with the odour sources onsite; and
    d. Be conducted in general accordance with VDI 3940 "*Determination of Odorants in Ambient Air by Field Inspection*" or as set out in the AQMP.

    These inspections may cease if for 12 months (after site is fully operational) no complaints have been received and validated by [insert consent authority]. Monitoring shall resume at any time if requested by the [insert consent authority].

Dust consent conditions

28. Drop heights shall be minimised to control dust from any crusher and conveyors used on site.
29. All stockpiles shall be constructed, positioned and maintained to minimise the potential for dust emissions.
30. Techniques to minimise dust emissions shall be used during rock excavating. Dust emissions from all crushing, screening and transfer operations shall be kept to a practicable minimum.
31. Dust suppression equipment shall be maintained in good condition. No part of the process shall be operated without associated dust suppression equipment being fully operational and functioning correctly except when processed materials are sufficiently dampened to prevent wind entrainment. This includes the use of water sprays on crushing equipment, screens and stockpiles.
32. Within the site boundaries all vehicle speeds shall be limited to XXkph (in conjunction with other controls), to ensure dust emissions are minimised.
33. Without contravening the requirement of any other consent, ponds or other water supplies shall be maintained at such capacities to ensure that the application of water as a dust control measure is not limited.
34. No material shall be disposed of by open burning on site.

Management plans

Consents often include conditions requiring a management plan for example:

35. That an Air Quality Management Plan ('the Plan') shall be submitted to the Manager for review within six months of the date of commencement of this consent. The Plan will accurately record all monitoring, management and operational procedures, methodologies and contingency plans required to comply with the conditions of this consent. The Plan shall include, but is not limited to, the following:
    - identification of all fugitive and point sources for discharges of contaminants into air, including a site plan showing the locations of each point source
    - details of complaint response procedures and investigations
    - procedures to minimise discharges of contaminants into air, including inspection and maintenance procedures for all equipment (this will involve a summary of the main points), monitoring and contingency procedures in place for all emissions control measures at the site
    - where appropriate, the operating parameters and manufacturer's instructions for all emissions control equipment
    - details of the frequency and scope of the regular checks to be performed on emissions control measures
    - details of management and monitoring practices in place to minimise discharges of contaminants into air
    - procedures for the monitoring of odour, including details of inspection procedures to comply with Condition XX, recording requirements and contingency measures (including for instances where odour is determined to be at risk of not complying with Condition XX)
    - procedures for the operation, maintenance and calibration of the meteorological monitor required by Condition XX
    - the identification of staff responsibilities
    - maintain a log of any maintenance required or undertaken to improve the operation, in order to comply with Condition XX of this consent.
36. The consent holder shall review and (if necessary) update the AQMP at least once every year for the term of this consent, to ensure that any review takes account of the monitoring for the previous year. Any proposed changes to the AQMP shall be submitted to [insert consent authority] for review within one month of the consent holder's review.

Review conditions

Most consent authorities have a standard review condition. The following are examples of customised review conditions:

37. If the effects, as determined by Condition XX above, are greater than the effects at the time the consent was granted, the consent holder shall review the appropriateness of control equipment and the scrubber and baghouse discharge limits. This would include:
    a. a comparison of the sites air discharge control equipment against the best available technology
    b. commentary on whether the site is utilising the best practicable option for the minimisation of discharges.

The consent holder shall communicate the outcome of the assessment to the Manager via a written report within 3 months of either the consent holder or Manager identifying that a review is required.

Advice note: If the review identifies that improvement to the site processes are required it is anticipated that the consent holder will adopt these, and will lodge an associated application to alter the consent conditions under RMA section 127 if necessary. The Manager has the ability to review the conditions under RMA s128 if not satisfied.

Appendix 2: Management options

This appendix provides some general background information about pollution control technology. For more detailed information, or information relating to specific applications readers are referred to the technical and guidance documents described in section 3.9.1.

Incineration of gaseous contaminants

Thermal incinerators

Thermal incinerators, referred to as ‘afterburners’ in some industrial applications, combust odorous materials to form mainly water and carbon dioxide. A straight thermal incinerator has a combustion chamber and does not include any heat recovery of exhaust air. The destruction efficiency of the contaminants depends on design criteria, including:

- chamber temperature
- residence time
- inlet contaminant concentration
- compound type
- degree of mixing.

