Ambient Air Quality Guidelines

2002 Update

Air Quality Report No 32

Prepared by the Ministry for the Environment and the Ministry of Health

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Ministry for the Environment

Foreword

Air pollution is harming our health and that of our children and parents. The young and old are particularly vulnerable to the effects of air pollution. A recent study estimates that around 970 premature deaths are caused every year in New Zealand by inhaling air pollution from sources such as vehicles, home-heating fires and industries. Premature deaths are just the ‘tip of the iceberg’. Air pollution causes many harmful effects, ranging from premature death, to headaches, coughing and asthma attacks.

The air resource is not a rubbish dump for the harmful particles and gases we emit as we drive our cars, heat our homes and run our factories. But it is easy to forget that as we put our foot down on the accelerator, or throw another log on the fire, potentially harmful pollutants spew out of the tailpipe or chimney. We tend to think pollutants simply blow away, but under some conditions they may be inhaled, minutes or hours later, by som

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Contents

1 Introduction

1.1 Purpose

This report contains new ambient air quality guideline values for New Zealand, and updated guidance on how they should be used to manage air quality under the Resource Management Act 1991 (RMA). The new guideline values replace those first published by the Ministry for the Environment in 1994. The 2002 Guidelines follow the previous guidelines in applying only to ambient air outside buildings or structures, and not to indoor air or air in the workplace.

The primary purpose of national ambient air quality guidelines is to promote sustainable management of the air resource in New Zealand.

Guideline values are the minimum requirements that outdoor air quality should meet in order to protect human health and the environment. Where air pollution levels breach guideline values, emission reduction strategies should be implemented to improve air quality. Where levels do not breach the values, efforts should be made to maintain air quality and, if possible, reduce emissions. This is particularly important for those pollutants, such as particles less than 10 microns in diameter (PM_{10}), for which the guideline value cannot be based on a 'no observable adverse effects level'.

Guideline values should not be used as limits to pollute up to. If pollution approaches the guideline value, then air quality is comparatively poor and has been degraded from iuo10.98 31.6en3

The 2002 Guidelines were developed as part of the Ministry's Air Quality Management Programme. The Programme develops well-debated national guidance for councils, industries and communities involved in managing air quality, and investigates, develops and implements appropriate national policy tools to improve air quality.

The document is structured as follows.

- Chapter 1 (this chapter) describes the process involved in developing the guidelines, briefly covers the legal framework under which air quality is managed in New Zealand, and explains the status of the guideline values and how they will be reviewed.
- Chapter 2 contains the guideline values, along with descriptions of the health effects of each contaminant and reasons for the chosen guideline value.
- Chapter 3 discusses the framework for air quality management and how guideline values can be used to determine the state of the air environment, devise regional criteria, set reduction targets and develop reduction strategies for both regional and national planning processes.
- Chapter 4 introduces an approach to assessing and managing the impacts of air pollution on ecosystems using critical levels.

1.2 Background

The development process

The new and revised guideline values and guidance on how to use them are derived from:

- comprehensive reviews of research on the health and environmental effects of the priority contaminants (see below)
- a review of how the 1994 guideline values were applied to managing air quality in New Zealand (Ministry for the Environment, 2000c, Chapter 2)
- consideration of current air pollution levels in New Zealand (Ministry for the Environment, 1998c; Chiodo and Rolfe, 2000)
- discussions in expert working groups and 17 consultation meetings
- submissions on the discussion document *Proposals for Revised and New Air Quality Guidelines – Discussion Document* (Ministry for the Environment, 2000c)
- submissions on the *Summary of Submissions Received on the Discussion Document and Proposals for Amendments* (Ministry for the Environment, 2001c)
- developments through the Ministry's Environmental Performance Indicators Programme.

The reviews of environmental and health research used to determine the new guideline values are written up in several technical reports prepared for the Ministry for the Environment:

- *Health Effects of Five Air Contaminants and Recommended Protective Ranges*. Air Quality Technical Report 12. L Denison, K Rolfe, and B Graham, 2000.
- *Health Effects of Eleven Hazardous Air Contaminants and Recommended Evaluation Criteria*. Air Quality Technical Report 13. J Chiodo and K Rolfe, 2000.
- *Preliminary*
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1.3 Legal and policy framework

The legal and policy framework for environmental management in New Zealand directs how air quality is managed in New Zealand. This information is generally well known, so this section only briefly covers the key points.

Regional air quality management

Under the RMA, regional councils and unitary authorities are responsible for managing discharges into the air and therefore for managing the quality of the outdoor air that we breathe. The purpose of the RMA is to promote the sustainable management of natural and physical resources, including air.

Sections 5 to 8 of the RMA outline the key principles and purpose of the RMA. Section 5 provides that the purpose of the Act is to promote the sustainable management of natural and physical resources including safeguarding the life supporting capacity of the air, while sections 6 to 8 describe other matters (including the Treaty of Waitangi) which must be considered when making decisions. Of particular relevance for air quality management is section 7(f), which states that persons exercising powers under the Act must have particular regard to the:

> *(f) Maintenance and enhancement of the quality of the environment.*

Section 30 of the RMA specifies the functions of regional councils and unitary authorities, which include controlling the discharge of contaminants into the air. Councils are also responsible for gathering sufficient information about the state of the environment to enable them to carry out their functions (section 35). To manage the environment, councils can prepare regional policy statements or regional plans specifying objectives, policies and rules to address any issues of concern (sections 63 to 70).

