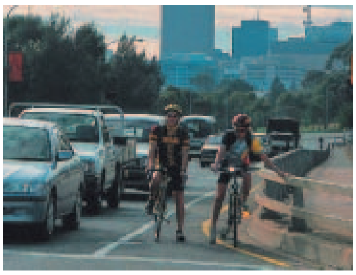



1 Atmosphere



Congested traffic
Photo: Transport SA

Air Quality

Trends

- **Air quality in metropolitan Adelaide: IMPROVING.**
- **Air quality in Port Augusta: IMPROVING.**
- **Air quality in Port Pirie: IMPROVING overall but sulphur dioxide and lead levels still unacceptable in some areas.**
- **Air quality in Whyalla: particulate matter WORSENING.**

Goal

Air quality that meets the standards set out in the National Environment Protection Measure (NEPM) for Air Quality.
To maintain and improve air quality in the Adelaide airshed and regional centres in South Australia.
Air quality objectives of the Environment Protection Authority

What are the issues?

Emissions from motor vehicles are the largest single source of air pollution in South Australia and we are relying solely on better engine technology and fuel standards rather than changing our behaviour to maintain air quality; in fact, dependence on motor vehicle transportation in South Australia continues to increase. Industrial processes are another major source of air pollution along with a range of commercial and domestic activities, such as burning wood for heat.

These activities can increase the concentration of gases and particles in the air to levels that have potentially harmful effects on humans and, to a lesser extent, on the environment.

The National Environment Protection Measure for Air Quality (Air NEPM) was introduced in July 1998 by the National Environment Protection Council (NEPC). The NEPM measure sets health protection standards for air pollutants to be achieved by 2008, based on hourly, four-hourly, eight-hourly, daily and/or yearly averages, depending on the pollutant and the manner in which it has an impact on human health.

The Air NEPM standards do not apply to locations adjacent to individual sources (such as an industrial facility) where peak concentrations may be expected, but relate to the exposure of the general population in residential zones or areas.

At present the Air NEPM addresses the following air pollutants: particles less than 10 micrometres in size (PM_{10}), carbon monoxide, lead, nitrogen dioxide, sulphur dioxide and ozone. Levels of other, larger particulates (TSP) are assessed using World Health Organisation (WHO) and National Health and Medical Research Council (NHMRC) guidelines.

The EPA conducts regular air quality monitoring of key air pollutants in the ambient, or surrounding, atmosphere at a variety of locations throughout the Adelaide airshed (Port Adelaide, Thebarton, Netley, Adelaide CBD, Osborne, Gilles Plains, Northfield, Kensington, Parkside, Gawler, Elizabeth and Christies Beach) as well as at sites in the Mount Gambier, Whyalla, Port Augusta and Port Pirie airsheds. It is also intended to monitor air quality for the Riverland and Barossa airsheds.

These areas form part of a five-year mobile monitoring program commenced by the Environment Protection Authority in 2000 to ascertain levels of air pollutants in regional areas, as part of its implementation of the Air NEPM, and to gain a more accurate understanding of air quality issues in those regions.

See also chapters on **Transport**; and **Climate Change.**

Findings

Making progress

Environment Protection Authority (EPA) monitoring over the last decade indicates that Adelaide's air quality is improving and is generally good by national and international standards. The reduction in point source emissions is due largely to industry-focused legislation and voluntary improvements by industrial and commercial operations, combined with a metropolitan-wide ban on burning waste on domestic premises (e.g. in backyard incinerators).

Lead levels in the metropolitan Adelaide airshed have continued to decline and no longer pose a health concern, to the extent that the EPA has ceased monitoring lead in Adelaide as of the end of June 2003.

The EPA is monitoring more air pollutants at a greater range of locations than in 1998. In 2000 the EPA commenced a five-year program using mobile stations to determine the extent of air quality problems experienced in Whyalla, Port Pirie, Port Augusta, Mount Gambier, the Barossa and the Riverland.

Attention required

The level of lead in the air from the Pasminco lead smelter in Port Pirie is the most significant air quality issue for South Australia. Over 50% of children in Port Pirie exceed the blood-lead goal set by the National Health and Medical Research Council. Sulphur dioxide emissions also frequently exceed national health guidelines, however, no clear relationship with health has been found in several studies undertaken to date in Port Pirie.

Whyalla's OneSteel facility continues to cause particulate (airborne dust) levels that exceed the EPA requirements at the Pellet Plant boundary on several occasions a year.

Odour emissions are still a problem in certain locations. The EPA also needs to upgrade its odour monitoring capabilities in order to enable more informed decision-making.

What more should we be doing?

The Environment Protection Authority recommends that:

1.1 A comprehensive air quality management plan is developed and implemented for South Australia to ensure a coordinated approach is used to manage the cumulative effects of emissions in major urban centres from stationary and mobile sources.

1.2 A comprehensive Environment Protection Policy for air quality is developed and implemented, and the Environment Protection (Burning) Policy 1994 is reviewed as a matter of priority to reflect contemporary approaches to air quality management.

1.3 Odour monitoring capabilities are updated to comply with the most recent Australian Standards.

1.4 Community education activities are enhanced to improve public understanding of air quality issues. This should include eco-efficiency programs that target small to medium sized industrial activities as a priority.

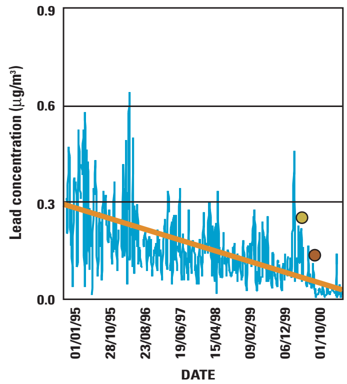
1.5 The Environment Protection Authority (and where applicable the Department of Human Services) continues to ensure, as a high priority, the management of air quality issues on the basis of risk to public health and amenity (e.g. Pasminco, OneSteel and others). Industry Environment Improvement Programs for such issues must focus on high priority risks, and contain short and long term strategies to provide outcomes that are based on recognised national and State standards.

KEY FACTS

- **The emission of lead from the Pasminco lead smelter in Port Pirie is our most serious air quality issue.**

Lead smelter at Port Pirie

Figure 1.1: Trend in ambient lead concentrations at Port Adelaide – 1995–2000



SOURCE: EPA, 2002

Environmental indicators

CONDITION INDICATOR

- Exceedences of NEPM guidelines for key air pollutants (reported on in the *State of the Environment Report 1998*)

The NEPM guidelines have been developed for specific air pollutants which pose a risk to human health. They are an accepted standard against which to evaluate the quality of the air we breathe.

PRESSURE INDICATOR

- Level of emissions of key pollutants (new indicator)

Emissions of key air pollutants in each airshed are compiled by the National Pollutant Inventory. This provides an indication of the volume of emissions and the areas in which emissions are most heavily concentrated.

What is the current situation?

CONDITION INDICATOR: Exceedences of National Environment Protection Measure (NEPM) guidelines for key air pollutants

Lead

Metropolitan Adelaide

Lead levels have been monitored regularly in Port Pirie and the Adelaide metropolitan area at Thebarton, Northfield, Gilles Plains, Kensington, Parkside and Port Adelaide.

There has been a steady decline in airborne lead levels in the metropolitan area due to the mandatory introduction of unleaded petrol for all new vehicles in 1986, the gradual reduction in the lead content of leaded petrol and phase-out of its supply (Figure 1.1).