Typical thermal incinerator design efficiencies for the thermal oxidation of contaminants range from 98–99.99 per cent and above. Typical design conditions are:

Thermal incinerators

- Minimum temperature of between 750 and 850°C, and a minimum residence time of between 0.75-2 seconds.

  A range of conditions are given because higher temperatures and residence times are necessary for those contaminants that are difficult to burn such as particulate and products of incomplete combustion. Generally a temperature of at least 750°C and a design residence time of at least 0.75 seconds in excess oxygen (and an operational residence time of at least 0.5 seconds) is suitable for flammable VOC’s and most odours.

- Designed to achieve a VOC removal efficiency at least 99% or, where there is an inlet concentration of less than 400 ppmv VOCs, they should be designed to achieve an outlet concentration of less than 20 ppmv VOCs.

Crematoria

- Minimum temperature of 850°C in the secondary chamber, and a minimum residence time of 2 seconds in at least 6% excess oxygen.

Thermal incinerators should be interlocked so that the process cannot operate until the afterburner is at the appropriate temperature. Where appropriate, interlocks should also shut down the process if the minimum operating temperature is not achieved during operation.

The thermal oxidiser must be designed to ensure suitable turbulence within the main chamber and hence adequate and consistent mixing with oxygen.

Recuperative incinerators

Recuperative incinerator systems use heat exchangers to preheat the waste-gas stream before combustion, and may recover heat to generate steam or hot water or to provide process heating. Shell-and-tube and plate-heat exchangers may be used. Shell-and-tube units are more common and have advantages when temperatures exceed 540 degrees.

Recuperative incinerators have similar destruction efficiencies to thermal incinerators, but they can be limited by the need to operate the heat exchanger at lower temperatures to prevent damage. These incinerators are usually more economical to operate than straight thermal incinerators, because they can recover 40–70 per cent of the waste heat from the exhaust gases, but they do have higher maintenance costs.

Suitable design and performance criteria for recuperative incinerators are similar to those for simple thermal incinerators (see above).

The reduced temperature of the discharge must be recognised in any dispersion model.

Catalytic incinerators

With catalytic incinerators, gas passes through the flame area and then to a catalyst bed. The catalyst increases the oxidation reaction rate and enables conversion at lower reaction temperatures than in thermal incinerator units. Catalysts typically used for VOC incineration include platinum and palladium. Other formulations include metal oxides, which are used for gas streams containing chlorinated compounds (United States Environmental Protection Agency, 1998).

Several different types of catalytic incinerators are available, which are largely distinguished by the method of contacting the contaminated gas stream with the catalyst. Both fixed-bed and fluid-bed systems are used.

Contaminant destruction efficiency is dependent on the composition of type, and space velocity. Temperature and space velocities are particularly important. High temperatures and low space velocities produce increasing destruction efficiencies. Performance criteria of 95–99 per cent destruction could be required for inlet gases with high contaminant concentrations, or a minimum outlet concentration specified for treatment of low-concentration waste streams.

Regenerative thermal incinerators use direct contact with a high-density medium such as a ceramic-packed bed for heat recovery and to preheat the waste gas. Preheated and partially oxidised gases enter the combustion chamber, where final destruction takes place. Cleaned gases are then directed to one or more packed beds to heat the bed, and the gas flow is periodically reversed.

Regenerative incinerators can use a catalyst rather than ceramic material in the packed bed, which allows for destruction at lower temperatures. Contaminant destruction efficiencies of thermal regenerative incinerators typically range from 95 to 99 per cent, while catalytic units range from 90 to 99 per cent. Catalytic units have the advantage of being able to remove carbon monoxide from VOC-laden air.

Regenerative incinerators are expensive and difficult to install, are large and heavy, and have a high maintenance demand for moving parts. Advantages include their low fuel requirements, an ability to operate at higher temperatures than recuperative incinerators, and their suitability for high-flow, low-concentration waste streams.

Flares

Flares are primarily safety devices, which deal with flows of short duration such as an upset condition or an accidental release from a process, rather than a control device that treats a continuous waste stream.