The costs and benefits of measures to improve air quality through regional policy statements and regional plans must be analysed in accordance with section 32 of the RMA. The options must be discussed with, and take into account the views of, the local community before being implemented.

1.6 Reviews

Developing and applying guideline values is an iterative process. New research findings

2 Health-based Guideline Values

2.1 Introduction

The revised and new guideline values listed in

Table 1: Guideline values and the key health effects

Contaminant	Guideline values[a]		Key health effects
	Value	Averaging time	
Carbon monoxide	30 mg/m^3 10 mg/m^3	1-hour 8-hour	Reduced birth weight (non-smoking mothers), decreased work capacity, increased duration of angina (for those with ischaemic heart disease), decrease in visual perception, decreased manual dexterity, and decreased ability to learn.
Fine particles (PM_{10})	**50 μg/m^3** **20 μg/m^3**	24-hour Annual	Mortality, morbidity, hospitalisation, work-affected days, increased use of medication. There is no evidence of a threshold below which adverse health effects will not be observed.
Nitrogen dioxide	**200 μg/m^3** 100 μg/m^3	1-hour 24-hour	Apparent contribution to morbidity and mortality, especially in susceptible subgroups, including young children, asthmatics and those with chronic inflammatory airway disease.
Sulphur dioxide[b]	350 μg/m^3 **120 μg/m^3**	1-hour 24-hour	Daily mortality, hospital admissions and emergency room attendances for respiratory and cardiovascular disease, increases in respiratory symptoms and decreases in lung function.
Ozone	150 μg/m^3 100 μg/m^3	1-hour 8-hour	Increased daily mortality, respiratory and cardiovascular disease; decreases in lung function; increases in hospitalisations, and in respiratory illnesses such as cough, phlegm and wheeze.
Hydrogen sulphide[c]	7 μg/m^3	1-hour	Nuisance and unpleasant odour – sensitivity is reduced through continuous exposure. Higher concentrations lead to eye irritation, eye damage, and over-stimulation of

2.3 Particles (PM_{10} and $PM_{2.5}$)

2.3.1 Guideline values

The PM_{10} guideline values are 50 $\mu g/m^3$ (24-hour average) and 20 $\mu g/m^3$ (annual average).

Research has been unable to determine a threshold for PM_{10} below which there are no adverse effects (WHO, 1999). Consequently, these guideline values are associated with a higher level of health risks than for many of the other contaminants. The values for PM_{10} are designed to be the first step in reducing the health effects caused by particles in areas where concentrations breach the guideline values. Where PM_{10} levels are within the guideline values, efforts should still bCBT/TT7 1 Tf0.000e21 0 b d0.98 .eline val

2.3.3 Description and sources

Particles ar

2.4.3 Description and sources

NO_2 is a pungent, acidic gas. Corrosive and strongly oxidising, it is one of several oxides of nitrogen (NO_x) that can be produced as a result of combustion processes. Combustion of fossil fuels converts atmospheric nitrogen and any nitrogen in the fuel into its oxides, mainly nitric oxide (NO) but with small amounts (5–10%) of NO_2. NO slowly oxidises to NO_2 in the atmosphere. This reaction is catalysed in the presence of O_3. In the presence of sunlight, NOx, including NO_2, react with volatile organic compounds to form photochemical smog.

The main source of NO_2 resulting from human activities is the combustion of fossil fuels (coal, gas and oil). In cities, about 80% of ambient NO_2 comes from motor vehicles. Other sources include the refining of petrol and metals, commercial manufacturing, and food manufacturing. Electricity generation using fossil fuels can also produce significant amounts.

2.5 Sulphur dioxide

2.5.1 Guideline values

The guideline values for sulphur dioxide are 350 µg/m^3 (1-hour average) and 120 µg/m^3 (24-hour average).

These values are set to provide protection of lung function and prevent other respiratory symptoms of vulnerable sub-groups in the population, including asthmatics and those with chronic obstructive lung disease. They are in line with current international guideline values and standards. The annual guideline value for sulphur dioxide is now discussed in Chapter 4 on ecosystem-based guidelines. The short-term guideline value has been removed, as it is not appropriate for managing air quality in large air sheds, however, shorter-term criteria for sulphur dioxide may be appropriate for assessing industrial discharges.

2.5.2 Health effects

Sulphur dioxide (SO_2) is a potent respiratory irritant when inhaled. Asthmatics are particularly susceptible. SO_2 acts directly on the upper airways (nose, throat, trachea and major bronchi), producing rapid responses within minutes. It achieves maximum effect in 10 to 15 minutes, particularly in individuals with significant airway reactivity, such as asthmatics and those suffering similar bronchospastic conditions.

The symptoms of SO_2 inhalation may include wheezing, chest tightness, shortness of breath or coughing, which are related to reductions in ventilatory capacity (for example, reduction in forced expiratory volume in one second, or FEV_1), and increased specific airway resistance. If exposure occurs during exercise, the observed response may be accentuated because of an increased breathing rate associated with exercise. A wide range of sensitivity is evident in both healthy individuals and more susceptible people, such as asthmatics, the latter being the most sensitive to irritants.

Epidemiological studies have shown significant associations between daily average SO_2 levels and mortality from respiratory and cardiovascular causes. Increases in hospital admissions and emergency room visits for asthma, COPD and respiratory disease have also been associated with ambient SO_2 levels. These associations were observed with up to a two-day lag period. Long-term exposure to SO_2 and fine particle sulphates (SO_4^{2-}) has been associated with an increase in mortality from lung cancer and development of asthma and cardio-pulmonary obstructive disease. Increases in respiratory symptoms have also been associated with SO_2 levels.