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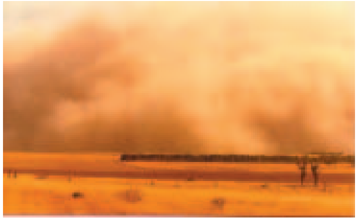
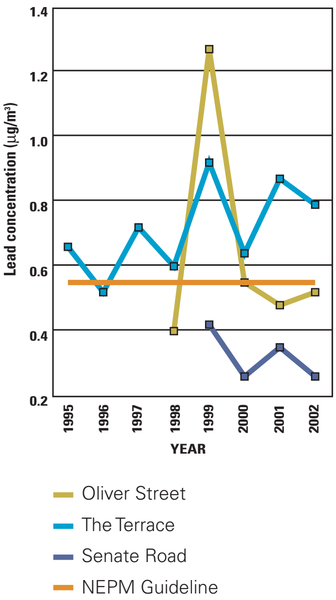


Jamestown Dust Storm
Photo: Gavin Young, Rural Solutions

OneSteel, Whyalla

Figure 1.2: Annual mean lead levels at three Port Pirie monitoring sites against the NEPM standard



SOURCE: EPA, 2002

Leaded petrol sales were overtaken by unleaded sales in 1994 and, following the introduction of Lead Replacement Petrol in May 2000, were phased out completely in South Australia by October 2000, ahead of the nationally legislated date of 2002. Lead levels have progressively decreased and are now well below the NEPM standard. As a result the EPA ceased monitoring lead levels in air in the Adelaide region in June 2003.

Port Pirie

The Pasminco Lead Smelter in Port Pirie is the world's largest lead smelter and refinery, producing 230,000 tonnes per year of lead and lead alloys.

The emission of lead from the smelter is by far the most significant environmental concern for the Port Pirie community. Despite a program to reduce lead emissions from the process stacks, 53% of young children in the town still have higher levels of lead in their blood than is recommended by the National Health and Medical Research Council Guideline (i.e. more than 10 micrograms per 100 millilitres).

Recent studies (Calder et. al., 1994; Esterman & Maynard, 1998; Van Alphen, 1999) demonstrated that most of the airborne lead in Port Pirie arises from the plant site, particularly from lead-bearing fugitive dust, as distinct from the disturbance of lead particles deposited in soil around the city during the operating life of the smelter. It is therefore important that emissions reduction work focuses on the control of this dust.

The NEPM standard for airborne lead is still exceeded at one site in Port Pirie (Figure 1.2). Significantly higher lead levels are often recorded at another site adjacent to the smelter boundary, indicating the influence of fugitive emissions from the smelter. This site is used to evaluate source control strategies within the plant.

Particulate matter (airborne dust)

Particulate matter is monitored in the Adelaide metropolitan area, Whyalla, Port Pirie, Port Augusta and Mount Gambier. Particulate matter generally refers to airborne dust or solids. Some industrial processes can create dust as a consequence of processing raw materials. Dust storms and bush fires can also result in high levels of particulates. This dust has been implicated in a range of health problems, particularly respiratory and cardiovascular difficulties.

PM_{10} refers to particles that are less than 10 micrometres (one thousandth of a millimetre) in diameter. Total Suspended Particulates (TSP) refers to slightly larger particles with a diameter less than 50 micrometres.

Airborne dust is still a significant problem in the area of **Whyalla** adjoining the boundary of the OneSteel Pellet Plant, where PM_{10} levels still exceed EPA performance requirements several times a year. Residences and infrastructure immediately surrounding the plant are continually covered in fine red dust, resulting in considerable community concern.

~~In 2002 the EPA requirement for PM_{10} at Hummock Hill, adjacent to the OneSteel Pellet Plant, was exceeded 18 times (Figure 1.3). This is a significantly worse result than for the previous 11 years of monitoring.~~

Monitoring for PM_{10} and TSP levels at Civic Park in Whyalla, several kilometres east of the Pellet Plant, commenced in 2001. During 2002 there was only one exceedance of the NEPM standard for PM_{10} at t his site.

On occasions, levels of dust exceeding NEPM standards are recorded in **Port Augusta**, although there was no exceedence in 2001 or 2002. Some of these occurrences were partly attributable to the Northern and Playford powerstations, while others were recorded during dust storms.

There are occasional exceedences of the NEPM standard for PM_{10} in **Port Pirie**, largely due to dust storms. There were no exceedences in 2001.

Wood combustion heaters in the home are likely significant contributors to occasional exceedences of the NEPM standard for PM_{10} concentrations in **Mount Gambier**, as well as diesel trucks and the wood industry – such as forestry burning and particleboard manufacture.

Carbon monoxide

Hindley Street, in the Adelaide CBD, is the only location in South Australia where carbon monoxide is monitored. Levels have fallen considerably over the last decade and there have been no exceedences of the NEPM standard since 1997. This is mainly due to improvements in motor vehicle engine design and the addition of catalytic emission controls.

Sulphur dioxide

In the **metropolitan area** sulphur dioxide (SO_2) is monitored at Christies Beach near the Port Stanvac oil refinery, which was a primary source of this air pollutant until its closure in July 2003. There have been no exceedences of the NEPM standard since 1996. Monitoring also commenced at **Mount Gambier** in 2001, with no exceedences of the standard detected.

Monitoring for SO_2 attributable to Pasminco in **Port Pirie** began at Oliver Street in 2002. The results of the first six months of monitoring are provided in Figure 1.4. During this time there have been 23 exceedences of the NEPM one hour SO_2 standard. However, several asthma studies undertaken to date in Port Pirie have not demonstrated a relationship between these emissions and health.

Ground level ozone

Ozone is monitored at a variety of locations throughout the Adelaide airshed, but no exceedences of NEPM standards have been recorded for many years. Formation of ozone is dependent on strong sunlight to promote the chemical reactions between nitrogen oxides and hydrocarbons released into the air and thus is more prevalent during long hot summers. Monitoring for ozone commenced in **Mount Gambier** in 2001; no exceedences were recorded.

Nitrogen dioxide

Nitrogen dioxide levels in the air are recorded at a variety of locations in the **Adelaide** airshed, but no exceedences of the NEPM standards have been recorded since 1990 and average concentrations are well within the guidelines. Nitrogen dioxide monitoring also commenced in **Mount Gambier** in 2001, but no exceedences were recorded.

Errata

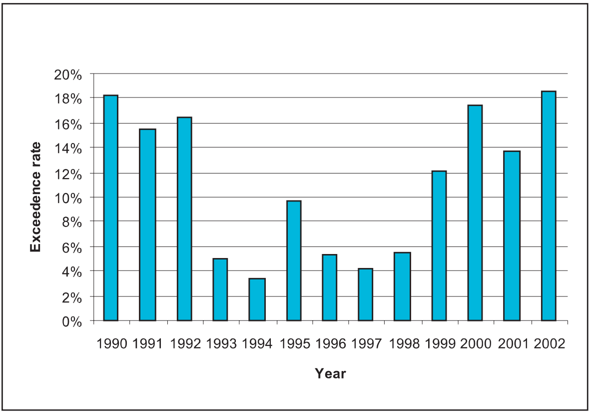
Please note the following amendments.

- page 20, last paragraph of column one—replace 'In 2002 the EPA requirement...' with the following:

In 2002 the PM_{10} value of 50 ug/m^3 as a daily average at Hummock Hill, adjacent to the OneSteel Pellet Plant, was exceeded 18.5% of the time. This is significantly higher than in the mid 1990s when the PM_{10} value of 50 ug/m^3 as a daily average at the old site at Hummock Hill was exceeded about 5% of the time. Relocation of the monitoring station in May 2000 has had a discernible effect on measured dust levels on occasions under certain wind conditions. Nevertheless, since the mid-to-late 1990s there has been an overall worsening of air quality in the area, with levels in 2002 comparable to those encountered in the early 1990s (see revised Figure 1.3).

- page 21—replace Figure 1.3 with the following:

Figure 1.3: Proportion of time per year that PM_{10} exceeded EPA performance requirements at Hummock Hill, Whyalla, 1990–2002



EPA—July 2004

PRESSURE INDICATOR: Level of emissions of key pollutants

The level of key pollutants in the air shows a continuing pressure on air quality and highlights areas where there may be a potential impact on health or the environment.

The National Pollutant Inventory (NPI) is an internet database that provides information on the location of emissions sources, the levels of emissions and change over time for many major airsheds in Australia. The NPI can be accessed through the internet (www.npi.gov.au).

For all major pollutants the highest emission levels tend to be in densely populated areas. This illustrates the large contribution of motor vehicles and domestic activities to local air quality (e.g. lawn-mowing, solvent use and wood heaters).

Emerging air quality issues

Air toxics

A group of pollutants known as 'air toxics' have been less frequently monitored than other pollutants but there is increasing recognition of their potential negative health effects. Air toxics are pollutants present in the air (in either solid, liquid or gas form) in low concentrations but their toxicity is such that they represent a risk to human health and the environment.