Flares are generally categorised by the:

- height of the flare tip – ground or elevated
- method of enhancing mixing at the flare tip – steam-assisted, air-assisted, pressure-assisted or non-assisted
- candle type or enclosed flare.

Elevating the flare can prevent potentially dangerous conditions at ground level, and also allows the products of combustion to be dispersed. Flares can be used to control almost any VOC stream, and can typically handle large fluctuations in concentration, flow rate, and other characteristics. The primary application of flares is in the petroleum and petrochemical industries, but flares are also common for landfill gas treatment, and biogas from anaerobic digestion of sludge at wastewater treatment plants. Pilot flames can run continuously or by auto-ignition. It is important to monitor the flare to ensure that the flame does not go out in strong winds. Monitoring may be by regular inspection or automatic monitoring and an alarm.

It well established that "*flaring wastes potentially valuable natural gas and produces emissions that can affect human health, livestock and the environment*" (CCEI, 2007). As a result there has been international action[32] to ban routine flaring and to dramatically reduce flaring during all other activities, as well as ensuring flaring safely disposes of gas during equipment failures, power outages and other emergencies or upsets in drilling or processing operations.

Scrubbing and adsorption systems

Scrubbing systems

Scrubbing systems can vary from a simple spray tower to multiple counter-flow packed towers. Packed scrubbers are generally in the form of a tower, with the gas inlet at the base and outlet at the top. The scrubbing liquid flows counter-current to the gas stream. The tower is filled with packing material, which increases the surface area for absorption. Packing materials may be symmetrical in shape (eg, saddles or rings), or random (eg, coke, plastic scrap and scoria).

Plate scrubbers operate in a similar way to the packed tower. The scrubbing liquid contacts the gas stream in a series of stages. The liquid enters the top stage, flows across the plate and discharges through holes to the next plate. The gas stream rises through the same holes or openings, creating bubbles or froth where removal of the contaminant takes place.

32 There is a Global Gas Flaring Reduction Partnership that includes 18 countries from the United States to Nigeria, Uzbekistan and the Russian Federation, all the major oil companies and the European Union and the World Bank (World Bank, 2016).

The scrubbing liquid may be water or a chemical solution. Other solvents may be used to remove substances with a low solubility in water. The scrubbing liquid should have high gas solubility (or reaction), low volatility, be chemically stable and non-corrosive, and preferably have a low toxicity. Scrubbing liquor could include acid solutions, alkaline solutions, hypochlorite, or catalysed systems. Multi-stage systems with different scrubbing solutions are sometimes needed.

Scrubbing systems can be bought 'off the shelf', and can often be trialled for particular applications at particular sites.

Purpose-built scrubbing towers designed for a specific duty may reach efficiencies of 99.99 per cent for certain contaminants. Common efficiencies are in the 90–99 per cent range. The effectiveness depends on inlet concentrations, and whether equilibrium is approached between the gas and the liquid. A disadvantage of scrubbing systems is the production of a liquid waste, which requires treatment for reuse or disposal.

Adsorption systems

With adsorption, contaminants attach or condense onto the surface of a porous solid (adsorbent). Carbon, zeolite and polymer adsorbents have been used to adsorb VOCs and other pollutants from relatively low-concentration gas streams. Other adsorbents used industrially include alumina, activated clay, silica gel and molecular sieves. A large surface area is key, because this increases the amount of adsorption that can be achieved per unit of adsorbent.

Adsorbents eventually become exhausted when all the surface area is taken up by the contaminant and 'breakthrough' is reached. Monitoring for breakthrough is important. Adsorbents can be regenerated by incineration, or desorption with another gas or liquid, and the contaminant may be either recovered or destroyed.

The most common adsorption systems in New Zealand use activated carbon. Systems range in size and complexity from small systems designed to remove odours from cooking operations, to complex solvent-recovery systems for the surface-coating and pharmaceutical industries. They have also been used successfully to control odours from asphalt manufacture.

Well-designed adsorption equipment can achieve control efficiencies of 95–98 per cent for VOC inlet concentrations in the range 500–2000 ppm, independent of the recovery or disposal process. If incineration at, for example, 98 per cent efficiency is used for regeneration, total removal efficiencies may be 93–96 per cent (USEPA CATC, 1998). Lower efficiencies are achieved where regeneration is less effective.