2.5.3 Description and sources

SO_2 is a colourless, soluble gas with a characteristic pungent smell. It is mainly produced by the combustion of fossil fuels containing sulphur and some industrial processes.

2.6 Ozone

2.6.1 Guideline values

The guideline values for ozone are 150 $\mu g/m^3$ (1-hour average) and 100 $\mu g/m^3$ (8-h

- decrease in lung function
- increase in symptoms of respiratory illness such as cough, phlegm and wheeze
- increase in bronchodilator usage.

These effects are observed in sensitive sub-populations, although effects on lung function have also been observed in the healthy normal population.

2.6.3 Description and sources

O_3 is a secondary air pollutant formed by reactions of primary pollutants – oxides of nitrogen (NO_x) and hydrocarbons – in the presence of sunlight. These primary pollutants arise mainly from motor-vehicle emissions, stationary combustion sources and industrial and domestic use of solvents and coatings.

O_3 is only one of a group of chemicals known as photochemical oxidants (commonly referred to as photochemical smog), but it is the predominant one. Also present in photochemical smog are formaldehyde, other aldehydes, and peroxyacetyl nitrate. Most epidemiological studies relate to O_3 plus the other oxidants, though it is usually only the former that is measured as an indicator of 19f.Tm6e120nly.im(og)Tj10.98 e0jlogical studies75.98 524.509 10.98 475.407210.98 0 0 1Ju510.9803 Tm(e

2.7.2 Health effects

The health effects of lead are related to the level of lead in human blood. Although there are some differences in the bio-availability of different lead compounds, the health effects caused by increased blood lead levels are the same, regardless of the lead compounds causing the exposure.

One of the most widely recognised effects of lead exposure is a decrease in intelligence and general academic performance in children, especially when exposed to lead within the first two to three years of life. The sub-groups most vulnerable to lead are young children and developing foetuses. There is now clear epidemiological evidence of a close causal relationship between prenatal exposure to lead and early mental development indices, and it has not been possible to identify a clear threshold for its effects.

Where there is the likelihood of ingestion from de

Further monitoring and research is required to develop a guideline value for long-term exposure to hydrogen sulphide where natural background concentrations from geothermal activities occur above the odour-based guideline value. H_2S will be reviewed at the same time as $PM_{2.5}$ and CO.

2.8.2 Health effects

H_2S is a colourless gas with a distinctive odour at low concentrations. Humans detect it at levels of 0.2–2.0 μg/m^3, depending on its purity. This is the odour threshold, which is defined as the concentration at which 50% of a group of people can detect an odour. At about three to four times this concentration range it smells like rotten eggs.

H_2S causes nuisance effects because of its unpleasant odour at concentrations well below those that cause health effects. Continuous exposure to H_2S reduces sensitivity to it.

In acute exposures H_2S acts on the nervous system to cause a range of symptoms characterised as H_2S intoxication. At levels above 15 mg/m^3 it causes eye irritation, and above 70 mg/m^3 it causes permanent eye damage. Above 225 mg/m^3 it paralyses olfactory perception so that the odour is no longer a warning signal of the gas's presence. At concentrations above 400 ug/m^3 there is a risk of pulmonary oedemea, and above 750 mg/m^3 it over-stimulates the central nervous system, causing rapid breathing, cessation of breathing, convulsions, and unconsciousness. At 1400 mg/m^3 it is lethal.

Adverse effects have been observed in occupationally exposed populations at an average concentration of 1.5–3.0 mg/m^3. Symptoms include restlessness, lack of vigour, and frequent illness. In occupationally exposed groups, at levels of 30 mg/m^3 or more 70% complained of fatigue, headache, irritability, poor memory, anxiety, dizziness and eye irritation.

2.8.3 Description and sources

H_2S occurs naturally in geothermal areas. It also forms under anaerobic conditions where organic material and sulphate are present. Human activities can release naturally occurring H_2S, such as when natural gas is extracted or when heat is extracted from geothermal waters. H_2S is also produced in industrial processes where sulphur and organic materials combine in oxygen-deprived environments. These include pulp and paper manufacturing, oil refining, tanning of

2.10.2 Health effects

The most significant chronic adverse effects from prolonged exposure to benzene are haemotoxicity, genotoxicity and carcinogenicity (WHO, 1996). Haemotological effects of varying severity have occurred in workers occupationally exposed to high levels of benzene. Decreased red and white blood cell counts in humans have been reported above median levels of approximately 120 mg/m^3. There is only weak evidence for effects below 32 mg/m^3, and no reported effects at 0.03–4.5 mg/m^3.

Data from animal and human exposures indicate that benzene is both mutagenic and carcinogenic. Increased mortality from leukaemia has been demonstrated in occupationally exposed workers. Benzene has been classified as a Group A carcinogen of medium potency by the US EPA, and a Group 1 carcinogen by IARC (see Appendix 3).

2.10.3 Description and sources

Benzene (C_6H_6) is a colourless, clear liquid with a density of 0.87 g/cm^3 (at 20^{o}C) and a boiling point of 80.1^{o}C. Chemically it is fairly stable but it undergoes substitution and addition reactions.