Motor vehicles and fuel burning are two significant sources of air toxics. Air toxics are also of concern for indoor air quality as they are present in many household products such as paints, solvents, aerosols, cleansers and disinfectants and dry-cleaned clothing.

The National Environment Protection Council (NEPC) is currently developing a NEPM for air toxics. The first substances to be addressed are benzene, formaldehyde, polycyclic aromatic hydrocarbons, toluene and xylenes. The EPA currently conducts 'hotspot' monitoring for some air toxics.

Fine particles – $PM_{2.5}$

Particles less than 2.5 micrometres in diameter are called fine particles ($PM_{2.5}$). These fine particles have been shown to have health effects and to penetrate deeper into the lungs than larger particles. As such, they warrant increased monitoring and the establishment of separate health guidelines. The EPA will initially establish one monitoring site for $PM_{2.5}$ at Netley. The air quality NEPM was varied in 2003 to include monitoring requirements for fine particles ($PM_{2.5}$).

Odour

Odour emissions are a concern in some areas, most notably adjacent to industrial facilities such as foundries, animal rendering plants, intensive animal husbandry and composting facilities. Specific site issues are being addressed through licence conditions where appropriate. The EPA will be upgrading its odour testing capabilities to meet the new Australian Standard in order to enable more informed decision making.

There are approximately 45 foundries in Adelaide, of which three (Castalloy, Hensley Industries and Mount Barker Products) have drawn frequent complaints from nearby residents about noise and odour (EPA, 2001b). The problems faced at all three sites are in large part a consequence of residential areas being located too close to industrial areas.

Woodsmoke

The use of firewood for home heating has been the subject of growing concern in recent years as knowledge of the implications for biodiversity and the impact of wood smoke on human health have become better known. Wood smoke contains $PM_{2.5}$ and a range of toxic compounds similar to those from cigarette smoke and is thought to be involved in heart and lung disease and cancer.

Indoor air quality

Indoor air quality is an issue of increasing concern, particularly in relation to emissions from products such as tobacco smoke, solvents, disinfectants, paints, paint strippers, glues and air fresheners (see **Air toxics**). Mould and mould spores can also cause allergic reactions in some people.

Unfortunately, there is not a great deal of statistical information available on indoor air quality in South Australia, but there is early evidence that a significant percentage of offices and homes suffer from poor indoor air quality particularly from combustion products from indoor appliances, tobacco smoke and from biological allergens (e.g. dust mites).

What impact does poor air quality have?

Some of the environmental, social, public health and economic effects of poor air quality are listed below to illustrate the broader significance for sustainability.

Environmental impact. Just as it affects humans, poor air quality adversely affects the health of vegetation and animals and even the health of the marine environment. Certain toxic pollutants present in air can also be deposited in soil or water, becoming part of terrestrial, marine and aquatic environmental systems.

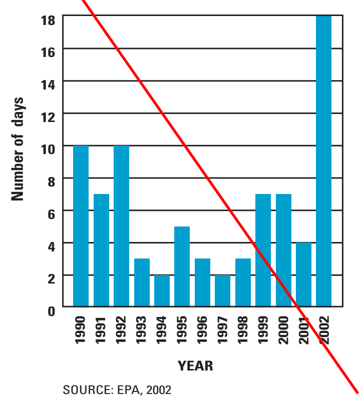
Economic impact. Poor air quality increases medical costs, reduces workforce productivity, has indirect effects on the quality of life, damages buildings, cars and monuments and has an impact on tourism.

Impact on human health. Excessive carbon monoxide can inhibit the uptake of oxygen through the bloodstream and can effect visual perception, mental concentration and heart function. Nitrogen dioxide, sulphur dioxide, ozone and fine particulate matter contribute to respiratory problems and potentially to increased rates of mortality. Lead can result in reduced mental capability, particularly in children, and reduced fertility levels. Volatile organic compounds (i.e. air toxics) are thought to be involved in a wide variety of health effects, including respiratory irritation, damage to internal organs and cancer.

Sources: www.ea.gov.au/atmosphere/airquality/pollutants.html and www.epa.gov

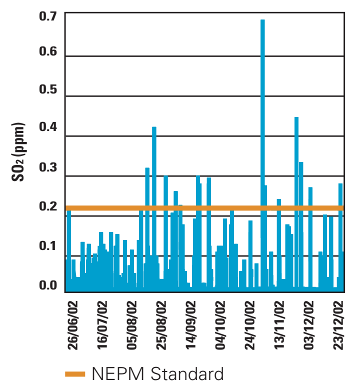
Coal storage, Flinders Northern powerstation, Port Augusta

Figure 1.3: Number of days per year PM_{10} exceeded EPA performance requirements at Hummock Hill Whyalla – 1990–2002



SOURCE: EPA, 2002

Figure 1.4: Sulphur dioxide concentrations at Oliver Street, Port Pirie, against the NEPM standard (one hour averages)



SOURCE: EPA

1 Atmosphere

Smokestack

Hot Spot air quality monitoring van

What are we doing about it?

Air quality in the Adelaide metropolitan area has vastly improved in the last 20 years, largely due to the phasing out of leaded petrol and improved motor vehicle emissions standards, the banning of backyard burning and improved environmental management by industry. The **EPA's monitoring of air quality** has expanded in Adelaide since the *State of the Environment Report 1998* with new monitoring stations constructed at Port Pirie and at Whyalla. **'Hot Spot' air quality monitoring** capabilities have been developed to monitor industry emissions and local air quality issues as they arise.

In 2000 the EPA also commenced a five-year monitoring program using **mobile air quality monitoring stations** to determine the extent of air quality problems experienced in Whyalla, Port Augusta, Port Pirie, Mount Gambier, the Barossa Valley and the Riverland. Previously some of these regions had not been monitored at all, and others only for specific pollutants.

Some regional air quality issues remain a concern. Lead and sulphur dioxide levels at Port Pirie continue to pose a health risk to residents, and children in particular. The Department of Human Service's **Port Pirie Lead Implementation Program**, which commenced in 1984, aims to reduce the levels of lead that residents are absorbing from their environment. While blood lead levels in Port Pirie have decreased significantly since the mid-1980s, they are still considerably higher than the national average, with 53% of young children exceeding the NHMRC guidelines for lead-in-blood. This is despite measures instigated by Pasminco over the last 20 years to minimise emissions of lead and sulphur dioxide from the smelter, including fulfilling the requirements set out in its EPA Environment Improvement Program. It is clear that more work must be done to reduce emissions.

Whyalla's OneSteel facility continues to cause particulate (airborne dust) levels that exceed the EPA requirements at the Pellet Plant boundary on several occasions a year.

The current Environment Protection (Air Quality) Policy is considered outdated and requires review. The EPA intends to review this policy in light of emerging air quality issues and other best practice standards available. It also intends to review the Environment Protection (Burning) Policy.

An **Environment Improvement Program** (EIP) is a program approved by the EPA that is developed by a business which holds an environmental authorisation, usually in the form of a licence to conduct an activity of potentially major environmental significance. A business can voluntarily submit an EIP or the EPA may require it as part of its licensing conditions. These EIPs require the inclusion of environmental improvements in business plans to progressively reduce the impact of that business's operation on the environment. Successful implementation of an EIP may be a necessary prerequisite for the continuation of the environmental authorisation, or licence. Major companies undertaking EIPs with respect to air quality include OneSteel, NRG Flinders and Playford powerstations, and Pasminco.

For more information on programs and initiatives see the *State of the Environment 2003 Supplementary Report.*

References

Calder, I., Maynard, E., Heyworth, J. *Port Pirie Lead Abatement Program*, 1992, Environmental Geochemistry and Health, 16, 137-145.

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Environment Protection Authority (EPA) (2001a). *National Environment Protection (Ambient Air Quality) Measure: Ambient Air Quality Monitoring Plan for South Australia*. Environment Protection Authority, Adelaide.

Environment Protection Authority (EPA) (2001b). *Environment Protection Authority 2000–2001 Annual Report.* Environment Protection Authority, Adelaide.