Biofilters and bioreactors

Biofiltration is where vapour-phase organic contaminants are passed through a bed of material and adsorb to the substrate surface, where they are degraded by micro-organisms. The bed material may be soil, bark, compost or any mixture of these components. Synthetic bed materials are also used. Bed material is either contained in a structure or in a depression in the ground, and the gas stream is distributed through pipes placed under the bed. More information on biofiltration can be found in the appendices of the *Manual for Wastewater Odour Management* (New Zealand Water and Wastes Association, 1999).

Bioreactors are a development of the biofilter and operate in a similar way, but use an inert support medium such as plastic rings, scoria or pumice. The support medium used can vary widely, depending on the application. The micro-organisms are cultured as a biofilm on the surface of the support medium, which is supported by recirculating water.

Biofiltration is dependent on the biodegradability of the contaminants. Under proper conditions, biofilters can remove virtually all selected contaminants. Biofiltration is used primarily to treat hydrogen sulphide, organosulphides, organonitrogen compounds and non-halogenated hydrocarbons. Halogenated hydrocarbons can also be treated, but the process may be less effective because the compounds can inhibit biological activity.

Inlet concentrations of contaminants in the gas stream may range from fractions of a part per million (ppm) up to 1000 ppm, or higher. The efficiency of removal is dependent on the system and contaminant. General odour removal (measured by olfactometry) from wastewater treatment plants is expected to be at least 90 per cent. Removal efficiencies for hydrogen sulphide and methyl mercaptan are greater than 99 per cent and 95 per cent respectively (Brenman et al, 1996). Biofiltration efficiency is limited by the inlet odour concentration, because it is difficult to achieve high efficiencies with a low-concentration effluent gas due to residual odour in the outlet from the filter medium itself.

Biofilter design is based on the required gas residence time in the bed. Typical gas-volume to bed-area ratios to ensure adequate residence time range from 50 to 100 $m^3/m^2/hr$, with bed depths typically 0.8–1.2 m. The principal disadvantage of biofilters is the large space required. This can be overcome by using stacked systems with synthetic media, or bioreactors, which have less demanding requirements on residence time.

To maintain maximum efficiency, moisture levels must be maintained at higher than 60 per cent and temperature in the 20–35 degree range. Control of pH is less critical, but should be within the range of 4–8. Bed moisture content is very important, and humidity of the gas stream should be maintained at near to 100 per cent to prevent drying of the underside of the bed. Overhead watering systems are also common. The filter bed should be maintained in an aerobic condition. A humidifier may be necessary before the effluent gas is passed to the biofilter, to ensure that the bed moisture is maintained.

Biofilters have advantages over conventional adsorbers: bio-regeneration keeps the maximum adsorption capacity available constantly, and contaminants are destroyed, not just separated, as with adsorption systems. In biofilters the bed material will need replacing from time to time, depending on the media used. Experience shows that bark and compost filters start to break down over time, increasing back pressure, which can cause problems in the process. In any case, the bed media should be completely replaced on about a five-yearly basis, but this will depend on the conditions under which the biofilter is required to operate. Monitoring back pressure is one indicator of when the filter will require turning or replacement. Biofilters may be designed in two cells, so that one can be isolated while maintenance is carried out on the other.

Bioreactors using an inert bed material normally require the biofilm to be seeded with the most appropriate bacteria, and a liquor circulated to provide nutrients for microbial activity.

Biofilters and bioreactors are suitable for many applications, and the variety of processes using them is growing. In New Zealand biofilters are used in wastewater treatment, composting, and the food and animal products industries. They may be applicable for the treatment of VOCs and other contaminants from the surface coating, printing and petrochemical industries, but their success has not been well proven in these areas.

Fabric filters (Baghouses)[33]

Fabric filters are used to remove particulate from gas streams. During fabric filtration particulate laden gas is drawn or pushed through the fabric by fans. The fabric is responsible for some filtration but more significantly it acts as a support for the dust layer that accumulates. The dust layer (cake) then acts as a highly efficient filter even for sub-micron particles.