Motor vehicles and household fires are significant sources of benzene in New Zealand’s air. There are also some industrial activities that use and discharge benzene. Motor vehicle exhaust emissions of benzene are thought to derive partly from unburnt benzene in the fuel, and partly from the dealkylation of other aromatic hydrocarbons. Other sources of benzene that may impact locally include oil refining, petrochemical production, and synthetic rubber manufacture.

2.11 1,3-Butadiene

2.11.1 Guideline value

The guideline value for 1,3-butadiene is 2.4

WHO notes that there is substantial inter-individual variability in human formaldehyde responses. Significant increases in signs of irritation occur at levels above 0.1 mg/m^3 in healthy

2.13.2 Health effects

There are no human data on the effects of acute exposure to benzo(a)pyrene (BaP) and other PAHs. Chronic exposure to BaP in humans has resulted in dermatitis, photosensitisation, eye irritation, and cataracts. Epidemiological studies have reported increases in lung cancer in humans from exposure to coke-oven and roof-tar emissions and cigarette smoke, all of which contain a number of PAHs.

WHO notes that the carcinogenicity of PAH mixtures may be influenced by other compounds emitted with PAHs during incomplete combustion, and also points out the poor quality of available data sets from which to derive a risk assessment for BaP (WHO, 1996).

WHO has determined an inhalation unit risk of 8.7 x 10^{-2} per µg/m^3 BaP, based on interpolation from risk estimates for PAHs in coke-oven emissions. WHO has also determined an inhalation unit risk from studies of animals exposed to complex mixtures of PAHs of 2 x 10^{-5} per µg/m^3 BaP 10^{-5} per ng/m^3 (WHO, 1996). They recommend that unit risks be used to set ambient air quality guidelines.

The US EPA has classified BaP as a Group B2 carcinogen of medium potency. The IARC classification is Group 2A (IARC, 1998). The US EPA has not determined an inhalation unit risk for BaP.

The UK has proposed a new objective for BaP of 0.00025 µg/m^3 (annual average at 20^{o}C) to be achieved by the end of 2010.

2.13.3 Description and sources

PAHs are a large group of organic compounds with two or more benzene rings. They are semi-volatile compounds that occur in both the gaseous phase or attached to particles. PAHs with low vapour pressures are almost totally adsorbed ontP A H s j A l t P o u g h a l

2.14 Mercury

2.14.1 Guideline values

The guideline values for mercury are 0.33 $\mu g/m^3$ (annual average) for inorganic mercury and 0.13 $\mu g/m^3$ for organic mercury (annual average).

The guideline values aim to protect people from adverse health effects caused by inhaling mercury fumes or particles.

The value for inorganic mercury is derived from the occupational health standards for inorganic mercury and the US EPA reference concentration (RfC) and the Californian Air Resources Board's reference exposure level (REL) values (Chiodo and Rolfe, 2000). The value for organic mercury is derived from the value for inorganic mercury by scaling according to the occupational health standards.

The above levels should be viewed as applicable where exposure to mercury is mainly through inhalation. They will need to be adjusted downwards where dietary intake is significant.

2.14.2 Health effects

The effects of chronic exposure to elemental mercury include central nervous system (CNS) effects (such as erethism, irritability, insomnia), severe salivation, gingivitis and tremor, kidney effects (including proteinuria), and acrodynia in children. The primary effect of chronic exposure to methyl mercury is CNS damage, while chronic exposure to inorganic mercury induces kidney damage (US EPA, 1998). Acute inhalation exposure to high levels of elemental mercury in humans results in CNS 341.821 0v Tm(The primary)Tj91849 379.2809 Tm(su)Tj0.0084

The US EPA RfC for elemental mercury is 0.3 μg/m^3, and the reference dose (RfD) for methyl mercury is 0.3 μg/kg/day (US EPA, 1993). The California Air Resources Board (CARB) RELs are as follows:

- elemental mercury 0.3 μg/m^3 (chronic REL)
- inorganic mercury and mercury compounds 30 μg/m^3 (acute REL)
- methyl mercury 1 μg/m^3 (chronic REL).

The acute REL for inorganic mercury is under review, and a draft value of 1.8 μg/m^3 is to be reviewed by the Scientific Review Panel on Toxic Air Contaminants.

2.14.3 Description and sources

Elemental mercury exists almost totally in the gas phase in the atmosphere, as does methyl mercury, while inorganic mercury compounds are usually particle-bound (CARB, 1998).

Volcanic and geothermal activities are

2.15.2 Health effects

Chromium VI compounds are more toxic than chromium III. The respiratory tract is the major target organ for acute inhalation exposure to chromium VI. Dyspnoea, coughing, and wheezing in humans have been reported following exposure to very high levels. Gastrointestinal and neurological effects have also been reported. Chronic inhalation exposure has been associated with effects on the respiratory tract. Perforations and ulcerations of the septum, bronchitis, decreased pulmonary function, pneumonia, asthma, and nasal itching and soreness have also been reported in humans following exposure. Other effects of chronic inhalation exposure have been reported on the liver, kidney, gastrointestinal and immune systems, and possibly the blhighy the bl

2.16 Arsenic

2.16.1 Guideline values

The guideline value for inorganic arsenic is 0.0055 μg/m^3 (annual average). For arsine the guideline value is 0.055 μg/m^3 the (annual average).

The ambient guideline value for inorganic arsenic is based on an acceptable risk value of 1 in 100,000 for a high-potency carcinogen.

As is the case for mercury and chromium, these values may need to be adjusted downwards if dietary intake is significant. Contaminated soils may be a significant source of exposure for children.