Esterman, A. and Maynard, E. (1998). *Changes in Airborne Lead Particulate in Port Pirie, South Australia, 1986-1996.* Environmental Research, 79, 122-132.

Van Alphen, M. (1999). *Atmospheric heavy metal plumes adjacent to a primary lead-zinc smelter.* Science of the Total Environment, 236, 199-134.

Further information

Air pollution in Major Cities Program
www.nht.gov.au/programs/airqual.html

Airwatch National Project
www.airwatch.gov.au

Alternative Fuels Conversion Program
www.greenhouse.gov.au/transport/afcp

Current Air Quality Information – Air Quality Index
www.environment.sa.gov.au/reporting/atmosphere/airindex_sum.html

Environment Protection (Air Quality) Policy 1994
www.austlii.edu.au/au/legis/sa/consol_reg/epqp1994460/index.html

National Environment Protection Council
www.ephc.gov.au

National Environment Protection Measure for Ambient Air Quality
www.ephc.gov.au/nepms/air/air_nepm.html

National Pollutant Inventory
www.npi.gov.au

Climate Change

Trends

- **Greenhouse gas emissions in total in South Australia: UP 7.8% since 1995.**
- **Emissions per person: UP from 21.48 tonnes in 1995 to 22.43 tonnes in 2001.**
- **Emissions from industry: UP 23.3% since 1995.**
- **Emissions from the transport sector: FALLEN slightly.**
- **Emissions from land use change (i.e. vegetation clearance): REMAIN at negligible levels.**
- **Significant fugitive emissions from gas production representing 10% of total emissions.**

Goal

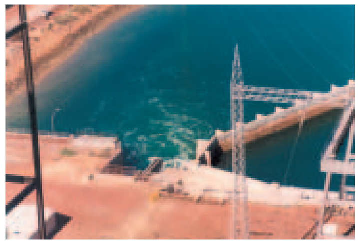
- Limit net greenhouse gas emissions, in particular, to meet international commitments.[1]
- Foster community knowledge and understanding of greenhouse issues.
- Lay the foundations for adaptation to climate change.

National Greenhouse Strategy (Australian Greenhouse Office, 1998)

What are the issues?

The characteristics of the earth's climate are influenced by the 'greenhouse' effect. The greenhouse effect is a natural phenomenon whereby certain 'greenhouse' gases in the atmosphere trap and retain heat, maintaining the earth at a habitable temperature. Without these gases, life on Earth would not exist.

Since the industrial revolution in the mid-eighteenth century certain human activities have resulted in rising concentrations of greenhouse gases in the planet's atmosphere. These gases act like a blanket over the earth's surface, enhancing the natural greenhouse effect and keeping the planet warmer than it would be otherwise. Over the last century, global average surface temperatures have increased by around 0.6°C, snow cover and ice extent has decreased and the sea level has risen by an average of



Flinders powerstation

Section of Santos's Moomba Plant, Cooper Basin, northern South Australia
Photo: SANTOS Ltd

Findings

Making progress

The State Government has indicated its support for ratifying the Kyoto Protocol and is committed to the development of a South Australian Greenhouse Plan. This will establish actions to reduce emissions and develop strategies that will assist in the reduction of greenhouse gas emissions and adaptation to the consequences of climate change.

The State Government has committed to the purchase of around 6% of its energy requirements from the Starfish Hill windfarm.

Attention required

South Australia's greenhouse gas emissions continue to rise, increasing by 7.8% between 1995 and 2000/01. Per capita emissions have risen from 21.48 tonnes of greenhouse gases per person in 1995 to 22.43 tonnes of greenhouse gases per person in 2001. Emissions from the generation of electricity and industrial activity in particular continue to grow, while fugitive sources, such as gas production and distribution amount to 3.44 million tonnes, over 10% of the State's total.

While there have been a range of initiatives in South Australia to reduce greenhouse gas emissions their effectiveness has been scarcely noticeable. High profile measures are initiated frequently to reduce emissions but these have a limited impact on reductions, in the order of a few thousand tonnes annually, when the need is many orders of magnitude larger.

What more should we be doing?

The Environment Protection Authority recommends that:

1.6 A State Greenhouse Plan and associated Action Plan be developed and implemented as a matter of priority. This must be consistent with, and feed into, the national forward strategy on climate change and address matters such as carbon sequestration, industry development, emissions reduction and adaptation and risk management strategies for coping with the inevitable consequences of climate change.

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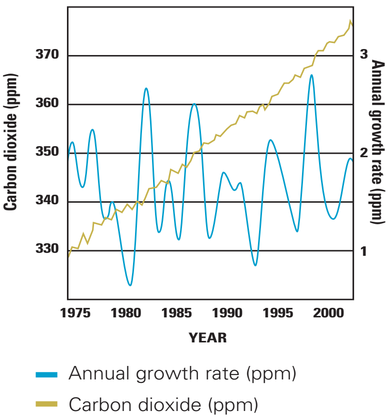
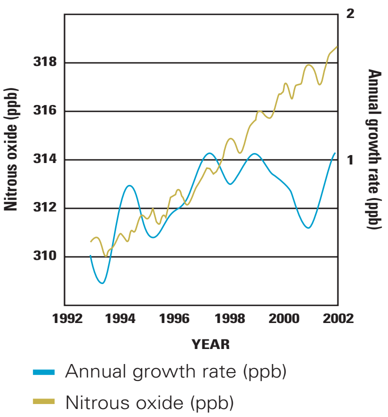
[1] In signing the Kyoto Protocol in 1998, the Australian Government has committed to containing greenhouse gas emissions to 108% above 1990 levels.

Figure 1.5: Carbon dioxide concentrations 1975–2002, Cape Grim, Tasmania



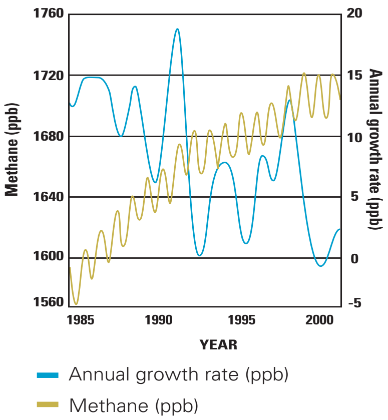
SOURCE: CSIRO

Figure 1.6: Nitrous oxide concentrations 1992–2002, Cape Grim, Tasmania



SOURCE: CSIRO

Figure 1.7: Methane concentrations 1985–2002, Cape Grim, Tasmania



SOURCE: CSIRO

10 to 20 centimetres. It is very likely (90% to 99% probability) that the 1990s was the warmest decade and 1998 the warmest year on (instrumental) record since 1861 (IPCC, 2001).

The world's climate has always varied naturally. The Mount Pinatubo eruption in the Philippines in 1991 released about one cubic kilometre of ash and cooled the earth by about 0.4°C for several years. The periodic warming of the eastern Pacific Ocean, known as El Niño, results in heavy rainfalls in some regions and droughts in others. Australia's location and size mean that it is subject to a wide range of climatic influences and can be subject to wide variations in climate.

Despite natural variability in climate, the rise in global temperatures of around 0.6°C experienced over the past century is unprecedented and the weight of scientific evidence is that this is linked with increased levels of greenhouse gases as the result of human activity.

It is projected that globally averaged surface temperatures will increase by 1.4 to 5.8°C over the period 1990 to 2100. The projected rate of warming is much larger than the observed changes during the twentieth century and is very likely (90% to 99% probability) to be without precedent during at least the last 10,000 years.

The major greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (NO). The major source of carbon dioxide is the burning of oil, coal and gas (fossil fuels). This includes the burning of petrol in motor vehicles and the generation of electricity from coal and gas. CO_2 emissions also result from cement manufacture and the clearance of forests and other vegetation. Plants absorb CO_2 from the atmosphere thereby acting as CO_2 'sinks'.

Methane (CH_4) is produced when organic material is broken down in the absence of oxygen. One of the largest sources of methane comes from animals such as sheep and cattle that produce it as a by-product of the digestive process. Methane is also emitted from coal mines, waste disposal landfills, burning vegetation and natural gas.