Fabric filters can be made of either woven or felted fabrics and may be in the form of sheets, cartridges, or most commonly cylindrical bags with a number of individual fabric filter units housed together in a group, hence the terms 'bag filters' or 'baghouses'. The most common types of baghouse in Auckland are pulse jet baghouses; however, other types such as reverse air baghouses, shakers, static bag filters and cartridge collectors may be used in certain circumstances.

Fabric filters have a number of advantages over other types of particulate control devices, including:

- very high intrinsic collection efficiencies
- the flexibility to treat many types of dusts
- the ability to handle a wide range of gas flows
- generally low pressure drop.

Provided the baghouse and filters are appropriately designed, baghouses can be used in most particulate streams including asphalt plants, concrete batching plants, solid fuel-fired combustion processes, metallurgical process, wood and wood product processing and grain milling. However there are some factors that limit their use. These include:

- Temperature of the gas stream. There are few fabric filters that can handle temperatures above 300°C for long periods of time. At all temperatures care needs to be taken that the appropriate filter is being used.
- Humidity of the gas stream. Gas streams with high humidity can require the baghouse to be insulated or heated to maintain temperatures well above the dew point to prevent condensation. Moist gas streams can also clog the bags.
- Characteristics of the dust including how adhesive the dust is and the explosion potential of the dust (some fabrics are also flammable).
- Spark carryover from the process, which may cause a fire within the bags.

For cement silo filters, the key issue in avoiding dust discharges from silo filling is to avoid sudden pressure release through the silo – for example, when tanker unloading is finished, drivers frequently release tanker pressure through the silo in one massive surge, rather than bleeding it off over 10 minutes. Site management plans should require either that tanker pressure is not released through the silo, or that it is gradually released over a minimum period of 10 minutes after unloading has finished.

33 Auckland Council, (in press).

Electrostatic precipitators[34]

Electrostatic precipitators (ESP) function by electrostatically charging the dust particles in the gas stream. The charged particles are then attracted to and deposited on plates or other collection devices.

There are a number of different configurations of ESP (eg, plate or tube, single-stage or multi-stage); however, the most fundamental split is between wet and dry units. In dry ESPs the collectors are knocked or rapped by various mechanical means to dislodge the particulate matter, which slides downward into a hopper. In wet ESPs, the collectors are either intermittently or continuously washed by a spray of water, the collection hoppers replaced with a drainage system. A portion of the fluid may be recycled to reduce the total amount of water required.

ESPs may be installed for particulate emissions control on a wide range of discharges, including:

- chemical manufacturing
- refineries
- cement manufacturing
- pulp and paper
- incineration
- textile industry, pulp and paper industry
- metallurgical industry.

Key advantages and disadvantages of ESPs compared to other forms of particulate emissions control are summarised in table 2-1.

Table A2.1: Advantages and disadvantages of ESPs

Advantages	Disadvantages
Wet or dry ESP • High efficiency even for small particles (>1µm). • Suitable for wide temperature, pressure and gas flow ranges. • Low pressure drop, hence energy requirement tends to be low. • Wet ESP only. • Wet ESP can also handle sticky particles, mists and highly resistive or explosive dusts.	Wet or dry ESP • Re-entrainment can be a problem due to high gas velocities, poor rapping or poor gas flow. • Corrosion near the top of the wires because of air leakage and acid condensation. • Sensitive to maintenance of the correct geometrical alignment, eg, wire discharge electrodes. • Sensitive to fluctuations in gas stream conditions (flow rates, temperatures, PM and gas composition, particulate loading). • Relatively large space required. • High quality personnel required. • Special precautions to protect personnel from the high voltage. • Dry ESP. • Explosion risk with dry ESP. • The separation capacity depends on the resistivity of dust particles (with dry ESP). • Dry ESP not recommended to remove sticky or moist particles.

34 Auckland Council, (in press).

Inertial Separators (Cyclones)[35]

Cyclones are widely used for applications involving large particulate where only moderate collection efficiencies are required, such as timber milling and processing, pneumatic conveying and the production of wood shavings and wood chip, generally because they have lower capital and operating costs than other devices with greater particle collection efficiency. They have, historically, been extensively used for the collection of fly-ash from coal combustion.

Cyclones can be described as high efficiency or high rate (or high throughput), referring to the particulate removal efficiency and air flow rate respectively. Cyclones are generally not suitable for discharges that contain a large proportion of PM_{10}. A high efficiency cyclone may remove as much as 60–70% of the PM_{10} fraction, whereas a high rate cyclone may remove as little as 10–20%. In contrast, a suitably designed baghouse will remove >99% of PM_{10}.