2.16.2 Health effects

Acute inhalation exposure to inorganic arsenic may result in gastrointestinal effects, haemolysis, and central and peripheral nervous system disorders in humans. Effects of acute exposure to arsine (a gaseous compound of arsenic) include haemolytic anaemia, haemoglobinuria and jaundice, and can lead to kidney failure. Acute inhalation exposure to arsine can lead to death: it has been reported that exposure to 87–170 mg/m^3 arsine for half an hour can be lethal.

Chronic inhalation exposure to, and contact with, inorganic arsenic is associated with irritation of the skin and mucous membranes, including dermatitis, conjunctivitis, pharyngitis and rhinitis. Several studies of women working or living near metal smelters, and in the electronics industry, have associated exposure to arsenic and arsine gas with an increased in 0 0 10.98 496.1286 404.65267404.208 ith,05

CARB specifies a non-cancer chronic REL of 0.55 $\mu g/m^3$ for inorganic arsenic, considering blood disorders as the toxicological endpoint, and a non-cancer chronic REL of 140 $\mu g/m^3$ for arsine, for which the toxicological endpoints are considered to be the respiratory system, the central and peripheral nervous systems, and the skin (CARB, 1998).

2.16.3 Description and sources

Arsenic and its compounds are ubiquitous in the environment and exhibit both metallic and non-metallic properties. The trivalent and pentavalent forms are the most common oxidation states. At least six groups are present in the environment, with inorganic forms (such as arsenic trioxide and arsenic pentoxide) and gaseous inorganic and organic arsenic compounds (for example, arsine) being the most important for air quality.

Specific sources of arsenic include timber treatment using copper/chrome/arsenic preservatives, and previous pesticide application. Emissions are largely to land or water. Arsine can be released into the air from old chemical landfill sites. The burning of treated timber releases volatile arsenic oxides, either in the gaseous form or associated with particle emissions. Health and environmental guidelines for selected timber treatment chemicals are available (Ministry for the Environment, 1997b).

3.1 [redacted]

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3.2.2 Amount and location of monitoring

Obviously it is impossible to monitor at every location where a person may be exposed to a particular contaminant. It is therefore necessary to select a number of representative

Areas with populations of 25,000–100,000

For large towns (population between 25,000 and 50,000) the minimum level of monitoring should include representative short-term surveys, certainly of PM_{10} or $PM_{2.5}$ and carbon monoxide. Nitrogen dioxide should be measured where there is significant traffic congestion, and sulphur dioxide should be investigated in areas with significant coal or oil burning. If the

Table 2: Recommended monitoring methods

Contaminant	Revised or new method
Carbon monoxide	**AS3580.7.1 – 1992**
Particles (PM_{10})*	**US 40 CFR Part 50, Appendix J**
Particles ($PM_{2.5}$)*	**US 40 CFR Part 50, Appendix L**
Nitrogen dioxide	AS3580.5.1 – 1993
Sulphur dioxide	AS3580.4.1 – 1990
Ozone	AS3580.6.1 – 1990
Hydrogen sulphide	**AS3580.4.1 – 1990, coupled with a hydrogen sulphide to sulphur dioxide converter**
Lead content of PM_{10}	**US 40 CFR Part 50, Appendix J**

3.2.4 Comparing monitoring data to guideline values

Many factors affect pollution levels measured at a particular site, including:

- proximity and type of emissions sources
- background or natural concentrations
- monitoring method used
- meteorology
- quality assurance checks
- atmospheric reactions
- topography.

Careful analysis of how these factors interact and influence pollution levels is required to understand and interpret the data collected at a site.

The first stage is usually to determine whether the contaminant concentrations recorded comply with the guideline values. This usually focuses on the magnitude and frequency of peak monitoring results. As part of the quality assurance process, the reasons for the peak values must be investigated. Some peaks may not be valid results (for example, due to equipment failure), or they may be valid but occur because of unusual events (for example, Guy Fawke's night or a diesel generator parked nearby).

It is difficult

3.2.5 Emission inventories

Emission inventories are an integral part of air qualit

The main goal for sustainable air quality is to maintain air quality where it is good and to improve air quality where it has been degraded and is affecting people's health. When it comes to guideline values, this means that where pollution levels breach a guideline value, emissions into the air shed should be reduced so that breaches do not occur; where possible, further improvements should also be made (particularly for those contaminants with no threshold level for adverse effects). It also means that where air quality does not breach the guideline values but looks like it might worsen over time (based on emissions inventory predictions), action should be taken to prevent it from breaching the guideline value. This is particularly important because measures required to reduce emissions may take some time to be implemented and become effective.

A framework for directing this process and establishing regional criteria using air quality 'categories' has been developed through the Environmental Performance Indicators (EPI) Programme. Table 3 lists five air quality categories. While these values are somewhat arbitrary, they have been widely used in planning processes since their introduction in 1997.

Table 3 shows that pollution levels recorded above 66% of any national guideline value fall within the 'alert' category, as defined by the EPI Programme. This warning level indicates that the guideline value could be exceeded if upward trends are not curbed. In a sense, this provides a definition of degraded air because it implies that 66% of the guideline is the threshold above which it is necessary to consider taking action to maintain or reduce emissions into the air shed. In this situation it may be necessary to develop policies aimed at curbing a potential upward trend, or at enhancing air quality – depending on the circumstances, local community aspirations and the costs and benefits of the actions required.