Nitrous oxide (NO) is emitted naturally from oceans and soils; however, it is also produced by burning vegetation, clearing vegetation, the use of fertilisers and some industrial processes. Unlike other greenhouse gases, nitrous oxide does not break down easily and stays in the atmosphere for more than a century after being emitted.

See also chapters on **Energy**; **Transport**; and **Air Quality**.

Environmental indicators

CONDITION INDICATOR

- Greenhouse gas atmospheric concentrations (reported on in the *State of the Environment Report 1998*)

Annual average concentrations of greenhouse gases present in the atmosphere, as measured at Cape Grim in Tasmania.

PRESSURE INDICATORS

- Annual greenhouse gas emissions in South Australia per capita (new indicator)

Greenhouse gas emissions per person.

- Sources of greenhouse gas emissions in South Australia (new indicator)

Details the activities that produce greenhouse gas emissions and quantifies emissions by sector.

- Annual greenhouse gas emissions in South Australia indexed against Gross Domestic Product (reported on in the *State of the Environment Report 1998*)

Shows changes in the energy intensity of our economic productivity. In other words, the amount of energy we use to produce every dollar of economic output.

What is the current situation?

CONDITION INDICATOR: Greenhouse gas atmospheric concentrations

In Australia the CSIRO undertakes monitoring of atmospheric greenhouse gas concentrations at its Cape Grim facility on the north-western coast of Tasmania. The yellow line in Figures 1.5 and 1.6 indicates continuing increases in the atmospheric concentration of carbon dioxide, predominantly from fossil fuel burning and land clearance, and nitrous oxide, predominantly from land clearance, burning of vegetation, use of fertilisers and some industrial processes.

Methane levels are now higher than at any time over the past 420,000 years but the annual growth rate has slowed over the past decade (Figure 1.7).

PRESSURE INDICATOR: Annual greenhouse gas emissions in South Australia per capita

Australia's rate of greenhouse gas emissions is the highest in the industrialised world at around 27.9 tonnes per person per year. By comparison, greenhouse gas emissions per person for the United States of America are 18.1 tonnes per year (Turton et. al., 2002). South Australia's greenhouse gas emissions totalled 34.07 million tonnes in 2000/01, a rise of 7.8% (2.47 million tonnes) over 1995 levels. Per capita emissions have risen from 21.48 tonnes of greenhouse gases per person in 1995 to 22.43 tonnes of greenhouse gases per person in 2001.

In the broadest sense, the largest single activity that releases greenhouse gases is the generation and use of energy. The consumption of energy, such as the use of petrol in cars and trucks, and the generation of energy, such as electricity generation in powerstations, contributes around 64% of our total greenhouse gas emissions.

Our emissions from energy use and generation continued to climb in 2000/01, rising by 3.6% over the two years since 1999. Greenhouse gas emissions from electricity generation in South Australia are less than the Australian average however, because around one-third of our electricity is generated using natural gas. This is the highest proportion of any State other than the Northern Territory.

For more information on energy use see chapter on **Energy**.

PRESSURE INDICATOR: Sources of greenhouse gas emissions in South Australia

In 2000/01 the major sources of greenhouse gas emissions in South Australia were (Figure 1.8):

- stationary energy (28%) – emissions from non-transport based energy use, primarily from the generation of electricity from powerstations but also from the use of fossil fuels by industry and in the home (e.g. the use of gas to heat hot water);
- transport (23%) – the use of petrol and diesel by various forms of transport;
- agriculture (18%) – the release of greenhouse gases by sheep, cattle, horses, pigs and poultry as part of the digestive process;
- industry (14%) – the use of fossil fuels such as black coal and natural gas;
- 'fugitive' emissions from natural gas processing (10%) – oil and gas production from Moomba and Ladbroke Grove gas fields.

Figure 1.9 compares 2000/01 greenhouse gas emissions in South Australia with the previous State assessment by the National Greenhouse Gas Inventory in 1995.

Emissions from **non-transport based energy use**, primarily from the generation of electricity from powerstations, shows the largest increase in emissions, up by 21% between 1995 and 2000/01. Emissions from generating electricity come from burning coal and gas, which are used to fuel power generators. See chapter on **Energy** for more information on energy use and sustainable energy.

'Fugitive' emissions resulting from gas production at Moomba and Ladbroke Grove have increased by 12% since 1995. Emissions as the result of oil and gas production now contribute around 10% of the State's total greenhouse gas emissions.

While Figure 1.10 indicates that greenhouse gas emissions from the **transport sector** as a whole have declined by around 1% since 1995, emissions from road vehicles (cars, trucks, buses, motorcycles) have increased by 7.6% over the 1988 to 2001 period (Figure 1.10). Emissions from road vehicles account for 87% of all transport emissions, more than six times all other sources put together. Cars account for 64% of all emissions from road vehicles. Emissions from rail and sea transport are declining while emissions from air transport are increasing (Figure 1.10). For more information see chapter on **Transport**.

Agricultural emissions remain stable. Agriculture is a mature industry in South Australia and livestock numbers have remained fairly static between 1995 and 2000. It is therefore assumed that there is unlikely to have been a significant change in emissions from livestock between 1995 and 2000/01 (Lothian, unpub.).

Emissions from the **land sector** are negligible. Based on figures from the National Carbon Accounting System in 2002, emissions from vegetation clearance in 1995 were 0.4 megatonnes and had fallen to 0.2 megatonnes by 1998. Given this trend and that clearance has been regulated in South Australia since 1983, emissions from this source are now negligible.

Since the completion of the Victoria/South Australia interconnector in 1990, South Australia has been a net importer of electricity. Greenhouse gas emissions in Victoria resulting from the use of electricity imported to South Australia make up 3% of the State's total emissions, a slight reduction on 1995 levels.

PRESSURE INDICATOR: Annual greenhouse gas emissions in South Australia indexed against Gross Domestic Product

Greenhouse gas emissions when compared against the Gross Domestic Product (GDP) provide a broad indication of energy efficiency. The less energy used to create every dollar of GDP, the more efficiently that energy is being used. During the 1970s, major price rises in petroleum along with other factors led many countries to improve energy efficiency so that each unit of energy produced more income, or GDP, than before.

In South Australia greenhouse gas (CO_2-e) emissions per Gross State[2] Product (GSP) have fallen steadily from 55,400 tonnes per million dollars of GSP in 1991 to 49,850 tonnes per million dollars of GSP in 2000/01. This means that in 1991 a tonne of greenhouse gases was produced for every $18 generated in the State's economy. In 2000/01 a tonne of greenhouse gases was produced for every $20 generated in the State's economy. These figures suggest a minor (11%) improvement in energy efficiency over the last decade. This equates to about 1% improvement per year.

What impact will climate change have?

Climate change is likely to have significant environmental, social and economic consequences (CSIRO, 2001).

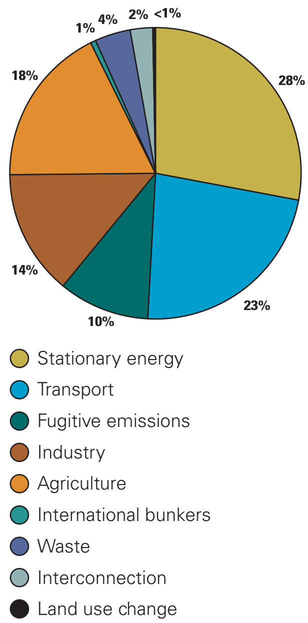
A change in the extent and range of ecosystems. Some ecosystems will adapt better than others. Those ecosystems likely to be most sensitive to climate change include native grasslands, mangroves, wetlands and deserts.

Increased vulnerability of plants and animals. Habitat loss and fragmentation will increase the pressures on some plants and animals, particularly those that live in habitats that are sensitive to climate change.

Increased pressure on watercourses and wetlands. Reduced rainfall will have an impact on water resources. Stream flow in the east-central Murray-Darling Basin could be reduced by up to 20% by 2030 and up to 45% by 2070, having an associated impact on aquatic plants and animals.