Collection efficiency generally increases with increases in:

- particle size or density
- inlet duct velocity
- cyclone body length
- ration of cyclone body diameter to exit diameter
- inlet dust loading
- smoothness of the inner cyclone wall

Collection efficiency generally decreases with increases in:

- gas viscosity or density
- cyclone body diameter
- gas exit diameter and inlet duct area
- leakage of air into the dust outlet.

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35 Auckland Council, (in press).

Appendix 3: NO to NO_2 conversion

This method is based on guidance provided by Auckland Council (Auckland Council, 2014). This method provides an alternative to the ozone-limiting method, outlined in the good practice guide for dispersion modelling. Either method is appropriate.

Ambient air contains around 78 per cent nitrogen. The combustion of any fuel in the presence of air therefore, results in the formation of nitrogen oxides. Nitrogen oxides (NOx) are emitted primarily as a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2). Nitric oxide usually makes up around 95 per cent (by volume) of the total NOx in combustion emissions from boilers, with the remaining 5 per cent being nitrogen dioxide. With respect to human health, nitrogen dioxide is the pollutant of most concern.

Nitric oxide reacts with ozone (O_3) in the atmosphere to form nitrogen dioxide and oxygen.

$$NO + O_3 \rightarrow NO_2 + O_2$$

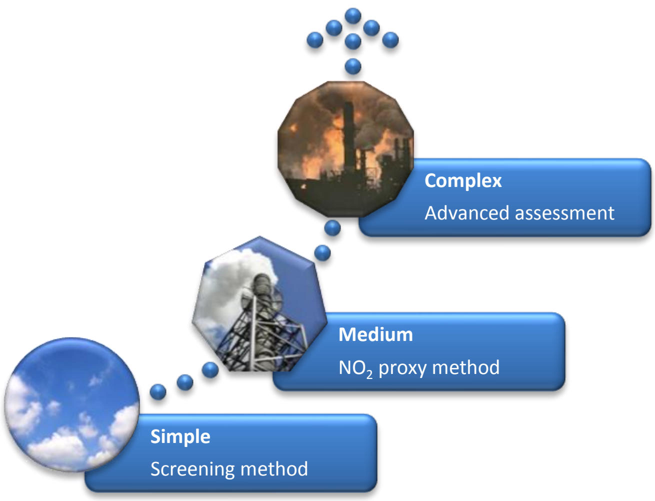
There are a number of methods for estimating the downwind conversion of nitric oxide to nitrogen dioxide. This guide recommends a tiered approach from simple to complex, as shown in figure 3.1. In simple terms, assessment should begin with the screening methodology (in which all nitric oxide is assumed to be nitrogen dioxide), and if this turns out to be too conservative then use more complex methodology as recommended later. If the more advanced assessment still results in elevated maximum predicted downwind concentrations, mitigation is recommended.

In practice, the reaction of nitric oxide to nitrogen dioxide is limited by the:

- amount of ozone and other reactive organic compounds available in the atmosphere
- rate of mixing of ozone in the atmosphere with the plume of gases discharging from the stack
- rate of chemical reaction
- reverse reaction (from nitrogen dioxide back to nitric oxide).

The above factors mean that concentrations of nitrogen dioxide are normally less than nitric oxide (except at very low concentrations).

Figure A3.1: Methods for assessing conversion of nitrogen oxides to nitrogen dioxide



NO_2 screening method

For a screening assessment it can be assumed that all nitrogen oxides from the modelled emission is nitrogen dioxide. The predicted ground level concentration of nitrogen dioxide is therefore:

$$[NO_2] = [NO_x]_{mod} + [NO_2]_{bkd}$$

Where:

$[NO_2]_{bkd}$ = background nitrogen dioxide

$[NO_x]_{mod}$ = the nitrogen oxides concentration at the receptor estimated from the modelled nitrogen oxides emissions. In this very conservative screening approach, all NOx is assumed to be NO_2 (ie, NOx as NO_2).

NO_2 proxy method

Where the screening assessment predicts unacceptable concentrations, the 'proxy' method is recommended.