Table 3: EPI programme air quality categories

Category	Measured value	Comment
Action	Exceeds the guideline value	Exceedances of the guideline are a cause for concern and warrant action, particularly if they occur on a regular basis.
Alert	Between 66% and 100% of the guideline value	This is a warning level, which can lead to exceedances if trends are not curbed.
Acceptable	Between 33% and 66% of the guideline value	This is a broad category, where maximum values might be of concern in some sensitive locations, but are generally at a level that does not warrant urgent action.
Good	Between 10% and 33% of the guideline value	Peak measurements in this range are unlikely to affect air quality.
Excellent*	Less than 10% of the guideline value	Of little concern: if maximum values are less than a 10th of the guideline, average values are likely to be much less.

* The 'excellent' category should not be applied to PM_{10} because the level of detection of most monitoring methods is not accurate enough.

Regional criteria should be based on monitoring data indicating current air quality and community aspirations for the level of air quality desired in an area or region. They can have a spatial extent, such as a particular city area, receiving environment or monitoring site type. Regional criteria should not be less stringent than national guideline values.

In general, the top of the acceptable category range is appropriate to maintain and protect air quality in most areas of New Zealand where, although there is limited information, the air quality is generally clean and there are no specific issues. Typically, this would apply to rural areas or small- to medium-sized urban areas without too many problems.

Reduction targets are usually based on peak monitoring results, emission inventory information, the guideline value (or regional criteria), any air-shed modelling, and investigations determining the relationship between emissions and concentrations measured at a monitoring site. The following need to be taken into account:

- whether monitoring data from the site are representative of pollution levels in the air shed, including peak values
- the accuracy of monitoring results
- any health effects assessments highlighting particular areas or contaminants of concern
- atmospheric dispersion modelling that explains the relationship between emissions and ambient concentrations
- community aspirations for emissions reductions
- the emission sources requiring greatest control, estimated through an emissions inventory and, where necessary, atmospheric dispersion modelling.

To determine reduction targets, councils should also consider the following:

- Do the peak values represent relatively frequent pollution events that are likely to cause health effects?
- Were there any unusual circumstances when the peak values were monitored (for example, bonfire night, diesel generator parked nearby)?
- Have the peak values occurred relatively frequently over the past few years?
- How accurate is the monitoring method?

If the peak values represent relatively frequent pollution levels and are not anomalous, then it is appropriate to base the reduction target on the peak results (possibly averaged over a number of years). If there is reason to believe that the peak results are not representative of typical peak pollution levels, then the monitoring results should be considered carefully. If one or more peak results are determined to be anomalous or do not occur on a regular basis, they should

3.4.2 Community consultation

Consultation with the community is also an integral part of regional air quality management and plan development under the RMA, and for national policy development.

Councils and central government agencies should ensure that the community is kept informed about air quality (especially where it does not meet the guideline values), the main pollution sources, and their potential effects on people's health and well-being. Adequate information is particularly important when discussing the potential cost of improvement options and when asking the community to make decisions on the actions required to improve air quality.

Methods for presenting air quality monitoring information are being developed by councils, the media and the Ministry. The *Good-practice Guide to Air Quality Monitoring and Data Management* (Ministry for the Environment, 2000a) the Ministry's *The Air We Breathe* web pages, regional state of the environment reports and the EPI Programme all have useful examples and guidance on how to present and interpret monitoring data, and how to communicate monitoring results to the general public.

3.5 Evaluating reduction strategies

Once reduction strategies and actions are implemented, their effectiveness needs to be assessed over time by ongoing air quality monitoring and analysis of the pressures.

Assumptions used to predict the effectiveness of different measures should be checked. For example, if an emission inventory model was used to predict the reductions associated with a particular policy, the assumptions used in the model should be periodically checked and re-evaluated.

Likewise, air quality monitoring can be used to check predicted improvements in air quality, taking into account the influence on meteorology. Given the factors affecting air quality it may take a number of years before a clear trend can be determined.

If evaluation shows that the predictions were inaccurate and the rate of anticipated improvements is not being achieved, plans and policies should be reviewed and revised. The same applies if improvements are faster than anticipated and particular rules or policies are perhaps not needed as urgently.

3.6 Involving Maori

Traditionally Maori have had a close relationship with the environment, of which air quality is an important part. Iwi and mana whenua have traditionally exercised their roles as kaitiakitanga, and this role differs in each area.

The way in which Ngai Tahu may choose to exercise their role of kaitiaki in Christchurch might be different from the way it is done in Kawerau by Tuwharetoa-ki-Kawerau. And clearly, for urban Maori this could again be markedly different from the practise of Maori living in rural areas.

The practice of kaitiakitanga will be largely influenced by the nature of the influence in their geographical area. Iwi and mana whenua may seek to employ a vast range of differing tools both traditional and modern in order to meet these responsibilities.

In developing guidelines the Ministry has aimed to provide flexibility so that local regional approaches can be tailored to local circumstances. The recommended approach of applying guidelines and developing management options at a regional level under the RMA will enable Maori to be better placed to establish regional measures that are consistent with the tikanga, history and present expectations of that region.

For this to work effectively, there needs to be a good relationship between local iwi and regional councils. The Ministry has produced guidance on how to build relationships with local iwi: *Talking Constructively: A practical guide for building agreements between iwi, hapu and whanau and local authorities,* and *Iwi and Local Government Interaction under the Resource Management Act 1991: Examples of good practice*. Both of these are available from the Ministry's publications department, or they can be downloaded from:
http://www.mfe.govt.nz/about/publications/rma/rma.htm.