[2] *Gross State Product is used as Gross Domestic Product figures are only available nationally.*

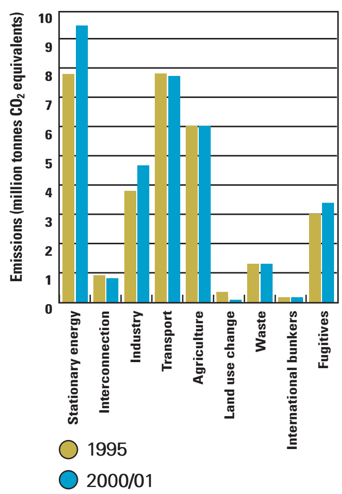
Figure 1.8: The source of South Australia's greenhouse gas emissions – 2000/01



Note: Interconnection refers to the electricity interconnection from the eastern States.

SOURCE: LOTHIAN, UNPUB.

Figure 1.9: Change in South Australia's greenhouse gas emissions – 1995 & 2000/01



Note: International bunkers refers to fuel used in international transport and shipping. All figures are expressed in CO_2-e, which convert methane and nitrous oxide into the equivalent global warming potential of CO_2 (methane has 21 times the global warming potential of CO_2).

SOURCE: LOTHIAN, UNPUB.

1 Atmosphere

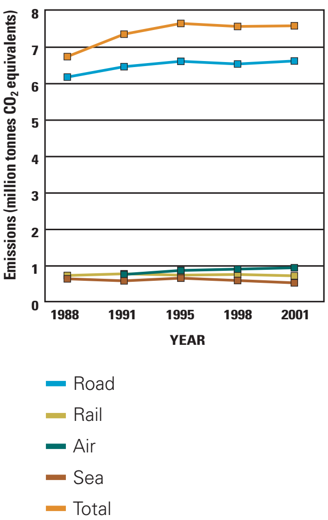
KEY FACTS

- **Stream flow in the east-central Murray-Darling Basin could be reduced by up to 20% by 2030 and up to 45% by 2070, having an impact on aquatic plants and animals.**
- **Climate change could have significant environmental, social and economic consequences.**

Congested traffic on Main South Road
Photo: Transport SA

Dairy cattle grazing

Figure 1.10: South Australia's transport greenhouse gas emissions by type – 1988–2001



SOURCE: APELBAUM, 2002

Increasing competition for scarce water resources. Reduced rainfall across southern Australia will increase the demand on already stressed water resources.

A change in the range and distribution of pests. Warmer temperatures are likely to increase pests' ability to survive winter conditions and accelerate their growth rates and population levels in summer months. Warmer temperatures may cause the fruit fly to expand its range southwards. Plant diseases are likely to become more severe. This would affect the viticulture industry in particular.

A drop in agricultural productivity. Initially higher CO_2 levels will stimulate plant growth but in the longer term productivity will decrease. This has significant implications for South Australia's wheat industry. Fewer frost days will affect the setting of stone fruits and apples. Reduced rainfall in the rangelands will reduce their productivity.

Economic restructuring. This will be experienced primarily by the coal generated electricity industry.

Increases in sea level and the intensity of storm events. This is likely to have a significant economic and social impact on coastal communities, with implications for the provision of adequate infrastructure for stormwater management.

Impact on human health. This is likely to include increased injury and death from higher summer temperatures (partially offset by fewer winter deaths) and extreme weather events. Increased numbers of mosquitos in some areas may see an increase in cases of Dengue fever and Ross River virus.

Adaptation to climate change

Table 1.1 outlines the ability of different sectors within South Australia to adapt to climate change in the coming decades and suggests areas where improved knowledge and planning is required. Planning for adaptation to climate change is a relatively new concept and there has, as yet, been no formal policy development by the State Government regarding this topic. The development of future strategies must address adaptation as a matter of priority.

PREDICTIONS: South Australia's climate in the 21st century

The CSIRO Division of Atmospheric Research has recently completed a review of global warming for South Australia, which includes projections[3] for climate change in the coming century (McInnes et. al., 2003). The following is a summary of the major findings.

- Annual average temperature **increase** over the north of the State of 0.4 to 2.0°C by 2030 and 1.0 to 6.0°C by 2070. In the south temperatures will **increase** by 0.2 to 1.4°C by 2030 and 0.6 to 4.4°C by 2070[4].
- Projections for rainfall in South Australia tend toward a **decrease** over most of the State (in the range of -13% to +6% in 2030 and -40% to +20% in 2070), with exceptions in the far south-east (**stronger decreases**) and in the north-east of the State (**increases and decreases equally likely**)[5].

Table 1.1: Sectoral adaptations to climate change

Sector	Issues
Water and Catchments	Water management within South Australia requires a high degree of adaptability due to the considerable variation in our climate from year to year. However, the effect of projected long term reductions in water supply due to climate change need to be assessed.
Agriculture	This sector is generally well adapted to climate variability but further work is needed to determine how climate change may affect production to maximise agricultural performance under future climate conditions.
Biodiversity	An understanding of the relationships between biodiversity and climate change at the species and community level is generally poor and needs improvement in order to develop options for adaptation.
Coasts	Rising sea levels in the future, combined with storms of possibly greater intensity than experienced now, will increase the vulnerability of low-lying coastal areas. There is little room for adaptation at present as so much development has occurred directly adjacent to the coastline.
Health	With trends in South Australia towards an ageing population, the major risks of climate change in this sector are likely to be associated with heat stress, while health problems associated with floods, such as drowning and vector-borne diseases such as malaria, are likely to increase only in the north of the State.
Energy and Urban Settlement	Increasing frequencies of high temperatures will increase energy use in warmer months and the State's capacity to deliver increased energy demands may require assessment. More extreme rainfall events and sea-level rise may require the development of new flood and stormwater strategies in low-lying suburbs of Adelaide.

Source: adapted from McInnes et. al., 2003

- Evaporation rates will increase significantly in the northern arid region and to a lesser extent in the south.
- Hot spells above 35°C and 40°C will **increase** across the entire State with the exception of the South East and Kangaroo Island.
- Although rainfall will decrease, extreme rainfall events will **increase** by up to 10%. Heavy rainfall events in summer in the far north will **increase** in frequency and amount of rainfall leading to a 20% **increase** in flood frequency for that region. Drought frequency will increase by the end of the century.
- By 2100 sea levels are expected to **rise** by up to 88 centimetres.

What are we doing about it?

Australia has signed and ratified the **United Nations Framework Convention on Climate Change (UNFCC).** The convention commits Australia to taking action to reduce greenhouse emissions in order to counter potential climate change due to human-induced greenhouse gas emissions.

The Commonwealth Government has indicated that it will not ratify the **Kyoto Protocol** to the UNFCC but will work to achieve the target set by the Protocol for Australia of an 8% increase above 1990 emissions during the first commitment period from 2008 to 2012.

In August 2002 the Commonwealth announced the development of a **forward strategy on climate change** to focus on long term greenhouse issues over 20 to 30 years. This will build on the **National Greenhouse Strategy (NGS)**, which was endorsed by the Commonwealth, State and Territory Governments in 1998.

In August 2002 the South Australian Government gave its **formal support to ratification of the Kyoto Protocol.** The Government's sustainable energy platform also commits to the development of a **South Australian Greenhouse Plan**, which will be consistent with the proposed forward strategy on climate change. The Plan will establish priorities in those areas where the State is vulnerable to climate change, develop strategies to assist with adaptation to climate change and establish programs for the abatement of greenhouse gas emissions in both the shorter and longer term.

To obtain important information to help underpin the development of the Greenhouse Plan and adaptation strategy the South Australian Government commissioned the **CSIRO to report on observed and projected climate change in South Australia**, its impact and potential adaptation. A final report was released in December (McInnes et. al., 2003).

The **South Australian Greenhouse Committee**, with representation from all State Government Portfolios, advises Cabinet on greenhouse issues and coordinates agency reporting on the NGS. The **South Australian Kyoto Protocol Working Group** has been formed to advise the Premier on the costs, benefits and issues associated with whether the Commonwealth should ratify the Protocol or not.

Over the past five to ten years there has been a range of programs introduced in South Australia to combat greenhouse gas emissions. These include various **energy efficiency programs**, such as the Solar Hot Water Rebate Scheme, coordinated by Energy SA and the TravelSmart program by Transport SA, which promotes the use of public transport and other alternatives such as cycling and walking in an effort to reduce emissions from cars.