The proxy method assumes that all of the nitric oxide is converted into nitrogen dioxide, but that this process is limited by the availability of ozone as follows:

$$[NO_2] = [NO_x]_{mod} \times F(NO_2) + [\text{Proxy } NO_2]$$

Where:

[Proxy NO_2] = combined nitrogen dioxide with ozone (as nitrogen dioxide equivalents) from a suitable background monitoring site

$[NO_x]_{mod}$ = the nitrogen oxides concentration at the receptor estimated from the modelled nitrogen oxides emission

$F(NO_2)$ = the mass fraction of nitrogen dioxide in the nitrogen oxides emissions from the source. Applicants should note that F varies depending on the source.

Default values for combined nitrogen dioxide with ozone [Proxy NO_2] as nitrogen dioxide equivalents have been derived for Auckland, based on monitoring data from sites where nitrogen dioxide and ozone are measured concurrently. These default values are considered appropriate for assessments in other regions.

Default values are provided below in table 3.1.

Table A3.1: Default background combined nitrogen dioxide with ozone [Proxy NO_2] concentrations

Contaminant	Location	Averaging time	Default value
Total NO_2 + O_3 [Proxy NO_2]	Roadside*	1 hour 24 hour	113 µg/m^3 75 µg/m^3
	All other locations	1 hour 24 hour	95 µg/m^3 75 µg/m^3

*Within 300m of a motorway or 150m of an arterial

In rural areas the background concentration of nitrogen dioxide is lower compared with urban areas. However the default combined nitrogen dioxide with ozone [Proxy NO2] is the same for rural and urban areas, because rural areas have relatively high ozone concentrations. The combined nitrogen dioxide with ozone (as NO_2 equivalents) is similar in rural and urban areas. This provides some confidence that the proxy method is applicable in any location, except roadsides where direct emissions of nitrogen dioxide are likely to cause higher nitrogen dioxide concentrations.

NO_2 – advanced assessments

Where the methods described above predict unacceptable concentrations of nitrogen dioxide, use of the chemistry modules provided with advanced dispersion models may be considered.[36] However, this requires detailed input data and advanced knowledge of dispersion modelling. Any advanced assessment needs to be undertaken by a suitably qualified expert with relevant experience, and the methodology should be agreed with consent authority staff before the assessment is undertaken.

Alternative methods, such as the empirical approach used in the US, should also be discussed with the consenting authority before undertaking the assessment. To date, this method has not been validated or rigorously assessed for the New Zealand context.

Some historical air quality assessments for thermal energy plants have used the Janssen equation (Janssen et al, 1988) to calculate the conversion of nitrogen oxides to nitrogen dioxide. This equation may be appropriate in certain circumstances for the assessment of large combustion plant discharges occurring in rural areas. However, this would need to be justified in detail and discussed with the consent authority. Use of the Janssen equation has not been validated or assessed for its relevance in other situations and is not recommended.

36 For example, American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD), California Puff Model (CALPUFF) and Atmospheric Dispersion Modelling System (ADMS).

Appendix 4: Composition of constituents in New Zealand air

Some computer dispersion models require knowledge of the baseline concentrations of constituents in the air. The standard global values can be found in many textbooks, but some of these are out of date, and others are slightly different for New Zealand conditions. Table 4.1 provides some values, many of which have been measured very accurately.

These values are based on measurements by NIWA at the Baring Head Clean Air Station, near Wellington, and are representative of values for uncontaminated air that has not passed over New Zealand (ie, only measurements made in clean southerly winds are included) (retrieved from www.niwa.co.nz).

Table A4.1: Clean air background concentrations of some atmospheric gases in New Zealand