3.7 Assessing individual discharges to air

As was stated in the 1994 Guidelines, the ambient guideline values are not designed to be used to assess the environmental and health impacts of individual discharges to air as required by the RMA, or a regional or district plan. Individual discharges include point, area or line sources from activities such as industries, roads and sewage-treatment plants.

We recognise, however, that in the absence of

In general, guideline values:

- *should not* usually be used as limits to pollute up to by one industry
- *should not* be applied without taki
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4 Ecosystem-based Guidance

4.1 Introduction

The RMA requires consideration of the potential and actual effects of air pollutants on ecosystems as well as human health. This chapter presents new guidance for assessing the effects of air pollution on ecosystems. It must be read in conjunction with *Effects of Air Contaminants on Ecosystems and Recommended Critical Levels and Critical Loads*

4.2 Recent research

There has been considerable resear

It is important, however, to recognise

Contaminant and land use	Critical level	Averaging period	Additional requirements
Fluoride:			
• special land use	1.8 µg/m^3	12-hour	
	1.5 µg/m^3	24-hour	
	0.8 µg/m^3	7-day	
	0.4 µg/m^3		
	0.25 µg/m^3	90-day	
• general land use	3.7 µg/m^3	12-hour	
	2.9 µg/m^3	24-hour	
	1.7 µg/m^3	7-day	
	0.84 µg/m^3	30-day	
	0.5 µg/m^3	90-day	
• conservation areas	0.1 µg/m^3	90-day	

Notes: Critical levels for nitrogen dioxide assume that either O_3 or SO_2 are also present at near guideline levels. Critical levels for ozone 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^{o}C), calculated as the sum of the difference between hourly ambient ozone concentrations and 85.6 µg/m^3, when ozone concentrations exceed 85.6µg/m^3). Ozone is only measured during daylight hours with a clear global radiation of 50 Wm^{-2} or greater; vpd = vapour pressure deficit.

In general, areas where sensitive ecosystems are located (rural and forest environments) are unlikely to experience pollution levels that breach these critical levels. There may be cause for concern if valued ecosystems are located near large individual sources or urban environments. It is difficult to make this same broad statement with regard to ammonia, since emission sourceswo47u

Where the potential effects of acid deposition and nitrogen enrichment need assessment, acid deposition and nitrogen enrichment can be estimated using approximate relationships between ambient air concentrations and their deposition rates for the pollutants of concern. In this way, ambient air monitoring data (modelled or monitored) can be used to estim

Appendix 1: Relationships to other Ministry and government programmes

Air Quality Management Programme

The Ministry's Air Quality Management Programme develops national tools and guidance to promote sustainable local air quality management. It aims to improve the quality, consistency and cost-effectiveness of monitoring and managing air quality in New Zealand. The Ministry works collaboratively with other government departments, councils and other stakeholders.

Current projects include:

- development of guides on atmospheric dispersion modelling and assessing discharges to air
- reviewing the Ministry's 1995 *Guide to Odour Management under the RMA*
- preparation of a Particle Action Plan to address emissions of particles from all sources, but especially domestic fires, which may include a national environmental standard
- consideration of indoor air quality – its likely impacts on people's health and responsibilities for its management.

Completed projects published by the Ministry include:

- *Good Practice Guide to Assessing and Managing the Environmental Effects of Dust Emissions* (2001a)
- *Good Practice Guide to Monitoring and Managing Visibility in New Zealand* (2001b)
- *Good-practice Guide for Ambient Air Quality Monitoring and Data Management* (2000a)
- *Emissions Testing and Compliance Monitoring of Discharges to Air* (1998c).

Organochlorines Programme

The Ministry's Organochlorines Programme recently sought comment on a draft *Action Plan for Reducing Discharges of Dioxin to Air* that includes a proposed national environmental standard for dioxin emissions. A large-scale monitoring programme was implemented in the early stages of this Programme to ascertain the level of dioxins and furans in different environments.

Hazardous Waste Management Programme

These 2002 Guidelines include air contaminants arising from the management of hazardous waste. The guideline values and Dioxin Action Plan will be taken into account in developing the Ministry's Hazardous Waste Management Programme.

Climate change policy

In general, both the ambient air quality guidelines and climate change policies aim to manage and, where appropriate, reduce the emissions of contaminants into the air. The Ministry aims to ensure that these programmes are complementary.

Government action on energy efficiency and renewable energy

Energy efficiency is at the heart of the Government's energy policy. The Energy Efficiency and Conservation Authority (EECA) is responsible for achieving the Government's energy policy goals and, specifically, energy efficiency and renewable energy policy. EECA also supports and complements other Government actions to improve the nation's environmental and economic performance, with emphasis on the housing, transport, business, industrial and other sectors with significant energy use.

EECA's focus is on developing and implementing a diverse range of operational energy efficiency, renewable energy and energy conservation programmes. EECA was recently designated a Crown entity role under the Energy Efficiency and Conservation Act 2000. The Act has put EECA in a position to lead the Government's charge to engage all sectors of the economy in the drive towards greater energy 98 205.383n

Hazardous Substances and New Organisms Act

A number of the new air contaminants covered in this document are used (in liquid or other form) in manufacturing and other processes. As a result, their use – and to some extent their disposal – come under the provisions of the HSNO Act. However, ERMA may take some time to evaluate the chemicals and determine specific environmental criteria and conditions of use. Once this has been done, these regulations and requirements will have greater weight than the air quality guideline values.