The State Government has also supported the establishment of **renewable energy infrastructure**, with the purchase of around 6% of its energy requirements from the Starfish Hill windfarm.

Local Government is involved in efforts to reduce greenhouse gas emissions through programs such as **Cool Communities**, which has a focus on community education, and **Cities for Climate Protection**, which aims to provide a framework and action plan to see Local Government lower its emissions. Recent **changes to building regulations** now require all new houses to meet a 4-star energy rating.

High profile measures, such as the installation of solar panels on the roof of the SA Museum, have also been initiated in order to raise awareness in the South Australian community of renewable energy generation. While these programs have significantly contributed to education on the impact of climate change, their effectiveness in reducing State greenhouse emissions is minimal.

South Australian greenhouse emissions, however, on the whole continue to grow.

For more information on programs and initiatives see the *State of the Environment 2003 Supplementary Report*.

THE KYOTO PROTOCOL

As a result of the United Nations Framework Convention on Climate Change (UNFCC) meeting in Kyoto, Japan, in December 1997, developed countries agreed in principle to accept greenhouse gas emission targets. These agreements are included in a treaty called the Kyoto Protocol. Australia negotiated a target of 108% of 1990 emissions, to be achieved on an annual average basis over the years 2008 to 2012 (referred to as the first commitment period).

Australia signed the Protocol in April 1998, but has not yet ratified it, or legally accepted it. The Protocol will enter into force after it has been ratified by 55 parties representing at least 55% of developed country CO_2 emissions at 1990 levels.

A key feature of the Kyoto Protocol is its flexibility mechanisms to help countries fulfil their reduction commitments. One of these is international emissions trading. This scheme will allow developed countries that have higher costs of greenhouse gas reduction to purchase surplus emission allowances from countries that are able to reduce their emissions more cheaply.

Cleland wildlife reserve
Photo: Clare Nicolson

[3] *These projections are based on computer modelling of climate change scenarios. The models used involve simplifications of physical processes that are not fully understood. Therefore, these must be considered estimates that have been developed using the best available knowledge.*

[4] *Projections based on the combined estimates from 10 climate models.*

[5] *Projections based on the combined estimates from 10 climate models.*

Flood on Hindmarsh Island
Photo: Tony Wynne courtesy Coast and Marine Branch

The Starfish Hill Windfarm on the Fleurieu Peninsula is South Australia's first windfarm and is being developed by Tarong Energy
Photo: Tarong Energy

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Further information

Australian Greenhouse Office
www.greenhouse.gov.au/

CSIRO Division of Atmospheric Research
www.dar.csiro.au/information/greenhouse.html

Kyoto Protocol
unfccc.int/resource/convkp.html

Managing Greenhouse
www.epa.sa.gov.au/greenhouse.html

National Greenhouse Inventory
www.greenhouse.gov.au/inventory

National Greenhouse Strategy
www.greenhouse.gov.au/pubs/ngs

Still Waiting for Greenhouse (a website for skeptics)
www.vision.net.au/~daly

Ozone Depletion

Trends

- **Concentration of ozone-depleting substances in the atmosphere above Australia: DECREASING.**
- **Predictions indicate that signs of ozone layer recovery will start to be noticed over southern Australia in the next ten to fifteen years.**
- **Complete recovery of ozone could possibly be observed by 2050, however, this may take until 2100 due to the impact of climate change and larger than anticipated use of ozone-depleting substances in developing countries.**

Goal

To phase out the use and emission of ozone-depleting substances in South Australia according to the Montreal Protocol, which sets the targets shown in Table 1.2. The Montreal Protocol came into force on 1 January 1989 and has been signed by over 165 countries. It is considered one of the most successful environment protection agreements in the world, setting out a mandatory timetable for the phasing out of ozone-depleting substances.

What are the issues?

Ozone (O_3) occurs naturally in the stratosphere (upper atmosphere) at concentrations of tenths of a part per million. Although it forms a very small component of the atmosphere, it plays a vital role in limiting the amount of solar ultraviolet radiation that reaches the earth's surface. It is important to note that the ozone in the stratosphere is distinct from ground-level ozone. At ground-level, ozone is an air pollutant and contributes to smog over large cities.

The biggest contributors to stratospheric ozone reduction are chlorofluorocarbons (CFCs), chlorinated solvents, halons and methyl bromide. These chemicals were once widely used as refrigerants, aerosols, cleaning solvents, fire-fighting chemicals and fumigants.

Ozone-depleting substances began being released on a large scale when mass production of CFCs for refrigeration began in the 1930s. Emissions of ozone-depleting substances progressively increased during the twentieth century and began to upset the natural equilibrium of the processes that maintain the ozone layer. This caused a progressive thinning of the ozone layer in all areas of the globe, but most notably over Antarctica. This much-reduced ozone layer now allows more ultra violet radiation (UVR) to penetrate the atmosphere, with significant implications for human health and the environment.

Ozone depletion is not an irreversible problem and it appears that the achievements of the Montreal Protocol will result in the eventual recovery of the ozone layer. It is expected that the first signs of ozone recovery will be noticed in ten to fifteen years' time. Total recovery may occur as early as 2050, but could be delayed as long as 2100.

See also chapters on **Air Quality**; and **Climate Change.**

Aerosol spray cans

Table 1.2: Targets of the Montreal Protocol

Key ozone-depleting substances	Montreal phase-out dates	Australia's achievements
Chlorofluorocarbons (CFCs) Used in air conditioners, refrigerators, aerosols	Phase-out end of 1995	Phase-out end of 1995
Halons Used for fire-fighting	Phase-out end of 1993	Phased out
Methyl chloroform Used as a solvent	Phase-out end of 1995	Phased out
Hydrochlorofluorocarbons (HCFCs) Used in air conditioners, refrigerators, aerosols – short term replacement for CFCs	Freeze consumption beginning of 1996 35% reduction by 2004 65% reduction by 2010 90% reduction by 2015 Total phase-out by 2020	Phasing out at twice the required rate; 2004 target already met, will meet 2010 target by 2004
Methyl bromide Used for fumigation	Freeze in 1995 at 1991 base level 25% reduction by 1999 50% reduction by 2001 70% reduction by 2003 Total phase-out by 2005	Phasing out at required rate

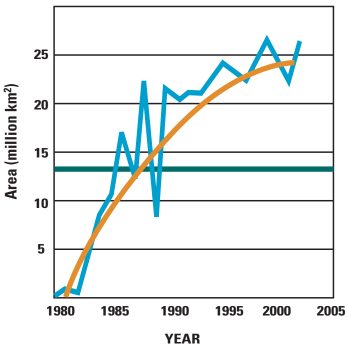
Source: Environment Australia in Manins et. al., 2001

1 Atmosphere

KEY FACTS

- **The concentration of ozone-depleting substances in the atmosphere above Australia is declining.**

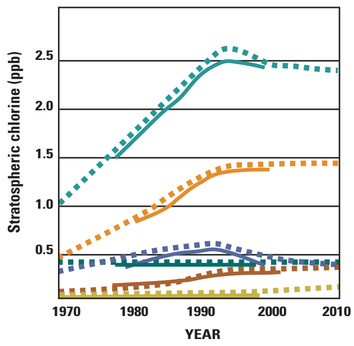
Figure 1.11: Ozone hole area (October 1–15 average) – 1980–2001



- The area of the Antarctic continent
- Trend line
- Area of ozone hole

SOURCE: MANINS ET. AL., 2001

Figure 1.12: Stratospheric chlorine levels (ppb) from the major ozone-depleting substances recorded from Cape Grim, Tasmania



- Montreal Protocol Scenario
- Atmospheric Data

- Total
- CFC's
- Solvents
- Methyl Bromide
- Halons
- HCFCs

Notes: Fig 1.12 compares chlorine level measurements at Cape Grim in Tasmania with a scenario that depicts concentrations assuming global compliance with the Montreal Protocol.

SOURCE: MANINS ET. AL., 2001

Findings

Making progress

Australia is either on target or ahead of schedule for the phasing out of all ozone-depleting substances under the Montreal Protocol.