Gas	Mean value	Unit	Accuracy +/–	Seasonal range	Comment
Carbon dioxide (CO_2)	368	ppm	1.0	1.0	Increasing at 0.4% per year.
Carbon monoxide (CO)	0.055	ppm	0.005	0.015	Strong season and space variation.
Nitrous oxide (N_2O)	0.316	ppm	0.001	0.001	Little space and time variation, increasing at 0.6% per year.
Methane (CH_4)	1.75	ppm	0.01	0.03	Local sources can bias (eg, strong agricultural sources).
Hydrogen (H_2)	0.70	ppm	0.01	0.01	Reasonably constant.
Sulphur dioxide (SO_2)	0.016	ppb	0.012	0.016	Maximum in summer, practically zero in winter.
Nitrogen dioxide (NO_2)	< 0.5	ppb	0.5	na	Estimated from urban monitoring.
Ozone (O_3)	30	ppb	2.0	15	Highest New Zealand levels are often in clean air, and are strongly seasonal. This level is 'natural'.
Particulates (as PM_{10})	1.0	$\mu g/m^3$	0.1	1.0	All sea salt.
Chlorofluorocarbon (CFC12)	0.50	ppm	0.05	0.01	Recent global increase.
Benzene (C_6H_6)	0.05	ppb	0.01	na	Can be zero in ultra clean air, over 30 ppb in city contaminated air.
Other toxics	< dl		est.	na	Not measured, but most are below detection limits for the most sensitive equipment.
Nitrogen (N_2)	780,900	ppm	est.	–	Not measured routinely in New Zealand.
Oxygen (O_2)	209,400	ppm	est.	–	Not measured routinely in New Zealand.
Argon (Ar)	9,300	ppm	est.	–	Not measured routinely in New Zealand.
Other inert gases	20	ppm	est.	–	Not measured routinely in New Zealand.

Glossary

Term	Definition
AAQG	Ambient air quality guideline
Acute	Short-term exposure (eg, 1-hour).
Airshed	An area designated by a unitary authority, regional or district council for the purposes of managing air quality, and gazetted by the Minister.
Chronic	Long-term exposure (eg, over the period of a year or more).
Compliance	A range of activities usually carried out by agencies with regulatory functions to ensure people and other organisations adhere to rules and regulations for the public good.
Concentration	An amount of a pollutant (or odour) per unit of volume.
Dispersion modelling	Calculations of concentrations of an airborne pollutant downwind of a source.
Effects	The consequences of the changes in airborne concentrations for a receptor. This may be amenity related or more serious, such as adverse health effects. The term 'effect' has a legal definition under the Resource Management Act 1991 (the RMA) (see section 1.3.2).
Emission	A discharge to air.
FIDOL factors	Frequency, Intensity, Duration, Offensiveness/Character and Location. These factors determine whether an odour has an offensive or objectionable effect.
IARC	International Agency for Research on Cancer.
Impacts	The changes in airborne concentrations. An activity can have an 'impact' without having any 'effects', for instance if there are no receptors to experience the impact. This is particularly true for odour, which is entirely perception based.
Industrial or trade premises	(a) any premises used for any industrial or trade purposes; or (b) any premises used for the storage, transfer, treatment, or disposal of waste materials or for other waste-management purposes, or used for composting organic materials; or (c) any other premises from which a contaminant is discharged in connection with any industrial or trade process— but does not include any production land.
LOAEL	Lowest observed adverse effects level.
m^3	Cubic metres.

Term	Definition
National environmental standard (NES)	Tools used to set nationwide standards for the state of a natural resource such as air quality.
(the) NES for air quality	The Resource Management (National Environmental Standards for Air Quality) Regulations 2004.
NOAEL	No observed adverse effects level.
Non-threshold compound	Substances, such as genotoxic carcinogens, where there is no known safe level of exposure.
Offset	Offsets are when emissions from a new activity are ‘offset’ by emission reductions elsewhere in an airshed.
PM	Particulate matter.
$PM_{2.5}$	Particulate matter less than 2.5µm in diameter, sometimes referred to as ‘fine’ particulate matter.
PM_{10}	Particulate matter less than 10µm in diameter, includes ‘fine’ particulate (less than 2.5µm) and ‘coarse’ particulate (2.5 to 10µm).
Receptor	A location that may be affected by an air contaminant. Human receptors include locations where people spend time.
Reverse sensitivity	Newer, more sensitive, activities constraining the ability of established activities to continue.
RMA	Resource Management Act 1991
Separation distance	Distance between an industrial or odorous/dusty activity and a sensitive activity.
Threshold compound	Substances where a threshold has been established below which there are no known adverse effects from exposure.
µg	Microgram, one millionth of a gram
µm	Micrometre, one millionth of a metre
WHO	World Health Organisation

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