Environmental Performance Indicators Programme

The EPI Programme develops and uses indicators to measure

Appendix 2: Summary table of actions required, by air quality category

	Action	Alert	Acceptable	Good/Excellent
Definition	Above the guideline			

Appendix 4: Basis for the guideline values for the new air contaminants

Contaminant	Guideline values ($\mu g/m^3$)		Implied risk (per 10^6)	Levels for risk of 1 in 10^6 ($\mu g/m^3$)	Ambient levels (annual average, or as specified)	Comment
	Ambient (annual average)	Basis				
Benzene	10 (now) 3.6 (2010)	EC (now) UK (long-term goal)	44–75 (WHO) 16 (WHO)	0.13–0.23	~ 7 (urban) 20+ (traffic)	
1,3-Butadiene	2.4	UK	17–72 (RIVM) 670 (US EPA)	0.03–0.14 0.0036	~ 1 (24-hour)	
Formaldehyde	15	WHO (health) converted	196 (US EPA)	0.077	12 (17-day) ~ 30 (1-hour)	
Acetaldehyde	30	WHO (health) converted	450–2700 (WHO) 66 (US EPA)	0.001–0.067 0.45	No NZ data US ~ (2–4)	
Benzo(a)pyrene	0.0003	Risk of 2–3 in 10^5 assumed acceptable	26 (US EPA)	0.00001	7–72 (24-hour)	
Mercury (organic)	0.13	TWA/100	–	–	No urban data	
Mercury (inorganic)	0.33	TWA/100	–	–	< 50 (7-day)	
Chromium (VI)	0.0011	Assume risk of 1 in 10^5 is acceptable (between WHO and US EPA)	12–140 (WHO)	0.000007–0.00009	No NZ data	Ignores dietary intakes
Chromium (metal and III)	0.11	100 x Cr (VI)	1.3 (US EPA)	0.00083		
Arsenic (inorganic)	0.0055	Risk of 1 in 10^5 assumed acceptable (between WHO and US EPA)	8.3 (WHO)	0.00067	No NZ data	
Arsine	0.055	RfC (US EPA)	24 (US EPA)	0.00023		

Glossary

Ambient air	The air outside buildings and structures. This does not refer to indoor air, air in the workplace, or contaminated air discharged from a source.
Critical level	The concentration in ambient air above which adverse effects may occur to vegetation.
Critical load	An exposure, in the form of deposition, to one or more pollutants, below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge.
Dispersion modelling	A computer modelling technique used to predict downwind concentrations of air contaminants from a known discharge rate, height and temperature.
Emission	The discharge of contaminants into the air.
Guideline value	A concentration value, and averaging period over which it applies, for assessing and managing ambient air quality.
Hui	Gathering to speak and share ideas and thoughts.
Indicator	A contaminant that can be used as an indicator of other contaminants.
Kainga	Home area, including dwelling and gardens.
Kaitiakitanga	Means the exercise of guardianship; and, in relation to a resource includes the ethic of stewardship based on the nature of the resource itself (section 2 RMA).
Mahinga kai	Food gathering, processing or preparation site.
Marae	Significant gathering area of whanua, hapu or Iwi-connected usually with an Ancestor
Maximum Design Concentration	A value specifying a concentration and averaging time that is used to assess the results of atmospheric dispersion modelling.
Percentile	A statistical value that represents a distribution of data – in this case of of data8

Target date	Date by which a council or other agency aims to achieve a specific regional criterion or guideline value.
Taonga	Prized possession, treasure.
Waahi tapu	Sacred or significant site applying to various types of area. Iwi determines the use of the word.

Abbreviations

ANZECC	Australia and New Zealand Environment and Conservation Council
BaP	Benzo(a)pyrene
C_4H_6	1,3 Butadiene
C_6H_6	Benzene
CARB	Californian Air Resources Board
CNS	Central nervous system
CO	Carbon monoxide
COHb	Carboxyhaemoglobin
COPD	Cardio-pulmonary obstructive disease
Cr	Chromium
EECA	Energy Efficiency and Conservation Authority
EPAQS	

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About the Ministry for the Environment

The Ministry for the Environment works with others to identify New Zealand's environmental problems and get action on solutions. Our focus is on the effects people's everyday activities have on the environment, so our work programmes cover both the natural world and the places where people live and work.

We advise the Government on New Zealand's environmental laws, policies, standards and guidelines, monitor how they are working in practice, and take any action needed to improve them. Through reporting on the state of our environment, we help raise community awareness and provide the information needed by decision makers. We also play our part in international action on global environmental issues.

On behalf of the Minister for the Environment, who has duties under various laws, we report on local government performance on environmental matters and on the work of the Environmental Risk Management Authority and the Energy Efficiency and Conservation Authority.

Besides the Environment Act 1986 under which it was set up, the Ministry is responsible for administering the Soil Conservation and Rivers Control Act 1941, the Resource Management Act 1991, the Ozone Layer Protection Act 1996, and the Hazardous Substances and New Organisms Act 1996.

Head Office
Grand Annexe Building
84 Boulcott Street
PO Box 10-362
Wellington, New Zealand
Phone (04) 917 7400, fax (04) 917 7523
Internet www.mfe.govt.nz

Northern Regions Office
8-10 Whitaker Place
PO Box 8270
Auckland
Phone (09) 913 1640, fax (09) 913 1649

South Island Office
Level 3, Westpark Towers
56 Cashel Street
PO Box 1345
Christchurch
Phone (03) 365 4540, fax (03) 353 2750