With continued adherence to the Protocol by participating nations, it is possible that ozone levels may have fully recovered within 50 years, although some predictions forecast it may take up to 100.

What more should we be doing?

The Environment Protection Authority recommends that:

1.7 The State Government continues to assist in meeting the national targets set out under the Montreal Protocol through regulatory and administrative measures that complement those at the Commonwealth level.

Environmental indicators

CONDITION INDICATOR

- Stratospheric ozone concentrations (reported on in the *State of the Environment Report 1998*)

Stratospheric ozone provides protection from harmful UV radiation for all life on the planet.

PRESSURE INDICATORS

- Concentration of ozone-depleting substances in the atmosphere (reported on in the *State of the Environment Report 1998*)

Increases in the concentrations of these chemicals accelerate the destruction of ozone.

- Effective ultraviolet radiation (UVReff) levels at the surface (reported on in the *State of the Environment Report 1998*)

This measurement demonstrates the impact of ozone depletion and is related to increases in incidences of eye damage, skin cancer and immune system disorders.

What is the current situation?

CONDITION INDICATOR: Stratospheric ozone concentrations

Ozone levels in the upper atmosphere, or stratosphere, over Australia are measured at Macquarie Island, Melbourne, Perth, Brisbane and Darwin. Since the late 1970s, data from Melbourne and Perth show ozone decreases during summer of between 3 to 4% per decade. The data also shows, however, that the rate of ozone depletion was relatively slower in the 1990s compared to the 1980s (Figure 1.11).

It is not yet possible to determine whether the ozone hole has reached its maximum size, as there is considerable difference in its size from year to year. However, it is suspected that it will not grow much larger. The trend line in Figure 1.11 illustrates this, with the rate of increase in the size of the ozone hole appearing to level off in recent years.

It is expected that the first signs of ozone recovery will be noticed in ten to fifteen years. Total recovery may occur as early as 2050, but could be delayed as long as 2100 due to slow compliance by some countries with the Montreal Protocol and the influence of climate change. The greenhouse effect is expected to result in a cooler upper atmosphere over the next century – ozone depletion is accelerated in cooler conditions (Manins et. al., 2001) (see chapter on **Climate Change**).

PRESSURE INDICATOR: Concentration of ozone-depleting substances in the atmosphere

Measurements of concentrations of ozone-depleting substances over Australia are made at Cape Grim in north-west Tasmania. The data indicates that, on the whole, concentrations of ozone-depleting substances slowed in the early 1990s and began to decline gradually in the mid 1990s (Figure 1.12). The graph compares chlorine level measurements at Cape Grim in Tasmania with a scenario that depicts concentrations assuming global compliance with the Montreal Protocol (Manins et. al., 2001).

Levels of some CFCs, halons and hydrochlorofluorocarbons (HCFCs) have continued to grow in the background atmosphere, remote from human or volcanic influences, due to their expanding use in the developing world and the continued emission from large 'banks' (such as old refrigerators or solvents) in the developed world (Manins et. al., 2001).

HCFCs are short term replacements for CFCs, halons and chlorinated solvents under the Montreal Protocol. Although containing chlorine, they break down more rapidly and have a lower ozone-depleting potential.

PRESSURE INDICATOR: Effective ultraviolet radiation (UVReff) levels at the surface

Over the last 30 years, since ozone depletion was first noticed over Antarctica, research has shown that there is a direct relationship between decreasing levels of ozone and increasing levels of harmful UV-B radiation on clear days (Manins et. al., 2001).

UVReff is closely related to UV-B, but is considered a more accurate indicator for assessing the biological effects of ultraviolet radiation (UVR), as wavelengths outside of the UV-B range also have an impact on human health.

It is not possible to determine the precise impact of ozone depletion on levels of UVR in Adelaide. However, since 1980, UVR levels in tropical Australia have increased by 4% as a consequence of ozone depletion and decreases in cloud cover, while UVR levels in southern areas, such as Adelaide, have remained static or decreased slightly, largely due to increases in cloud cover.

What impact does ozone depletion have?

Some of the environmental, social and economic effects of ozone depletion are listed below, to illustrate the broader significance for sustainability.

Impact on plant growth and productivity. UV-B radiation can affect plant growth and productivity. Plants have the ability to handle a single stress such as increased UV-B levels, however, when this is combined with another stress such as warming as a consequence of the enhanced greenhouse effect, as many as 25% of plants may be affected (DELM, 1993).

Impact on the marine food chain. Phytoplankton are microscopic plants that form the basis of the marine food chain. These are particularly susceptible to increases in UV-B radiation. Reduced phytoplankton numbers would significantly affect other marine species, including commercial fish stocks (DELM, 1993).

Human health. At high exposure levels, the UV-B component of UVR can weaken the human immune system and cause skin cancer, cataracts and eye cancer. Increased levels of UVR will contribute to rising incidences of skin cancer. Australia has high levels of UVR and the highest per capita rate of melanoma in the world (AIHW, 2001). The economic cost to the Australian community of skin cancer alone is estimated at approximately $300 million per year (Mathers et. al., 1998).

Deterioration of materials. Increased UV-B radiation can accelerate the deterioration of plastics, wood, paper, cotton and wool (Manins et. al., 2001).

What are we doing about it?

The **Montreal Protocol** came into force on 1 January 1989 and has been signed by over 165 countries. It is considered one of the most successful environment protection agreements in the world, setting out a mandatory timetable for the phasing out of ozone-depleting substances.

Australia's obligations under the Montreal Protocol are implemented via complementary legislation and policy developed by Commonwealth, State and Territory Governments. Environment Australia is responsible for coordinating national ozone protection measures and administering relevant legislation.

The **Commonwealth *Ozone Protection Act 1989* and Regulations** govern the production and import of ozone-depleting substances at a national level. This legislation currently does not cover the storage, sale or use of ozone-depleting substances, which is regulated at State level. In South Australia this requirement is met by the **Environment Protection (Ozone) Regulations 1994.**

A review of the Commonwealth legislation has been conducted and it is anticipated that legislation will be introduced in 2003/04 to cover the storage, sale and use of ozone-depleting substances and also to regulate the HCFCs that were introduced as temporary substitutes for ozone-depleting substances. This legislation will take over many of the functions of ozone legislation at State level.

As of September 2002, South Australia had deposited 181 tonnes of halon with the Department of Administrative Services Centre for Environmental Management's (DASCEM) **National Halon Bank**, a facility developed to destroy halon and maintain Australia's supply for essential purposes (such as fire extinguishers for aircraft or submarines). This is an increase of approximately 11 tonnes since the *State of the Environment Report 1998*. It is believed that little halon remains in circulation. Halon is a gas with high ozone-depleting potential and was previously frequently used in fire extinguishers.

South Australia banned the manufacture and import of CFCs on 1 January 1996; manufacture and importation past this date is allowed for 'essential uses', such as asthma inhalers.

For more information on programs and initiatives see the *State of the Environment 2003 Supplementary Report*.

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Further information

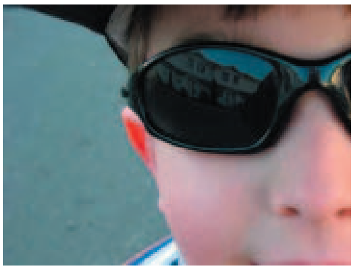
Environment Australia's Ozone Program
www.ea.gov.au/atmosphere/ozone/index.html

The Montreal Protocol
www.unep.ch/ozone/montreal.shtml

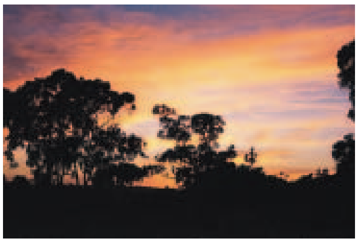
United Nations Environment Program (UNEP) activities relating to ozone
www.unep.org/themes/atmosphere

KEY FACTS

- **It is expected that the first signs of ozone recovery will be noticed in ten to fifteen years.**



Research has shown that there is a direct relationship between decreasing levels of ozone and increasing levels of harmful UV-B radiation on clear days



Skyline Murraylands, South Australia
Photo: South Australian Tourism Commission

Port Elliot Beach